PRODUCTIVITY AND QUALITY MANAGEMENT:

A MODULAR PROGRAMME

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Glossary
Why productivity and quality?

For many years, productivity has been a key issue for all governments and companies. This is because of the impact of productivity on economic and social development and its importance as a source of income and an integrative objective, encompassing as it does improved labour-management cooperation, workers' participation, the criteria for enterprise competitiveness and the formulation of a long-term strategy for governments, employers and employees in alleviating poverty and promoting human rights and economic democracy. It is a well-known fact that the most productive companies and government productivity-oriented policies are strongly committed to the promotion of a better quality of working life, participation, market economy principles, individual initiative and creativity, and human-oriented management styles and practices.

This concern for quality is important because quality is an essential part of productivity, indeed its major factor, particularly when we think about not only the quality of products but also the quality of all business and production systems and elements - strategy, organization, people, technology, processes, etc.

Productivity and quality objectives, when accepted by all parties concerned, become the important instrument of an equitable distribution of wealth, sound industrial relations and democratic workers' participation. Productivity is also the best measure for balancing efforts between different economic, social, technical and environmental objectives.

**Productivity and poverty alleviation.** There is strong macroeconomic and statistical evidence that the more effective (productive) the national economy, the higher the personal income of workers and the lower the rate of inflation in the long term - and also a larger share of the national income is available for social distribution to those who are young, old, handicapped or unemployed. Higher productivity and quality also provide more profit for investment to promote enterprise development and economic growth in underdeveloped regions. Therefore, high productivity packaged with good distributional policy is the best available means for poverty alleviation.

**Productivity and the promotion of employment.** Long-term international statistical trends show that there is a close correlation between national productivity and the level of unemployment. The more productive an economy, the more competitive it is in the foreign market and the lower the unemployment rate. The more productive an enterprise, the more income it can save for new investments and therefore create new jobs. Short-term effects of productivity on unemployment growth can be countered by sound economic and social policies and measures. Therefore, productivity is not only the best indicator of where to invest and create more jobs, but also the source of funds for new job creation and for redeployment.

**Productivity, participation and tripartism.** Economic democracy can be exercised through promoting entrepreneurship, self-employment, small enterprise development and participation so as to provide opportunities for everyone to set up their own businesses, start an individual activity, or participate more actively in decision-making. These numerous undertakings can survive only on the basis of higher productivity, providing a political and institutional environment enabling tripartism to be exercised as part of economic democracy.

The most important objective of tripartism is a more effective and peaceful organization of economic and social activities, as well as participation and the sharing of gains between major
economic agents. Therefore, productivity improvement as the main source of income could be the main and common objective of tripartism.

**Productivity and quality of working life.** The promotion (or imposition) of certain norms and labour standards to improve the quality of working life, without taking into account the competitiveness and productivity of enterprises, could result in additional costs, often prohibitive, leading to a reduction in competitiveness which in turn would lead to the deterioration of working conditions, the closure of enterprises and job losses. This is particularly so in developing countries and economies in transition.

In practice, very few companies promote high labour standards if to do so threatens the firm’s existence.

A sure way of promoting labour standards and a better quality of working life is to promote them in a package with measures for productivity improvement. First of all, if it can be proved that introducing certain standards would result in better labour productivity, they would be more eagerly and voluntarily accepted by employers. Secondly, productivity growth could provide a more sound financial framework for introducing more demanding labour standards without undermining competitiveness.

**Productivity and human resource development.** The philosophy which values human resource development as the most important productivity factor would also consider labour standards and norms as a means and framework for further development within the productivity improvement package. Therefore, productivity movement and productivity objectives, if properly introduced into company-level and country strategies, have a high potential for promoting the quality of working life and human resource development.

**Productivity and sustainable development.** Sustainable development is increasingly becoming a major issue in national and enterprise-level development strategies. In assessing the impact of industrial growth on sustainable development, it is important to identify activities which have environmentally negative effects. Today, those countries which have drastically reduced their specific energy and material consumption are also at the top of the international economic performance table.

Because of the serious environmental results of overtaxing the ecosystem, the efficient use of resources ("materials productivity") has become a major new strategy for achieving sustainable development.

In the broad sense, sustainability means that the input of raw materials and energy into an economy and the output of waste materials and heat must be within the regenerative and absorptive capacities of the ecosystem, and that development must meet the needs of the present without compromising the ability of future generations to meet their own needs. Therefore, it is evident that there are close positive links between productivity and sustainable development.

Productivity in its broad sense is a measure of how efficiently and effectively resources are used as input to produce the output of products and services of the quality needed by society in the long term.
The International Labour Organization and productivity

Created in 1919 by the Peace Treaty of Versailles along with the League of Nations, of which it was an autonomous part, the ILO’s mandate is to promote social progress through harmonious economic and social development. It assists in working out and implementing development policies and strives to ensure that fundamental human rights are protected.

The ILO supports all efforts aiming at raising living standards, protecting the safety and health of workers, increasing productive employment and promoting cooperation between governments, employers and workers. The ILO’s tripartite structure makes it unique among international organizations. From this point of view it would be right to state that the ILO’s objective is to help to create economically efficient and human-oriented peaceful societies.

The ILO’s view on productivity is reflected in the resolution concerning the contribution of the ILO to production and productivity improvement, adopted by the International Labour Conference in June 1984. No longer does the term “productivity” bring to mind long shifts and exhausted assembly-line workers slaving away under dehumanizing conditions. The resolution says that “... as a basic principle ... production and productivity improvement must serve the well-being of the people”. In fact, without this fundamental condition, there would be no long-term productivity improvement.

In the 1950s and 1960s, the ILO’s activities in productivity were centred on industrial engineering and the better organization of shop-floor operations. Later, its activities were widened to embrace other functions and problem areas of the enterprise and higher management levels. In the 1970s small enterprise development began to receive increased attention. In the mid-1980s more thought was given to structural adjustment and privatization as a main macroeconomic condition for productivity enhancement in countries with old industrial structures or central planning domination.

Over the past 40 years the ILO has been assisting developing countries in management development and the promotion of small enterprises in support of their efforts to attain their economic and social goals, and in the improvement of productivity. This assistance has resulted in the establishment of national productivity centres and related organizations as focal institutions in over 80 countries, and the introduction of several thousand training and consulting programmes and assignments. With this large pool of experience and expertise, the ILO is today assisting governments, employers and workers in their efforts to enhance productivity in the following ways:

- productivity and quality improvement advisory services, including needs surveys, the analysis of productivity problems and barriers at the national, sectoral and enterprise levels;
- management development, design and implementation procedures and techniques for the measurement, improvement and sharing of gains from productivity, along with the publication of manuals, guides, training programmes and conceptual monographs on productivity management and improvement; and
- building/strengthening productivity networks and institutions to serve as focal points for productivity promotion.

As a result, extensive experience and know-how in the development and implementation of productivity improvement methods have been accumulated, and the ILO has achieved international recognition in this field.
The ILO’s present activities also cover other aspects of productivity, placing more emphasis on macroproductivity: linking productivity with structural adjustment and privatization, the quality of working life, industrial relations, labour standards and poverty alleviation, and promoting productivity growth as a main national objective in order to help to solve the most urgent social and economic problem of the day. As can be seen, from being a purely technical problem, productivity is becoming a global economic, social and multidisciplinary policy issue, and we feel that not only cooperation but also close integration with our partners in the field are critical for future success.

Asian Productivity Organization and productivity

The Asian Productivity Organization (APO) was founded in 1961 to synthesize efforts of individual productivity movements and to promote the improvement of productivity and subsequently, accelerate the economic development in the Asia-Pacific region.

A unique feature of APO is its close relationship with the National Productivity Organizations (NPOs) which are either branches of the government or statutory bodies established by legislation to promote productivity within our 18 member countries. APO, in collaboration with NPOs, has contributed significantly to promoting the concept and techniques of productivity.

During its thirty-five years of existence, APO’s program strategies have evolved through distinct phases, reflecting the development in Asia and the Pacific region. In its formative years, the emphasis of APO was on the rationalization at the enterprise level, especially among small- and medium-size industries. In the 1970s, the scope of the APO programs expanded into management consultancy, quality control circles, technology transfer, energy management, and agriculture. By the 1980s, APO programs emphasized the importance of developing positive macro-micro linkages to foster a policy environment conducive to productivity enhancement. And in early 1990s, with the fundamental changes occurring worldwide, APO has been taking an interdisciplinary approach in the following areas: potential of agro-industry, expanding world trade, need for international competitiveness. Furthermore, in order to pursue the sustainable socio-economic development of the world without destroying the environment, APO is promoting the idea of Green Productivity which aims at instituting cleaner production systems in the process of increasing productivity.

In concrete terms, APO programs cover an extensive range of activities: environmental protection, quality management, human resources development, small and medium industries development, productivity measurement, information technology, agricultural resources management and technology, agro-industrial management, and rural development, and the organization functions as a think-tank, catalyst, regional adviser, institution builder, and clearing house of productivity information.

The recent trend in globalization and market friendly economic policies has resulted in the emergence of a highly competitive and complex business environment. In this regards, productivity and quality improvement has assumed a new sense of urgency to gain competitive advantage. This calls for a cadre of productivity specialists in the pursuit of higher productivity. APO recognizes from its onset that without the willing and efficient people, the most wonderful work system, comprehensive policies, and even the state-of-the-art technology cannot be effective. The quality of the human resources ultimately determines productivity. The enhancement and
empowerment of such quality can be facilitated through education and training programs to develop the new skills required for different assignments and requirements.

In the light of this, at a Workshop of Head of NPOs, it was suggested that in order to strengthen the core competence of NPOs, it is imperative to develop the needed human resources development capabilities within NPOs.

This Modular Programme on Productivity and Quality Management is one more, and the latest, contribution towards the promotion of effective, efficient, ecologically sustainable and human-oriented development.

Twenty-seven internationally recognized authors from Australia, Austria, Belgium, Canada, Germany, Japan, India, the Netherlands, the Philippines, Sweden, Switzerland, the United Kingdom and the United States, with considerable experience in productivity and quality management, have helped the ILO to prepare this Modular Programme. They include practising management consultants, researchers, professors and lecturers in university and business schools, experts specializing in business matters, and officials of employers’ organizations and international agencies.
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HOW TO USE THE MODULAR PROGRAMME INTRODUCTION AND GUIDE
INTRODUCTION AND GUIDE

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Bibliography
1. Introduction to the Modular Programme on Productivity and Quality Management

1.1 Objective of the Introduction and Guide

The objective of this Introduction and Guide is to explain:
- the modular approach to productivity and quality management;
- how to adapt the Modular Programme to specific enterprise conditions and training needs;
- how to define enterprise development problems and individual training needs;
- how to use the Modular Programme in designing tailor-made programmes; and
- how to organize and conduct a training and development programme.

1.2 Main target groups

This Modular Programme on Productivity and Quality Management is intended for:
- senior and middle-level line and functional managers;
- Company management trainers and programme designers;
- human resource management and development specialists;
- management consultants, advisors and members of management service units dealing with productivity and quality improvement; and
- teachers in external management education institutions and business schools.

1.3 The essence of productivity and quality management

Productivity and quality are two of the most important and closely interlinked objectives of enterprises and are indicators of their performance. And, like any other result of human endeavour, they are achieved through the well-planned, well-organized, well-managed and concerted efforts of everyone in the organization. Productivity and quality improvement should be an organization-wide concern in which everyone at all levels and in all units and departments participates and in which he or she contributes to the achievement of clearly defined improvement targets through involvement in the implementation of coordinated strategies and programmes.

Productivity is the efficient and effective use of resource - labour, capital, land, materials, energy, time, information, etc. - in the production of goods and services that meet users' needs and requirements. As an efficiency measure, high productivity implies that production inputs are fully utilized and that waste is minimized. Effectiveness, on the other hand, means that outputs (and activities and processes) contribute to the attainment of the organization's specific goals, whether these be meeting customers' needs and giving them satisfaction, the achievement of business aims or a contribution to attaining the social, economic and ecological objectives of society. Productivity therefore means creating more value for consumers, workers, employers, enterprise owners and society at large from the processes and resources employed in the production activities of the organization.

This broad concept of productivity reveals its close links with quality, which measures the degree to which the products or services (or business operations and systems) meet the standards, specifications and/or expectations generated by their nature, properties, functions, performance,
costs, etc., and relating to their intended use and application. Productivity improvement involves the use of high-quality resources and processes to produce outputs that are of constant or better quality. Improved quality should therefore mean improved productivity; and improved productivity means improved quality.

Improved productivity and high quality do not happen by accident or by chance, however. They are the result of a conscious, deliberate and managed process: productivity and quality management. Bottlenecks and possible areas for improvement must always be identified, productivity improvement targets and the desired quality levels must be set, and the plans and strategies for their attainment must be prepared. The organizational systems and operating environment necessary to encourage a continuous search for improvement must be developed, the attitudes and competencies of everyone in the organization must be built up through proper training and human resource management, and the mechanisms for organization-wide involvement and participation must be put in place. Productivity and quality improvement programmes must be implemented, and constant monitoring and evaluation of productivity and quality achievements must be undertaken, thus making it possible to identify the areas where additional improvements can be made. In short, there must be a productivity and quality management system if continuous improvement is to be attained.

This Modular Programme for Productivity and Quality Management shows you how to do this.

1.4 Why choose a Modular Programme?

1.4.1 From standardized training to flexible development

There are two major approaches to management training and development: knowledge/standardized and flexible/results-oriented. If the first (standardized) approach is generally used for initial management education in business schools and management institutions and is traditionally function-oriented, with the objective of giving a broad view of management as a whole, the second (flexible, results-oriented) is aimed at improving the performance of the jobholder.

The trend is now towards a move from the first to the second approach. More and more companies are looking on management training and development as an investment, and good businessmen normally invest in what is required for their business to be successful. They need managerial productivity as well as capital and workers' productivity. This trend is the result of the following dramatic changes in business and managerial practices in the recent past:

- the spread of structural adjustment processes, resulting in more privatization, deregulation, decentralization and delegation;
- economic internationalization, even for small and medium-sized companies;
- increased flexibility of products, technologies and labour markets;
- quality and productivity: the creation of new markets becomes an important strategic objective;
- the organizational structure is "flatter", matrix, fragmented and profit-oriented. Large companies become leaner and tend to decentralize;
“horizontal” management becomes more important than “vertical” management; management practice promotes innovation, creativity, self-direction, cross-cultural skills, risk-taking and a long-term orientation, and shifts from a bureaucratic to an entrepreneurial style of management; and human resources and talent are considered the most important productivity factors and investment items.

These trends and changes require a less functional, standardized attitude towards management training and development and a more flexible, results-oriented approach in order to train and invest as much as is necessary to solve the enterprises’ present and future (expected) problems and to improve the productivity and quality of products and services, as well as to increase client satisfaction.

Thus, moving from vertical (functional) management to horizontal (integrative) management calls for different management skills, attitudes and conceptual knowledge.

However, in addition, productivity and quality themselves require a horizontal, across-the-board approach, since they are the result of a balanced and optimized integration of the activities of all organizational functions and elements. None of them are important any more on their own. They are important only in their totality and integration.

This explains why the ultimate beneficiaries of this Modular Programme are managers who are in a position to integrate functions and separate organizational elements. It also explains why we need a modular approach: we can achieve integration when we start to integrate different functions, such as R & D, product development, marketing, production, etc., around the final objectives: high productivity, high quality of products and services, and client satisfaction.

To achieve these objectives, the traditional textbook approach built around functional logic is no longer valid.

1.4.2 The modular approach

In the Modular Programme we provide relatively independent and self-contained knowledge/skills blocks which can be put together in any combination by a programme designer, manager, trainer or consultant to provide know-how, for example, or to show how to identify and analyse problems, how to make decisions, how to improve productivity and quality, etc.

We call these blocks modules.

The module is a set of structured items of information on knowledge and skills for certain well-defined areas of managerial activity. It is normally self-contained and gives sufficient information for the user to understand or master certain homogeneous and independent managerial components or job tasks.

For example, the area of productivity and quality can be broken into self-contained blocks of information (figure 1), for each of which a training module can be produced.

Each module in its turn is further subdivided into learning elements (normally four to six),
which we call units. These blocks are relatively independent and may be used in any order the designer considers relevant to enterprise development and individual training objectives.

**Figure 1: The modular approach**

**Programme:**

<table>
<thead>
<tr>
<th>Productivity and Quality Management</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Modules:**

1  2  3  ...  22  23

**1.4.3 The advantages of the Modular Programme**

Among the advantages of the Modular Programme the following are particularly important:

- it is flexible and results-oriented, and easily adjusted to specific company problems and training needs;
- it can be used to upgrade existing training programmes;
- it reduces the cost of preparing tailor-made training materials;
- it decreases dependence on personal and other biases, including the level of trainer competence;
- it simplifies the compilation and adaptation of tailor-made programmes;
- it introduces consultancy activities as an integral part of enterprise growth and human resource development;
- it facilitates the upgrading of trainers’ and consultants’ skills; and
- it can be used for self-development.

**1.5 Structure of the Modular Programme**

The Modular Programme covers the most important body of skills and knowledge required for the management and activities of productivity and quality improvement, including:

- conceptual issues dealing with productivity and quality;
- productivity improvement programmes (PIP);
- productivity improvement tools and techniques; and
- high potential productivity areas.

The Modular Programme is broken down into two major parts (figure 2).

**Figure 2: The framework of the Modular Programme**

- **Part I:** Productivity and Quality Improvement: Concepts, process and techniques
- **Part II:** High Potential Productivity and Quality Improvement Areas
INTRODUCTION AND GUIDE

Part I answers the following questions: What are productivity and quality? What are their importance and roles? What are the major productivity and quality factors? How can we improve productivity and quality?

Part II answers questions about the most important potential areas where there is great scope for productivity improvement.

Thus in Part I the reader will find specific information, grouped in 12 modules as shown in figure 3. This information provides the reader with concepts and definitions of productivity, together with its main roles and importance in economic and social development as well as in enterprise growth and human resource development. The most important factors influencing productivity and quality levels are linked with the productivity improvement process; some important productivity instruments, such as TQM (Total Quality Management), industrial engineering, financial and cost analysis, change management, organizing a productivity movement, developing a productivity and quality culture, etc., are explained in detail.

Notwithstanding productivity and quality, management is an integrative concept and process that should cover all (1) organizational elements and areas. We think it useful, therefore, using practical experience and statistical evidence, to provide some advance indication of where to look for productivity reserves, and what are the key potential areas for productivity improvement programmes to concentrate on in order to avoid wasting time and resources.

Our analysis enables us to suggest the most important areas for examination, where between 80 and 95 per cent of all productivity and quality improvement potential is likely to be found (provided that the business mission and strategies are right).

These areas constitute the eleven modules in Part II (figure 4).

Figure 3: The contents of Part I

| Part I: Productivity and Quality Improvement: Concepts, process and techniques |
|---|---|
| 1. Organizational excellence and productivity culture |
| 2. Productivity and quality factors and barriers |
| 3. Diagnosing productivity and quality problems |
| 4. Productivity measurement and analysis |
| 5. Designing a company PIP |
| 6. Implementing a company productivity improvement programme (PIP) |
| 7. Organizing a company P&Q movement |
| 8. Managing organizational change |
| 9. Total quality management |
| 10. Industrial engineering techniques |
| 11. Financial and cost analysis |
| 12. Capital productivity management |
Here the reader can find information on how to identify, uncover and make better use of company resources hidden in human resource management areas (training, motivation, participation), innovation, product and work design, production, materials and energy management, the productivity potential in information technology and improving office management, etc.

Integrating these modules from Part I and Part II gives the complete package of the Modular Programme for Productivity and Quality Management (figure 5).

The user can easily and quickly identify the subject area and the relevant module or block of modules needed to compile a tailor-made programme tuned to specific enterprise conditions to meet identified individual training and organization development needs.

1.6 The contents of the modules

Each module contains structured course material which enables a user to learn one relatively homogeneous element of the productivity and quality improvement process. Each module is written in such a way as to provide information and learning materials for:

- learning concepts and acquiring knowledge of the subject-matter; and
- mastering skills to use the subject-matter practically.

This is achieved by combining structural information and materials on what to do in certain areas (concepts and knowledge) and why, and explaining how to do it. The latter information is supplemented by a number of exercises and case studies to develop the user’s practical ability.

For easy orientation, each module is broken down in a few learning units (normally four to six, depending on the complexity of the subject-matter). As a rule the first units deal with the conceptual background and the others with the practical implementation of these concepts.
Figure 5: Contents of the Modular Programme

The Modular Programme: Productivity and Quality Management

How to use the Modular Programme: Introduction and Guide

| Part I: Productivity and Quality Improvement: Concepts, process and techniques |
| Part II: High Potential Productivity and Quality Improvement Areas |
| 1. Organizational excellence and productivity culture |
| 2. Productivity and quality factors and barriers |
| 3. Diagnosing productivity and quality problems |
| 4. Productivity measurement and analysis |
| 5. Designing a company PIP |
| 6. Implementing a company productivity improvement programme (PIP) |
| 7. Organizing a company P&Q movement |
| 8. Managing organizational change |
| 9. Total quality management |
| 10. Industrial engineering techniques |
| 11. Financial and cost analysis |
| 12. Capital productivity management |
| 13. Developing human resources |
| 14. Productivity motivation and Gainsharing |
| 15. Industrial relations and participation for productivity improvement |
| 16. Innovation management and new technologies |
| 17. Work organization and design |
| 18. Production management |
| 19. Materials management |
| 20. Using energy efficiently |
| 21. Productivity by maintenance |
| 22. Information management |
| 23. P&Q in the office |

Therefore, at the beginning of each module the user finds a list of the main learning objectives of the module, describing what the learner should master and be able to do after going through it, as well as where to locate the necessary materials within the module. At the end of the module users will also usually find a list of bibliographical sources and references for expanding their knowledge of the subject-matter.

Thus the standard module framework is as shown in figure 6.

Figure 6: A typical module framework

Module learning objectives and contents

- Unit 1
- Unit 2
- Unit 3
- ...
- Unit N
(Bibliography)
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Every unit conforms to the following standard pattern:

- unit learning objectives and contents;
- the main body of the unit, with materials on concepts and their practical application in certain areas of productivity and quality management;
- practical exercises and/or case studies, where relevant; and
- questions for discussion to check that the material has been assimilated and to discover new information about the subject-matter that is particularly related to the user company’s own situation.

2. How to use the Modular Programme

2.1 Objectives of the Modular Programme

Now that you are familiar with the structure and contents of this Modular Programme, it is time to start thinking about how to use it for practical management training and development.

The first warning is as follows:

Do not consider this Modular Programme as a textbook for education, as a finished product and as the last word on productivity and quality improvement. It is not, because:

- it is impossible to put everything into one programme or publication;
- Productivity and Quality Management is an innovative, creative and continuing process, and while you are reading these lines something new is emerging somewhere in these areas; and
- a universal programme which meets different cultural and company conditions, problems and individual training needs perfectly does not exist and probably never will. This is because all society cultures are different, people are different, enterprises are different and the gaps between people’s attitudes and abilities and company/job demands are different.

Therefore, the main objective of the Modular Programme is as follows:

- to develop managerial capabilities in productivity and quality improvement processes by improving training, learning and consulting in these areas.

The more immediate objectives of the Programme are:

- to serve as a framework and background for designing tailor-made productivity and quality improvement programmes to meet the specific needs of enterprises and their managers;
- to provide basic training and learning materials which can be easily adjusted and/or directly used, when training and development needs do not require essential changes;
- to serve as a manual for management self-development; and
- to reduce the cost and increase the efficiency and effectiveness of the tailor-made programmes.
Thus, the Modular Programme should be considered not as a Bible in productivity and quality improvement, but as an aid to managers, trainers and consultants.

The best and the most efficient way to use the Modular Programme is to adjust the materials to the specific problems, conditions and managerial training needs of the enterprise.

To make these adjustments you will need to take into account:

- the type of enterprise (mass or small-scale production);
- its competitive position;
- the size of the enterprise;
- the technology used;
- the type of organizational structure;
- the organizational culture and management style;
- the local culture and traditions;
- specific company problems, both at present and anticipated, and the reason for taking up the productivity and quality improvement programmes;
- the specific management training and development needs; and
- anything else? You decide!

2.2 Programme adjustment

Typically, the major steps of the programme adjustment process would be as follows (see also figure 7).

1. Study and understand the framework, contents, materials layout and potential of the Modular Programme.
2. Identify the enterprise's problems and its management training and organization development needs.
3. In accordance with the training and development needs, choose the appropriate set of modules.
4. To achieve the best alignment of your programme with the identified training and development needs, select the relevant set of units from each module chosen.
5. If items 3 and 4 above seem rather unoriginal exercise to fit the available materials to the identified problems and needs, you now have to be more creative and provide your own contribution if and when necessary. This means that you must review the training package you have put together and check the gaps between the package learning materials and the enterprise's problems and management training needs that you have identified. Make sure that you fill the remaining gaps with your own materials, cases, examples and, if necessary, concepts not mentioned in the Modular Programme.
6. Decide on the training methods and techniques that would be most appropriate for the tailor-made programme materials that you drew upon in item 5.
7. Plan how you will organize the learning process, evaluate the available and obtainable training equipment and facilities, make sure that you get proper trainers and/or consultants if you cannot yourself cover all the subjects selected, and involve line and functional managers as resource persons.

The rest of the Guide will be devoted to illustrating the above adjustment process elements
in detail, other than item 1 (understanding the module), which was described earlier in the Introduction section of this Guide.

2.2.1 Selection of learning materials from the modules

As an example, let us assume that the most urgent training needs happen to be as follows: understanding productivity; practical skills in problem diagnosis; quality control techniques; materials management; and energy management problems.

You now have sufficient information to choose the right set of modules from which to extract the relevant training materials. The Modular Programme contents list (figure 5) will help you to do this.

Having selected the most suitable modules, examine the learning elements within each one, and from these choose only those which exactly correspond to your needs. Some slight overlapping is inevitable, and may be beneficial, but be sure to cover all the really important training and organization development needs.

2.2.2 A tailor-made training package

Now that you have made your selection of the training materials which most closely meet your training needs, you have assembled your basic training materials.

However, to make them even more effective you should adjust them to your country’s economic, social, political and cultural environment and to the specific technological and microsocial conditions and training needs of your enterprise or department. What do we mean by “adjusting the material to specific conditions and training needs”? Remember that the Modular Programme is a basic programme which contains training materials relevant to many different cultural, sectoral and technological conditions. But only occasionally can it fit any given specific training need without adjustment.

There are several steps in adjusting a selected set of training materials to specific conditions:

1. Replace our practical examples and case studies with your own, taken from your organization’s experience, or adapt them so that they correspond reasonably closely to your organization’s practice.
2. Go through all the examples and replace them or make them look as though they could have been taken straight from your own enterprise’s environment.
3. Examine the training material and especially any examples which deal with other countries’ human and industrial relations aspects, since there could be tremendous cultural, traditional, social, political and other differences as well as legislative and institutional divergences.
4. You may need to alter the balance of material given in a module or unit in order to meet specific training needs or circumstances.
5. Make sure you have sufficient copies of the learning text for distribution to the trainees as handouts.
6. Review your training methods and techniques in accordance with the changes you have introduced into the trainee’s learning text. Make sure that you have checked your training
equipment and facilities in accordance with the revised training methods.

The complete process of module adaptation is shown diagrammatically in figure 7.

The most critical step in the adjustment process is the assessment of training and development needs. However, before we discuss this part of the process we must determine what a flexible, results-oriented training system means.

**Figure 7: The Modular Programme adjustment process**

- Identifying management training needs
- Choosing the right set of modules
- Choosing the right set of units
- Adjusting the training package
- Your tailor-made training package
- Select training methods & techniques

### The Modular Programme

- M-1
- M-2
- M-3
- M-4
- M-5
- M-6
- M-7
- M-8
- M-9
- M-10
- M-11
- M-12
- M-13
- M-14
- M-15
- M-16
- M-17
- M-18
- M-19
- M-20
- M-21
- M-22
- M-23

### Adjustment process

- U-1
- U-2
- U-3
- U-4

### An example of identified needs

- (1) Understanding productivity
- (2) Practical skills in problem diagnosis
- (3) Quality control techniques
- (4) Material management
- (5) Energy management problems

### Your tailor-made training package

- Design your own case studies or adjust those which are in the modules
- Give more examples from your enterprise and its environment
- Put your national cultural and social background into the learning materials
- Replace the examples on legislation or traditions with those existing in your country, sector or enterprise
- Change the proportion between different learning materials if necessary

Your programme is ready.

A - 12
3. **Identification of management training and organization development needs**

3.1 **Flexible, results-oriented training system**

The implication of this system is that training programmes should change as often as the training and development needs change. The learning process aims at filling the gap between present and future organizational needs and human professional and attitudinal capacities to carry out the jobs productively and with the required quality.

Thus, whereas a standardized training system aims at improving and expanding knowledge and skills in accordance with a standard programme, the flexible, results-oriented training system aims at solving specific organizational tasks and improving productivity and quality.

As can be seen from the model (see figure 8), the first stage is the assessment of training and development needs. This assessment provides the most important information for designing training and development objectives. Omitting to assess the needs inevitably leads to setting the wrong objectives and designing (or purchasing) programmes that miss the target. From this management development cycle it is easy to see why it is necessary to assess the needs carefully. It helps:

- to decide whom to train, and what to change and develop;
- to decide on contents and methods of the management development programme;
- to decide what resources are needed for cost-effective training;
- to decide on the future strategic development of the business school (policies, programmes, faculty, markets, resources, etc.); and
- to improve managerial competence and performance.

The detailed sequence of steps in assessing management and organization development needs is presented in figure 9.

In this model, the starting-point is not the individual managers but rather the existing (or potential) organizational problems, their urgency and their importance. The next step is to trace and identify the main causes and problem areas. Only step 4 to 6 in figure 9 deal with individual managers, at different levels and in different parts of the organization, who have “created” or influenced problems in some way. These steps enable us to concentrate our future development efforts exclusively on those individuals who are really the source of the problems, because they deal with the identification of their individual needs through performance appraisal, job analysis and comparisons with performance standards or expectations.

Finally, the last step is the separation of non-training needs from training needs and suggesting the appropriate training and non-training solutions. The latter could be translated into specific programme objectives and actions to meet development needs and organizational problems.

So where do we stand as regards results orientation and flexibility? Results orientation is built into the model by starting the needs assessment with an assessment of enterprise performance (productivity and quality) and problems and finishing with the feedback (training and development evaluation), based on a comparison with the practical results achieved in productivity and quality, not in skills and knowledge improvement.
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Figure 8: The flexible, results-oriented training and development system

The flexibility is based on the fact that there is no standardized programme - each new variation of the programme reflects identified enterprise problems and managerial training needs, which are changed often in reality.

This is the main reason for introducing the modular approach. There is no need to design a new programme from scratch every time: you use modules and learning units as building blocks to create the main tailor-made package and adjust it to your specific conditions, again using information from the problems and needs analysis survey.

Another interesting feature of this model is that if the training (impact on individual capabilities) and development (impact on organizational improvement) interventions are integrated with the total performance improvement, the results could be better organizational productivity and quality.

Within the framework of this results-oriented, flexible management training and development system, we shall now consider the important elements of the Modular Programme adjustment process.
3.2 Defining the gap between current and desired performance

The identification of current performance begins with fact-finding, which consists of collecting information about performance, and describing and measuring it. For example, plant utilization may be chosen and measured as a global indicator of performance. The related problems of managerial competence may lie in production scheduling and control, maintenance management, quality improvement and/or purchasing. Factors other than the production managers' competence (calling for non-training solutions) may include a shortage of foreign exchange, the absence of any bonus system for stimulating the more productive utilization of plant, and so on.

To judge current performance, the following type of standards to assess the desired performance levels could be used:

- standards (benchmarks) achieved by some other organizations, serving as models ("excellent" companies, organizations representing a "solid" standard without being the top performers, etc.);
- sectoral or national standards, reflecting agreed levels of "best practice" in particular industries, services, etc. (e.g. standards recommended by trade associations, centres for interfirm comparison, or consulting firms);
- standards established as performance targets or quotas (planned standards), to which actual performance in the current period of time can be compared; and
- standards used and achieved by the same organization in the past (in order to show trends in performance improvement or deterioration).

Excellent methodologies on how to identify company productivity and quality problems are provided in Modules 3, 4 and 9.

3.3 Managerial development needs

To assess managerial needs, individual competence can be broken down into a number of elements to throw more light on its structure and to focus on assessing and changing those elements that ought to be improved.

The most common way of examining and structuring managerial competence is by listing and describing the knowledge, traits and attitudes, skills and experience required to perform certain managerial tasks.

The second way groups the above-mentioned attributes into two broad areas: technical and behavioural. The technical area includes knowledge, skills, aptitudes and attitudes concerning the technological, economic, financial, structural and procedural aspects of the job. The behavioural area includes all people-related aspects affecting the manager's communication and dealings with people inside and outside the organization. This grouping is significant because it reflects the two fundamental sides of every management job: the technical side and the human side. It is helpful in needs assessment since different management development approaches and techniques can be chosen for developing technical and people-related skills.

The third way describes managerial behaviour rather than the characteristics that the holder of the job must possess. In this way we are also coming closer to performance, in particular if the
description of a behavioural pattern can also refer to the results to be achieved. For example, a sales manager “ensures that all customers’ complaints are handled, or at least acknowledged, within one week of reception, and that no more than 5 per cent of customer complaints remain unresolved after one month”.

The fourth way is that of competency models. A competency model - a variant of the previous approaches - defines a set of individual characteristics required for effective or superior performance in a job, or class of jobs. These characteristics are derived from the observation of actual managerial behaviour in particular jobs, and from the identification of capabilities exhibited by those individuals who achieve superior job performance.

The fifth way takes a reversed approach: rather than defining managerial competence, it tries to detect evidence of incompetence or the absence of specific competencies. George Odiorne has compiled a list of reasons why managers were fired in several organizations. He observed that managers could not control emotions, behaved immaturely, lacked a sense of urgency, were stopped by trivial obstacles, could not respond quickly enough to change, hung on to obsolete ways of doing things, persistently ignored labour-management relations, did not know when to stick to policy (when to enforce company rules rigidly and when to be flexible), could not delegate, could not communicate, were not tough enough, lacked a sense of humour, did not anticipate. These reasons can be analysed with a view to identifying training needs and developing tailor-made training programmes.

3.3.1 The management system perspective

Individual managerial jobs do not exist in isolation. They are part of a management system in a particular organization and are related to other jobs, managerial and non-managerial, within this system. It is important to keep this perspective in mind in using any of the above-mentioned approaches for describing the competence, performance and training needs of individual managers.

To begin with, we need to have a complete picture of the structure of the given management system. There are, of course, many alternative structures, but in most medium-sized to large business organizations we would normally find three basic echelons of the management hierarchy: lower, middle and higher management. In addition to this vertical structuring, there is normally some horizontal structuring resulting in specialization by functions, sectors, divisions, products, and the like.

In dealing with training and development needs, it is therefore necessary to find out how a particular organization describes the work content, responsibility and competence required for the various positions at each echelon of the hierarchy. Such a description may be available from organizational documentation (statutes, mission statements, organization manuals and charts, internal instructions, job descriptions), or we may find that it does not exist or is incomplete. In the latter case it may be appropriate to analyse the organizational mission and objectives and bring organizational documentation up to date, which is the organization development need in itself.
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3.3.2 Present and future needs

Present (short-term, current) needs can be established by comparing the real, present performance of managers with a desired standard that should be attained immediately or in a relatively short time. For example, performance may be substandard and corrective measures are required as soon as possible to redress the situation. In another case, some change in the environment or in the organization itself may be occurring (e.g. computerized production control is being introduced) that requires virtually immediate training so that managers may develop new competencies in parallel and in accordance with this change.

Future (long-term) needs are linked with future projections and long-range objectives. The underlying idea is that the existing managers should not only be made more efficient in the short run but should also be prepared to face new situations likely to develop in the future.

Thus, present and future needs should be indicated separately in diagnoses of training needs.

3.3.3 Qualitative and quantitative needs

The final dimension of needs concerns their qualitative and quantitative aspects. Qualitative needs reflect the content of managerial jobs and competence and of the required changes. They define the main problem and/or functional areas (accounting, leadership, motivation, maintenance, etc.) and those sorts of additional knowledge and skills that have to be developed, or attitudinal and behavioural changes that have to be achieved, in identified areas. In other words, qualitative needs help to identify programme subjects or disciplines as well as objectives of qualitative change to be achieved through training and development interventions.

Quantitative needs do not exist independently of qualitative needs. They indicate how many managers have identical or similar qualitative needs, and what volume of developmental effort and what resources will be required to achieve a defined qualitative change. Thus, the main indicators of quantitative needs are numbers of managerial posts, numbers of managers to be trained, developed and replaced, time allocated to training, the volume of training and development activities, and the human, material and financial resources required.

3.4 Results-oriented needs assessment process

With this approach we have to direct the whole assessment exercise towards improving individual managerial and unit/organizational performance after the training and development programme. Here our concept of “results” covers not only the immediate present, but also the future.

This approach is shown in model form in figure 9. In this model, the starting-point (step 1) is to identify the existing (or potential) organizational problems (in productivity, profitability, quality, marketing, etc.) and the degree of their urgency and the order of priority in which they will have to be tackled. Step 2 involves tracing and identifying the main causes and areas of the problems. Here we might identify causes such as lack of communication, slack discipline and poor morale, wrong or inefficient equipment and facilities, problems with excessively complex organizational design and cumbersome procedures, and so on.
At the same time we may identify precisely the main areas (technical, functional, geographical, etc.) where the problems arise - marketing department, assembly line, financial or planning department, workshop, etc.

Step 3 involves building awareness and recognition of the problems and their causes and the areas affected by them. During this stage it is important to identify those managers at different levels and in different parts of the organization who have "created" these problems or influence their existence in some way. This step enables us to avoid a full analysis of the training needs of all managers in an organization, and to concentrate only on those individuals who are really the sources of the problems and who are working within the areas where problems have arisen or can be dealt with.

When the problem areas and the particular managers responsible for them have been identified, step 4 is to analyse each job (including the job requirements and the actual behaviour of the jobholder) and compare it with the performance standards and the results of performance appraisals. The results of this comparison will show the gap between performance standards and actual achievements, expressed in terms of inadequate competence, which in turn will have to be broken down into specific skills, knowledge, attitudes and managerial behaviour, as well as other organizational factors and forces that codetermine managerial behaviour and effectiveness (step 5).

This analytical exercise will be pursued in step 7 by separating non-training needs from training needs and suggesting the required non-training solutions (interventions) in addition to training solutions.

The assessment of training needs has thus been completed. In step 8, the conclusions reached are translated into specific objectives and programmes for training and action.
Figure 9: Model of results-oriented needs assessment

1. Spotting organizational problems
2. Tracing problems to their main causes and areas
3. Recognizing individual (group) performance problems
4. Job analysis
5. Performance appraisal
6. Determining performance improvement needs
7. Separating training from non-training solutions
8. Information for developing training and non-training objectives and programmes
3.5 Needs assessment methods and techniques

To cover the whole process of assessing management training needs one has to master certain methods and techniques, which could well now number 50 to 70. It is impossible to describe all these methods and techniques in detail, nor is it necessary since there are many publications on the subject (see the bibliography at the end of this Introduction and Guide). The problems, methods and techniques are described in detail in Kubr and Prokopenko (1992) and Kubr (1995); see also Modules 3, 4 and 9 of the Modular Programme.

We should like, however, to provide here a set of the most common instruments used for the analysis of management training needs. Any combination of the following techniques and methods for identifying management training needs could be applied in most cases: observation of supervisory actions; reports and records analysis; critical incidents approach; interview; group discussion; questionnaire; organization development; action learning; and structured performance improvement programmes.

Observation of supervisory actions. Many training problems become apparent simply by careful observation and judgement. An observer watches a manager during a normal working day as he deals with people and problems. The observer keeps a log of the manager's activities, and analyses what is going on. In the process, deficiencies in the manager's skills come to light. Subsequently the observer summarizes his findings and uses them to analyse the manager's training needs.

Reports and records analysis. Much valuable information spotlighting existing training problems may be obtained from company or department reports and records (e.g. labour turnover, age distribution, skills, education, production figures, financial data, quality problems, etc.). These reports and records can give the trainer background information on the manager's education, training, experience, successes and failures. Employees' problems and grievances are also identified. This kind of information brings into focus deficiencies which can be remedied by training.

Critical incidents approach. This technique requires collecting and classifying, by different means, information on various departmental (or enterprise) problems and incidents and on unsatisfactory managerial performance in the particular job or task. Usually the trainers or managers are asked to identify specific behaviour or problems that are crucial to effective performance. The most frequently mentioned behaviour or problems are then grouped into categories of training needs.

Interview. The interview is a method of gathering information through personal contact and is well described in the specialist literature (e.g. ILO, 1972; Prokopenko, 1995). Group discussion. The managers who will be taking part in the training programme are brought together to discuss different aspects of management development. The discussion, which may last several hours, must be clearly structured, and the aim is to identify the most urgent problems, suggest their solutions (and if possible, classify them into training and non-training solutions) and produce clear-cut recommendations.

Questionnaire. A questionnaire asks the respondent to supply written information related to his or her job. Managers are usually asked to complete the questionnaire on their own; but the immediate superior may be asked to assist them or to evaluate their training needs. Normally the questionnaires are "closed" or "open". The closed questionnaire can be fully structured with scales or
"yes/no" responses. It consists of a list of items to be checked, with alternative answers to be selected or blanks to be filled in. The open questionnaire offers an opportunity to give a more complete and comprehensive picture, or describe a situation. It encourages the respondent to go beyond the factual material and data and convey his or her attitudes, feelings and opinions. A combination of closed and open questionnaires is particularly effective.

Any or all of the above-mentioned diagnostic techniques can be used jointly or separately.

We should also like to provide a list of the most important and frequently used methods and needs analysis techniques with some indication of the areas where their application may provide the best results (see table 1).

**Organization development.** Organization development (OD) is a planned activity or organization-wide effort managed from the top and directed to increasing organizational effectiveness and health through interventions in the organization's processes using behavioural science knowledge and techniques. It aims to help members of an organization to interact more effectively in pursuit of organizational goals. It is intentionally based on an awareness of human behaviour and organizational dynamics, provides for harmonizing individual and organizational goals, and promotes participative management. The main OD objective is to improve present and future organizational health and effectiveness. OD is characterized by the following features:

- the focus of change is a whole system and its interrelated parts;
- OD is a long-range approach to change, seeking to influence an organization's culture and norms by changing values, attitudes, knowledge, behaviour, processes and structures;
- OD is a top-to-bottom strategy for change that recognizes the importance of gaining the commitment and involvement of top management and any other person or group that could significantly influence the outcome of the effort;
- OD is a data-based approach that uses data for analysis, problem-solving and stimulating change rather than for making assumptions about what the real issues are; and
- OD focuses firstly on organizational and group change and secondly on individual change.

The OD process itself thus consists of the following stages:

1. **Entry stage.** Preliminary needs assessment, programme design and negotiation, commitment building.
2. **Diagnostic stage.** Analysis of organizational strengths, weaknesses and needs; processing the results and feeding them back through the system.
3. **Change stage.** Improvement changes in an organization using OD intervention techniques such as programme design re-evaluation, problem solving, team building, conflict resolution, confrontation meetings, feedback, training, strategic planning, etc.
4. **Evaluation stage.** Another diagnosis and comparison of the results with the previous ones, analysis of changes in productivity, profit, turnover, etc., identification of new problems to be resolved in the future.
5. **Follow-up stage.** Used to sustain the improvements made during the OD programme.

As can be seen, the OD process is oriented towards problems and results: it concerns both individual and organizational changes, rather than training. OD also draws heavily on various needs analysis methods and techniques, in particular at stages 1, 2 and 4.
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Thus, there is a multiple relationship between OD and its various improvement techniques, on the one hand, and training and development needs assessment and training interventions, on the other hand. It is not difficult to see that almost every step of this process involves some aspect of identifying managerial training and organizational needs and even uses a number of needs analysis techniques (questionnaires, interviews, group discussions, appraisal systems, report and record analysis, critical incidents techniques, etc.). For example, the first two steps (entry and diagnosis) of an OD programme are usually based on personal interviews about job problems with every member of the team, group interviews with managers from different departments or functions, supervisors' group discussions, activity sampling and an analysis of the data already available. The third step can reveal such symptoms as frequent complaints of poor communication, other departments being blamed, hostility between managers, indecision, and so on.

The evaluation of the change process can supply interesting and practical information on present and future organizational and management weaknesses, and on problems that OD has failed to resolve, and indicates further management training and development needs. Thus, nearly all the information obtained during an OD programme may be used to identify management and organizational training needs.

Action learning. Action learning is both a practical problem-solving approach and a management development method. Organizational problems and the identification of performance needs are a very important part of action learning. A manager who engages in an action-learning exercise works at the diagnosis and solution of a real organizational problem. As a rule, this would be an "open-ended" problem, i.e. one which does not have a single straightforward solution but can be approached and solved in various ways and whose solution requires considerable judgement and "people skills", in addition to the application of management techniques. Examples might be how to reduce absenteeism in a factory, or how to make sure that functional departments start exchanging and jointly analysing information generated by their decentralized information systems. The problem chosen must be important enough to the organization and must also represent a challenge to the managers working on the solutions. In one variation of action learning, managers work not only on new problems in areas or sectors other than their own, but also in other organizations than those employing them. Interaction with the "client" organization where the project is undertaken is very strong - the project idea has to be "sold" to it, collaboration in finding facts and searching for solutions must be enlisted, the solution must also be "sold", and the implementation must be undertaken as a joint task.

The contribution to needs assessment can be considerable and straightforward. The process of action learning identifies training and organizational performance needs at all its stages. First, these can be the needs of the individual undertaking the project - new information, knowledge or skills that are required in order to pursue the project successfully. In action learning, these needs are not recorded for later action, but are immediately met in the course of the project. This provides the opportunity for immediate application and feedback, and for correcting and supplementing the training provided if necessary. Second, action learning also generates information on those organizational performance needs which become apparent in working on the project, or are defined as conditions of implementing the proposed solutions.

The advantages of this method are the focus on needs requiring immediate action and application of the results, hence a quick feedback on the relevance of the training provided; and there is also a strong management motivation for meeting priority needs that will be rapidly translated into results. However, needs identified are confined to areas treated under a given action-learning
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project; therefore, this method can be used for wider needs assessment only if a sufficient number of relevant action-learning projects are taking place in the organization.

Structured performance improvement programmes (PIPs). Structured PIPs are launched with the specific purpose of bringing the organization, over a definite period of time, from one condition (regarded as unsatisfactory, or below a feasible standard) to another condition (standard or optimum). Various methodologies have been developed and applied for this purpose and their full description would exceed the scope of this publication. We shall therefore limit ourselves to pointing out their main characteristics, referring to the example of the PIP (planning, or programming, for improved enterprise performance) methodology which has been used by the ILO and other organizations.

These methodologies follow a structured interdisciplinary approach. In developing and implementing a set of performance measures, the company rigorously follows a particular procedure in order to respect the technical logic, maintain momentum and ensure coordination and control of the whole exercise, which may involve a large number of managers and units to enlist participation, generate commitment to the action agreed upon and taken, and deal with behavioural problems. Thus, these approaches are characterized by definite commitment and leadership from the top, and usually include the following major phases:

1. Preliminary diagnosis of enterprise problems. At the beginning, the objective is to establish that the potential for improvement exists and that the senior executives are willing to embark on organization-wide PIPs that may be demanding on their time and require some painful decisions. If the enterprise is found to be receptive to the idea of a programme of change, a number of preliminary diagnostic surveys are undertaken to provide current baseline data and some indications of existing major problems. These surveys may include a management survey, a financial appraisal, comparisons with other enterprises, a preliminary analysis of trends and opportunities in the given industrial sector, and so on.

2. Orientation for senior managers. During this phase, meetings and workshops for senior managers are organized to explain the nature, implications and methodology of the programme. Preliminary information and assessments produced in Phase 1 are used to demonstrate the magnitude of the problems to be tackled.

3. Preparation for implementation. The timetable and organizational arrangements for the programme are established. These include decisions on the possible use of external consultants and the roles assigned to internal consultants and trainers. If necessary, training in diagnosis, problem solving, systems analysis and other methods is provided.

4. Analysis and definition of the mission, objectives and key performance indices. At this stage, the exercise focuses on analysing and defining the enterprise's mission, long-term objectives, position in the national or sectoral economic system, and operational indices and targets. Stage 4 is usually completed in a special performance improvement workshop attended by senior management.

5. Identification and analysis of key impeding and impelling forces. The objectives suggested in the previous phase are confronted with the factors and forces that will hamper their achievement, as well as with positive driving forces from which the enterprise will be able to benefit. The analysis is both external (environmental factors) and internal (the enterprise's own resources, capabilities and potential). Both impeding and impelling forces are ranked in their order of priority, with assessment of their strengths.

6. Strategies and action programmes for improving performance. Teams of managers and specialists from various sectors and functions of the organization undertake the task of finding
realistic solutions to the problems identified. Various problem-solving methods are applied, including brainstorming and other group creativity techniques.

7. Arrangements for implementation. Various sorts of projects and actions will be the outcome of the previous stage and will now require management's approval, the allocation of the necessary resources, the assignment of responsibilities and the agreement on arrangements for continued coordination and monitoring.

8. Implementing action programmes. This phase provides for the implementation of those action programmes (e.g. finding new distributors of products, reorganizing the production departments, establishing a strategic planning unit, etc.) that require some time both for technical reasons and for having the changes accepted within the organizations.

9. Evaluation and feedback. As with any organizational change programme, at some point in time the major PIP exercise is considered to be completed and the results are assessed. The methodology and organization are assessed as well. It may be decided that some action programmes will have to continue.
### Table 1: Needs assessment techniques

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<td>Records and reports analysis</td>
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<td>Management climate surveys</td>
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Key:  
X     Good  
XX    Very Good  
XXX   Excellent  

4. An overview of basic training methods and development techniques

4.1 Defining learning objectives and development interventions

You have now identified your management development and training needs and learning objectives, and you have designed your tailor-made package by adjusting the Modular Programme as necessary. Next, you have to select your training methods and development techniques.

**Figure 10: Interventions for improving management performance**

![Diagram of interventions for improving management performance]

Source: Kubr and Prokopenko, 1989

However, before doing so you have to decide what kind of intervention you are going to use in order to change managers' attitudes. Figure 10 will help you here by relating different kinds of interventions for improving managerial performance to the type of training and development needs you identified for your clients. For example, management education and in some respects training are the most effective approaches for developing knowledge and skills, while management consulting and organization development are the best for changing the organization and the practical behaviour of managers. Some approaches may be used for all purposes (management development, management training, consulting, experiential learning, etc.)

Figure 11 will provide you with definitions, training and development objectives, evaluation techniques and major target groups for each of the interventions mentioned in figure 10, from which you will be able to select the kind of interventions or their combinations you need to fit specific managerial needs and learning objectives.

The next step is to select the training and development methods themselves. However, before doing this it is important to consider the following principles:

- **There is no one best training method.** Different methods enjoy varying degrees of effectiveness, depending upon such variables as the training objective, the trainees' background and
### Figure 11: Key characteristics of the seven types of intervention

<table>
<thead>
<tr>
<th>Concept structure</th>
<th>Management education</th>
<th>Management development</th>
<th>Management training</th>
<th>Experiential learning</th>
<th>Organization development</th>
<th>Improvement in organization systems and practice</th>
<th>Management consulting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DEFINITION</td>
<td>Formal learning process</td>
<td>Planned integral, comprehensive and ongoing process of developing managers' abilities and organization environment at all levels in order to improve organizational performance</td>
<td>Formal learning process which helps managers to acquire and develop mainly practical skills and abilities to manage, and to a lesser degree knowledge and attitudes under well-defined training needs</td>
<td>Process of learning by solving open-ended problems in organizations with emphasis on acquiring skills for analysing and solving future problems</td>
<td>Process of planned and purpose-oriented development of the human side of organizations as well as their norms, culture and psychological climate using behavioural science to improve the general organizational performance</td>
<td>Process of providing professional and independent assistance to help in problem identification and solving and to improve general management competence</td>
</tr>
<tr>
<td>2</td>
<td>OBJECTIVES</td>
<td>Improve managers' performance and potential for promotion. Management team building within the organization. Improving organizational climate and opportunities</td>
<td>Improve skills in accordance with well-defined jobs and tasks and for immediate application. The nature and volume of new knowledge is defined by practical tasks</td>
<td>Improve managerial competence through identification and solving real organizational problems</td>
<td>Improve organizational performance, integrate organizational and individual objectives, introduce positive organizational changes to achieve organizational goals</td>
<td>Improve organization systems and practices, better management technology, information systems, procedures and communications</td>
<td>Improve organizational performance through consultants' intervention, assist in practical implementation, suggest solutions, upgrade managerial abilities</td>
</tr>
<tr>
<td>3</td>
<td>ORIENTATION</td>
<td>People- oriented, aimed to improve the manager's system of knowledge covering the broad range of managerial disciplines</td>
<td>People- and task- oriented, aimed to develop performance of all managers in accordance with organizational objectives</td>
<td>Task-oriented, aimed at specific, well-defined jobs or functions</td>
<td>People- and action-oriented, aimed at improving practical abilities to identify and solve real organizational problems</td>
<td>Aims to improve organization system and behaviour rather than individuals, and to introduce changes</td>
<td>Aims to solve specific organizational problems or improve specific parts of the organization, to introduce changes and to develop problem-solving capabilities</td>
</tr>
<tr>
<td>4</td>
<td>EVALUATION</td>
<td>Impact on organization effectiveness can be logically traced, but not proved</td>
<td>Certain results can be immediate and easily measured if component of management education in the development process is not essential. Otherwise, results should be considered in the long term</td>
<td>Results can be immediate and easily traced and evaluated</td>
<td>Results can be immediate and easily traced and measured</td>
<td>Results can be both immediate and long term, and are easily traced and measured</td>
<td>Results can be immediate and can be easily traced and measured in the whole organization</td>
</tr>
<tr>
<td>5</td>
<td>CLIENTS</td>
<td>Students, as a rule without or with little management experience, often too young. In some cases also, experienced managers</td>
<td>All managers, and would-be managers, within the organization</td>
<td>Mostly practising individual managers or those who are being prepared to enter management</td>
<td>Managers, sometimes technical, non-managerial personnel</td>
<td>Organization and its human components, management teams</td>
<td>Organizational structures, systems (&quot;hardware&quot;), managers</td>
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<tr>
<td>6</td>
<td></td>
<td>Management consulting</td>
<td>Improve organizational performance, integrate organizational and individual objectives, introduce positive organizational changes to achieve organizational goals</td>
<td>Improve organizational performance, integrate organizational and individual objectives, introduce positive organizational changes to achieve organizational goals</td>
<td>Improve organizational performance, integrate organizational and individual objectives, introduce positive organizational changes to achieve organizational goals</td>
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<td>Management consulting</td>
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<td>Improve organizational performance, integrate organizational and individual objectives, introduce positive organizational changes to achieve organizational goals</td>
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motivation to learn and the trainer’s skill.

- Any single learning event may utilize a number of training methods. Most training programmes have several learning objectives to be achieved. Therefore even a single lesson may demand a combination of several methods, for example to develop skills and knowledge and to change attitudes.

- A variety (combination) of methods improves trainees’ motivation to learn effectively. A variety of techniques means a variety of stimuli to the learner, and a variety of stimuli means a variety of trainee responses. These generate interest and motivation to learn. The process of selecting training methods is shown in figure 12.

**Figure 12: Selecting training methods**

<table>
<thead>
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<th>Identification of training needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting up learning objectives</td>
</tr>
<tr>
<td>Knowledge</td>
</tr>
<tr>
<td>Attitudes</td>
</tr>
<tr>
<td>Skills</td>
</tr>
<tr>
<td>Designing the learning/training event</td>
</tr>
<tr>
<td>Selecting training methods</td>
</tr>
<tr>
<td>Availability of financial and material resources</td>
</tr>
<tr>
<td>Availability of skilled trainers</td>
</tr>
</tbody>
</table>

There are many factors affecting the choice of methods used in management training. The most important are learning objectives, the content and subject area, the number of trainees and their background, the time, finance, facilities and other resources, including trainers’ skills, that are available, and finally, the principles of learning (such as learners’ readiness and motivation, their involvement in the learning process and the design of the learning event itself).

We shall now discuss in detail how to define learning objectives.

Normally, management development needs based upon an organization’s present and/or future problems/tasks and related to individual managers’ capabilities serve as the starting point for designing learning objectives. These are defined in terms of the changes to be effected in three major learning outcomes - improved knowledge, skills and activities. It is rightly assumed that in a positive organizational environment these changes should afterwards lead to improved managerial performance.

The following are examples of learning objectives illustrating each category of learning outcome.

<table>
<thead>
<tr>
<th>Learning outcome</th>
<th>Sample of learning objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge acquisition</td>
<td>The participant will be able to define the terms “conflict” and “conflict management” and outline a seven-step process for handling conflict situations.</td>
</tr>
</tbody>
</table>
Skill building

Given a specific conflict situation, the participant will be able to demonstrate accurately at least two alternative ways of handling the situation.

Attitude change

The participant will demonstrate through behaviour and specific actions that he or she is not afraid of handling a conflict situation.

In designing learning objectives we should focus them on the learner. Therefore, the objective should be stated in terms of what the learner will be able to know, to do and to be, after the training programme. The learning outcomes and objectives provide the programme designer and/or the trainer with ideas about the most appropriate training methods.

The classic relationship between general management development objectives, the learning process and training methods is shown in figure 13.

Figure 13: Links between management development objectives and training methods

Therefore, from a preliminary analysis of needs, you can identify training objectives. Methods will then be selected with regard to their ability to impart new knowledge, influence attitudes and develop practical skills.

In this connection an example of a simple but interesting model with six participative methods related to the general skills which a manager should possess, whatever his special field of work or level may be in the hierarchy, is presented in figure 14.

Each method in the model can serve various purposes; however, a method reaches its peak of effectiveness only in connection with a specific purpose.

The main lesson to be drawn from this model is that, if training is intended to improve multiple skills (which is usually the case), a combination of teaching methods must be used. A similar type of analysis could be made to determine which methods are most likely to affect the managers’ attitudes or impart a specific kind of knowledge. The model in figure 14 makes it possible to recommend a broad set of training methods and specific techniques.

The next step should be to select methods that are focused more precisely on identifying
Figure 14: Effectiveness of participative methods

Management skills:

- Observing
- Selecting pertinent data
- Diagnosing problems
- Formulating solutions
- Deciding
- Communicating
- Motivating

Effectiveness:

- Field studies
- Incident method
- Case method
- Decision simulations
- Role playing
- Group projects

Source: B. Hawrylyshyn: "Preparing managers for international operations", in Business Quarterly (London, Ontario (Canada), University of Western Ontario, School of Business Administration), Autumn 1967.
specific learning objectives from the broad sets already selected. Let us take the example of using specialist knowledge and experience in the preparation of management decisions on complex business matters. It is of little use to give a lecture on the value of specialists to a manager who overestimates his own individual judgement and is not willing or perhaps able to use the specialist services which are available to him. Teamwork in syndicates, participation in business games or practical projects might make such managers aware of their drawbacks so that they will begin to change their attitudes towards teamwork and the importance of specialists. Their interest in new knowledge and skills will undoubtedly be awakened. On their leadership style, communication abilities and behaviour in general, managers may get more direct and stronger feedback from other participants in sensitivity training or as members of a team working on a group project than from years of work in a managerial position.

4.2 Major training and development techniques

A variety of training methods, techniques and visual aids can be used in putting your material across. The most detailed description of these techniques can be found in the ILO publication Management development: The trainer's guide (Prokopenko, 1995).

Here we shall briefly comment on some of these training methods, namely lecture/talk; group instruction; discussion leading; case study; role playing; in-basket exercises; and management games.

Other techniques include programmed learning, individual study, quiz, panel, cross talk, expert in the witness box, syndicate work and visual aids.

4.2.1 Lecture techniques

When presenting the modules, try to reduce the use of the lecture to the absolute minimum. In its pure form, it lacks participation and gives you very little feedback. It is useful for introductory sessions and subjects of general interest, or for giving an outline of a new thesis or technique, but from a management training point of view its value ends there.

If you have to deliver your material in lecture form, here are some hints on keeping your trainees attentive and retentive.

A good lecture consists of three parts: preparation; presentation; and summary.

**Preparation.** Never plan to speak for more than 30 minutes. Break up longer sessions with other techniques and aids such as films or discussions. Grade your subject-matter into these three categories: must know; should know; and nice to know. Do not pack too much into a session and plan when you are going to allow questions.

**Presentation.** Do not read out long passages unless you must, because you cannot then easily maintain eye contact with the group. If you are speaking from a text, try underlining the main points and use these as reminders of what to cover next, then speak conversationally about them. Better still, if you know your subject well, note down clearly printed headings on a card and let these prompt your memory. When you introduce your subject, tell the group whether they need to
take notes or if you have a handout to distribute. Let your listeners know whether you welcome questions whenever they wish, or if they are to reserve them for a special time. It is very important to invite questions at some stage, and when you plan your talk you should allot time for them. If none are raised you can always finish early.

Summary. They say that when you address an audience, you should tell them three times over: tell them what you are going to tell them; tell them; and tell them what you have told them. A good summary enables them to fill in any missing pieces of information; enables you to single out and stress the “must know” points; reminds them how much they have learned; and provides a good prelude to a firm, positive, businesslike, applause-provoking conclusion to your talk.

Have a good handout summary if possible. It is a waste of time making your trainees copy down factual information and diagrams.

4.2.2 Group instruction

You can use this technique with the modules when you have to communicate facts which you want trainees to retain completely. Whereas a lecture may be used for imparting a general picture or background information, group instruction is recommended for conveying facts and ensuring their assimilation. So, for example, if you were talking about work study you might use the lecture to give them some examples of what it can do, but you would need to use group instruction to ensure that they remember the meaning of the symbols which are used in methods planning.

Whereas the lecture only involves preparation, presentation and summary, group instruction involves five stages: preparation; presentation; summary; recapitulation; and test. As we have already considered preparation, presentation and summary, which are the same in group instruction as in the lecture, we shall now refer only to recapitulation and test.

Recapitulation. In the recapitulation, instead of telling the audience again what you have already said, you give them the mental exercise of recalling this information. So you ask questions, but you ask them not to call out the answers; if they do, the passive trainees will not bother to think and will let the eager ones get on with it.

You pose the question, allow everybody a few minutes to think and then choose the group member whom you want to reply. If someone gives you the wrong answer, make sure he or she and the group know the correct reply.

Test. The test will tell you if they have assimilated what you wanted them to learn and how much each person remembers. The main points of your lesson should be summarized in question form and the question should have only one answer. Ask each trainee to write down the answers, and when the test is over let everyone mark their own paper. Call out the answers, then afterwards ask anyone who has them all correct to raise his or her hand. However, use this technique to test managers only when the precise answers are of critical importance.

4.2.3 Discussion leading

This is a very important tool. The questions for discussion at the end of each unit are designed
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for use either by the trainer in plenary session or by syndicates. The discussion-leading technique helps a group to become a well-motivated team with a sense of purpose and achievement.

1. When should you use the discussion-leading technique?
   - You can use this method when the trainees already have some knowledge of the subject and you want to pool their experience, thereby deepening their understanding of the principles involved.
   - Discussion leading can also help a group to find an acceptable level of maturity, intellect and experience.
   - It is useful when trainees need to see other people’s points of views and perhaps modify their own fixed ideas.

2. How should you prepare and lead a discussion?
   - Determine your objective and make an outline for a discussion.
   - Consider particular trainees’ experience on which you can draw.
   - Consider which problems and controversies are likely to arise.
   - Open the session by tying the subject in with participants’ problems or a preceding unit or module. State the topic and objectives and write them up on the board or chart.
   - Conduct the discussion: create an atmosphere of conversational ease and security in which free discussion will take place; ensure that the group understands and accepts the objectives of the discussion; stimulate the expression of ideas; and ensure that all have an opportunity to participate. Encourage trainees to pass the topic round amongst themselves rather than have a session between yourself and individual trainees. It is important to clarify comments, rephrasing woolly ideas, in order to ensure their relevance, give information if needed, and summarize the discussion. The leader should control the discussion by asking questions. Good questions are brief, simply worded and easy to understand, related to one point only, and arranged in logical order.

   It is particularly important to make an effective summary at the end of a discussion session, itemizing the unanimous conclusions and crystallizing the issues of disagreement, formulating all the group members’ ideas, and leaving them to consider more fully the points of contention.

4.2.4 Case study

You will find a number of case studies in the modules, and these can be either used in their existing format, adapted, or replaced by similar but more appropriate ones for your particular situation. The trainer needs to be skilful in discussion-leading techniques and be able to summarize a real-life situation in the form of a story, so that the trainees can identify the causes of the problems in it and suggest appropriate courses of action. The important and lasting result of a case study is not so much the identification and treatment of a particular problem, since identical cases are not likely to occur. It is either:

   - the gaining of experience in analytical methods of diagnosis and decision-making; or
   - developing knowledge, insight and understanding.

In some instances, both of these can be achieved.

Identify the training need which you want a case study to meet. For example, in Module 3,
"Diagnosing productivity and quality problems", you want the group to learn a technique for analysing a problem, evaluating a range of alternative courses of action, and selecting the best option. In this instance you select a story which presents a good exercise in diagnosis and in prescribing corrective action. It is always important to ensure that it is relevant to the experience of the group.

In Module 8, “Managing organizational change”, you may want to use the method to highlight the problems of introducing changes in an organization and achieving acceptance. For this purpose you would select a story in which a company was reorganizing, introducing a new product, or moving location. The case would show how the people involved resisted this in a variety of ways and it would give examples of the adverse reactions and consequences. This would provide a good basis for the group to discuss how the changes should have been introduced.

Case studies could be used for examining the problems of failure to delegate, poor communication, lack of manpower planning - in fact, every aspect of management.

Decide what you want the case study to achieve and then select the best and most relevant one you can find. Here are some of the purposes for which you may want to use the method:

- to look at a practical case as a prelude to relevant theory;
- to exercise the understanding of newly learned theory;
- to stimulate research into an aspect;
- to provide a vehicle for useful information;
- to give experience of a stress situation in a game context so that they can cope better in real life;
- to improve the skills of problem analysis and communication/listening skills; and
- to cause the group to appraise their own attitudes.

It is a good idea to introduce the case towards the end of an afternoon and ask the group to read it and, if possible, discuss it amongst themselves that evening in readiness for a session the next day.

At this stage you could clarify some aspects of the story such as the structure of the organization concerned and any common assumptions which it would be helpful to make. You may want the group to direct their attention to particular aspects of the story for especial attention.

When you plan the use of the case study, decide how you are going to structure the discussion and approximately how much time you will allow for each part.

For example, in a problem-solving case you might arrange it like this:

- Introducing the case on the previous day 20 minutes
- Introductory remarks on the session 5 minutes
- What is the problem? 20 minutes
- What were the causes? 10 minutes
- How could it have been avoided? 10 minutes
- How can it be solved? 30 minutes

This technique should be handled flexibly, and if you are deriving great benefit from a
particular phase of the discussion do not adhere too rigidly to your timetable. It is up to you to decide whether the session’s objectives are being achieved. Be ready to replan your time allocation and possibly even the sequence of discussion phases as the session progresses.

4.2.5 Role playing

The use of role-playing exercises carries the case study technique a stage further by getting trainees to assume a role and act out a conversation in order to become more adept at handling similar real-life situations.

Role playing is a method whereby participants assume an identity other than their own in order to cope with real or hypothetical problems in human relations and other areas.

This training technique allows a player to practise reacting to conflict and other stressful situations. In addition to the general insight into human interactions, the trainee can be helped to modify his own behaviour patterns by getting feedback from others who have watched him play a role. This may open up communication channels and release some of the inhibitions which may otherwise hinder the resolution of conflict situations.

If some trainees say that they have difficulty in dealing with certain situations or individuals, you could ask them to act out these problem situations in role plays.

You could ask each of the two or more people involved to read a prepared brief for the character they are to assume, and when each of them has been primed they are brought together to let the conversation or argument take its course.

Role-playing exercises provide a useful training medium for many situations involving an interaction between people, notably: selling; persuading; negotiating; handling grievance situations; dealing with disciplinary problems; counselling, etc.

Sometimes, in a case study, when a trainee suggests a certain course of action in relation to one of the characters in the story, you can ask him or her to enact that particular approach with a colleague as the other party.

It is very important to make the proper role-playing briefs. Unless you know your group quite well, you may find that they question the plausibility of a complete ready-made role-playing situation, perhaps arguing about unrealistic details in the story. A good way of dealing with this contingency is to give them only the sketchiest outline and let them put in their own details.

Practically, effective role playing can take place in almost any setting, since no specific physical arrangement or special equipment is required. It is a very useful teaching device which can be employed in almost any training context.

4.2.6 In-basket exercises

The in-basket exercise trains supervisors to cope with pressure and sort out their priorities. The trainer gives the trainees a brief, such as “You are the deputy to the department manager, who
has just been taken to the intensive care unit of the local hospital after a road accident, and you have been asked to deal with any emergencies and keep the wheels turning until your manager returns in four days time."

Having sketched this background, the trainer asks the trainee to imagine that he is now in the department manager's office and is confronted with his in-tray. It contains messages, memos and other documents. After the trainee has worked out a plan for dealing with the crisis, the trainer discusses with him or her and with the other trainees the wisdom of the decisions made.

The benefits of this type of exercise are:

- Trainees realize that life in the "hot seat" is often like this, and learn to treat the handling of these competing priorities as a challenge.
- They learn the difference between adaptive action; corrective action; interim action; contingency action; and preventive action; and in what sort of situation each is appropriate.
- They see how important it is for the manager to delegate and to have contingency plans.
- Trainees learn that sometimes you cannot completely deal with a problem and 'put it to bed'. There are some problems which can be only partially solved with a temporary compromise.
- You can identify which trainees are likely to "go to pieces" under pressure and give them special help and coaching.

For the purpose of the exercise you need to tell the trainee what time it is, what day it is, and how much time he has to deal with the problems. It also helps if you give trainees an organization chart showing where they fit in and who they have working for them.

4.2.7 Management games

Management games will motivate trainees, inject variety into the course, introduce competition and provide a change of pace in the programme.

A business or managerial situation is simulated in a game which encapsulates a problem or series of problems and in which discussions have to be held, knowledge exercised and/or skills practised. There are parameters within which decisions must be taken and rules which must be observed. (The game of "Monopoly", for example, gives you the general idea.)

The element of chance must always be reckoned with in business, so you can use dice or random cards containing instructions or fresh information to provide this element of uncertainty and chance.

You can devise games which will:

- exercise problem-solving and decision-making skills;
- help trainees to select strategies;
- give practice in deciding priorities;
- develop analytical skills;
- develop an understanding of the importance of teamwork back on the job;
- help trainees to experience organizational and communication problems and develop their ability to produce solutions; and
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- develop skills in negotiating, interviewing, conducting meetings and communicating.

Games contribute to the spirit and motivation of a group of trainees by developing teamwork and motivating through competition.

4.3 How to select proper training and development techniques

Besides giving information on the above-mentioned training methods and techniques, table 2 provides a brief description of more than 40 training methods and their most important advantages. You can find an indication of those methods which could be used for the development of knowledge, skills or attitudes, or interpersonal skills, as well as the level of trainee participation and involvement in the learning process.
<p>| Training method                  | Description                                                                 | Skills building | Knowledge | Interpersonal skills | Attitudes, values | Level of trainee participation in management | Best application in management | Problem identification | Team-building | Motivation | Organization development | Decision-making | Problem-solving | Organization development | Problem-solving | Integrative skills | Creativity | Problem identification | Organization development | Business clinics | Problem analysis | Analytical skills | Organization development |
|---------------------------------|-----------------------------------------------------------------------------|-----------------|-----------|--------------------|-------------------|-------------------|---------------------------------|-----------------------------|-------------------------|----------------|-------------|--------------------------|----------------|----------------|--------------------------|----------------|----------------|----------------|------------------------|------------------|----------------|------------------------|-----------------|----------------|----------------|------------------------|
| Action learning                 | Process of learning by solving open-ended problems in organizations for analysing and solving future problems |               |           |                    |                   | Low               |                                |                             |                         |               |             |                          |                |                |                          |                |                |               |                        |                  |                |                          |                |
| Action maze                     | A case study or incident that has been programme, involving a series of decision points with options at each point, the choice of which leads to the description of a new situation with new alternatives |               |           |                    |                   | Low               |                                |                             |                         |               |             |                          |                |                |                          |                |                |               |                        |                  |                |                          |                |
| Application project             | A role (often practical) laid down by the trainer, of ten providing opportunities to develop and use practical skills and cognitive experience, creativity and initiative. Trainers learn from designing and taking action |               |           |                    |                   | Low               |                                |                             |                         |               |             |                          |                |                |                          |                |                |               |                        |                  |                |                          |                |
| Behaviour modelling             | A model or ideal enactment of a desired behaviour. This is usually followed by a practice session of the trainee, which the trainer monitors by increasing their behaviour repertoire |               |           |                    |                   | Low               |                                |                             |                         |               |             |                          |                |                |                          |                |                |               |                        |                  |                |                          |                |
| Brainstorming                   | A relatively unstructured form of discussion where creative thinking is emphasized rather than practical analysis |               |           |                    |                   | Low               |                                |                             |                         |               |             |                          |                |                |                          |                |                |               |                        |                  |                |                          |                |</p>
<table>
<thead>
<tr>
<th>Buzz groups</th>
<th>Case study</th>
<th>Coaching (mentoring)</th>
<th>Colloquy</th>
<th>Conference</th>
<th>Critical incident</th>
<th>Debate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small discussion teams with specific tasks normally ideas products which should be solved in specific time limits. The group then share their ideas between themselves</td>
<td>A written or oral presentation of an event, incident or situation of a small group to identify and analyse problems and solutions</td>
<td>Long-term assistance to a young manager by an experienced mentor, helping the manager to grow in management skills</td>
<td>A modification of the panel idea 6-8 people of whom 3-4 are experts. The audience express opinions and raise issues to be treated by the experts. A moderator directs the discussion</td>
<td>Used to discuss problems, gather solutions, or exchange information between a group of 5-10 participants. It is designed to establish a rapport between the audience and the experts</td>
<td>Participants are asked to describe an important incident related to their work, lives, which brought about change. Behaviours and incidents are suggested by facilitators. The audience are then asked to participate in their own problem solving.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Developing a learning-centered agenda</th>
<th>Decision-making</th>
<th>Industrial relations</th>
<th>Problem-solving</th>
<th>Identification</th>
<th>Problem identification</th>
<th>Organization development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem-solving</td>
<td>Decision-making</td>
<td>Industrial relations</td>
<td>Problem-solving</td>
<td>Identification</td>
<td>Problem identification</td>
<td>Organization development</td>
</tr>
<tr>
<td>Behavioral skills</td>
<td>Specialized knowledge</td>
<td>New information skills</td>
<td>Discussion skills</td>
<td>Presentation skills</td>
<td>New information skills</td>
<td>Problem identification</td>
</tr>
<tr>
<td>Analytical skills</td>
<td>New experience</td>
<td>Problem identification</td>
<td>Organization development</td>
<td>Learning skills</td>
<td>Analytical skills</td>
<td>Presentation skills</td>
</tr>
</tbody>
</table>

A - 39
| Demonstration | A resource person performs an operation or a job, showing others how to do a specific task. The participants could practise the same task |  |  |  | Job structure  
Job orientation  
Skill development |
|---|---|---|---|---|---|
| Discussion | A group of 5-12 people have a relatively unstructured exchange of ideas and opinions focused on the attitudes and values they hold relative to a specific issue or problem |  |  |  | Values and attitude changes  
New information  
Listening skills  
Team-building  
Evaluation  
Organization development |
| Exercises, structural experiences | Planned exercises or experiences, repeated performance of a skill, usually using some instrument or guide, followed by a discussion of the participants' feelings and reactions. Confront participants with important decisions or information; could also be a test of knowledge and skills. Could be used for job enrichment, job relation and job enlargement |  |  |  | Practical skills  
Sense of relevance  
Result orientation  
Independence |
| Field trip (Study tour) | The group travels to offices, factories and other establishments that provide sights, equipment or operations not possible within the classroom. The results can be used as the basis for discussion, reports and other practical exercises |  |  |  | New information  
Developing sense of relevance |
| Forum | A form of free and open discussion with the moderator's assistance in which any participant is permitted to talk any time the attention of the group can be secured. Could be accompanied by a brief speech before discussion |  |  |  | Presentation skills  
Listening skills  
Sensitivity skills  
New information |
| Games | An activity characterized by structured competition between a few teams to provide an opportunity to practise specific skills (e.g. decision-making); gives an insight into the attitudes, values and interests of the participants. Decisions are made and actions are taken by participants (6-12) with different managerial roles |  |  |  | Behaviour modelling  
Team-building  
New information  
Sense of relevance  
Organization development  
Problem-solving  
Decision-making  
Skills assessment |
| Guided reading | An important assignment to be accomplished either in or out of class hours. Reading management books, articles and handouts in accordance with the programme and involving an element of test and reinforcement |  |  |  | New information  
Self-development |
<table>
<thead>
<tr>
<th>Training Experiences</th>
<th>Example</th>
<th>Required Skills</th>
<th>Add:</th>
</tr>
</thead>
</table>
| In-basket exercises                        | A form of stimulation that focuses on the "paper symptoms" of a job. Participants respond to material, files, letters or documents managers might have in their in-basket. Action taken on each item helps trainers to sort out their priorities, and develop their understanding of different activities and decision-making skills. | Priorities setting  
Communication skills  
Decision-making  
Sense of relevance  
Understanding an organization, its culture and structure  
Cope with pressure |                                            |
| Incident process                           | A case study in which an individual or small team analyses the case (incident), uncovers a problem and critical facts, clarifies them and makes a decision for action | Diagnostical skills  
Fact-finding and setting of priorities  
Decision-making  
Industrial relations  
Team-building |                                            |
| Individual study                           | Learning factual and conceptual information, working at the trainee's own pace, often alone and probably at odd times. Could be structured or unstructured; combines both reading and experimental learning | New information  
Self-development  
Specialized functions |                                            |
| Instruction                                | A relatively precise formula for teaching a person to do a job or specific operations by presenting factual information and ensuring repetition and retention | Skills development |                                            |
| Lecture/talk                               | A one-way, organized, formal talk given by a resource person to a large audience for the purpose of presenting a background information series of events, facts, concepts or principles. Could be accompanied by questions and discussions by participants | New information  
Attitude changes |                                            |
| Management consulting                      | Process of providing professional and independent assistance to help in problem identification and solving and to improve general management competence and abilities | General management  
Functional management  
Problem identification  
Problem-solving  
Team-building  
Organization development |                                            |
| Nominal group techniques (NGT)             | Groups of people "nominate" problems through data collection techniques, tapping individual judgements and arriving at decisions which cannot be made by one person | Organization development  
Problem identification  
Sense of relevance |                                            |
<table>
<thead>
<tr>
<th>Observation</th>
<th>Structured observation of senior, more experienced managers' actions in different job situations, and learning from their successes and mistakes</th>
<th>Sense of relevance</th>
<th>New information</th>
<th>Organizational understanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>On the job</td>
<td>Combination of training and non-training events on the job, closely related to management activities, using career development, job rotation, job enrichment and job enlargement methods</td>
<td>Practical skills</td>
<td>Relevance</td>
<td>Organizational understanding</td>
</tr>
<tr>
<td>Organization development</td>
<td>Planned and purpose-oriented development of the human side of organization as well as the norms, culture and psychological climate, using behavioural science to improve the general or organizational performance and management of human relations skills</td>
<td>Human resource management</td>
<td>Human relations skills</td>
<td>Organizational understanding</td>
</tr>
<tr>
<td>Panel</td>
<td>A group of 3 - 8 experienced people present their views on a particular topic or problem. A moderator assists with questions and discussions among the panel members, often without participation</td>
<td>New information</td>
<td>Attitudes and values</td>
<td></td>
</tr>
<tr>
<td>Programmed learning</td>
<td>Learning factual information at the trainee's own pace, usually alone. The material appears in small, carefully sequenced segments, which elicit a response from the learner, who immediately finds out whether or not his or her response was correct. This facilitates cumulative learning. Computer applications are broadly used</td>
<td>New information</td>
<td>Attitudes and values</td>
<td></td>
</tr>
<tr>
<td>Question-and-answer session</td>
<td>Small groups of participants develop questions to which they wish resource persons to respond extemporaneously. Could be separate activities or part of other training techniques</td>
<td>New information</td>
<td>Attitudes and values</td>
<td>Analytical skills</td>
</tr>
<tr>
<td>Role playing</td>
<td>The spontaneous dramatization of a situation or problem followed by a group discussion. Trainers are asked to enact, in the training situation, the role they will be called upon to play in their job. The trainer acts as a coach, staging and reinforcing the desired role performance</td>
<td>Communication</td>
<td>Attitudes and values</td>
<td>Behavioural modelling</td>
</tr>
</tbody>
</table>
| Seminar | A group of persons gathered together to study under an experienced leader, doing research, identifying and analysing problems, exchanging results through reports and discussions | | | Planning  
Self-awareness  
Attitudes and values  
Problem identification |
| Sensitivity training | A group of people assist each other with self-disclosures and feedback. The learning assisted by a trained psychologist focuses on group process and interpersonal relations, creating an effective group to change behaviour so as to contribute toward more effective leadership styles, and improve awareness of their actual and possible behaviour | | | Team-building  
Self-awareness  
Behaviour modelling  
Communication  
Human relations skills  
Leadership skills  
Organization development |
| Simulation | A learning environment or a model that simulates a real setting in which the skills are required, with the focus on attitudes and values being related to the situation presented. Given basic data about the situation, participants make decisions and follow through to the next sequence, to decide again what to do. This cycle continues until the learning objective of the simulation has been achieved | | | Planning  
Organizing  
Team-building  
Trouble-shooting  
Problem-solving  
Organization development |
| Symposium | A series of related meetings with speeches (3 - 6) by persons qualified to speak on different phases of a single subject or problem | | | New information  
New concepts |
| Syndicate | A small group of trainers assigned specific tasks as part of a large training design. The chairman usually presents the syndicate report or findings to the larger group (or other syndicate) and it is commented on by them and a trainer | | | Team-building  
New information  
Communication skills  
Problem-solving  
Organization development |
| Transactional analysis | A method to improve face-to-face communication, analysing the emotional and behavioural states of a person, or the interaction between two persons | | | Understanding one's own behaviour  
Communication  
Improving relationships |
| Workshop | A group of persons with common interests and experience which works in much the same manner as a seminar, emphasizing free discussions, practical methods, skills and applications of principles. It allows considerable flexibility in the combination of concepts and practice | | | New information  
Skill development  
Communication  
Problem-solving  
Organization development |
INTRODUCTION AND GUIDE

BIBLIOGRAPHY

This Introduction and Guide on how to use the Modular Programme is based on ILO publications such as:


***

The volumes in this bibliography may be used to master your conceptual and practical skills in:

- the modular training approach;
- the identification of development and training needs; and
- training methods and techniques.


Herriot, P.: *Assessment and selection in organizations: Methods and practice for recruitment and appraisal* (Chichester (United Kingdom), John Wiley, 1989).

Quay, J.: *Diagnostic interviewing for consultants and auditors: A participative approach to problem solving* (Columbus, Ohio (United States), Quay Associates, 1986).


Smith, Barry J.; Delahaye, Brian L.: *How to be an effective trainer* (New York and Brisbane, John Wiley, 1987).
<table>
<thead>
<tr>
<th>Concept structure</th>
<th>Management education</th>
<th>Management development</th>
<th>Management training</th>
<th>Experiential learning</th>
<th>Organization development</th>
<th>Improvement in organization systems and practice</th>
<th>Management consulting</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFINITION</td>
<td>Formal learning process which helps managers to acquire and develop mainly basic or advanced knowledge and to a lesser degree skills for a wide range of managerial jobs</td>
<td>Planned integral, comprehensive and ongoing process of developing managers' abilities and organization environment at all levels in order to improve organizational performance</td>
<td>Formal learning process which helps managers to acquire and develop mainly practical skills and abilities to manage, and to a lesser degree knowledge and attitudes under well-defined training needs</td>
<td>Process of learning by solving open-ended problems in organizations with emphasis on acquiring skills for analysing and solving future problems</td>
<td>Process of planned and purpose-oriented development of the human side of organizations as well as their norms, culture and psychological climate using behavioural science to improve the general organizational performance</td>
<td>Process of planned introduction of new organization structures and systems, including management techniques and procedures</td>
<td>Process of providing professional and independent assistance to help in problem identification and solving and to improve general management competence</td>
</tr>
<tr>
<td>OBJECTIVES</td>
<td>To enable people to enter the managerial profession and to cope with a large number of broadly defined tasks in different organizational contexts</td>
<td>Improve managers' performance and potential for promotion. Management team building within the organization. Improving organizational climate and opportunities</td>
<td>Improve skills in accordance with well-defined jobs and tasks and for immediate application. The nature and volume of new knowledge is defined by practical tasks</td>
<td>Improve managerial competence through identification and solving real organizational problems</td>
<td>Improve organizational performance, integrate organizational and individual objectives, introduce positive organizational changes to achieve organizational goals</td>
<td>Improve organization systems and practices, better management technology, information systems, procedures and communications</td>
<td>Improve organizational performance through consultants' intervention, assist in practical implementation, suggest solutions, upgrade managerial abilities</td>
</tr>
<tr>
<td>ORIENTATION</td>
<td>People oriented, aimed to improve the manager's system of knowledge covering the broad range of managerial disciplines</td>
<td>People and task oriented, aimed to develop performance of all managers in accordance with organizational objectives</td>
<td>Task oriented, aimed at specific, well-defined jobs or functions</td>
<td>People and action oriented, aimed at improving practical abilities to identify and solve real organizational problems</td>
<td>Aimed to improve organization system and behaviour rather than individuals, and to introduce changes</td>
<td>Aimed to improve organization system and structural opportunities to use advanced managerial skills and talent</td>
<td>Aimed to solve specific organizational problems or improve specific parts of the organization, to introduce changes and to develop problem-solving capabilities</td>
</tr>
<tr>
<td>EVALUATION</td>
<td>Impact on organization effectiveness can be logically traced, but not proved</td>
<td>Certain results can be immediate and easily measured if component of management education in the development process is not essential. Otherwise, results should be considered in the long term</td>
<td>Results can be immediate and can be easily traced and evaluated</td>
<td>Results can be immediate and can be easily traced and measured</td>
<td>Results can be immediate and easily traced and measured</td>
<td>Results can be both immediate and long term, and are easily traced and measured</td>
<td>Results can be immediate and can be easily traced and measured in the whole organization</td>
</tr>
<tr>
<td>CLIENTS</td>
<td>Students, as a rule without or with little management experience, often too young. In some cases also, experienced managers</td>
<td>All managers, and would-be managers, within the organization</td>
<td>Mostly practising individual managers or those who are being prepared to enter management</td>
<td>Managers, sometimes technical, non-managerial personnel</td>
<td>Organization and its human components, management teams</td>
<td>Organizational structures, systems (&quot;hardware&quot;), managers</td>
<td>Managers and non-managerial personnel, organization or its parts</td>
</tr>
</tbody>
</table>

**Figure 11: Key characteristics of the seven types of intervention**
PART I:
PRODUCTIVITY AND QUALITY IMPROVEMENT:
CONCEPTS, PROCESS AND TECHNIQUES
CONTENTS

Part I: Productivity and quality improvement: Concepts, process and techniques

Module 1: Organizational excellence and productivity culture
Module 2: Productivity and quality factors and barriers
Module 3: Diagnosing productivity and quality problems
Module 4: Productivity measurement and analysis
Module 5: Designing a company productivity improvement programme (PIP)
Module 6: Implementing a company productivity improvement programme
Module 7: Organizing a company P&Q movement
Module 8: Managing organizational change
Module 9: Total quality management
Module 10: Industrial engineering techniques
Module 11: Financial and cost analysis
Module 12: Capital productivity management
MODULE 1
ORGANIZATIONAL EXCELLENCE AND
PRODUCTIVITY CULTURE
MODULE 1: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand and explain the nature of productivity and quality and their role in economic and social development as well as in company effectiveness.

2. Understand and explain the meaning of organizational excellence and its relationships to productivity.

3. Understand the meaning of and make distinctions between macro-culture, micro-culture and productivity culture and know their main elements.

MODULE 1: CONTENTS

UNIT 1: Organizational excellence and productivity

UNIT 2: Societal culture and productivity

UNIT 3: Productivity culture and the future

Bibliography
UNIT 1: ORGANIZATIONAL EXCELLENCE AND PRODUCTIVITY

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and explain the nature of productivity and quality and role in economic and social development.
2. Understand and exploit the concept of competitiveness and its dependence upon productivity and quality.
3. Understand and explain the meaning of organizational excellence, its main criteria and its factors.

UNIT 1: CONTENTS

1.1 Productivity and quality: Historical background
1.2 Organizational excellence
1.3 Assessment systems and organizational excellence
1.4 Customer orientation: A key to excellence
UNIT 1: ORGANIZATIONAL EXCELLENCE AND PRODUCTIVITY

1.1 Productivity and quality: Historical background

The history of mankind is the record of a struggle for survival and of efforts to achieve a better quality of life. Until the technologies of navigation, shipbuilding, armaments, steam engines, electricity and electrical machinery were developed, the world’s per capita GDP did not improve substantially for thousands of years. Limited land space and primitive capital systems made it impossible to keep pace with population growth. People could increase output only by working longer and harder.

The application of new and highly productive technologies, however, enabled productivity to be raised above the level of subsistence without an accompanying increase in hours of work. Entrepreneurs discovered that the most effective use of technology occurred under certain organizational structures, and thus enterprises became effective tools for generating more value from available resources.

With the emergence of imitators and the consequent competition in the market, a technology-based cyclical growth took place in the economy. Organizational excellence arose from management’s ability to integrate resources, and this became a major source for survival, both through the revitalization of old technology and through the creation of new breakthrough technology.

Although the importance of in generating more value from available resources was a known economic principle, it was viewed essentially as a political issue of the exploitation of labour and the distribution of wealth, with the result that the world was divided into two camps, i.e. industrialized market and centrally planned economies.

The United States, with its plentiful land, natural resources, aggregate capital and innovative entrepreneurs, became the new leader of the global economy after the Second World War. It had the highest level of technology and, while the rest of the world struggled for survival. Toward the end of the 1940s, American levels were three times higher than those of most European countries and ten times higher than those of Japan. With a view to creating a new world order, the United States undertook the task of assisting Europe, and later Asia, in improving their through the transfer of technology, know-how and funds.

A new concept of improvement, involving the philosophy of cooperative labour-management relations and fair distribution of the fruits of improvement, was advocated. This was to be promoted and supported by tripartite catalytic bodies (government, employers and workers).

The idea that productivity was an essential means for improving living standards became widely accepted and, looked upon virtually as a productivity movement, became firmly established throughout the industrialized market countries. The productivity movement spread throughout Western Europe and Asia, and enabled those countries to improve their performance dramatically in the booming economies following the end of the War.

With the collapse of the centrally planned economy countries towards the end of the 1980s,
Module 1
Unit 1

China, the Eastern European countries and the States of the former USSR are now also seriously examining the possibility of introducing this “culture” and organized movement into their economic systems in order to restructure them and to improve their effectiveness.

1.2 Organizational excellence

1.2.1 Definition - Quantifiable factors

The presence of organizational excellence can be inferred from the quantifiable performance of a company and its non-quantifiable ability to survive in the ever-changing market environment.

Examples of typical quantifiable records of excellence in performance are: (a) productivity levels and growth rates; (b) general trend in market share (ranking in niche markets); and (c) average return on total assets, equity and sale.

The question arises as to how long should elapse before a company qualifies as a company of excellence. Because of the ups and downs of corporate performance in the market-place, a decade may be too short a time for proper observation and analysis. On the other hand, a requirement of excellent performance for over two decades may eliminate dynamic up-and-coming companies with the potential and ability to cope quickly with emerging changes in the market. In the past, organizational excellence was defined as the ability of a company: (a) to make a substantial enough investment in new or improved technology to reap the profit from scale and scope economies; (b) to make a substantial investment in distributing and marketing the specific products; and (c) to form management teams capable of integrating production and distribution.

1.2.2 Competitiveness - Global implications

In addition to these factors, we need to look into the competitive strategy of companies to cope with not only national but also global competitors. It is becoming evident that new enterprises in developing countries, taking advantage of easy access to new equipment and know-how in open markets, make the greatest possible use of a relatively inexpensive and yet well-educated workforce. Their entry into the former preserve of the industrialized market countries can upset the traditional and static concept of performance.

Companies in newly industrializing and developing economies try to enter at the lowest end of the product and service markets by making the most of their advantage of inexpensive labour. While doing so, the governments of these countries usually protect the domestic market for their immature companies by building tariff and non-tariff barriers that enable them to charge relatively high prices in order to compensate for the low prices they charge in overseas markets.

In this situation, though political solutions such as quota negotiations and legal reprisals for unfair trade practices may help, what really enables companies in the industrialized market economies to compete with them may turn out to be their innovative capability to develop new products, technology and processes, and to increase horizontal and vertical diversification as well as the intellectual and skill levels of their workers. It is not only the ability of a company to produce
breakthroughs in technology that is important but also its ability to commercialize the emerging technology more quickly than its competitors.

1.2.3 Dynamic potential - Qualitative factors

Even though organizational excellence may be assumed from companies’ performance over the past few decades, this is a static evaluation. We should recognize that the rapidly changing industrial profile of the world makes it necessary for us to look into non-quantifiable dynamic factors that may ensure their survival in new markets now and in the future.

These non-quantifiable and dynamic factors are:

1. The ability of a company to identify the future needs of the market and to develop matching technology through integrated approaches.
2. The ability of a company to develop and provide new, better-quality products and services in less time than their competitors for a lower cost.
3. The vision of decision-makers to take risks.
4. The ability to create the optimal human interface between hardware and software technologies with the highest regard being paid to human dignity and workers’ potential.
5. The ability to improve the quality of the working environment, including harmonious and cooperative labour-management relations, so that managers and workers are motivated to maximize their intellectual input and physical output.

These factors contribute towards ensuring the fine performance of excellent companies. We have seen, however, that many companies with excellent performance records and innovative management styles become complacent and follow pre-established procedures based upon their past successes. Changes in customers’ preferences, competitive profiles in the market and new value systems (as with young workers) require constant adjustments and improvements in management’s strategy relative to investments, human resource development, labour-management relations and market development.

In the future, organizational excellence will stem from the ability of management to make adjustments in these areas. In doing so, they must earn the trust of their employees and the confidence of their customers in their products and services.

1.2.4 Technology - A key competitive factor

It takes about 50 years for a new technology to emerge, grow, mature and finally fade away. Companies which utilize new technology benefit from its commercialization through its growth stage, but eventually reach the point where future investment no longer yields an acceptable return on investment. The technology will then be replaced by newer technology, resulting in radically different commercial products or in products that are more reliable and durable and that have better performance and functions.

By applying new technologies, companies may show fine performances for a few decades. But without a continuing awareness of emerging new technologies and the ability to
commercialize them with the proper developmental techniques and resources, a company may not be able to maintain its high performance standards.

Products are now commercialized much more quickly than in previous decades. A single model line of motor vehicles which lasted over, say, seven years in the 1960s needs to be changed in less than three years in the 1990s. Consumer electronic products now have a product life-cycle of less than six months.

On the other hand, there are many instances where excessive preoccupation with changes and improvement produces only a marginal return on investment. Management has to ensure that organizational excellence is maintained by carefully balancing investment between the improvement of old technology, on the one hand, and the application of new technology, on the other. This requires vision on the part of decision-makers.

1.2.5 Cooperative labour-management relations

As has already been mentioned, technological innovation and investment in new plant and equipment are major contributors to improvement. These findings explain the heavy investments by the American motor vehicle industry during the 1980s. However, the American companies steadily lost their market share to their Japanese counterparts, who invested considerably less during the same period. General Motors' experience in the joint venture operation of its Fremont plant with the Japanese company Toyota showed that it was not necessarily investment but rather management's ability to create an optimal human interface between hardware and software that resulted in their fine performance. It also proved that the harmonious and cooperative working arrangements between unions and management in both enterprises were one of the key factors for success. The plant now has a reputation as being one of the finest operations among many General Motors plants, with about a 50 per cent higher performance rate in than the average.

The success of the rationalization movement in Germany and new job design concepts developed by the Scandinavian countries, as well as the harmonious labour-management relations in Japan, triggered off a new movement throughout the rest of the world, giving rise to participatory management and cooperative relationships. Human resources are now regarded as a key factor for the improvement of corporate performance.

1.3 Assessment systems and organizational excellence

It is also possible to learn about organizational excellence by studying internationally or nationally renowned awards such as the Deming Award of Japan, the Malcolm Baldridge Award of the United States or the Canadian National Award. Although there are some variations, the standards applied in selecting the recipients are essentially similar.

1.3.1 Japanese award system

In Japan, applicants for the Deming Awards are reviewed for their performance in six categories: management indices; quality; quantity and delivery; technical and developmental capability;
human resource development and employee morale; and safety.

Management indices include sales, operating profit, net worth, break-even point, level of borrowing, inventory turnover, cost reduction, value-added, sales per employee and output per employee. In the quality category, market share, complaint ratio, return ratio, breakdown ratio, user satisfaction, process defect ratio and other pertinent ratios particular to the industry of the applicants are reviewed.

In the category of quantity and delivery, data such as output, the number of breaches in the delivery contract, the number of delays in delivery, the number of defective products delivered, delivery conformance ratio and lead time are reviewed.

In order to assess the applicants' technical and developmental capabilities, an increase in product lines, the contribution of new products to the total sales, the number of new products, their developmental period and an evaluation of the products in the market are reviewed.

In the human resource development and employee morale category, the number of suggestions, problems solved by quality circles and the number of patents developed are examined. And lastly, in the safety category, data on accident frequency and intensity ratios as well as the number and nature of accidents are reviewed.

1.3.2 Canadian National Award system

While the Japanese award is given for total performance over the preceding six years (through intensive personal observation and guidance by designated reviewers for three years, which follows a documentary review of the preceding three years), the Canadian National Awards for Business Excellence are divided into separate categories, which include entrepreneurship, environment, industrial design, innovation, invention, labour-management cooperation, marketing, and quality. We shall now discuss some of these categories.

The entrepreneurship award is given to entrepreneurs in recognition of outstanding achievement in starting, taking over or substantially changing an independent business venture, while exhibiting an extra measure of leadership, daring and creativity in successfully confronting new and untried situations. The qualifications reviewed include strategic and innovative approaches, personal commitment, management style and results, and economic impact.

The industrial design award is given for the introduction of outstanding design by manufacturers of Canadian products. The category stresses a cooperative approach to product design, combining market research, product definition, aesthetics, material selection, manufacturing and marketing. The design and development process, product functions and quality, user friendliness, innovativeness and commercial impact are reviewed in this category.

The invention award recognizes outstanding breakthroughs of scientific or technical significance that have contributed to the development of a process, product or technology. Both the scientific and technical merit as well as the commercial merit of the invention are weighed.

The marketing award recognizes outstanding innovation and creativity in all aspects of marketing, including market research, planning and market success sustained over time. Strategy
formulation, planning and implementation and results are reviewed.

The award is given in recognition of outstanding improvements relating to processes, products or services through effective planning, the involvement of all employees, and the achievement of results sustained over time. In a similar fashion, the quality award is given in recognition of outstanding achievements in quality of product or service and overall business operations through a commitment to continuous quality improvement. Emphasis is placed upon the total involvement of the company, success in the market-place and a high level of customer satisfaction.

1.3.3 American Award System

The criteria used in evaluating applications for the Malcolm Baldridge Award are: leadership, 10 per cent; information and analysis, 6 per cent; strategic quality planning, 9 per cent; human resource obligation, 15 per cent; quality assurance of product and service, 15 per cent; quality results, 15 per cent; and customer satisfaction, 30 per cent.

In leadership, the intimate involvement of top management in the development of quality strategy and their close relations with customers are judged as a key factor. In information and analysis, evaluations are made of efforts to identify and target quality measures in all areas of the business, constant analysis and dissemination of data throughout the enterprise. As for strategic quality planning, a formal quality planning function is stressed. Follow-through mechanisms need to exist for linking the planning function with execution.

Essentially, everyone in the company is to be involved in these improvements. Great reliance is placed on problem-solving, with the emphasis on team efforts. Training must be widely available in all areas and is to be closely linked with action.

Quality assurance must be an integral part of the operating process, extending into both manufacturing and non-manufacturing sectors. Results must be obvious, through customer satisfaction. Efforts are to be made to measure the quality of competing organizations and to evaluate the final quality so that constant improvements can be made.

Although the Malcolm Baldridge Award has a relatively short history and the recipients have so far been few in number, a study found that they tended to share the following characteristics: high level of quality goals; establishment of standards and benchmarks; short reaction time; effective customer feedback system; quantitative measurement orientation; and major human resource investments.

It is evident that there is a growing consensus among American businesses that quality, on which the Award is focused, is a key factor that enables them to improve their performance and gives them the competitive edge in the global market.

1.3.4 Common standards

The common themes of award systems for business excellence designed by various organizations, irrespective of nationality, are: (a) growth-oriented company policies and behaviour based upon customer satisfaction; (b) team-based work organization with the emphasis on cooperative
labour-management relations and human resource development; (c) diversification in product lines and integration of operations; and (d) research and development capability. Companies with outstanding capabilities in these areas will obviously experience continued high performance and growth in the market-place.

1.4 Customer orientation: A key to excellence

1.4.1 Customer satisfaction and market share

In order to maintain a high performance in the market, companies need to systematize their behaviour, thus enabling them to react constantly to customers' changing needs so as to ensure growth by increasing value added. The customers' needs may consist of the following elements: (a) durability and reliability of products with minimum failures; (b) proper functioning and user friendliness; (c) acceptable cost; (d) timely delivery of products and services; and (e) prompt after-sales services.

Durability and reliability are important elements of quality. In the past, quality has been variously defined as customer satisfaction or compliance with specifications.

Quality ensures a market share. Obviously, a customer's purchase decision takes into account the obtainable quality and the price he has to pay for it. The higher the quality and the lower the cost, the better a vendor's chance of selling his goods or services.

The traditional concept was, however, that improvements in quality required additional investment, and therefore that customers had to pay higher prices for better quality. Even in the calculation of productivity, if an extra investment was required for the same physical output it was assumed that such an investment was made to improve quality.

1.4.2 Impact of quality improvement

The Japanese, however, discovered that, the quality level attained by eliminating redundant labour input for rework and by avoiding the waste of energy and materials in producing defective goods could lead to a reduction of costs as well. In addition, the cost reduction, when reflected in prices, resulted in an increase in the volume of sales that enabled a producer to apply in greater depth the principles of economies of scale and the learning curve, which could reduce relative costs even more.

The continued maintenance of a high level of quality in the market enables the provider of products and services to establish brand loyalty among customers, a factor which is one of the key competitive advantages.

Recognizing the importance of quality in the market-place, existing and potential competitors try to improve the quality of their products and services. In the absence of monopolies or oligopolies, fierce competition for quality and improvements becomes a way of life for organizations.
Organizational excellence may therefore be summarized as a company’s ability to maintain a competitive position in the market for a relatively long period of time through improvements in and quality, customer and employee satisfaction, and flexibility to cope with changes in the market. The company needs to systematize and improve these activities continuously through creating its own culture in order to ensure that it will continue to exist for a long period of time.

Questions for discussion

1. What is productivity? Discuss different productivity concepts and definitions.
2. What is quality, and what is its relationship with productivity?
3. Why and how are productivity and quality levels important to a nation’s economic and social development?
4. What is the relationship between productivity and competitiveness?
5. What is organizational excellence, and what are its main criteria?
6. Why is customer orientation the key to organizational excellence?
UNIT 2: SOCIETAL CULTURE AND PRODUCTIVITY

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and relate to societal culture and productivity.

2. Distinguish and explain differences between macro- and micro-cultural environments and their impact on decision-making processes.

3. Understand and explain the impact of organizational culture on productivity improvement.

UNIT 2: CONTENTS

2.1 The meaning of culture and its impact

2.2 The micro-cultural environment
UNIT 2: SOCIETAL CULTURE AND PRODUCTIVITY

2.1 The meaning of culture and its impact

Culture, as the core philosophy of a society or an organization, shapes the values and behaviour patterns of its members. The culture of a society is the complete network of relationships between human beings. Societal culture, in turn, influences the philosophy, values, behaviour patterns and rules of work performed by managers and employees.

Corporate culture sets the goals of the organization in either tangible or intangible forms, such as becoming the best performer in the market for a specific product or service, improving the quality of life of the people within the organization, and finally improving the quality of life of individuals by providing them with the finest products and services.

Culture is a powerful source of motivation for management to develop particular corporate policies and strategies. It also becomes a basis for structuring an organization in such a way as to accomplish its goals and, in turn, ensures the long survival of the corporate culture.

Corporate culture regarding productivity is particularly important as it ensures the continuing generation of new wealth through efficient operations arising from harmonious working relations between employers, employees, customers and vendors, as well as the optimal mix of other available resources.

Since an organization must exist in a society with its own culture, we need to review which societal factors affect corporate operations. Thus we must determine which corporate culture is conductive to continued excellence in the productivity performance of enterprises. This we do in the following subsections.

2.1.1 The market economy and the role of government

A profit-driven free market is a dynamic economic system that motivates people and organizations to perform better. There is a lot of evidence that the productivity levels of countries with a high degree of direct state intervention are considerably lower than those of the market economy countries. The recent privatization of public monopoly enterprises is also accompanied by a dramatic improvement in the performance of those companies. In a maturing stage of the economy, a government may play a key role in directing the limited resources toward high growth and high value-added sectors through tax privileges, low interest loans and cooperative research projects. However, in developed societies, a market-oriented economy would provide more effective goods and services.

2.1.2 Capital market structure

Though the source of funds is no longer restricted to the domestic capital market, many companies still depend heavily upon their domestic sources for procuring the necessary funds for their operations. A nation's fiscal policy, capital market structure and savings rate determine the degree
of availability of funds needed for industry and business.

A chronic deficit in a nation's fiscal account places constraints on the capital market. *Money games* played by financial institutions contribute toward the instability of the market and affect the savings rate. The savings rate is also affected by the people's sense of value as well as by the welfare programme of the nation.

Since investment in new plant and equipment and in research and development is a major contributor towards productivity improvement, the behaviour of the capital market determines a nation's industrial potential.

The emergence of the global financial market somewhat weakened the importance of the domestic capital market. A flow of money across national boundaries could be triggered off by profit motivation on the part of individuals and institutions based upon a spread in interest rates and exchange rates. Since the private sector's investments in wealth-generating industrial capabilities and an efficient *tertiary sector* are the major factors needed for productivity improvement, peoples' attitudes towards the need for savings and investment are an important determinant of productivity levels and trends.

Investment decisions are subject to societal rules and traditions with respect to the achievement of acceptable returns on investment. In the recent past, many countries have experienced a *separation of ownership from management*. Depending upon the nature of the *fiduciary relations* between management and investors (owners) and the behaviour of the capital market, management tries to make a balanced judgement between the short- and long-term return on investment. Societal perceptions of ownership and the fiduciary responsibility of management predetermine the degree of long-term investment which is essential for the continuing growth of productivity.

### 2.1.3 Quality of general education

The academic and intellectual knowledge attained through education creates the knowledge base, which is a major dynamic factor contributing toward productivity improvement. Product cycles are becoming shorter in order to cope with the changing needs of the market. Products and services have a higher technological content in order to satisfy customers and to increase value-added. The higher the technology content of the products and services, the broader and deeper must be the knowledge base of the people who work in these fields. Traditional trade skills may not be enough to satisfy people's future needs. What counts is that the workforce should be flexible enough to learn quickly; this flexibility can be provided only by the nation's educational system and has to be supplemented by company-specific training.

The scientific, mathematical and reading skills of high-school seniors were tested in various countries, and it was found that the highest scores were attained in countries where education is traditionally regarded as one of the highest goals for the future generation. The already industrialized countries with high productivity levels as well as newly industrialized countries with high productivity growth rates show the same trait in this regard. Society's orientation toward education is obviously an important factor that predetermines the quality of the labour force as well as technological capability.
2.1.4 Home market demand

One of the important environmental factors that forces the suppliers of products and services to excel by providing good-quality goods and services is the degree of the demand placed on them by their users. Those customers who tolerate low quality, delays in delivery and sloppy after-sales maintenance tend to create an environment that discourages the efforts of producers and service providers to excel. Tougher customer demands lead to better performance. The higher the satisfaction levels of customers, the higher the potential of the organization to compete and excel in the market. High-quality products and services are generated only by a tough domestic market environment and the cultural orientation of people towards quality. If the domestic competition is much tougher than in foreign markets, it prepares the organizations for coping much more easily with the global market.

2.1.5 Structure of intermediate input

No single company can excel in every field. Though vertical integration was traditionally thought to be one of the ways to become competitive in the market-place, in an era such as the present, when each company tries to excel in a "niche" market in highly segmented product and service lines, a reliance on intermediate suppliers becomes an efficient way to operate its business.

An efficient structure and a cluster of vendors of parts and components and business services enables companies to develop niche-market-specific technology, to commercialize technology and to shorten development processes. A complementary and cooperative relationship between a vendor and a manufacturer becomes established.

On the other hand, the increasing sophistication of product-specific technology also hastens the access of vendors to final product operations (downstream diversification) and incites the manufacturers of final products to begin manufacturing parts (upstream diversification), thereby increasing competitiveness in the domestic market. This competitive and complementary relationship is a key factor that triggers off innovations, productivity growth and quality improvement.

2.1.6 Relationships between business, the academic world and labour

A synergetic effect results from good communications and cooperative relations between academic institutions, management and unions. Academic institutions improve the knowledge base of the workforce as well as the research and development capabilities of the nation. They need to meet the requirements of the real world, and management should be encouraged to discuss its needs and work together with educators in order to ensure the continuing high quality of the labour force.

Management and labour need to work together to optimize the human interface of hardware and software technologies through legislated labour-management relations. A nation may make provision by law for such cooperation or voluntarily develop participatory programmes. In order to create a harmonious and cooperative relationship between labour and management, there must
be a fair distribution of value-added between the public (the ultimate user of wealth), management and labour. The government plays an important role in creating such harmonious relationships between the social partners.

2.1.7 Societal concept of employment

In Western societies and the former colonies of Western nations with strong Anglo-Saxon influences, employment is considered to be a contractual agreement. A job applicant is fitted into a job that requires a certain knowledge and skill level. Unless a person has general management potential, his or her specific skill-based qualifications are a major factor in finding a job in the labour market. Applicants look for an employer who offers the highest compensation level and favourable benefits. In countries with strong Confucian values, employment is considered to be the commitment of an employer to job applicants which guarantees employment, though their jobs may change within the company.

In return for the guarantee, the employee is under an implied obligation to stay with the company until reaching the compulsory retirement age. Though the latter system is now undergoing a gradual change, it forces management to give priority to protecting the interests of employees over those of investors. The societal obligation of employers also forces them to devise strategies for survival without resorting to easy lay-offs and the discharge of employees as a means of adjusting output. Company-specific skill training and upgrading as well as a high mobility of the labour force within the framework of the company become inevitable in this environment.

2.1.8 International learning

A wide gap in productivity levels between the United States and the rest of the world immediately after the Second World War, and the American initiative to share its knowledge, experience and technology, triggered off a strong productivity movement throughout Europe and Japan. In order to restructure the European and Japanese economies, the United States offered substantial financial aid to its allies as well as to the former Axis countries. Many public and private non-profit-making institutions consisting of tripartite bodies (with representatives from government, business and labour) were established in those countries to set off a national productivity movement. The initial programme consisted mainly of sending a large number of public officials, businessmen, academics and trade union representatives to the United States to learn about American practices in improving productivity performance.

The practice of each country having a productivity institution for promoting international learning became well established throughout the industrialized countries. Subsequently, with American and Japanese initiatives and support, the practice spread throughout Asia and to some African countries. It became a way of life for many businessmen and government officials to be exposed to the others' experiences before introducing new systems or processes in their own countries. Particularly in Japan, learning through study team projects became a standard learning method for business. Such learning makes it possible to avoid unnecessary investments in “reinventing the wheel” and eliminates the need to go through the process of trial and error.

A combination of these macro factors creates a unique behaviour pattern in an economy, and
in the course of time becomes an accepted standard of societal behaviour: that is, it becomes a societal culture.

2.2 The micro-cultural environment

Though macro environments have an important impact on the performance of a national economy, its level is dependent upon the performance of public and private organizations in producing maximum output using optimal mixes of available resources.

The materials, energy and direct labour costs of the total product are becoming relatively smaller. More value-added is generated by the technology and quality content incorporated into products and services. The sophistication of the creative input based upon knowledge and the skill level of the workforce and its ability to integrate hardware and software technologies become an essential factor in generating higher value-added.

2.2.1 Quantitative factors

Thus, the way in which goods-producing and service-providing organizations optimize the resources available to them becomes a key determinant of productivity levels. Productivity is the generation of value-added through an optimal mix of limited resources.

Again, the key quantifiable factors that improve the productivity performance of an organization are: (a) investment in value-generating equipment and facilities; (b) investment in creating new product and process technology; and (c) investment in human resource development and skills training.

2.2.2 Investment in plants and equipment

Investment in new plants, equipment and systems is essential in order constantly to improve a company's performance. Time and again, it has been shown that a company that lags behind its competitors in investing in new plants and equipment eventually falls behind. Such a company is unable to apply the principles of economies of scale and scope so as to be competitive in the market-place. Nor is the company able to take advantage of the most sophisticated equipment commercially available. There is an obvious correlation between the age of a company's equipment and the productivity it can achieve. Most of the market leaders in the United States, Europe and Japan show higher levels of investment as a percentage of sales, as compared with their competitors.

2.2.3 Research and development investment

A company's ability to develop new products and efficient product-specific processes ahead of its competitors determines its share of the market and its competitive advantage.

The emergence of higher performance companies in newly industrialized countries that have
a pool of inexpensive labour with a relatively high educational and skill level has accelerated price competition. Though quality, timely delivery and prompt after-sales service are an important consideration for customers, the major determinant of competitiveness in the market is the technology content that is incorporated into the products and services offered, whilst maintaining acceptable prices.

Thus, innovative capability is rapidly becoming a key factor in determining competitiveness in the market. A quantifiable factor of this innovativeness is its investment in research and development.

2.2.4 Training and education

A rapidly changing market-place requires producers to cope with their customers' needs through the shortening of product cycles and the introduction of new services. A company's ability to develop the in-house capabilities needed to cope with these changes in the market-place becomes an important determinant in beating the competition. The acquisition of this flexibility is dependent upon the ability of employees to expand their knowledge base quickly and to acquire the necessary skills. Though the selection of qualified employees is a key to ensuring such capabilities, rapid changes in the market require a company to upgrade the knowledge of employees, improve their skill levels and teach them new skills constantly in order to maintain its flexibility. In the same way, products, knowledge and skills also become obsolete if they are not improved.

Although the nature and quality of general education predetermines the nature and quality of the labour force and its future flexibility, it needs to be supplemented by company- and product-specific education and training that are provided within the corporate framework. The investment in the education and training of managers and workers ensures the quality of the human resources that are needed to respond promptly to changes in the market-place and to prepare for the future.

2.2.5 Qualitative factors

We should note that quantifiable factors are the only measurable contributors toward productivity improvement. Numerous unquantifiable factors in the cultural environment contribute substantially toward the improvement of corporate performance as well.

While the quantifiable factors can be easily identified and understood, an increase in investment and greater efforts with measurable elements do not necessarily give the results that management hopes to accomplish unless there is an appropriate human contribution too.

An important key to organizational excellence and high performance is represented by a company's ability to create an optimal human interaction between hardware and software technology.

The right investment decisions of management (i.e. the timing and criteria of investments) are perhaps more important than the volume of investment. Similarly, the proper identification of future technology needed for survival may be more important than quantifiable R & D investment.
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If educational institutions are unable to produce a quality workforce, companies themselves may have to ensure that workers understand written instructions, have the knowledge base to participate in group decision-making processes and institutionalize the improvements they propose. These types of investment in human resources, as with hardware and software, are important so as to create the most efficient interaction of these two factors, which optimize the quantity and quality of outputs.

A company's sensitivity toward the current and future needs of its customers, management's vision of its future, appropriate policies and strategies that are well understood by employees, an organizational structure able to cope with changes and maximize employee participation in the decision-making process, relationships with investors and labour, job and compensation design—all these are unquantifiable factors that actually determine the effectiveness of the quantifiable factors.

2.2.6 Market sensitivity

Organizational excellence starts with market sensitivity. While discussions on productivity tend to be either macro-based or self-satisfying output/input indices of minutely broken-down operational processes or functions, the aggregate of these self-satisfying improvements does not add up to organizational excellence.

The productivity index does not go up unless the market can absorb the products and services the company provides. It is not just the improvements in separate functions, but rather the harmonious integration of all functions to produce what the market needs.

2.2.7 The integrated approach

Every function of an enterprise must be designed in such a way that it properly identifies external and internal customer satisfaction. There must be a continuous effort to identify the needs of the subsequent internal process for which it serves: that is, with the entire corporate efforts being geared towards satisfying the market needs - or better yet, creating a hitherto unknown new market. Each corporate function must meet the internal and external demands on it with high quality information, services, parts and components, and with cooperative relationships linked with sequentially and randomly accessible functions within the enterprise.

Customer feedback and competitive information must be shared by those responsible for strategic planning, designing, engineering and production in order to develop the products and services that satisfy the market.

2.2.8 Quality

Because of the realization that the quality of products and services has been a major determinant of market share, efforts by American, European and Asian companies have been concentrated more and more on quality improvement. No longer is there a tremendous gap in the defect ratio between similar products produced by different companies. A typical gap in quality levels
between the market leader and its followers is becoming smaller. The quality gap between the top performer and the average performer, which was 1:30 ten years ago, is now 1:10. The defect ratio will become a marginal issue when similar products manufactured by different companies have a similar meantime between failures.

Markets are becoming more sophisticated and diversified, and, in the case of consumer goods, people want to identify their personality and individuality through the products they purchase and the services they use. More and more purchase decisions will be based upon aesthetic quality as expressed by appealing designs, ease of use and the user-friendliness of products, as well as the incorporated technologies that make them more effective, functional, comfortable and pleasant to use.

Because everyone can learn and apply techniques for reducing the defect ratio, such quality concepts and standards will be taken for granted. When manufacturers can satisfy physical quality, people will look for functional quality.

A refrigerator can no longer be a box that cools what is put inside it. It may have to freeze or defrost quickly. It may incorporate sensors and microprocessors so that it can identify the contents placed inside and cool them at an optimal temperature, and at the same time save energy.

Increasing emphasis will be placed on the organoleptic quality; - a quality that people can see, feel, smell, hear and touch, satisfying an instinctive, aesthetic and symbolic need. Attractive designs, colours that appeal to an individual’s taste, pleasant sounds, reliable feel and convenience will become essential requirements for products.

Suffice it to say that quality and the timely delivery of products and services and prompt after-sales service are equally important factors when taking the decision to purchase.

Survival can be ensured only through a business-wide awareness of the needs of the market, an organizational structure that enables a company to be flexible and cope rapidly with the changes in the market and a never-ending effort to eliminate waste, inattentiveness, disorderliness and untidiness at work stations. Quality products and services come from integrated systems in a high-quality working environment and a better qualified workforce.

2.2.9 Pricing policy

Price remains one of the major determinants of purchase decisions. Thus the pricing policy of a company is important to productivity improvement. A company may choose to plan on receiving the highest return on investment (ROI) in the shortest possible time, or may sacrifice short-term profit in favour of a long-term acceptable ROI through the expansion of market share and an application of the experience curve. The company may look at the expected total ROI in a given product cycle within the limits of the market size, and adopt a forward pricing policy. The company’s goal is to maximize its profit on either a short-term or a long-term basis.
2.2.10 Vision for the future

Management’s vision for the future is just as important in creating organizational excellence. A lack of clear vision on the part of management, constantly shifting *contingency plans* and poor communication of policies arising from management’s vision tend to cause disorder in the organization.

Employees need to know the future direction in which the company will proceed and the role they will have to play. Organizational excellence comes from the realization of management’s vision. Management’s vision is not a mere strategic plan to be developed by the strategy planning staff. It is a clearly stated management philosophy with regard to the future of the company. It is a core value standard for the organization’s behaviour.

But it also has to be tangible enough to be the basis for a clear policy that can be translated into processes for implementation by middle management. Vision is a basic element of leadership.

2.2.11 Strategy

Management’s vision and policy condition the basic strategy of a company. Although the goal of the company is to maintain a competitive edge in the market and to survive, strategy may be determined by management’s perception of its responsibility.

In a booming economy, an expansive strategy to cope with the increasing demand is an accepted way of corporate behaviour. In a declining economy, management strategy may differ. Corporate management with a strong orientation concerning its fiduciary responsibility towards the investors/owners either lays off or discharges workers in order to adjust labour input as output declines. This adjustment enables the company to maintain relatively constant labour productivity and prevents a drastic decline in profit. Though this strategy enables the company to survive through an economic decline, lay-offs and discharges give rise to *residual animosity* in the minds of workers. It also affects the degree of enthusiasm the workers display towards their work and the company as they are constantly threatened by the possibility of losing their jobs in declining economies. A strong leader with the determination to cope with the adversities of labour, and informed managers who have to make better decisions than workers, become indispensable in running the company.

On the other hand, a company with an express or implied no-lay-off policy has to survive through a declining economy by reducing prices and seeking overseas markets. The *negative impacts* of the economy must be borne by both management and labour. The strategy requires teamwork in seeking new markets, developing new products and systems and reducing costs, as the sharing of the future of the company becomes the basic corporate culture.

The nature of the linkage between management and workers has an influence on the effectiveness of the various tactics to be developed by a company in the areas of cost reduction, market penetration, research and development, process and quality improvement, and timely delivery.

The distinction between the companies with these contrasting strategies is becoming
somewhat ambiguous with the greater use of employee participation as a tactical weapon in coping with the fierce global and domestic competition. In order to improve the effectiveness of various corporate tactics, the managers of companies with a strong fiduciary responsibility toward investors and autocratic decision-makers are introducing worker participation, teamwork and group-oriented incentive systems. The effectiveness of these programmes as a tactical approach rather than as a strategic approach based upon the underlying corporate philosophy, however, is still in doubt.

### 2.2.12 Organizational approach

An organization is a legal entity. It can be sold and bought. Its rigid functional structure can be written clearly in a chart, and channels of command can be unmistakably defined. It has a book value and a market value, and a difference in the two measurable values sometimes results in a flurry of activity in the financial market.

The organization is also made up of people who have their own philosophy, goals in life, interests and emotions. Human life is organic and dynamic while the legal entity is static. Now that we have a complete separation of ownership from management, the responsibilities of hired professional managers are to place dynamic people into a static structure. Each person's duties and responsibilities are described in detail, and his or her position in the organizational structure and commensurate compensation level is defined. Everyone subscribes to predefined codes of conduct. Thus, people become familiar with the scope of the job, the degree of effort to exert, and the opportunities for promotion and increase in compensation, should they exceed the predefined degree of accomplishment. Within the scope of employment, most of the people feel stable and comfortable, provided that they learn to adjust their values and behaviour patterns to certain discomforts and constraints imposed by the command structure.

The dynamic nature of the market, however, defies the law of stability and challenges the organization to react. To minor stimuli, the organization reacts with tactical programmes; to major stimuli, with strategy. The organization loses its competitiveness if it tries to react with tactical programmes when a major strategic response is needed. Some of the best-known tactical programmes are MBO, PIMS, PERTS, JIT and TQM. Though they are effective tools, they are not effective strategies. They fit well into a static and predefined command structure, but may not be a proper solution to faster-than-expected changes in the global market.

Some of the strategic responses are changes in corporate goals and policies, organizational restructuring, internal or external (merger and acquisition), downstream and upstream diversification and the globalization of operations.

### 2.2.13 Organizational structure

The structure of an organization is based upon its experience in coping with past changes in internal and external environments. Organizations are divided into functions and groups of products or services, with clearly defined scopes of responsibility and demarcation lines between these functions and groups. Senior management or a corporate group is entrusted with responsibility for setting policies and coordinating all the activities.
The system enables a company to respond effectively to relatively slow changes in the environment. Current and future changes will occur much more quickly and more frequently, thus reducing the response time. Strict adherence to functional responsibility or confinement within the group may hinder the required quick responses.

Rigidity in the organization is important so that the basic rule of business conduct may be observed. But complacency and self-satisfaction with rules based on the past retard the company’s competitiveness.

Depending upon what the changes are, rules may have to be changed. Integrated rather than functional responses are required in the market. Group-specific information and technology may become generic. The constant formation of task forces to cope with changes makes demarcation lines between functions and groups ambiguous.

In order to cope with these changes, a company needs to structure the functions in such a way that flexibility will be maintained through a constant horizontal flow of information across the functional demarcation lines.

The old organizational structure based upon the vertical flow of information from the top downwards through rigid channels of command, needs to be replaced with a networking structure allowing the various functions to react to each other.

Senior management will become a core in the network, with direct channels of communication between all functions. Middle management will become the coaches and advisers to maximize the potential of their subordinates, rather than being the controllers and issuers of commands. Their function will no longer be the filtering of information for and from senior management.

The accelerated development of information technology will enable anyone to have access to corporate-wide information sources. Access to information will cease to be the basis for power. Power will rest with those who maximize the human potential of people with the optimal mix of hardware and software.

In manufacturing, finely tuned coordination and cooperation between the different functions becomes absolutely necessary in order to effectively apply the JIT system, simultaneous engineering and other integrated approaches. As dependence on the intermediate input of parts and components manufactured outside the organization becomes more conspicuous in order to maximize the use of technology, as well as the principles of economies of scope and scale, the organization as a whole needs to have a flexible structure so that it can coordinate with the activities of various outside organizations. Thus, the flexibility of the organization is rapidly becoming an important factor for attaining organizational excellence.

2.2.14 Labour-management relations

One of the key determinants of organizational excellence is the company’s philosophy and practice in the area of labour-management relations. How management views the role of its employees and the trade unions, and how it copes with various issues arising out of these
relationships, determines the effectiveness of the use of hardware and software.

No matter how much investment is made in new automated equipment, plant facilities and software, if the workers are not enthusiastic about their jobs the company cannot obtain the maximum results from its investments.

In a company where employees' welfare and interests are protected in the same way as those of the investors, either through societal codes of business conduct, negotiated agreements or legislated programmes such as a co-determination system and co-ownership, the stability of the jobs or employment offered by the company tends to give the employees a sense of pride in their work. Such a sense of sharing in the destiny of the company tends to create synergetic effects that generate an optimal mix of human knowledge and quantifiable contributions towards performance excellence.

Moreover, this sense of sharing encourages employees to participate in the decision-making process and arouses their enthusiasm for contributing towards organizational excellence. The policy has to be supplemented by appropriate incentive systems that reward the employees through either a negotiated bonus system, the Scanlon Plan, Improshare, the Rucker Plan or employee stock option programmes, in order to give employees tangible results for their contributions.

In the macro environment which acknowledges employment as a contractual arrangement where management has the discretion to lay off and discharge employees, investors tend to view an announcement of such lay-offs and discharges as a sign of management's rational approach to cope with the declining market, and thus the value of stocks increase.

Management also may use the fear of possible lay-offs and discharge as a tool for motivating workers to perform better. This may temporarily give rise to better performance on the part of workers, but management may have to cope with long-lasting and negative residual effects, once the economy recovers.

Although many companies have tried small group activities such as employee involvement, quality circles and management participation programmes as tactical measures to improve the performance of employees, without the esprit de corps based upon the partnership philosophy to which management is committed the results have been rather disappointing.

On the other hand, job security won either from the power position of unions or through social legislation imposed upon management without a commitment to mutual partnership, tends to create complacency on the part of employees.

A true partnership, with a commitment from both management and workers, will ensure that management shows its ingenuity in expanding output in order to maintain constant input, with minimal disadvantage for the employees.

Only a genuine belief on the part of management and its commitment to its employees will result in organizational excellence through the employees' enthusiastic commitment to their jobs and the company.
2.2.15 Sharing of gain

All these factors contribute towards raising the productivity level of the organization. The fruits of a productivity increase should be shared by those who contributed to attaining the goals, i.e. better quality and lower cost for the consumers and users of the products and services, better quality of living for the public, higher benefits and compensation levels for employees and managers, and higher profit for investors, with an appropriate reserve for reinvestment in the organization's future.

A narrow-sighted approach, of retaining profits through labour input adjustment in order to cope with a decline in the market, lowers the quality of the working environment and degrades the quality of life of the people.

The optimal mix is thus created by the commitment of the people in the company, irrespective of their positions. Everyone's efforts to maximize their knowledge, experience and skills make it possible to obtain the optimal mix, and these efforts are a necessity in order to survive in the rapidly changing market environment.

Essentially, productivity is a learning process. It is a process of constant change. Organizational excellence is a result of a productivity culture fostered in the company, though a favourable macro environment facilitates the creation of such a culture.

Questions for discussion

1. What is the nature of culture in the macro and micro dimensions and how do they interact?
2. How does culture influence the most important economic processes as well as their results?
3. How could culture hamper or facilitate productivity, human performance and company excellence?
4. What is the relationship between an organization's culture, structure and managerial styles?
UNIT 3: PRODUCTIVITY CULTURE AND THE FUTURE

UNIT 3: LEARNING OBJECTIVES

Once having learnt this unit, you will be able to:

1. Understand the probable impact of productivity culture on future developments.
2. Understand and explain the essence of continuous change and its impact on the corporate culture.

UNIT 3: CONTENTS

3.1 The global market and its implications
3.2 New corporate citizenship and philosophy
3.3 Continuous change
UNIT 3: PRODUCTIVITY CULTURE AND THE FUTURE

Productivity culture, as a core philosophy of an organization, shapes behaviour, values and patterns of work. It sets the goals of a company as generating more value from available resources, serving customers' needs, developing harmonious working relationships between management and labour, and sharing the fruits of productivity improvement fairly with customers, workers, managers and investors. Its ultimate objective is to improve the quality of working life and the quality of life itself.

If it is to be a high performance company on a long-term basis, the company needs to develop policies and strategies as outlined in the preceding units. More than anything else, however, management needs to develop a firmly committed philosophy based on the purpose for which it exists. Its ultimate objective is the improvement of the quality of life of its employees, customers and investors. No longer is it acceptable to say that a company's sole goal is the pursuit of profit on behalf of its investors. Social partnership not only with the employees but also with suppliers, customers and the general public are rapidly becoming a way of corporate life.

3.1 The global market and its implications

More and more companies operate in the global market beyond the scope of national policies or values, though the societal culture and the competitive home market environment stimulate the development of the core philosophy. Managers of global enterprises will now shape their own values, behaviour patterns and codes of conduct of business across national boundaries.

Irrespective of whether businesses are large or small, they are now linked by new value systems of partnership as the market structure shifts from national to global in nature. Although global enterprises are large, they are dependent upon numerous small businesses for intermediate input in the form of raw materials, parts, components, technology and business services.

Small firms tied to global businesses will have to live with the latters' value systems and behaviour patterns, and in turn will affect the value systems of the global companies through their own indigenous culture.

Social obligations, such as not polluting the environment and contributing towards the improvement of the quality of education and working life, will become a responsibility between all companies and thus a part of their core philosophy.

Any temporary relief from tough competition that might be obtained by moving operations outside a company's national boundaries, in order to take advantage of inexpensive labour or less stringent environmental regulations, will not last long, as a global productivity culture emerges.

Though the business cannot survive on a philanthropic basis, global awareness of present-day social obligations forces the company to develop new philosophies with regard to its goals. Fulfilling these obligations may have a temporary negative impact on corporate performance under the old concept of profit; in the long run, however, management should be aware that it cannot survive in a deteriorating social and physical environment. The shrewd business sense of
entrepreneurs, the ability of managers to integrate resources and an enthusiastic labour force so as to create the optimal human interaction between hardware and software, and, in the final analysis, satisfied customers determine its ultimate performance.

### 3.2 New corporate citizenship and philosophy

Companies' philosophies may vary according to their line of business and their managers' perceptions of its goals. The survival and expansion of a company come from its constant effort to generate more value from available resources than its competitors.

Hardware and software both have their physical limitations. Human potential and imagination, however, have no limitations. Thus, the core philosophy of any company should be to discover how to tap human potential so as to create an optimal mix of other resources to satisfy the needs of the market-place.

Under the traditional concept, human resources were to be developed and motivated to produce more value for a company. Various promotional and compensation schemes were developed to satisfy the physical needs of workers and managers. In order to satisfy their personal and emotional needs, improvements were made in the promotion system, the working environment, participatory programmes and the various benefits offered. Yet we see substantial differences in performance between companies applying similar motivational schemes. Perhaps the difference comes from the core philosophy of the companies more than anything else. It is the philosophy that creates the key link between those who manage and those who are managed.

True philosophy, entered into by management, understood and believed in by workers and proven through deeds, can establish relationships based upon mutual trust. It is not a meticulously written agreement of job guarantee, but rather a vaguely implied commitment which workers know that management would respect and which would motivate them to perform far beyond expectations.

The core philosophy, therefore, must embody the company's regard for the human dignity of its employees and its belief in the unlimited potential of human resources. The same humanistic approach must apply between the company and its customers and suppliers through the establishment of relationships based upon trust. Customers buy products and services from a company they trust, just as the company depends upon trustworthy suppliers for its intermediate input.

Many companies advertise a philosophy of this kind for the sake of promoting worker involvement schemes, initiating exclusive vendor relationships and enticing potential customers. Without a true commitment to the philosophy, however, such tactical manoeuvres only produce half-hearted reactions from employees, customers and vendors. Productivity culture is based upon such a committed philosophy. Without genuine understanding and belief, productivity may be misunderstood as working harder or as management's exploitation of labour. In such a situation, the word productivity has to be replaced by competitiveness, total quality management, participation and many other expressions.

Logos, words and tactical approaches may change. But underlying them all there must be a productivity culture that determines the objectives, strategy and behaviour patterns of a company.
Even though the very goal of a business company is to produce profit, it may not be able to do so without improving its productivity. The question is simply whether the company returns the profit to its investors immediately or invests in plants, equipment, research and development and human resources to increase its ability to improve productivity so that investors may benefit in the long term. Manipulating the capital market, making hostile take-overs bids, and dumping for the sake of expanding the market may create an impression of good performance; but these manoeuvres rarely contribute towards productivity improvement, i.e. generating added value.

A social partnership culture shared by management, workers, customers, vendors and investors which is based upon trust gives rise to corporate efforts to excel in the competitive market in the following ways:

(a) satisfying customers through the improvement of quality and efficiency and with more technology incorporated in the products and services, timely delivery, cost reduction and after-sales service;

(b) ensuring labour-management stability through harmonious and cooperative working relationships, for example through labour-management consultation, works councils and participatory management and co-determination systems;

(c) mobilizing the entire corporate personnel and resources to strive constantly for the improvement of performance through team effort;

(d) introducing job design, work organization, employment practices and compensation systems that ensure the employees' job satisfaction, morale improvement and enthusiastic participation in problem-solving and group decision-making; and

(e) improving safety standards and the quality of the working environment.

The basic goal of productivity improvement is the generation of new value-added that contributes towards the upgrading of the quality of working life and ultimately the quality of life itself. A company is not, however, a welfare organization. The goal must be attained in a highly competitive market environment, and organizational excellence is the key for attaining that goal.

Organizational excellence produces quantifiable results but is highly dependent upon effective human interaction between hardware and software factors. Productivity culture determines the patterns of this interaction.

3.3 Continuous change

Like any other culture, the purpose of corporate culture is to become the basis for a predetermined behaviour pattern of an organization. A culture is created because people look for a norm that gives them the stability arising from an optimal set of rules and the assurance that people abide by them. Once the culture is established, people become comfortable and settled. The culture is essentially the opposite of conflict and dynamism.

On the other hand, productivity is a dynamic factor. To generate more value from limited resources requires constant innovation in a fiercely competitive market. Productivity culture, therefore, needs to be a static philosophy that constantly triggers off innovative and dynamic behaviour patterns.
The key corporate philosophy must be to give the highest priority to human dignity and potential by forming a partnership between labour, management, customers and vendors, irrespective of the location of operations or markets. Dynamic behaviour must occur when a company’s culture encounters changes in its own market or comes into conflict with other cultures.

Productivity culture must incorporate an institutionalized system that automatically and dynamically reacts to changes in the environment and the market. The company must develop an acute sensitivity to market needs and, better still, foster the ability to instigate market needs through innovation in products, services and processes.

Market sensitivity must be supported by integrated corporate efforts to create breakthroughs in strategic goal setting, and to make constant incremental improvements in tactical decision-making processes, the working environment, information systems, manufacturing processes, the quality of the final products and services to be delivered, and even the accepted administrative processes such as accounting, general affairs, record keeping and other staff work.

People’s commitment to attain the required dynamism must be institutionalized so that complacency will not set in. This can be done through repeated training and education of workers and managers. Constant individual and group-oriented efforts to upgrade skills must be institutionalized.

The organizational structure must reward and encourage voluntary efforts to make contributions towards improving group performance. Although individual accomplishment is important, it must be incorporated into group efforts and result in organizational excellence.

Organizational excellence is a result of a productivity culture based upon the belief that today is better than yesterday and tomorrow must be made better than today, through people’s own efforts to attain the ultimate goal of improving the quality of life.

Questions for discussion

1. How do you think organizational cultures, business strategies and management practices will change in the future?
2. What are the main elements of corporate philosophy?
3. What are the main implications of globalization for corporate philosophy?
4. How would globalization influence competitiveness and productivity?
BIBLIOGRAPHY


Illrank, Paul; Kano, Noriaki: *Continuous improvement* (Ann Arbor, University of Michigan, Center for Japan Studies, 1989).


MODULE 2
PRODUCTIVITY AND QUALITY FACTORS AND BARRIERS
MODULE 2: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand, list and explain what productivity factors are and classify them by major groups.

2. Understand and appreciate the major internal and external (i.e. to the enterprise) productivity factors and their potential and actual impact on the company’s performance.

3. Visualize and present the external and internal productivity factors (integrated model) in order to assess their magnitude and degree of priority and take them into consideration in the decision-making process as well as in productivity and quality improvement programmes.

MODULE 2: CONTENTS

UNIT 1: What are productivity factors?

UNIT 2: External productivity factors

UNIT 3: Internal productivity factors

UNIT 4: Integrated productivity factor model

Bibliography
UNIT 1: WHAT ARE PRODUCTIVITY FACTORS?

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand what productivity factors are and classify them into major groups for decision-making purposes.

2. Explain the difference between external and internal factors, process- and resource-related factors and their possible impact on productivity and quality.

3. Relate different factor groups to different decision-making elements of an organization.

UNIT 1: CONTENTS

1.1 Classification of factors

1.2 External and internal factors

1.3 Process-related factors

1.4 Resource-related factors

1.5 Other useful classifications
UNIT 1: WHAT ARE PRODUCTIVITY FACTORS?

First of all, the concept and definition of the word “factor” must be determined. For our purpose it is sufficient to state that a “factor” is any force or impact which changes the productivity level and its rate of growth. Therefore, to improve productivity and quality we have to be aware of all the critical factors (forces and impacts) in order to influence them by adopting different sets of actions.

Since the most common and practical definition of productivity is the relationship between, on the one hand, the volume of goods and services of acceptable quality and price that are produced and sold and, on the other, the necessary input costs, the most evident productivity factors could be the volume and quality of products and services bought by the market and the total resources used to produce and distribute them.

By increasing output and improving quality (in accordance with market demands), you can raise total productivity. You can also do this by reducing the volume and cost of the resources used. Again, you can play with both the output and the input factors at the same time to achieve productivity growth.

Exercise: Before you go any further, take a sheet of paper and try to have a brainstorming session (alone or with colleagues) to identify the most important productivity and quality factors and suggest any classification which you consider relevant to the situation of your own enterprise or country. Compare your classification with our suggestion below.

1.1 Classification of factors

Every company has an organizational structure reflecting various functions, products or job specializations. No single person, unit or department has ever been able to cope successfully with all the productivity and quality factors at the same time. These specializations indicate who and which part of the organization can deal effectively with each factor.

For this reason, in order to make good management decisions concerning productivity improvement, it is very important to classify all the productivity factors into general groups and subgroups which help to allocate to each its proper weight and priorities and put them in the care of the right persons and organizational units.

Since modern organizations (even medium and small ones) can easily have multidimensional production tasks, and therefore structures, the classification of productivity factors should also be multidimensional and correspond as far as possible to the organizational design and/or product cycle flow. Such a match may be achieved in two ways: by improving the classification of factors; and by modifying organizational structures leading to the better use of these factors.

We shall not provide here an exhaustive list of productivity factor groups, but those that are the most important and relevant to practical management will be discussed in the following sections.
1.2 External and internal factors

This classification is the most general, and helps to group factors into those that enterprise management cannot control or influence in the short run (external factors), and those that are under enterprise management control and should be influenced by it (internal factors).

A study by McKinsey revealed that 85 per cent of the variables affecting productivity in American companies are internal to the organization and controllable by management, while only 15 per cent are external and beyond management control. A Kepner-Tregor study further showed that 80 per cent of the internal variables can be influenced or changed by management, while only 20 per cent are influenced by labour. If these figures are close to reality, around 70 per cent of productivity factors in the industrialized market economy countries are under managerial control.

In developing countries and in countries undergoing a transition to a market economy the reverse could often be true, in view of their economic crises and unnecessarily high level of government intervention as well as their dependence upon the developed economies' markets. Indeed, too much government intervention and unreasonably high taxation could kill the business or drive it underground.

However, in both developed and developing economies, it is essential to know and understand the intensity and interplay of the external and internal factors.

Factors which are external and not controllable for one institution are often internal to another. Factors external to an enterprise, for example, could be internal to governments, national or regional institutions, associations and pressure groups. These institutions can improve tax policy, develop proper legislation, provide better access to natural resources, improve social infrastructure, price policy, and so on; but individual organizations cannot. That is why external and internal factors are often called macro- and microeconomic factors.

However, even if an individual enterprise is unable to control external factors, they must be of interest to its manager as an understanding of them can stimulate certain actions which may change the enterprise’s behaviour and its productivity in the long run.

Exercise: List the most important external and internal factors which influence your organization’s productivity performance. Arrange them in order of priority (the first being the most influential and the last the least). Discuss them with your colleagues and make suggestions on how to influence or use them to your company’s advantage. Compare your conclusions with the proposals in Section 2 of this module.

1.3 Process-related factors

The production process is a complex, adaptive, continuing socioproduction system. The interrelationships between labour, capital and the socio-organizational environment are important in the way they are balanced and coordinated into an integrated whole. Productivity improvement depends upon how successfully we identify and use the main factors of the socioproduction system.
Since the main consequential elements of any production process are input, process, output and feedback, it is often useful to classify the productivity and quality factors into these four groups:

- input (resource-related);
- process (transformation of resources into products);
- output (products and services sold); and
- feedback (measurement of results).

These groups of factors must be well balanced and coordinated. For example, if you spend too many resources on input and neglect the transformation process, the essential part of input (and sometimes all of it) would be wasted. A well-designed and organized technological process could save a lot of input. However, even balanced input and process elements can be wasted if the delivery of output to the market is late, or its packaging is of poor quality.

Feedback (in this case, productivity measurement and analysis) would provide the best criteria to judge the balanced combination and coordination of input, process and output factors.

Exercise: Identify and list four groups of factors: input related, process related, output related and feedback related; and list them by priority. Compare your selection with the suggestions in this module.

### 1.4 Resource-related factors

Many specialists in the analysis of productivity factors link them only with resource-related factors such as manpower and capital. The manpower factor includes work attitudes, skills, work organization, motivation, etc. When the capital factor is discussed, land, plant, equipment and facilities are usually mentioned.

This classification is particularly important since it corresponds well with partial productivity measures such as labour productivity and capital productivity. The analysis of capital/labour ratio and productivity provides important information for managerial decision-making by improving the quality and possible combinations of resources and the ways in which they are used.

### 1.5 Other useful classifications

Other possible classifications of productivity factors are useful in many cases. For example:

- positive productivity factors; and
- negative factors (often called productivity barriers).

Such groupings can be useful, as some management approaches favour the promotion and strengthening of the impact of positive factors (such as interest, enthusiasm, availability of technology, etc.) and the elimination or reduction of the impact of the productivity barriers (for example, resistance to change, safety hazards, low morale, shortage of skilled manpower, etc.).
Technically, it is often better to begin improving productivity with the elimination of well-known and evident barriers and bottlenecks before initiating the development of positive factors such as new technology, training, improving motivation, etc., which require a certain investment. This often starts with a group of people brainstorming and developing a checklist of the most important productivity barriers or problems.

A practical example of the results of a typical exercise is shown below.

<table>
<thead>
<tr>
<th>Critical barriers/problems affecting productivity improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Example from India)</td>
</tr>
<tr>
<td>Family-controlled industry leading to earning easy money.</td>
</tr>
<tr>
<td>Some segments have a monopolistic market, some a highly competitive one.</td>
</tr>
<tr>
<td>Erratic inflow of orders.</td>
</tr>
<tr>
<td>Lack of productivity/quality culture.</td>
</tr>
<tr>
<td>Shortage of funds and inadequate technology development.</td>
</tr>
<tr>
<td>Standardization and codification are at a low level.</td>
</tr>
<tr>
<td>Automation is not encouraged.</td>
</tr>
<tr>
<td>Low priority of marketing and commercial activities, poor after-sales service.</td>
</tr>
<tr>
<td>Complicated government policy, rules and regulations.</td>
</tr>
<tr>
<td>Inadequate communication facilities, particularly road transport.</td>
</tr>
<tr>
<td>Energy shortage.</td>
</tr>
<tr>
<td>Poor working conditions (light, ventilation, safety, housekeeping).</td>
</tr>
<tr>
<td>Non-availability of some basic material and components (to be imported), unreliable suppliers.</td>
</tr>
<tr>
<td>Too many levels of hierarchy in the organization leading to poor communication between managers and workers.</td>
</tr>
<tr>
<td>Poor utilization, old plant and machinery.</td>
</tr>
<tr>
<td>Surplus of manpower, and shortage of skilled workers.</td>
</tr>
<tr>
<td>Inadequate human resource development: low priority for technical skill development.</td>
</tr>
<tr>
<td>Poor industrial relations leading to lack of discipline, union militancy, political and external interference, poor employer participation.</td>
</tr>
<tr>
<td>High absenteeism.</td>
</tr>
<tr>
<td>Inefficient materials-handling facilities.</td>
</tr>
<tr>
<td>Rigid and authoritarian management style, lack of professionalism.</td>
</tr>
<tr>
<td>Excessive diversification and product variety.</td>
</tr>
<tr>
<td>Poor documentation of technical problems and their solution.</td>
</tr>
<tr>
<td>High social orientation with low priority for cost effectiveness.</td>
</tr>
<tr>
<td>Engineering and design groups are overloaded with routine activities.</td>
</tr>
<tr>
<td>Lack of time for developmental work.</td>
</tr>
<tr>
<td>Trade unions are adverse to higher productivity for fear of losing jobs.</td>
</tr>
<tr>
<td>Complicated organizational structure; role and task clarity are missing.</td>
</tr>
</tbody>
</table>
Another, more systematic example of productivity barriers, which Thurow (1991, pp. 6-11) called six weaknesses, or six characteristic patterns of organizational behaviour, is as follows:

Outdated business strategies (slow transition from mass to the flexible production system, lack of product quality, customization and speed of new product introduction).

Short-term horizons (the American firms often seemed less willing than their rivals to live through a period of heavy investment and low returns in order to secure a foothold in a growing market. Establishing and maintaining a competitive position requires a deep, broad-based, long-term commitment to R&D and innovation.

Significant technological weakness (despite their leadership in basic research, American companies often neglect "downstream" technical skills, i.e. the development, design, manufacturing and product planning skills that are essential to converting an invention into a well-designed, high quality manufacturing product).

Neglect of human resources development (this is one of the problems of institutions that prepare Americans for work, particularly those at secondary schools).

Failures of cooperation (adversarial rather than cooperative relations between business and government, between management and labour, and between firms and their suppliers; organizational walls between departments, barriers to cross-functional problem-solving, poor communication between product development and marketing).

Differences between government and industry objectives.

An Australian survey of the most important productivity barriers provided the following list:

The taxation system is such that it is not worth while working harder and earning more.

Everyone receives the same pay rise regardless of how hard they work.

People do not want to commit more time and energy to their work as to do so would interfere with family/leisure interests.

There are inadequate opportunities for workers to partake in planning and decision making.

Management does not know how to motivate workers.

We have provided only three examples of productivity barrier check lists developed from productivity surveys in different countries. As can be seen, though his information provides some ideas about productivity barriers, it does not give much practical help - which problems or barriers can be taken care of by company management; which are not under company control; which are most important and which less important; which re most urgent and which could wait; which component (or function) within the company should deal with them, and so on.

In addition, some of these barriers (or problems) are the results of others, meaning that certain orders of priority in the barriers' hierarchy should be established. This is important in order to avoid wasting time and energy on treating visible symptoms instead of causes which are often well hidden.
The following general model on productivity factors based on a typical production process flow is suggested as a basis for further, more detailed discussions and classifications of productivity factors (Figure 2.1).

**Figure 2.1: General Productivity Factors Model**

**External Environment**

Purchasing market

```
INPUT --> PROCESS --> PRODUCED OUTPUT --> SOLD OUTPUT
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FEEDBACK

```
INTERNAL ENTERPRISE ENVIRONMENT
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Selling market

The model clearly shows that the most general groups of factors which should be considered in the first instance are those which could be grouped around the external and internal enterprise environment.

**Questions for discussion**

1. What is a productivity factor?
2. Why do we need to classify productivity factors?
3. How could the classification of productivity factors into external and internal, resource- and process-related factors be used for management decisions?
4. Suggest other possible classification systems which might be more relevant to your own company’s situation.
UNIT 2: EXTERNAL PRODUCTIVITY FACTORS

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and explain the essence of the main external productivity factors and their possible impact on the company’s performance.

2. Take into consideration in your managerial activities the influence of different changes in external factors on your organization’s productivity.

3. Classify the most important external factors into the major groups to make it easier to forecast their possible impact on organizational performance.

4. Understand the role of productivity improvement in promoting productivity and quality.

UNIT 2: CONTENTS

2.1 Business cycle and structural changes

2.2 Resources

2.3 Government roles, policies and infrastructure

2.4 National productivity movement
UNIT 2: EXTERNAL PRODUCTIVITY FACTORS

It is a well-known fact that enterprise productivity depends to a large degree upon external economic, social, political and other infrastructural conditions which influence the effectiveness and decision-making process of enterprise management. For example, the influence of education and training is manifested in the skills and attitudes of workers. Technological progress, and R & D, can also be realized by the enterprise through a skilled labour force, better equipment and better management. Such environmental factors as business cycles, economies of scale, political and social conditions, climate and environmental legislation also have an impact on the production process through different kinds of direct and indirect linkages. Thus, external factors include government policies and institutional mechanisms; political, social and economic conditions; the business climate; the availability of finance, power, water, transport, communications and raw materials; and various social movements and networks. They affect productivity and decision-making in individual enterprises; but the organizations concerned cannot actively control them.

These factors should be understood and taken into consideration by management when making strategic and operational decisions. What is outside the control of individual enterprises in the short term might be controllable at higher levels of society’s structures and institutions. Bearing in mind all the social, political, economic and organizational links between consumers, workers, managers, government and different pressure groups and between institutions and organizational infrastructures, it is useful to discuss here the main macro productivity factors which speed or hinder productivity improvement processes. A general classification of the four main groups of macro productivity factors is shown in Figure 2.2.

Figure 2.2: External Productivity Factors

2.1 Business cycles and structural changes

Structural changes in society can dramatically influence national productivity. However, in the long term this interaction is a two-way one. Just as structural changes affect productivity, productivity changes also modify structure. Such changes are not only the result but also a cause of economic and social development. Understanding these changes helps to improve government policy and makes enterprise planning more realistic and purpose-oriented. The most important structural changes are economic and demographic.
2.1.1 Economic changes

The most important structural economic changes are in employment patterns and the composition of capital, technology, economy of scale and competitiveness.

Employment shifts from agriculture to manufacturing industry have caused an economy-wide increase in productivity that has surpassed productivity growth within any one sector in many countries. The number of people employed in agriculture, forestry and fisheries in these countries has now become so small that this historical source of productivity growth has very limited potential as a source of future growth. However, in many developing countries these shifts will continue to be a source of high growth of productivity in the future, since more people will move from the low-productivity agricultural sector into manufacturing.

From many international productivity comparisons, the following conclusions may be drawn. Developing countries are basically non-industrialized economies. Their major sources of income generation are the primary sectors, such as agriculture and mining, and the tertiary sectors, such as services. The levels of productivity in the primary and tertiary sectors are much lower than those in industry. This provides the fundamental explanation why productivity in industrialized countries is much higher than in developing countries.

For example, Indonesia is mainly a primary sector country. Approximately 42 per cent of Gross Domestic Product (GDP) was contributed by agriculture and mining in 1990, while industry contributed only 18 per cent, with employment of only 12 per cent of the total labour force. In agriculture, for every 1 per cent increase of value-added, employment rose by only 0.18 per cent, whereas in industry this figure was 0.46 per cent during the 1970s. This shows the higher potential of industry in terms of productivity and employment growth. Thus, while agricultural development in Indonesia could have its share of attention, the particular emphasis in the structural policy should be put on industrial development.

A second historical structural economic change is the move from manufacturing into service industries, such as trade, finance, insurance, real estate, personal and business services, etc. Even in Japan, with its strong emphasis on manufacturing, employment and consumer spending has shifted to the service sector, which now accounts for more than one-half of employment. In the United States nearly three-quarters of all non-farm employees work in services. The effect on productivity of this second major wave of structural change is controversial, since productivity in the service sector has tended to climb more slowly than productivity in general. However, it has held down the price of labour relative to the rapidly escalating price of capital and raw materials. As a result, in many countries wages declined dramatically during the late 1970s. This stimulated the shift of capital and energy away from equipment into investment in the labour force. Thus the productivity of other production factors was enhanced at the expense of labour productivity.

Because of the labour force shift from more productive industries into low productivity services, productivity in the service sector, along with white-collar productivity in companies (see box), is becoming central to national productivity growth.

The rapid growth in white-collar employment has surprisingly come at a time when new computer information technologies should have been leading to big cuts in such employment. Despite some specific individual improvements in white-collar productivity, the aggregate results
Some facts about white-collar workers

Today, the majority of workers in many developed countries hold white-collar jobs. In the United States there are two white-collar workers for every blue-collar worker. At the same time, in the past decade blue-collar productivity has risen by 3 per cent while white-collar productivity has remained stagnant. The result has been a very low national rate of productivity growth (1 per cent per year).

As Peter Drucker mentioned in the Harvard Business Review (Nov.-Dec. 1991), the single greatest challenge facing managers in the developed countries is to raise the productivity of knowledge and service workers.

For the past 120 years productivity in industry, construction and transportation has risen in developed countries at an annual rate of 3 per cent to 4 per cent, a 45-fold overall expansion. However, the productivity revolution is over, because there are too few people employed in making and moving things (about one-fifth of the work force in developed economies). Indeed, even in Japan the great majority of the work force are service (white-collar) workers with productivity as low as in any other developed country.

The chief economic priority and social challenge for developed countries, therefore, must be to raise the productivity of knowledge and service and work.

One of the new things we have learned is that capital alone cannot replace labour, nor will new technology generate higher productivity by itself. If, in manufacturing, capital and technology are factors of production, in service and knowledge work they are tools of production. The difference is that a factor can replace labour, while a tool may or may not. The promise of greater productivity led to massive investments in data-processing equipment; yet office and clerical forces have grown at a much faster rate since the introduction of information technology, and there has been virtually no increase in the productivity of service work.

Many specialists rightly believe that “working smarter” (i.e. more productively without working harder or longer) is the only way to increase productivity in the long term in the service and knowledge sector. It is important not only to ask “How is it done?” (the answer is often linked with mechanization and/or automation and capital investment), but also to ask “What is the task?” This question could lead to the elimination of unnecessary tasks and investment, and improve the ways of effecting those which remain.

show no net gains in productivity growth in this sector.

Banks and the accounting professions neatly illustrate the problem. Banks have computerized their accounting systems and installed robots (ATMs) to deal with their customers, yet their productivity has actually fallen in the past decade. The accounting profession has been computerized almost everywhere, yet the number of accountants on private payrolls has grown faster than real income.

Several reasons could be given for this poor productivity performance in the service and knowledge sector:
- New computerized forms have been introduced without the elimination of the old ones.
- The volume of information increased faster than was really needed. Much new information is not used.
- New information technology (IT) is not always introduced when it really pays off.
- In most enterprises those who request information do not have to pay for the cost of processing. Costs have to be tied into the budgets of the users of information and not into those of its producers.
- There may be unwillingness to get rid of redundant systems.
- Firms are much less rigorous in weeding out unneeded white-collar workers than they are for blue-collar workers.
- The measurement of white-collar workers’ productivity and performance is still lagging behind.
- In many cases, white-collar bosses’ payment is based on the number of people who report to them.

Therefore, the broadly accepted notion that a transition from manufacture to services, from blue-collar to white-collar jobs, is a natural and desirable process at this stage of economic development, particularly in developing economies, seems to many researchers to be premature.

**Variations in the composition of capital**, its relative intensity, age and type also affect productivity. The growth of capital depends on savings and investment. The age of the capital stock also influences the diffusion of innovations to the extent that technological change is embodied in new investment goods. However, above-average capital input per worker does not necessarily increase output per worker. Much of the capital investment that did take place in the 1970s, for example, did little to raise labour productivity. In Canada, Japan and the United States capital intensity differs significantly from relative productivity performance. Some manufacturing industries achieve high productivity with relatively low capital intensity, barely exceeding that of commerce.

**The structural impact** of R & D and technology is another important factor in productivity improvement at the macro level. The management of R & D and technology and the implementation of new methods, techniques, products and processes can significantly influence productivity and at the same time change structure: examples are the introduction of assembly lines, computers and microprocessors, and modern communications equipment. For example at present, in the rise of flexibility of the markets, it is essential to focus on mastering the fundamentals of the flexible manufacturing systems technologies.

Foreign investment is often an important factor in the introduction of new technology. However, indiscriminate imports of technology can injure countries. There is a growing awareness of the need for indigenous technological competence and research within the countries and industries concerned.

**Economy of scale** is also closely related to productivity and the industrial structure. Small and medium-sized enterprises can be fully competitive if they specialize and have long production runs. Some developing countries such as India, Indonesia, the Philippines and Thailand have deliberately promoted decentralized, rural and other small-scale industries in order to reduce unemployment and poverty, to curb urban migration and to help traditional artisans. Japan encourages small-scale industry to introduce and adapt imported technology and improve economic
viability. In this sector, capital can be productive and innovative. Even reverse engineering and
technology transfer from small to large-scale sectors can be effective.

*Competitiveness* affects the productivity of both the economy and individual enterprises. In-
dustrial competitiveness is often linked with the immediate and future ability of, and opportunities
for, entrepreneurs to design, produce and market goods within their respective environments
whose price and qualities form a more attractive package than those of competitors abroad or in
domestic markets. Among the factors which affect competitiveness are:

- the dynamism of the economy (growth rates, monetary strength, industrial production, direct
  and indirect labour costs, per capita output, employee motivation, turnover and absenteeism);
- the dynamics of the market, when efforts to improve competitiveness are directed to more
  intensive market forces;
- the strength of the commercial banking sector, stock and bond markets and their ability to
  provide capital;
- human resources (the quality of the labour force, employment, unemployment, executive
  quality and motivation);
- state fiscal policies and other regulations;
- resources and infrastructure;
- outward orientation, the will to promote international trade actively;
- innovative forward orientation which emphasizes national and corporate R & D efforts; and
- sociopolitical consensus and stability, the degree to which strategies and policies reflect a
  society’s aspirations.

2.1.2 Demographic and social changes

Structural changes in the labour force are both demographic and social. The high birth rates
and low mortality rates of the postwar period sent the world population soaring from 2.5 billion in
1950 to 4.4 billion in 1980. By the mid-1960s, the postwar baby boom was beginning to reach the
job market. At the same time, the number of women entering the labour force was steadily rising.
In addition to this, workers in the industrialized countries have increasingly had to compete not
only with each other but also with labour from the developing countries. Attention to various as-
pects of health has resulted in a tremendous saving owing to less illness, an extension of life and
increased vitality over the long run. These demographic changes have an impact on job seekers,
on worker experience and useful work skills, and on the demand for goods and services. Geo-
 graphical shifts of the population will probably also affect productivity as population density var-
ies from region to region.

Among the social factors, special attention should be paid to the increasing percentage of
women in the labour force. This is still well below that of men but it is increasing. A change in the
ratio of working men to women affects earnings. Men currently have a higher average income
than women. Much of this difference has been attributed to education, full- or part-time work and
length of work experience. As these facts change, so, most likely, will productivity and the in-
come structure. The retirement age may drift upward, as health and longevity improve. Eco-
nomic pressures may also persuade many older people to stay in the labour force.

All aspects of education affect productivity. Over the past few decades educational spending
has grown significantly. By the end of the 1970s educational expenses in Canada, for example, represented 8 per cent of GNP, and government spending on education accounted for 22 per cent of total government expenditure.

Cultural values and attitudes can also promote or hinder productivity. For example, the Chinese are known for their belief in hard work, their entrepreneurial spirit and their propensity to save. The Japanese are famous for their ability to seek, accept, assimilate and adapt to changing needs and circumstances, for their team spirit and discipline. In some countries, greater respect is traditionally given to brainpower than to manual work; in others, the elderly are valued, not merely tolerated.

It is important to study and understand these beliefs, attitudes and traditions, all of which change with new technology and economic and social development. The countries that have become development-oriented are under increasing pressure to upgrade their development policy and institutionalize social change through education and the media.

Below we should like to suggest a few more cases from different countries, and it would be useful for trainees to discuss what is common and different in your specific situation, and what could be projected for your own country or countries.

The case of Singapore

One of the most significant trends affecting productivity in Singapore is the expected slow-down in the labour force growth rate. From an average of 4.7 per cent during 1966-80 and 14 per cent during 1981-88, the growth has been projected to fall to 0.5-0.7 per cent in the 1990s. As capital investments are also expected to slow down, this means that economic growth can no longer come from mere increases in labour and capital inputs. Instead it will have to depend more on the greater efficiency with which labour and capital are used, or Total Factor Productivity (TFP). In the developed countries TFP contributes as much as 60 per cent to economic growth.

A consequence of the slower labour force growth is the increasing proportion of mature workers. From 25 per cent in 1981, the proportion of workers aged 40 and above increased to 28 per cent in 1988 and is expected to rise to 48 per cent by the year 2000. Correspondingly the median age of the workforce will also rise. In 1981 it was a relatively youthful 29 years, by 1988 this had edged up to 33 years, and by the turn of the century it is projected to reach a mature 38 years.

The gender composition of the labour force is also changing. The female labour force climbed from 45 per cent in 1981 to 48 per cent in 1988 and is expected to reach 50 per cent by 1995. At the work place, the amount of capital per worker in the 1990s will be at least double that of 1981. Rapid technological changes are adding new products and services, while making existing ones obsolete at a much faster rate.

Discuss this case in small groups and try to identify positive and negative productivity forces and barriers resulting from the above-mentioned demographic shifts. Do you have any suggestions to reduce the impact of negative forces? Relate this situation to that of your own country.
Canada. One of the most critical labour market issues in Canada is how to accommodate an overall slow-down in growth and an ageing population. Key trends include:

- Labour force growth is slowing down to an average rate of only 1.2 per cent during the 1990s.
- Fewer young people are entering the labour market (26 per cent in 1981 down to 17 per cent by 2000).
- By 2000, the percentage of the labour force aged 55 and above will be 49 per cent, a rise from 39 per cent in 1986.
- There is an increasing tendency for workers to retire at 60 with lower national pensions rather than to work until 65.
- Increasing participation rates of women are being experienced - today, 42 per cent of the labour force are women; within ten years their labour force share may rise to 50 per cent.
- Increasing participation by disabled persons in the labour force will result from technological advancements and sociological shifts towards their active participation.
- New immigrants to Canada are accounting for a growing proportion of new entrants to the labour market.

Despite having a highly educated workforce (in 1988 17.6 per cent had a university degree and 16.5 per cent had post-secondary education), almost 25 per cent of Canadians lack the basic literacy skills: one-third of these are secondary school graduates.

As regards the reduced number of young people entering the Canadian workforce, the educational picture is by no means encouraging. The national secondary school drop-out rate hovers around 28 per cent, having dropped slightly from the 35 per cent of the late 1970s.

All this has to be set against a background of rising skill requirements. Of all the jobs created between 1986 and 2000, it is predicted that 64 per cent will require more than 12 years of education and training and that almost half of these new jobs will need more than 17 years.

The challenges which policy-makers are facing today include how to facilitate lifelong learning to keep pace with evolving technologies, how to facilitate the retraining and training of older workers, and how to make the labour market more accessible and equitable for disabled persons, women and minorities.

Some steps taken by the Canadian Government to cope with these problems include:

- attempts to reallocate resources from passive income support to active measures for the development of the labour force;
- calling upon the private sector to double its expenditure on formal training by 1994;
- substantial revision of the whole industrial relations framework;
- the establishment of new partnerships between industry and education;
- the adoption of innovative methods of training tied to the concept of lifelong learning; and
- the accommodation of new patterns of working life in taxation and pension arrangements.

Japan. The conditions that led to productivity improvement in Japan during the past 35 years are changing. The workforce is growing older and includes more women, and educational levels are higher. Japan has been an egalitarian society, where one could be rewarded for effort. This is now changing. In short, the culture that supported the productivity movement is being destroyed little by little.
Japan is a rich country with poor people. Workers do not feel affluent and are not really contented. They are faced with high prices for commodities, and very long working hours. The attitudes of young people are changing: a Japan Productivity Center survey showed their strong preference for more leisure. Companies must now provide two days off a week to attract younger workers, and some employers are offering three days off. This is a challenge to the "good old Japanese work ethic".

The Japanese work system was designed for younger and middle-aged workers who were prepared to work hard. There is now, however, a shortage of experienced workers who can handle modern technology. Employers have therefore had to provide extensive in-house training.

The quality of the workforce is changing. Fewer than 10 per cent of older workers have a college education. They are not familiar with new technologies such as microelectronics. Some cannot even drive a car. Now, however, the younger age groups are better educated. Baby boomers have college training, they know about computers, they can drive cars, and so forth. Women also have a higher level of education than previously. They are coming into the business world as candidates for posts in the professions or management. Young people want to do something interesting. Women and leisure-oriented people have a better sense of marketing, and are more intelligent consumers.

Rising unemployment levels in many developing countries may also be caused by the large numbers of young entrants into the workforce and the limited absorptive capacity of the agricultural and large-scale manufacturing sectors. In response to this serious situation, many governments are initiating a range of self-employment and small enterprise promotion programmes, since these areas of the economy are the only ones which can realistically be expected to absorb a significant portion of the unemployed. Of particular concern is the group of young people (15-29 years) where unemployment levels are already in the 60 per cent range in many countries. Other similarly affected groups are women and the rural poor.

Some useful facts about worldwide demographic shifts:

Discuss their impact on productivity and relate it to your own country.
Stagnant or decreasing population because of falling birth rates.
An ageing population, owing to changes in the age pyramid and increasing life expectancy.
Growing rates of employment of women and of older people.
Young people entering the workforce are using their market advantage to move quickly ahead. They are no longer looking for lifetime employment; they are more oriented to leisure time, and loyalty to the company is decreasing.
There has been an increase in average educational levels.
Between 1980 and 2025, the population will triple in Africa and double in Asia and Latin America. However, in the industrialized countries and China population growth rates will stabilize and possibly decrease.
17 per cent of working-age persons are unemployed and 20 per cent are below the poverty line.
In 10 years time about 50 per cent of all people will be living in urban areas.
Women’s participation in the workforce is up by 41 per cent in industrialized countries and by 32 per cent in developing countries. A very high percentage of women work part-time. Older workers (over 55) constitute 20-26 per cent of the population of industrialized countries.

2.2 Resources

The most important resources are manpower, land, energy and raw materials. A nation’s ability to generate, mobilize and use these resources effectively is crucially important to productivity improvement and is, unfortunately, often overlooked.

2.2.1 Manpower

People are the most precious natural resource. Several developed countries such as Japan and Switzerland, which lack land, energy and mineral resources, recognized long ago that their single and most important source of growth is people, their skills, education and training, attitude and motivation, and development. Investment in these factors improves the quality of the labour force. The most developed countries take great care to invest in educating and training their manpower. Countries with a higher per capita GNP generally have a better trained and educated population. Attention to health and leisure has resulted in a tremendous saving, since the result is less illness, longer life expectancy and increased vitality. The general quality of labour has improved with improving health.

Thus the priorities in human resource development policies aiming to match manpower supply and demand in order to improve productivity could be the following:

- Invest in education and training. Unfortunately, in many developing countries, in times of financial difficulty education and training budgets are usually the first to be cut.
- Match supply and demand. Any shortage of young people has to be met by older workers and women. Incentives need to be provided for training institutes to train women for different productive activities.
- Flexibility and mobility of manpower are required to increase multiskilling and non-conventional work (temporary, part-time, working at home, and so on).
- Pay attention to young people, women and other special groups of worker, with the emphasis placed on careers, opportunities for advancement, and learning.
- Older workers are an especially useful resource. They can fill the gap created by the reduction in the number of young people entering the workforce. Also, older workers are “younger” (in spirit, in their capacities, and in health). A third advantage of older workers is that if they are working they are less of a financial burden on the social security system.

In conditions of economic globalization, more people are needed with the education and training enabling them to take on broader responsibilities in international business, through learning other languages, and about other customs and cultures. This means that investment, both public and private, in education is of critical importance in providing conditions for long-term productivity growth.
2.2.2 Land

Land is the most fundamental material input and a very important productivity factor. It requires proper management, development and a national policy. For example, industrial expansion and intensive farming have become aggressive consumers of land. The cost of land in urban areas influences the character of industrial and residential architecture and thus land productivity as well. Pressures to increase farm productivity per worker and per hectare can accelerate soil erosion. Such land loss can often be masked by using more fertilizer, but at increasingly high cost and with a risk of environmental pollution. The rising cost of energy-intensive agricultural input, the limited availability of new land, and the urgent need for more careful husbandry to prevent serious erosion all argue for a more prudent use of available land and sound government policies and regulations.

2.2.3 Materials and energy

Energy and raw materials are the next important resource. The dramatic rise in energy prices during the 1970s was the single most important cause of declining economic growth and productivity. Much of the capital investment that took place during that decade did little to raise labour productivity since it was directed towards retooling the economies to adjust to higher energy prices.

As the price of oil rose, a considerable amount of capital stock became obsolete and urgently needed to be replaced or used less intensively. As producers cut back on energy use and capital investment, their only recourse was to use more labour. Thus, the demand for labour tends to follow energy prices upwards. However, though more hours are worked, total output may not rise commensurately.

Raw material prices are also subject to fluctuation. As the richest and most accessible sources of minerals are mined out, the need to exploit lower grades of ore in more difficult locations has called for a more intensive use of capital and labour. This reduces productivity growth in extracting industries, despite increasing automation in many countries. The exploitation of ever more marginal mines decreases productivity further.

As the cost of materials rises, the economic rationale for repair, reuse and recycling becomes more compelling since, though productivity in the strictly conventional sense is lower for such work, it is much less expensive for society as a whole than buying new materials. This implies adopting the approach of sustainable development, with environmental considerations playing a greater role, in order to achieve growth with a higher quality of the natural environment.

2.3 Government roles, policies and infrastructure

Government policies, strategies and programmes greatly affect productivity through:

- the practices of government agencies;
- regulations (such as price control, income and wage policies);
- public infrastructure (transport, communications, education and health, etc.); and

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fiscal measures and incentives (interest rates, tariffs, taxes).

Many structural changes that affect productivity result from laws, regulations or institutional practices. In addition, the whole area of public administration and service productivity itself is extremely important because it enables governments to provide more services with the same resources and/or at lower cost. To design good policies, plans or programmes for company productivity improvement, all the external factors resulting from government roles and interventions should be analysed, understood and considered.

Three tiers of government organizations are concerned with promoting productivity in society. The top tier focuses on macro (or national) policies and frameworks. The middle tier is concerned with productivity targets and mechanisms that contribute to national aims for economic and social development. The third tier consists of enterprises and groups of enterprises, professionals and workers who analyse and implement improvements.

These three levels have both direct and indirect means of action. Direct intervention by government includes running public enterprises, determining government investment, sponsoring productivity enhancement schemes, etc. Indirect government intervention includes the popularization of productivity awareness, the sponsorship of education and training, and the support of institutions and institutional mechanisms promoting productivity.

All these means of action influence important macro productivity factors such as:

- macroeconomic structural change, economies of scale;
- labour structure and policy;
- education and training policy;
- technological change, research and development policy;
- the public infrastructure;
- the exploitation of the natural environment, raw materials and energy;
- the business cycle; and
- the international business and political environment.

An example: Australia

A recent survey in Australia on productivity barriers indicated that the taxation system takes away the incentive to work harder. Workers’ and entrepreneurs’ motivation needs to be improved. There was a particular call for relief for small businesses, such as finance at low interest rates, more emphasis on training (in particular, multiskilling), etc.

Let us therefore consider national and international activities in productivity improvement, taking into account the above-mentioned dimensions.

The effectiveness of national efforts to improve productivity depends largely on the extent to which the most important social forces can be combined and integrated. These forces include:

- government and its institutional mechanisms;
employers and managers, represented by their professional associations;
- workers, normally represented by trade unions; and
- other non-governmental organizations.

All these forces play (or should play) a major role in productivity drives at the national level through:

- direct intervention and participation in industry and economic processes, coordinating the activities of all the major social groups in productivity promotion;
- improving the quality of both workers and managers through productivity-oriented professional education and training;
- raising public awareness and productivity consciousness; and
- influencing business and labour legislation that encourages productivity growth.

It is important to stress that, in fact, government intervention often does not correspond to the real needs. There are also many cases where direct government intervention is less necessary and such indirect methods as economic and fiscal policy, legislation, education and training are more effective.

It is important that government intervention should be combined with decision-making at the lower levels - sectors, enterprises and even individuals. Good policy and strategy, government stability and strong leadership capable of implementing its own decisions are all necessary for economic growth and higher productivity. These are achieved by different combinations of promotional or regulatory policy measures.

Policy instruments available include such possibilities as public enterprises, accelerated depreciation allowances, low interest loans, subsidy programmes, advance exemption and reductions, tax concessions, incentives including tax holidays, and pioneer status for new types of business. All of these have been used effectively and with discrimination in many countries to accelerate and redirect capital investment, promoting high rates of economic and productivity growth. But indiscriminate reliance on some of these instruments, especially price controls, has proved unproductive in the long run.

Thus, while government control and intervention are necessary, they are effective only if they are applied with prudence and with a flexible approach. There is a short list of government instruments which any manager of productivity improvement programmes should understand in order to appreciate the possible positive and negative impacts of government regulations. This list includes:

- national economic plans and policies;
- public enterprises: investments and market position, and the roles these enterprises could play;
- labour legislation;
- pollution control;
- health and safety legislation;
- social welfare;
- commodity price support;
- monopoly on patents;
- required audits from enterprises;
- tariffs and import quotas;
- taxes and tax advantages;
- legislation encouraging affirmative action;
- government grants and subsidies;
- regulations on working conditions;
- restraints on competition;
- anti-trust enforcement;
- laws on incentive payments; and
- free or subsidized facilities or utilities.

The design of productivity improvement programmes or policies should take into consideration these and other environmental constraints or incentives. Let us now consider some aspects of the government role in productivity improvement.

2.3.1 Macroeconomic structural changes

As mentioned before, recent decades have witnessed a significant shift in the economic structure of developed countries: the proportion of high-productive manufacturing industries has decreased and the proportion of low-productive services has increased. This results in a decrease in national productivity. Consequently, the task of increasing productivity in the service sector has become an important national goal in many countries.

Government economic policy pays especial attention to economies of scale. In general, there is a strong correlation between the size of an enterprise and the output per worker. Large-scale production is often necessary for the full utilization of equipment; the cost of large-scale transport rises proportionately less than the increase in volume transported; larger plant makes possible a greater division of labour and greater specialization of workers.

Economies of scale do not, however, imply any neglect of the potential of the small and medium-sized enterprise sectors for productivity improvement. Small and medium-sized enterprises often constitute more than 90 per cent of developing countries’ economic units and in the manufacturing sector often account for more than one-half of total employment. An advantage of small and medium-sized enterprises in developing countries is their relatively low dependence on scarce managerial, technological and capital resources. Their social importance lies mainly in their ability to use local skills and resources to generate employment, sometimes even to a greater degree than capital-intensive large enterprises.

Finally, they offer flexibility, which is very important in the fluctuating business cycle of the modern economy and in a situation of rapid social change.

Increasing competition, rapidly changing technologies, budget deficits and inefficiency of public companies have led many governments to introduce a number of adjustment measures, including deregulation and privatization, moving towards a greater reliance on market forces and on decentralized decision-making.
2.3.2 Business cycle

Changes in productivity arise from a wide variety of causes associated with the business cycle. These changes have an important bearing on production costs as well as on prices, profits and incentives to invest, and therefore on inflation and economic growth, particularly in market economy countries with a low degree of government intervention.

Using sophisticated national statistics, economic research and marketing institutions can now predict business changes and inform industry about them, so that productivity slow-down during business recessions need not be so disastrous as in the past.

Good government long-term planning mechanisms, especially in developing countries, can also help the country to be prepared for business cycle fluctuations and thereby decrease their negative effect. Using a well-balanced intervention strategy, a government can promote new sectors and reduce the risks involved in initiating change by targeting sectors for new or stepped-up activities and by making resources available on favourable terms. It can, in effect, alter the risk/reward prospects, and offer negative incentives such as high-cost credit for investment in sectors it wants to discourage. Public companies and subcontracting arrangements can be used to promote and speed up government intervention, which can eventually reshape the industrial profile of a country.

However, indiscriminate and uncoordinated government intervention often results in decreasing economic efficiency. For example, isolated attempts to control inflation often result in depressed output, increased unemployment, declining investment and negative effects on economic growth.

2.3.3 Technological changes and R & D policy

It is vital to develop the optimal relationship between old and new techniques and equipment, and between different production processes which help to improve the effectiveness of fixed capital. One of the effective tools in this field is government legislation of depreciation, taxes, and patent and subsidy policies.

The optimal structure and high quality of R & D in a nation can make a huge contribution to productivity improvement. For example, about half of total R & D expenditure is estimated to be “productive” in the sense of having a direct influence on productivity growth.

One of the problems in this field is maintaining the right balance between basic and applied research. It is very important to close the existing gap between invention and its integration into the production process.

A great deal depends upon government policy in this field, e.g. the organization of R & D institutions, the distribution of funds between them, the priorities in science and technology, motivation, national impediments to the “brain drain”, and so forth.

A government can protect the domestic market during the initial period when the cost of new technology is relatively high by providing low-cost, long-term finance to promote capital
investment, and by restricting imports of foreign technology. It can also push companies to adopt the latest technologies and set minimum sizes for new plants.

2.3.4 Public infrastructure

A most important role of government is to provide the necessary infrastructure and to create opportunities for growth. Infrastructure covers education and training, health, housing, power, water, transport, communications, finance and banking, R & D, and the dissemination of technology. For example, without tremendous government investment in R & D, the growth of agriculture, highways, airports, water supply and railway systems would never have been possible in many countries. These systems provide the infrastructure to practically all other industries and, therefore, without their growth, the productivity increases of most industries would have been greatly hampered. All functions, services and financial support provided by the government have a profound and direct impact on all aspects of the national economy.

Besides, the public sector in the developed market economy countries now employs about 15-20 per cent of the total workforce, and the service sector more than 50-60 per cent. Increasing the productivity of the infrastructure is therefore itself a significant problem.

2.3.5 Natural environment

One shortcoming of present methods of productivity evaluation is that they do not adequately take into account the use of natural resources. Changes in the value of resources such as land, and the consumption of underground resources such as oil and minerals, should be incorporated into productivity measurement. The effects of pollution may also need to be included as a productivity factor (decreasing productivity in the short run but perhaps increasing it in the long term through improving the environment and the quality of life, as well as avoiding increasing fines for environmental pollution).

Raw materials and energy could also be considered as a significant aspect of natural resources. Their optimal use is an important government responsibility. One of the main goals of government policy is to maintain the accessibility and reasonable price of raw materials and energy, and to balance this with the protection of the environment and industrial demand. Proper government legislation, prices, fiscal and taxation policy and other environmental protection measures can force consumers (both industrial and individual) to minimize their consumption of energy and materials without prejudicing economic growth.

2.3.6 Manpower development

An effective employment policy is one of the important factors in productivity improvement, since the productivity of the national economy must be assessed from the point of view of the utilization of all available manpower. Unemployment reduces national economic and social performance independently of the effectiveness of some industries or individual enterprises. Thus any government needs a well-developed labour market system and a mechanism to pursue progressive structural changes. It has two main tasks:
- to develop and use human resources as fully as possible; and
- to fit the labour force structure (occupational, skill, sex, age, etc.) to the requirements of modern sectoral change.

No new technique or modern productivity improvement scheme can be introduced and used effectively without well-trained and educated personnel at all levels of the national economy. Therefore a strong and long-term government educational and training policy should be among the first priorities. This policy should promote balance and co-ordination between primary, secondary and higher education, between general and professional education, between specialist training in social and scientific subjects, and so on. Especial attention should be given to training managers and supervisors both for industry and for government bodies. These people will be responsible for productivity improvement at all economic levels.

A number of studies have revealed a significant positive correlation between education and productivity. Even a basic comparison of economic performance between different countries demonstrates that the best results, as regards both level of productivity and rate of economic growth, are found in those countries where manpower is better educated.

Indeed, technology is a product of education, culture, creativity, motivation and management systems. In the long term it is no exaggeration to define productivity as a type of mentality, based on education and culture, which develops the capacity to organize.

Thus, education can be seen as a major means of accelerating the development of the workforce and improving its quality. Figure 2.3 shows the multi-layer links between productivity and education. It can be clearly seen that people are the main productivity resource in the long term and are therefore the most important factor. In its broad sense, education covers all types of learning processes in human beings, both formal and informal:

- family education and upbringing;
- formal education in different establishments;
- practical experience; and
- experience of various social and cultural environmental influences.

Governments might encourage a more open and regular dialogue between industry and the education system, as well as between the components of the education system at different levels. Education and training curricula should include productivity issues stressing a human, behavioural attitude as an important component. A real, concerted and coordinated effort by all institutions dealing with education at all social levels and in all economic sectors is required to achieve this goal.

### 2.4 National productivity movement

Efforts to raise productivity nationally require effective governmental and non-governmental organizations to bring together all the elements of productivity.

Since productivity depends on many factors, both inside and outside the enterprise or sector, it is very important to create the economic, social, political, legislative and organizational
Figure 2.3: Links between productivity and education

- **Man**
- **Technology**
- **Materials**
- **Energy**
- **Processes**
- **Organizations**
- **Socio-economic structure**

**MANPOWER**

- **Work attitude**
- **Knowledge**
- **Skills**
- **Opportunities**

- **Motivation**
- **Labour-management relations**
- **Participation**

**VALUES SYSTEM**

- Traditional culture

**EDUCATION**

- **Formal education and training**
- **Non-formal education and training**
- **Informal education and training**

- Universities
- Colleges
- Schools
- National productivity centers
- National management development centers
- Training institutes
- Consultants
- On-the-Job training
- Seminars, conferences, meetings, etc.
- Educational media

**STRATEGY FOR DEVELOPING AND CO-ORDINATING EDUCATIONAL SYSTEM**

- Learning through doing
- Environmental influence
- Family education

conditions that favour productivity improvement. Therefore, one of the decisive points for productivity improvement on the national scale is mutual understanding between the main social partners and beneficiaries of productivity. This is achieved by means of equitable sharing in productivity gains, and by strengthening social and job security, labour legislation, real worker participation in management and other progressive changes.

Because of the interaction between productivity and these factors, the promotion of a national productivity movement programme and its realization, even on a limited scale, can have the catalysing effect on enterprise productivity improvement programmes.

To promote a national productivity movement, many countries have established special organizations, both national and regional, public and private. These organizations normally train, consult and do research. They can also assist other organizations or sectors in planning and carrying out their productivity programmes. Such institutions or centres are normally supported by government, employers, labour and other interested social groups. The main issues dealt with are:

- speeding up the elaboration of national objectives that can be adopted by governments, employers and workers;
- developing new productivity measurement systems and tools, information and data collection;
- carrying out applied research;
- performing demonstration projects, providing productivity consultancy;
- offering expertise for interested organizations;
- providing inter-firm and inter-country productivity comparison services; and
- offering educational and training services, both technical and those designed to raise awareness.

Specifically, the major long-term activities of many of the most successful national productivity centres are:

- creating a favourable climate and public awareness within the country so as to include the whole population in establishing national goals and priorities;
- working out a purposeful government policy for productivity improvement;
- establishing (or improving the effectiveness of) the statistical bodies which deal with data collection and analysis at the sectoral and macroeconomic levels; and
- increasing the role of such financial incentives as taxes, credit and incomes policies.

The development of an institutional mechanism which can accept challenge, provide the necessary input and forge closer links between interested parties is very important for the integration of national efforts and the provision of support to institutions engaged in promoting productivity.
Exercise: Discuss the following case and compare with your country’s productivity institutional framework. Indicate what is transferable to your working conditions and what is difficult to transfer, and why.

Japan Productivity Center

The Japan Productivity Center (JPC) was established in 1955. Its approach to productivity is based on three guiding principles:
- improved productivity will lead to increased employment opportunities and provide greater job security;
- methods of productivity improvement adopted should be discussed and agreed between labour and management; and
- the gains resulting from improved productivity should be evenly distributed between consumers, labour and management.

The structure of the JPC is as follows:

The policy-making body, i.e. the Board of Directors, is composed of representatives of business, labour and academic institutions. Though the Government is not a party to this body, it supports the movement as a part of its overall industrial policies and programmes. The Japanese productivity movement is, therefore, voluntary and oriented towards the private sector.

The JPC has established many special committees and study groups to deal with emerging issues. These committees and groups submit their findings and recommendations to government, employers and workers to help them to set their goals, policies and programmes.

The JPC is endeavoring to improve productivity further. It vigorously promotes productivity education programmes directed towards both labour and management, emphasizing the three basic principles of the movement mentioned above. The programmes expose senior managers as well as shop floor workers to such issues as labour-management relations and consultation systems, profit sharing, etc. The effort to install in-house labour management consultation enables the JPC to say that 100 per cent of large enterprises and 40-50 per cent of small businesses now use the system.

Other important activities that the JPC has developed include sending study groups abroad, publishing reports covering their findings, and sponsoring meetings and seminars in order to ensure the wide dissemination of information on management development programmes and consultation services throughout Japan.
Questions for discussion

1. Why do you need to be aware of external productivity factors, if they are not under your direct control?
2. Why do external productivity factors need to be classified in certain groups? What is your opinion of the suggested classification? Could you suggest a different one? If yes, explain its advantage.
3. How can you use your knowledge of the external factors in your decision-making?
4. What kind of information would you need to know about external factors to take them into consideration during strategy identification and planning?
5. Are any external factors missing from this unit that are important for your decision-making?
UNIT 3: INTERNAL PRODUCTIVITY FACTORS

UNIT 3: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. List and explain the role of the most important internal productivity factors.

2. Distinguish between input-, process- and output-related factors and explain how they influence the productivity level.

3. Place in order of priority and take into consideration the potential role of external factors in the decision-making process.

UNIT 3: CONTENTS

3.1 Input-related factors

3.2 Process-related factors

3.3 Output-related factors
UNIT 3: INTERNAL PRODUCTIVITY FACTORS

If external productivity factors may be considered as environmental forces which are not under the enterprise’s control in the short term, internal productivity factors are those which could and should be influenced by the enterprise’s management.

A good example of management’s role in controlling and managing internal productivity factors could be to break down the work content by the time spent on productive and non-productive activities (see figure 2.4).

Figure 2.4: How operational time is made up

The work content is the amount of work “contained in” a given product or process measured in “work-hours”.

The basic work content is the time taken to manufacture the product or to perform the operation if the design or specification of the product is perfect, if the process or method of operation is perfectly carried out, and if there is no loss of work time for any reason whatsoever during the period of operation. Thus, the basic work content is the irreducible theoretical minimum time required to produce one unit of output.
The excess work content (total ineffective time) is caused by poor product design or utilization of materials, inefficient methods of manufacture or operation, and ineffective time resulting from an unsatisfactory human resources situation. These groups of factors will be discussed in detail in the relevant section of this module. What is most important at this stage is to demonstrate that all these groups are internal productivity factors and can be controlled by managers.

We shall now follow the internal productivity factors through the production process. Each of these elements has its specific objective and logic. The first organizational element (input factors) is responsible for the provision of all necessary resources of the proper quantity, quality and price and at the right time and place.

The second element is the actual production process - the process of transforming resources (input factors) into products, i.e. output. Feedback could also be considered as an important part of the production process, since it deals with the measurement, assessment and analysis of the most important production stages and results, and with productivity (effectiveness). The third and last element (output factors) deals with the product mix: packaging, pricing, sales, delivery and after-sales services, etc. The optimal combination of these three groups of factors is critical in achieving an overall productivity improvement for the whole enterprise.

3.1 Input-related factors

The most important input productivity factors may be grouped as follows:

- capital, plant and equipment;
- technology and know-how;
- materials and energy;
- product design; and
- people.

3.1.1 Capital, plant and equipment

These include the volume and structure of capital investments in plant and equipment and the proper choice, taking into consideration the level of innovation, costs, quality and reliability and certainly the appropriate technology for the chosen production/technological process.

It is the task of company management to look into the capital goods that are on the market and to make the appropriate analysis and justification to minimize costs and to maximize future returns on investment (ROI), which is actually capital productivity.

Thus, the latter can be greatly influenced by experienced investment and supply specialists at the input stage, before a decision is actually taken. When making such decisions it is important to compare the price and (expected) future effectiveness, not only between alternative capital equipment but also between equipment and the workforce. This is normally called factor substitution.

A cheap and low-skilled workforce is often a barrier to mechanization, which in developing countries could be much more expensive than labour. However, in the short term, the results of
productivity analysis may point to the substitution of capital by labour, which could improve both productivity and employment opportunities in some regions. The long-term trend is for the substitution of labour (particularly low-skilled labour) by capital.

### 3.1.2 Materials and energy

Improving productivity also depends to a great degree upon the optimal choice of materials (even before their use in the production process). The material yield (output per unit of material or energy used) depends upon selection of the right material, its volume and mix, its quality and its market price.

Managers dealing with the provision of materials and energy should pay particular attention to long-term contract relationships with suppliers; to maintaining continuity of suppliers; and to developing new alternative sources of supply and import substitution. The use of lower-grade and cheaper materials is also recommended. Other important input factors are the reliability and timeliness of delivery of materials, energy and spare parts. Paying attention to these matters will help to optimize the materials stock situation, reduce the storage space needed and decrease other overheads as well as saving energy.

### 3.1.3 Technology and know-how

Technology, know-how and other information which is bought in the market-place should also be considered as an input factor, and thus any reasonable cost reduction on this side would contribute to productivity improvement. In technology choice many criteria should be taken into consideration, but the most common and important are: cost/benefit prospects; environmental friendliness; the availability of equipment for the chosen technology; and mass/individual production expectations.

Technological innovation constitutes an important source of higher productivity. More goods and services, quality improvements, new marketing methods, etc., can be attained through increased automation and information technology. Automation can also improve materials handling, storage, communication systems and quality control.

When considering these criteria it is important to compare cost and benefits for technology bought in the market-place with those for technology developed at the enterprise (if feasible). In many cases the latter may be more effective. The availability of skilled manpower (or the costs of its selection, hiring and training) should be also an important criterion when considering a technological choice.

### 3.1.4 Product design

Product design may actually be considered as a productivity factor at all stages of production (input-process-output). If product design is undertaken by the producing company, it should be considered as a process factor; but if it is bought in the market-place (for example, under licence) it should be viewed as an input factor like any other externally purchased resource. On the input
side it is important that the design of a product ensures that it can be produced with the least possible use of labour and capital.

In view of the importance of product design, therefore, product designers can contribute greatly to productivity improvement if during the design stage they can think professionally about a design’s impact on input and process costs. Besides leading to a reduction of the product design cost, which in many cases is very high, it could also contribute to productivity improvement.

3.1.5 People

Manpower (workers, engineers, managers and entrepreneurs) is the principle resource and the central factor in productivity improvement drives. On the input side the most important considerations, when dealing with the choice of workers, specialists and managers, are: their skills and education; their career and incentive expectations; their attitudes and values; and their health (physical capabilities).

Skills and education are critical for all kinds of production. The invention of new products is essentially an élite activity and can be very successful when based upon an élite education. In many cases the education and skills of the top 25 per cent of company manpower are what counts.

On the other hand, in process technology, the skills of the lower 50 per cent of the labour force are critical since it is they who manage and monitor the production process. New process techniques, such as statistical quality control or machine scheduling, require average production workers to have a level of education and skills that has never been required in the past.

Thus, to minimize internal training costs (and/or turnover), each individual enterprise strives to hire a well-educated and trained labour force using modern marketing and personnel selection techniques.

Managers should also take care to study future workers’ expectations and motivation. Some of them would put paying bills as their highest priority, while others would give preference to good career opportunities and a conducive working environment, etc. All these should be analysed and matched with company policies, production objectives and financial power to meet labour force expectations.

For many professions health is also an important factor to be taken into consideration while making selection decisions.

In other words, the main objective of the personnel manager at the input stage is to select and hire at minimum cost the minimum necessary manpower which, by its education and skill profile, health aspirations and attitudes, meets as closely as possible the company’s manpower needs and development objectives.

At later stages (process and output) this strategy minimizes, though never eliminates, the costs of manpower development and changes, thus contributing to productivity improvement.
3.2 Process-related factors

Effective process organization and management is the next important condition of productivity growth in any manufacturing or service company. This is the decisive stage, when available resources (input) are transformed into final products or services to be sold (output). In this connection, the most important productivity factors in the process stage are linked with:

- people (workers, specialists and managers);
- product design;
- technology;
- plant and equipment;
- materials and energy;
- work methods; and
- organization and management styles.

The order of this listing has nothing to do with the factors' importance or priorities. These are often changed according to the enterprise, its business conditions, its specific problems and stage of maturity, and so on.

3.2.1 People: Motivation, working conditions, industrial relations and training

In the process stage, the human factor of productivity improvement always refers to the development and effective use of human resources. For example, workers in an enterprise can influence the time of operations voluntarily or involuntarily as follows:

- Absenteeism and lateness. If management fails to provide a safe and satisfying work climate, workers may respond with absenteeism, lateness and deliberately “going slow”.
- Accidents and occupational hazards. If management fails to provide a safe and healthy place to work, accidents or occupational illnesses can occur, with adverse effects on morale and increased absenteeism.

If these factors can be eliminated, the minimum time and cost for the production of a given output, and hence the maximum productivity, are achieved. The human factor, in turn, can have many dimensions or subfactors, such as: the quantity and composition (age and sex) of the workforce; the skills level and structure; educational and cultural background; attitudes and values; and interests (incentives and motivation).

The productive use of manpower involves two important aspects: application and effectiveness. Application is the degree to which people apply themselves to their work. People differ not only in their ability but also in their will to work. This is explained by a law of behaviour: motivation (or “will to do”) decreases if it is either satisfied or blocked from satisfaction. For example, workers may do their jobs without working hard (no motivation), but even if they did work to their full capacity they would not be satisfied (motivation is blocked from satisfaction).

The second aspect in the productive use of manpower is effectiveness. Effectiveness is the extent to which the application of human effort brings the desired results in output and quality. It is a function of methods, technique, personal skills, knowledge, attitude and aptitude - the “ability
to do. The ability to do a productive job can be improved through training and development, job rotation and placements, systematic job progression (promotion) and career planning.

We shall now discuss some of these subfactors.

Motivation. Motivation is basic to all human behaviour and thus to efforts in productivity improvement. Successful productivity improvement programmes are first of all characterized by a wide sharing of financial and other benefits throughout the organization. Each person's pay should be determined by his contribution to productivity, and pay increases should be awarded mainly on productivity results.

For example, to be an effective motivator, a bonus scheme must be directly related to achievement in as simple a way as possible, so that the recipient can see immediately how much he has earned from his efforts. Material needs are still predominant, but this does not mean that non-financial incentives have no place in motivation. The workers' success in increasing productivity should be reinforced immediately by rewards, not only in the form of money, but also by improving recognition, involvement and learning opportunities. If management can plan and execute effective incentive schemes, the result is invariably a significant improvement in productivity.

Discuss the following case:

How wages influence service productivity
in the United States and Germany

American firms always have a low wage option. Services could be manned with low-wage American workers, and low-tech products could be made with very low-wage workers in offshore production facilities. In the United States, minimum wages are very low (one-third of average wages) and are widely ignored (almost 10 million workers are employed at wages below the legal minimum). And because of immigration, there is a large inflow of new workers willing to work for low wages. Unskilled labour shortages are rare; and social insurance charges can also be avoided by employing part-time labour.

In Germany, social legislation such as minimum wage laws and unionization ensured that service functions were staffed with workers paid approximately the same as those in manufacturing. As a consequence, German firms had to make the investments necessary to raise service productivity to the level where they could afford to pay the high wages that they were required to provide.

As a result, in Germany, during the past decade service productivity has grown almost as fast as in manufacturing. In contrast, in the United States, service productivity has been stagnant.

It is also possible to improve productivity by obtaining the co-operation and participation of workers. Labour participation in goal-setting, for example, has been quite successful in many countries. Human relations can be further improved by reducing the complexity of
communications procedures and by minimizing conflicts. Labour productivity can be tapped only if management encourages workers to apply their creative talents by taking a special interest in their problems and by promoting a favourable social climate. To achieve this, it is necessary to balance the needs of companies and employees. With better education the labour force will have higher expectations regarding the design of jobs, the nature of work and the work environment. Management and workers have to understand and appreciate each others’ needs. Companies should meet their employees’ needs by introducing effective quality of life programmes; innovative employee participation practices; flexible work methods and welfare programmes; decent working conditions; and by ensuring employment security as much as possible.

A set of values conducive to higher productivity should be developed and enhanced in order to bring about changes in the work attitude and work ethics of managers, engineers and workers. The standard of performance should be set at a high but achievable level to maintain confidence and the “will to do”. The latter is affected by job satisfaction, which managers can enhance by making jobs interesting, challenging and bigger, self-contained and more worthwhile.

Industrial relations. Certain surveys indicate that in some south Asian countries cooperative labour-management relations contribute to 70-80 per cent of productivity growth. Fostering sound industrial relations would require developing effective partnership skills, managing information effectively and balancing the changing aspirations of companies and employers. Both parties must be equipped with effective partnership skills, covering communication, teamwork negotiations and joint consultations.

Greater acceptance by managers of responsibility for building up good employee relations is of critical importance. It is necessary to keep a close watch on status symbols such as closed offices, deep carpets, reserved parking spaces and executive dining-rooms, which symbolize a sort of “apartheid” between the various levels of people in the organization and do not contribute to labour-management cooperation and productivity drives.

Discuss the results of the employers’ opinion survey in Australia on the trade unions’ role in productivity improvement. Indicate what you agree or disagree with, relating the survey to your own company circumstances.

A generally negative perception of the impact of unions on productivity emerged from written comments made by the 51 per cent of respondents who offered suggestions for making Australian organizations more efficient. Some typical examples were:

- “Diminish the power of the unions ... but make management correspondingly more accountable and responsible for the welfare of employees.”

- “Reduce the number of unions ... have compulsory secret ballots.”

- “Too many Australian organizations are run by unions, not employers. This limits productivity and efficiency.”

Training. The training of employees (workers, specialists and managers) is one of the most
critical factors on the process side of productivity improvement. To be effective, training objectives, programmes and methods must be closely linked to the enterprise’s long-term strategic objectives and immediate production tasks and problems, and be flexible and result-oriented. Training should be considered as an important investment item.

As in many areas (equipment, materials, etc.), training should be linked to productivity objectives. The infrastructure and content of training, trainers’ skills and technology should become flexible and responsive to the needs of the organization.

In a world of rapid technological change the workforce must be adaptable and flexible to changing job requirements. Hence, the multiskilling concept should be promoted. Another modern trend is that in training the emphasis is shifted more and more from formal off-the-job training to company-based on-the-job skills improvement: in other words from a fragmented and formalized approach to one that is focused and result-oriented.

3.2.2 Product design

We have already discussed the importance of the design quality of a product at the input stage, when a product design is bought from outside the company. However, in many cases the company itself produces a design of the product or services, or makes necessary changes in the bought design during the production process. In these cases, when the design is part of the process, it is necessary to consider it as an important productivity factor.

For example, work content increased by poor design or product specification could have the following consequences:

*Poor design and frequent design changes.* The product may be designed in such a way that it requires a large number of non-standard parts, making the length of assembly time much longer. Excessive variety and lack of standardization of products or their parts may mean that work has to be produced in small batches, with time lost as the operator adjusts the equipment and shifts from one batch to the next.

*Waste of materials.* The components of a product may be so designed that an excessive amount of material has to be removed to bring them to their final shape. This increases the work content of the job and wastes material as well.

*Incorrect quality standards.* Quality standards that are too high or too low can increase the work content. In engineering industries, an insistence on sometimes unnecessarily tight tolerances requires extra machining and a corresponding waste of material. On the other hand, setting tolerances too low may result in a large number of rejects. Deciding on the appropriate quality standard and the method of quality control is an important efficiency consideration at the design stage.

3.2.3 Technology

Although, as mentioned earlier, technological factors should be taken into consideration at
the input and product design stage, there is plenty of room for technological advance and improvement at the process stage: for example, introducing automatization, mechanization, new processes, etc.

During the past 20 to 30 years, considerable productivity increases have been realized through the use of automation, and current developments in information technology suggest great improvements to come. Significant examples of the application of this technology are the development of automatic downtime recording systems and automatic lubrication systems which have reduced the idle time of men and machines, as well as overtime. New technology is often introduced as a result of such productivity improvement programmes as fighting obsolescence, process design, R & D and the training of scientists and engineers.

Usually, the improvement of technology begins with the scanning process - what exists or can be found or modified to improve performance. Copying is always faster than inventing. Developing countries that can do more copying and less inventing probably do not need as much R & D as industrialized countries at this stage of their development. It is also recommended that most of the R & D money in non-industrialized countries should be focused on process research, while the leading industrialized nations normally spend about two-thirds of their research funds on product development. The United States is spending 88 per cent on high tech research, 8 per cent on middle tech, and 4 per cent on low tech research. In contrast, Japanese spending is 21 per cent on high tech, 12 per cent on middle tech, and 67 per cent on low tech. The German proportions are 67, 23 and 10 per cent respectively.

Discuss and try to answer this question: Is it effective for a less industrialized country to copy the industrialized countries' pattern of R & D expenditure? Explain your reasoning.

As a result, the Japanese have demonstrated that rethinking simple operations at the process stage can be very productive in most companies, even outside manufacturing. Even small process improvements (in middle and low tech areas) could be widely disseminated and take advantage of economies of scale.

3.2.4 Plant and equipment

If at the input stage the most important decisions are linked with equipment selection and capital investment, the critical area at the process stage is in the effective loading, use and maintenance of capital, as well as depreciation policy. These would contribute to capital productivity and a high return on investment. Many specialists believe that somewhere between 20 and 25 per cent of productivity growth has taken place because of fixed capital: the effective use of land, buildings and machines.

The optimal loading of the plant and equipment is particularly important. It is not uncommon to find a rate of machine utilization of between 50 and 70 per cent, because of poor production planning and a lack of preventive maintenance.

The following methods for using plant and equipment better are suggested: designing
optimal technological processes and subsequently seeking potential improvements; achieving a fit between technology and machinery; scheduling the utilization of machines; operating the equipment in optimal process conditions; increasing plant capacity by eliminating bottlenecks and by introducing corrective measures; organizing good maintenance; reducing idle time; and providing better training for operators and supervisors.

Plant and equipment productivity can be improved by paying proper attention to utilization, optimal age structure, modernization, cost, investment, internally produced equipment, capacity maintenance and expansion, inventory control, production planning and control, and so on.

3.2.5 Materials and energy

One very important factor of productivity is materials and energy. Waste of raw material often comprises about 40 per cent of the total national production cost on average; if we take energy into account as well as raw material, this figure increases a great deal. It is often considered as the biggest cost element. Poor operator practice, poor layout and inadequate storage space can aggravate the problems of handling materials and lead to excessive movement.

Even small efforts to reduce the consumption of materials and energy can bring remarkable results. These vital sources of productivity include both raw and indirect materials (process chemicals, lubricants, fuel, spare parts, engineering materials, packing materials).

Improving the productivity of materials and energy at the process stage is a system against waste. Materials and energy are wasted in so many ways that we begin to accept these wastes as a normal part of doing business. Materials are wasted owing to wrong specifications, inadequate quality assurance efforts in the early stages of the production cycle, inadequate procedures in storage and handling, wrong production methods, defective machines or outright pilferage.

This wastage is caused by employees and managers. They are the ultimate determinants of the level of waste in an enterprise. Work habits and attitudes, production or office procedures, labour-management relations, communications and other factors that affect the human element—all these determine whether there will be a wasteful or a cost-effective operation. Several of the following ways may be suggested at this stage to plan and implement the productive use of materials and energy:

- ensuring that the process used is the best possible one;
- ensuring that operators are properly trained and motivated;
- ensuring proper handling and storage at all stages from raw materials to finished products, eliminating all unnecessary handling and movement;
- ensuring proper packaging to avoid damage in transit to the customer;
- ensuring proper handling and storage at all stages from raw materials to finished products, eliminating all unnecessary handling and movement;
- ensuring proper packaging to avoid damage in transit to the customer;
- ensuring proper utilization of scrap and other waste materials;
- ensuring shorter throughput time;
- ensuring less raw material and work-in-process;
- upgrading materials by initial processing to improve their utilization in the main process;
Case: Cost structure of Philippine industries

Discuss the following case, relating it to your own company. Suggest strategies and ways for waste reduction.

In a developing economy such as the Philippines, materials, energy and capital equipment account for the major cost elements in industry. It is also typical that in many companies substantial wastage is generated in the use of materials and energy and in the misuse of capital equipment. It is probably a conservative estimate to say that at least 5 to 10 per cent of materials, supplies and energy consumed in many companies actually go to waste. Some estimates put the figure as high as 20 per cent.

Let us take a glimpse at the cost structure of some typical Philippine companies:

Cost structure - Light manufacturing industries

<table>
<thead>
<tr>
<th></th>
<th>Cost as % of sales</th>
<th>7% target savings (expressed as % of sales)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Raw materials, supplies and energy</td>
<td>51 - 78</td>
<td>3.6 - 5.46</td>
</tr>
<tr>
<td>Depreciation, repairs and maintenance</td>
<td>1.5 - 7.5</td>
<td>0.11 - 0.52</td>
</tr>
<tr>
<td>Direct and indirect labour</td>
<td>1.9 - 5.5</td>
<td></td>
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</tbody>
</table>

Cost structure - Garments manufacturing (labour-intensive)

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<thead>
<tr>
<th></th>
<th>Cost as % of sales</th>
<th>7% target savings (expressed as % of sales)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Raw materials, supplies and energy</td>
<td>61 - 69</td>
<td>4.3 - 4.83</td>
</tr>
<tr>
<td>Depreciation, repairs and maintenance</td>
<td>1.5 - 4.5</td>
<td>0.11 - 0.32</td>
</tr>
<tr>
<td>Direct and indirect labour as % of sales</td>
<td>15 - 20</td>
<td></td>
</tr>
</tbody>
</table>

These data clearly indicate which areas have the lion’s share of costs. Materials, supplies and energy costs have a disproportionate impact on total costs. Let us consider the savings potential for these industries. We may assume a target of 7 per cent of major costs could be eliminated.

Potential waste reduction - Light manufacturing industries

A casual look at the savings potential shows that a conservative 7 per cent target saving on materials can be larger and amount to an equivalent of one-fourth of the labour cost, even in a labour-intensive garments industry. If improved energy management and equipment maintenance and operation are further included, total savings can be quite substantial without creating unnecessary threats to industrial peace.

Therefore, the cornerstone in eliminating waste is to concentrate on areas where they occur in substantial amounts and thus to generate equivalent savings.
3.2.6 Work methods

Improved work methods, especially in economies where capital is scarce, where the technology is intermediate and where labour-intensive methods dominate, constitute the most promising area for productivity improvement.

Additional work content, ineffective use of time and therefore higher costs can result from a poor method of carrying out the operations, which involves unnecessary movements of persons or materials. Similarly, ineffective use of time can also result from inappropriate handling methods, poor maintenance resulting in frequent breakdowns, or poor inventory control causing delays because of an absence of materials or parts or leading to higher costs as a result of overstocking. Let us consider them in detail:

**Poor layout and utilization of space.** The plant space represents an investment. The proper utilization of space is an important source of cost reduction, particularly when an enterprise is expanding and needs a larger working area. Furthermore, a proper layout reduces wasted movement, time and effort.

**Inadequate materials handling.** Raw materials, parts and finished products are always being moved from one place to another throughout a production operation. The use of the most appropriate handling equipment for the purpose can save time and effort.

**Frequent stoppages as production changes from one product to another.** The proper planning and control of production operations can ensure that one production batch or order follows immediately after another, so that idle time of machinery, equipment or labour is eliminated or minimized.

**Ineffective methods of work.** A sequence of operations may be well planned but each or some of them may be done in a cumbersome manner. By examining the way a certain operation is carried out and devising a better method, ineffective time can be reduced.

**Poor inventory planning and control.** In every operation, raw material is usually ordered and stocked ahead of time, and at every stage of the operation an inventory of so-called “materials-in-progress” or semi-finished products and various parts are temporarily stocked whilst waiting to be processed. These various inventories represent a tied-up investment. A proper inventory control system can minimize such an idle investment while ensuring that the operators do not run out of the material needed.

**Frequent breakdown of machines and equipment.** Poor maintenance results in machinery and equipment often being out of action, and idle time ensues while repairs are carried out. Installing a preventive maintenance system would ensure the smooth functioning of machinery and equipment.

**Wrong use of tools.** This could result in low efficiency, accidents, poor quality, and wastage of materials and time.

Work study techniques aim at making manual work more productive by improving the ways in which the work is done, the human movements are performed, the tools are used, the workplace is laid out, the materials are handled and the machines are employed. Work methods are improved by systematically analysing present methods, eliminating unnecessary work and performing the necessary work more effectively with less effort, time and cost. Work study, industrial engineering and training are the main tools for improving work methods.
3.2.7 Feedback

In general, feedback is information on the interrelationships between input and output in an enterprise, and between the enterprise and the national (or international) environment. In other words, it shows how a society evaluates the quantity and quality of the product; how much it is ready to pay for it; and, from the other side, how much it wants to be paid for the main inputs (labour and capital) which a society supplies to an enterprise.

From this point of view feedback could be considered as productivity measurement. At the enterprise level we need to measure inter-relationships between the costs of input and output. A result of this measurement shows the effectiveness of the method/process in relation to the internal environment of the enterprise. This measurement takes into account business conditions, prices, some political circumstances, the degree of government intervention in the economy, product specialization, etc.

Efforts to raise productivity must start by making productivity visible and by aligning individual self-interest with company and society interests. By nature, productivity, despite its importance and role in development, is invisible to the individual. Since each worker is just a small part of the production process, no individual knows whether total output per hour of work is up or down by looking at what is happening around him or her. Therefore, by making productivity visible through measurement and feedback and by changing individual incentive structures to align them with productivity growth, a company is probably taking the most important steps towards becoming a firm with rapid productivity growth. However, productivity measurement for incentive purposes is not sufficient. Another important reason is that this information can be used for management decision-making. A closed-system productivity and profitability analysis in which variations in a firm’s profits are explained by changes in productivity and in the relative prices of inputs and outputs would be of critical importance. Data of that kind certainly help to sell productivity measurement to management and workers; they can appear in the annual report, focus attention on the increased awareness of productivity, and aid in making long-term projections. They can also provide the basis for useful inter-firm comparisons.

3.2.8 Organization and management styles

The well-known principles of good organization, such as unity of command, delegation and span of control, are intended to provide for specialization and division of work and co-ordination within the enterprise. An organization needs to be dynamically operated and led towards objectives and must be maintained, serviced and reorganized from time to time to meet new objectives.

One reason for low productivity in many organizations is their rigidity. They fail to anticipate and respond to market changes, and ignore new capacities in the labour force, new developments in technology and other external (environmental) factors. Rigid organizations lack good horizontal communication. This slows down decision-making and inhibits the delegation of authority close to the point of action, encouraging inefficiency and bureaucracy.

Compartmentation by professional groups or functions also inhibits change. For example, the decision-making steps may have been designed for a particular existing technology, for a definite product or service mix. Things have now changed, but procedures have survived because managers want to minimize change.
No system, however well designed, is efficient in all situations. Dynamism and flexibility should be incorporated into the system design in order to maximize productivity. Flattening hierarchies also contributes to more flexibility, as well as market and customer orientation, resulting in better productivity. However, each organizational structure should be matched with the proper management system and style.

There is a view that in some countries management is responsible for 75 per cent of productivity gains, because management is responsible for the effective use of all resources under enterprise control. One productivity expert and consultant to many leading Japanese companies believes that as much as 85 per cent of quality and productivity problems in United States industry are common problems of the systems that lie within the province of management style. Effectiveness depends upon when, where, how and to whom a manager applies a style. Management styles and practices influence organizational design, personnel policies, job design, operational planning and control, maintenance and purchasing policies, capital cost (working and fixed capital), sources of capital, budgeting systems and cost control techniques.

Peter Drucker once said that the problem faced in developing countries is the problem not of underdevelopment but rather of undermanagement. Actually, productivity is the most serious challenge confronting management. If we look at the results of the survey by M.E. Katsell, which indicates the most important factors influencing productivity, we find that ten out of 25 are in the areas of management control.

The task of management is to evaluate those factors which have a bearing on productivity and take appropriate measures to use them effectively.

Incidentally, managerial productivity itself is the key factor in improving labour and capital productivity. According to Changing Times 63 per cent of the respondents say that executive productivity is a serious concern in the running of businesses today. Ray Killian estimates that administrative employee performance in the United States has an efficiency rate of only 60 per cent. Comparisons between successful European and Japanese companies indicate the following similarities:

- In each case, the best firms were simultaneously pursuing improvements in cost, quality, service, and speed of new product introduction. None of these companies thought they could

<table>
<thead>
<tr>
<th>Factor</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Better planning</td>
<td>66</td>
</tr>
<tr>
<td>More effective management</td>
<td>65</td>
</tr>
<tr>
<td>Improved job procedures</td>
<td>49</td>
</tr>
<tr>
<td>Improved communications</td>
<td>48</td>
</tr>
<tr>
<td>More recognition of achievement</td>
<td>45</td>
</tr>
<tr>
<td>Better training of employees</td>
<td>45</td>
</tr>
<tr>
<td>More attention to productivity</td>
<td>39</td>
</tr>
<tr>
<td>Better human relations</td>
<td>36</td>
</tr>
<tr>
<td>Improved technology</td>
<td>35</td>
</tr>
<tr>
<td>New ways to motivate workers</td>
<td>34</td>
</tr>
</tbody>
</table>

1 Percentage of respondents considering each factor as "very important" in terms of influencing the organization's productivity.
compete by just focusing on one of these alone and ignoring the others.

- The best firms have also been successful in breaking down traditional functional barriers. For example, they have found ways to involve manufacturing and marketing people early in the design processes. This also means forming multifunction teams and broadening the definitions of individual jobs.
- Successful firms also dismantled steep corporate hierarchies, and in the process greatly improved internal communication and flexibility.
- The best firms are also developing closer ties with both customers and suppliers. They have drastically pruned their base of suppliers, in some cases from thousands to hundreds. They are working much more closely in component design, quality and training programmes with those vendors that are left. Successful firms also more effectively integrate technological choices with marketing, manufacturing and human resource strategies.
- Their managers also think globally. They practise competitive benchmarking, comparing their own performance with the best practice in their industry, wherever it happens to be in the world. They routinely scan the world for new technological developments.
- The best firms have also understood the importance of human resource development and a broadly trained, well-motivated work force. The role of production workers is shifting from that of the passive performance of repetitive tasks into an active collaboration in the organization and the fine-tuning of production. They are recognizing that the most important work qualification is the capacity to acquire new skills, and that many of the key work skills are best produced where they are used - in the workplace.
- The most striking thing about the best firms is the integrated nature of the changes they made. These firms had understood and acted upon the strength of the linkages between changes and market strategies, production methods, human resource practices, supplier relations, accounting policies, and so on. For example, trying to run quality circles with a poorly trained workforce is not likely to work, any more than investing in worker training without a parallel effort to reorganize the workplace and broaden jobs.

Productivity growth fundamentally is contrary to human nature. To improve productivity, humans must change their old ways of working. Unfortunately, humans hate change and almost always resist it. As a result, management must focus attention on how people can be persuaded to do an "unnatural act" - to change. This task is the heart of the management challenge and would be impossible without the total commitment of top management.

In the best companies managers treat workers with respect, listen to their ideas, consult them on decisions affecting them, give them regular feedback on results of their work, involve them in decision-making and use a participative management style; and have a long-term strategic view of their company objectives and resources development. Short-term considerations are subordinated to the long-term strategies.

As regards ineffective time spent by workers as a result of managers’ shortcomings in the production process, the following elements could be mentioned:

- excessive product variety and lack of standardization add idle time owing to short runs;
- design changes add ineffective time owing to stoppages and rework;
- bad planning of work and orders adds idle time of men and machines;
- lack of raw materials owing to bad planning adds idle time of men and machines;
- plant breakdowns add idle time of men and machines;
- plant in bad condition adds ineffective time owing to scrap and rework;
- bad working conditions add ineffective time through forcing workers to rest; and
- accidents add ineffective time through stoppages and absence.

To finalize the discussion on the role of management in productivity promotion, it is important to list the most vital managerial responsibilities which, if properly executed, could reduce inefficient time during the production process:

- product development to reduce work content caused by poor design;
- proper materials utilization to reduce and utilize waste;
- quality control to ensure proper standards and inspection methods;
- better layout and process planning to reduce unnecessary movements;
- materials handling to reduce time and effort;
- production planning and control to reduce ineffective time;
- method study to reduce work content owing to poor work methods;
- inventory control to define the most economical inventory levels;
- preventive maintenance to ensure longer life and continuous run of machines and equipment;
- proper human resource management to create a satisfying working environment;
- training to develop appropriate skills; and
- better working conditions to improve morale and reduce absenteeism.

3.3 Output-related factors

By output factor productivity we mean the extent to which the product meets output requirements. Use value is the amount that the customer is prepared to pay for a product of given quality. Use value can be improved by better design and specifications. Many companies around the world fight a constant battle to incorporate technical excellence into marketable products. Breaking down the walls between research, marketing and sales has become a major productivity factor. For example, leading Japanese companies continually redesign products which are on the market. Product place value, time value and price value refer to the availability of the product at the right place, at the right time and at a reasonable price. The volume factor in particular gives us a better notion of the economies of scale through increased volume of production. Finally, the cost-benefit factor can be enhanced by increasing the benefit for the same cost or by reducing the cost for the same benefit.

The following checklist may be suggested for productivity factors analysis on the output side:

- product/service volume;
- product/service quality;
- product/service price (competitive price);
- product/service customer (after-sales service);
- timely and reliable delivery;
- innovativeness of product/service design;
- good packaging product/service;
- product/service mix (assortment structure);
- availability at proper places and times;
- long-term guarantee and good warranty systems;
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- product influence on market share and penetration;
- product influence on corporate image; and
- product environmental characteristics.

These most important output productivity factors should be kept in view by management, particularly design, sales and marketing managers, in order to improve market penetration and product distribution to customers. They should evaluate feedback and quickly channel it back to the input and process managers in order that they can react to any changes in the market and thus contribute to long-term productivity improvement.

Questions for discussion

1. Why do you need to be aware of internal productivity factors?
2. What is the advantage and disadvantage (if any) of the classification of these factors into input-, process- and output-related factors? Any other suggestions for their classification?
3. How can you use the information on the internal factors for your decision-making?
UNIT 4: INTEGRATED PRODUCTIVITY FACTOR MODEL

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit you will be able to:

1. Understand and explain an integrated model of productivity factors which provides a general picture of their interrelationships.

2. Use this model as a checklist for the factor’s identification, analysis and privatization for decision-making.

UNIT 4: CONTENTS

Summary of the integrated productivity factor model
UNIT 4: INTEGRATED PRODUCTIVITY FACTOR MODEL

After considering the various productivity factors in their different groups and cross-sections, we can propose a more systematic model of these factors classified in a certain logical hierarchy (figure 2.5).

This model will help managers or consultants in productivity and quality improvement to give the required priority to productivity factors and to distribute them between the different organizational and institutional elements.

Indeed it is not sufficient just to know what kind of forces have an impact on different productivity factors. It is equally important to understand their place in the socioproduction system (company or government institution) and be able to allocate certain people (managers, functional specialists and workers) to influence, develop, use and monitor these productivity factors.

This integrated model can help practitioners in productivity improvement to make checklists, questionnaires and other analytical instruments to be used for the identification, measurement and analysis of specific productivity factors in a particular enterprise or organization. The logic behind the classification and integration of productivity factors in this model is as follows:

The first, most general level involves breaking down all productivity factors into two groups. The first group covers all most important factors which are external to an enterprise and are not under control of its management. However, managers should be aware of the possible impact of these factors on the company’s long-term strategy and productivity policies and should take them into consideration in market analysis, planning and operational decision-making.

This group, in turn, consists of three major subgroups of factors in accordance with the nature of their sources or areas of influence. These are (a) resources, (b) government policy and (c) infrastructure. Each of these groups also covers more specific factors (see figure 2.5) which actually indicate where managers and consultants should look for useful information, potential and room for improvements. This is particularly important in order to match organizational strategies, policies, plans and operations to environmental conditions as closely as possible, so as to avoid all kinds of mistakes and wastage.

The second major group in this model covers productivity factors that are internal to an organization: in other words, those which are fully under management control. These groups are also broken down into three subgroups of factors reflecting the main production elements: input factors, process factors and output factors. Their detailed specification is also given in the model.

This three-level classification of productivity factors provides a good instrument for management and consultants to carry out factor identification and analysis both vertically and horizontally as well as to allocate the strongest and weakest points in the organization and management system and functions: this information will subsequently be used for the design and implementation of productivity improvement programmes. The reader will also notice that all the other modules in this modular programmes are actually aimed at dealing with the main groups of factors presented in this model.
Questions for discussion

1. How can you use this model for productivity factor analysis?
2. What is missing in this model or what should be eliminated?
3. How to use this model in the decision-making process?
Figure 2.5: Integrated productivity factor model

Enterprise productivity factors

External factors

- Business cycle and structural changes
  - Business conditions, competition
  - Sectoral structural changes
  - Capital structural changes
  - Economies of scale
  - Demographic changes
  - Social changes

- Resources
  - Manpower: supply and demand, education, flexibility, mobility
  - Land: availability, price
  - Materials and energy
  - Access to finance

- Government policy
  - Structural adjustment policies
  - Productivity policies
  - Business cycle policies
  - Natural environment regulations
  - Fiscal, tax policies
  - Manpower education and training

Internal factors

- Input factors
  - Capital, plant and equipment
  - Material and energy
  - Technology and know-how
  - Product design
  - People: selection and recruitment

- Process factors
  - People: motivation, training, career, industrial relations
  - Product design
  - Technology
  - Plant and equipment utilization, maintenance, development
  - Materials and energy
  - Work methods
  - Feedback: measurement, analysis
  - Organization systems and management style

- Output factors
  - Volume
  - Product mix
  - Product price
  - Quality
  - Product design innovativeness
  - Packaging
  - After-sales service
  - Timely delivery
  - Product availability at any time
  - Guarantee and warranty systems
  - Market share and penetration
  - Company image
Asian Productivity Organization: Corporate culture and productivity: Case studies in Asia and the Pacific (Tokyo, 1994).


Evenden, Robin; Anderson, Gordon: Management skills: Making the most of people (New York, Addison-Wesley, 1992).


Lawlor, Alan: Productivity improvement manual (Aldershot, United Kingdom, Gower, 1985).


Prokopenko, Joseph: Management consulting focused on productivity (Geneva, ILO, 1994), doc. EMD/3/E.


MODULE 3
DIAGNOSING PRODUCTIVITY AND QUALITY PROBLEMS
MODULE 3: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Develop the participants’ understanding of the true nature of productivity problems.

2. Provide a logical, objective approach to the analysis and identification of such problems.

3. Demonstrate the use of tools for the identification of productivity problems.

4. Enable participants to become proficient in the processes and skills of the identification and analysis of productivity problems.

5. Provide a basis for improving the productivity of organizations.

MODULE 3: CONTENTS

UNIT 1: Diagnosing productivity and quality problems: An overview

UNIT 2: Making diagnostic proposals

UNIT 3: Problem identification

UNIT 4: Analysing the data and drawing conclusions

UNIT 5: Making recommendations and producing the report

Bibliography
UNIT 1: DIAGNOSING PRODUCTIVITY AND QUALITY PROBLEMS: AN OVERVIEW

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and explain factors which influence productivity, quality and organizational performance, particularly their behavioural component.

2. Distinguish the symptoms and fundamental causes of P & Q problems.

3. Relate open- and closed-ended problems to possible solutions and the most effective managerial approaches.

UNIT 1: CONTENTS

1.1 Productivity and quality problems in practice

1.2 The key symptoms of operational climate

1.3 Resolving productivity and quality problems
UNIT 1: DIAGNOSING PRODUCTIVITY AND QUALITY PROBLEMS: AN OVERVIEW

Diagnosis is the basis of all effective consultancy assignments. It provides:

- identification of the problem;
- evidence for testing hypotheses; and
- the basis for selling the assignment.

All consultants use diagnostics. Financial consultants use specialized audits to assess the viability of companies. Quality consultants use diagnostics to assess for accreditation, i.e. ISO 9000 (see Unit 3, Annex A, for example). Recruitment consultants use diagnostics to profile the positions they are retained to fill. Whilst most of the examples used in this module are taken from the productivity improvement area, the principles set out here are relevant to all kinds of consultancy. The module outlines the procedure for the initial analysis of productivity problems, the selection and application of problem identification tools, and the analysis of the collected data and the presentation of those data to the client.

The focus is on process consultancy, in the sense not of providing solutions to problems, but of helping organizations to help themselves. Whilst the module is written primarily for consultants, the procedures and methods outlined can be equally well applied by line managers.

Productivity and quality (P & Q) improvement is an interactive and ongoing process. Most productivity interventions run in a number of stages:

- Initial study phase - Diagnosing the key problems and agreeing on the approach.
- Detailed investigation and recommendation phase - Working with those who will have to live with the solutions to develop the programme(s) and put the systems in place.
- Implementation - Doing what has been agreed.
- Review and integration - Assessing what has/has not been achieved and agreeing on the way ahead.

Each of these phases is subject to a contract between the external or internal consultant and the client, with the initial contract usually forming the basis for the whole project. It is reviewed and renewed at the milestones indicated above. This module should be considered as complementary to Module 4, "Productivity measurement and analysis". The main difference between them is that, if Module 4 deals with hard facts and measurable productivity factors and aims at developing instrumental skills in the total factor productivity measurement to obtain a relatively precise picture of the company’s productivity status, this module considers mostly “soft factors” of P & Q improvement, or human competence: organizational culture, attitudes, motivation, management styles, communications, and other attributes of the human subsystem of any organization (see Boulden, Process consultancy).

Most people know what is wrong in their organizations: the difficulty lies in being able to prove it. One man’s opinion is worth no more than another’s: often it is worth less, if the other man is the boss. The secret of successful problem-solving is accurate diagnosis supported by irrefutable proof. This means having the evidence to prove your point. This module provides the basic tools for effective
problem identification and the mechanisms for presenting this information in a way which encourages action. However, it deals only with the initial study phase (see figure 3.1), since the subsequent phases are discussed in other modules of this programme.

Figure 3.1: The initial study - The diagnostic phase

The module is in five parts. Unit 1 provides an overview of the issues involved in solving productivity and quality problems. It highlights that, in practice, most P & Q problems are complex in that they have both technical and behavioural components. Solving one without solving the other will not resolve the problem as a whole. Indeed, it may even compound it. Unit 2 outlines the procedure for developing an understanding of organizations, their problems and their operational climates: information which is essential for developing proposals and designing diagnostic methods. Unit 3 examines the design and application of diagnostic instruments. Unit 4 covers the analysis of performance data and the procedure for drawing conclusions from these data. Unit 5 outlines a procedure for making recommendations based on the data, and writing and presenting the proposal(s) for action.

Two case studies are used through the module to illustrate how the diagnostic process works in practice. Company A is a medium-sized, specialist manufacturer. Company B is in the service sector. UNIT

This unit outlines the factors which influence the organization’s performance, and sets the scene for the diagnostic activity. The critical issue here for managers and consultants is to distinguish between the P & Q problems and the more fundamental ills. The real issues should be identified and dealt with.

1.1 Productivity and quality problems in practice

The P & Q problems facing managers fall into four broad categories:

- technology - those concerned with products or services;
- methodology/systems - those concerned with the managing systems;
- competence of the people - those concerned with knowledge, skills and attitudes of employees; and
- operational climate - those concerned with culture and management style.

1.1.1 Technology

There are two aspects to technology problems: product technology, i.e. the "engineering" involved in the product or service itself (what is made); and production technology, i.e. the tools used to make things (how it is made), or in the case of a service organization, how the service is delivered. The better the product technology, the higher the specification offered to customers; and, it may be hoped, effective design will make it easier to make the products. The better the production technology, the greater the potential for high-volume, high-quality, low-cost output or delivery cost: in short, better productivity.

1.1.2 Methodology or managing systems

These are the procedures that organizations use to control their affairs. They lay down how things should be done. They integrate effort and provide management information. They are the central nervous system of organizations. The goals and control processes used to control functional performance include production management systems, planning and control systems, management reporting procedures, order schedules, part numbering and purchasing systems, estimating and planning tools, quality systems, recruitment procedures, job evaluation schemes, succession planning, career development structures, communication systems, etc.: in short, all the systems that enable organizations to manage themselves.

1.1.3 Competence

The ability of all employees, managers and workers to do their jobs effectively is a fundamental requirement for the productivity of organizations. Competent employees are those who know what is expected of them, have the knowledge and the skills necessary to do the job, and have proper attitudes and are motivated to achieve. This means agreeing on performance requirements for people at all levels; ensuring that all employees are properly trained for what is expected of them; having procedures for the continuous monitoring and control of performance against the agreed goals; developing performance improvement programmes where there is a shortfall; training for new situations where people are promoted or transferred or where new technology is introduced; and carrying out a continuing assessment of the demands of jobs in organizations and of employees' ability to meet them and of their willingness to close any "gaps" that occur over time.

1.1.4 Operational climate

This is the organizational environment in which people work. It is reflected in the attitudes of employees and the organization's style of management. It reflects the value systems of the organization (see Boulden, Values and style) and provides the rewards and the procedures which dictate the way
things are done, which actions are encouraged and which are discouraged or punished.

The operational climate is the common denominator in the productivity equation. It determines people's attitudes, which in turn determine relationships and beliefs. The attitude of Sales to Production, the relationship between Design and Manufacturing, managements' view of Personnel, etc., are all determined by the inherent attitudes within organizations. These attitudes in turn determine the effectiveness of the other three factors. Technology and methods provide the opportunity to be productive, competency ensures the ability, but only the operational climate creates the desire to succeed and be productive. It dictates how things are done and the management style (see figure 3.2).

**Figure 3.2: Total productivity and quality: Organizational model**

- Technology
- Methodology
- Competence
- Operational Climate
- Opportunity
- Ability
- Desire
- Total Productivity and Quality

In "traditional" organizations the operational climate reflects the parent/child authority model of the natural family (see Harris, 1970). Managers are the "children" of their bosses and the "parents" of their subordinates. This means that they accept instructions from above and tell their subordinates what to do. Departmental managers are expected, and expect, to control what happens in their particular functions. Intervention or suggestions from other departments are unwelcome; the manager is responsible for his own area.

Traditional management style mitigates against teamwork and the effective use of resources. It is unsuited to current conditions. Increased rates of technological change, shorter cycle times, a better educated workforce, more demanding customers and fiercer competition, etc., have all conspired to undermine "traditional" structures. Subordinates today often know more about how to do their job than those who manage them. Capturing this knowledge means more participation and involvement, both within and across functions. Indeed, managements can only derive the full benefit from new technologies and systems through cross-functional teamwork. Traditional management style is in direct conflict with the philosophy behind such techniques as Total Quality Management (TQM), Just in Time (JIT), Cycle Time Reduction, Manpower Planning, Objective-based Performance Review Schemes, etc. The traditional style of management actually causes these initiatives to fail.
1.2 The key symptoms of operational climate

There are three key symptoms, inherent in traditional operational climates, which need to be understood by those wishing to solve P & Q problems. They are to be found to a greater or lesser extent in all traditional organizations and act as a hidden barrier to real change. They are:

1. Concentrating on restoring the status quo rather than on achieving real P & Q improvement.
2. Open- versus closed-ended performances - two types of problem.
3. Individual approach versus team work.

Let us consider them in detail for easier identification.

1.2.1 Status quo versus achievement

Managers see their role in traditional organizations as people who “get things done”. Most, whilst they accept that they have a responsibility to maximize the potential of the assets under their control, do not really see this as a key part of their job. To their mind the key task is solving the problems that get in the way of achieving the desired output.

The P & Q problems that managers face fall into two main categories: those which stop or reduce the efficiency of the existing processes; and those which are accepted as inherent in the technology and production methods of the organization.

The first category of problems are high profile, and everyone accepts that they must be solved immediately. Their solution, however, only restores the status quo: it does not improve P & Q. Thus managers, by focusing on these problems, ignore the real productive potential of their organizations.

It is the problems in the second category that offer the real potential for improvement, but these are often seen as “the running problems” inherent in the process or system. Something which must be lived with. Yet it is the solution of these problems that offers the opportunity for long-term performance improvement. Managers who accept that 10 per cent scrap is “normal” for their manufacturing process are maintaining the status quo. The real potential lies in reducing this figure. Managers who believe that planning systems routing products inefficiently are unchangeable only compound the problem.

Planned maintenance reduces the chances of breakdowns, and the effective training of maintenance staff coupled with the proper resourcing of spare parts ensures that the effects of unplanned stoppages are minimized. Yet how often are these things done? The neglect of routine maintenance is much more common in organizations than is planned maintenance.

Living with something which is clearly inefficient is in itself inefficient. New opportunities for productivity arise only when managers challenge the way in which operations, etc., are currently done. The problems in this second category must be solved if the total productive potential of the existing investment is to be achieved.

Management’s general acceptance of less than the potential performance means that most have a considerable potential for improvement which requires nothing more than a change of attitude to
release it. The Japanese call it Kaizen, which could be interpreted as a focus on continuous performance improvement (see Soeda, 1991).

Open- versus closed-ended performance

There are two types of problem which affect the P & Q of organizations:

- Closed-ended problems: Those which have one unique right answer and are mainly concerned with restoring the status quo; and
- Open-ended problems: Those which have many possible answers, the right answer being the one that people are willing to accept. These are mainly concerned with increasing P & Q.

Closed-ended problems can be solved objectively, using logic. They are, as Revans (1982) says, like puzzles: find the answer and the problem is solved. They are "simple" and the answers usually lie within the knowledge and skills available to the problem-solver. Open-ended problems, on the other hand, are "complex". The information and knowledge required to solve them are usually outside the area of control of the problem-solver. They are concerned with attitudes, with people's feelings about things, and can only be solved through a process of participation and involvement which produces ownership and commitment. To solve these two quite different types of problem effectively the problem-solver must understand that they are fundamentally different; and that to be effective, the problem-solving method used must reflect the type of problem to be solved. This means that the type of problem must be identified before the problem-solver attempts to effect a cure, if the cure is to be successful.

Closed-ended problems are usually logical and have the following characteristics:

- They can be solved through the application of systemized problem-solving techniques.
- The problems are not affected by the people studying them and they do have "right answer" solutions.
- The knowledge and skills necessary to solve the problem are within the control of the problem-solver.
- The commitment required for their solution is usually within the direct control of the problem-solver and the management of the enterprise.
- Solutions once found and implemented are obvious and usually solve the problem.

Open-ended problems have quite different characteristics:
- They are attitudinal rather than technical.
- They are usually intangible, difficult to "hold in your hand".
- They reflect people's values, how they feel and think.
- There are no particular right answers: for example, if quality continues to be a problem, even though all technical aspects appear to be correct, this could be for any number of reasons involving large numbers of people across the enterprise and even outside it.
- The knowledge and skills necessary to solve the problem are not within the control of the problem-solver.
- They respond to the "process of solution" rather than solution itself.
- Applying closed-ended problem-solving methods to open-ended problems invariably makes the matters worse.

The main criteria for success in solving this type of problem lie in:
- Recognizing that there are many possible solutions: the "right" solution is one that will work,
and that the majority of those involved believe will work. This can only be successfully achieved through the genuine involvement and commitment of the people who have to live with the solutions.

- Changing the reward systems. Current behaviour is results for the existing reward system. Changing behaviour means changing the reward system to one which will produce the desired behaviour.

1.2.3 Individual approach versus teamwork

In traditional vertical organizations the natural style of management is either "tell, sell" or "join, abdicate". Managers are expected and expect to make the decisions. They want issues to be resolved quickly and simply with the minimum discussion and maximum action. This conceptual framework encourages managers to use the right answer approach. It means that they make the assumption that all problems are the same. This is clearly untrue: they are not. The right answer approach is only effective in solving closed-ended problems. Low output may be caused by the capability of the machines being used, poor maintenance, etc. It may equally well be to do with design, specification of the materials, poor training, low morale, etc. If quality is low, it may be a competence problem - the operators may need more training, discipline may need to be tightened up, and so on. Equally it may be that the bonus scheme rewards quantity rather than quality, or it could be impossible to adhere to specifications, etc. These matters can be resolved only through the participation of those who are faced with the problem and will have to live with the solution.

In practice the natural tendency towards the closed-ended approach means that open-ended problems often remain unresolved. Decisions are made, certainly: but those who must implement them are not involved and are therefore not committed to the actions, and so nothing gets done. Open-ended problems can be solved only through real participation and teamwork, which means that the effective managers of the 1990s will be team players, people who can combine getting things done with a continuing performance improvement.

1.3 Resolving P & Q problems

In practice P & Q problems are invariably complex, as we have seen in Module 2, "Productivity factors". They both have closed- and open-ended elements, and real gains involve real change, not just the restoration of the status quo. The closed/right answer element is usually a small, if important, part of the productivity equation. It is the attitudes, particularly those of management, that must be tackled if lasting and essential gains are to be made, and these are open-ended problems. The strategy for solving open-ended problems differs from that used to solve closed-ended ones in three main ways.

1. The only part of the procedure which is under the direct control of the problem-solver (manager) is the setting up of the process to solve the problem. What would be considered as the solution of a closed-ended problem is only the first stage in the open-ended approach.

2. The successful solution of open-ended problems requires the commitment and genuine involvement of those who are facing the problem - often large numbers of people. This inevitably means that results using this approach take longer to achieve than those using closed-ended methods. This need for commitment can be a major problem in itself. It is often difficult to persuade
management teams who want instant solutions, that the problems they are suffering from are open-ended and that the only really effective approach is through genuine involvement.

3. Because the process, of necessity, involves many people, successful solutions can be arrived at only through teamwork, often with multidisciplinary teams. This implies a much higher risk for management than in closed-ended problem solving. Things which some managers would rather hide will be exposed and some of the problems may be traced back to management incompetence.

Management’s willingness to recognize and accept the need for openness and mutual trust is crucial to the maximization of an organization’s productive potential. The most intractable problems facing enterprises fall into the open-ended category and they can be solved effectively only through participation. Yet, while most organizations have well-developed ways of resolving closed-ended problems of the purely technical, systems and competence type, few have any structured systems for tackling the open-ended ones. To solve these problems calls for a change of style.

All the improvement tools that offer a real opportunity to boost performance require participation. Putting in systems such as JIT, TQM or MAPICS\(^1\) is mechanically (closed-ended part) easy but behaviourally (open-ended part) difficult. Without “buy in” these systems just will not work. Managing the “operational climate” (behavioural) aspect of the performance problem-solving process is arguably the most important ingredient in achieving productivity improvement. More good initiatives have foundered on the operational climate rock than have been lost in any other way. This is the most difficult problem to tackle, concerning as it does beliefs and attitudes that are seldom discussed and deeply ingrained. Identifying and analysing attitudinal issues so that they can be dealt with in an open and rational way is one of the biggest challenges facing those who want to bring about real, sustainable productivity gains.

Pure technology/systems problems are the most straightforward of all the problems that managers face. They are normally task related and in their simplest form are unaffected by people or the operational climate (they have little or no open-ended component). Managers usually have the technical competence to solve such problems themselves or have the relevant expertise within their department. For example, if the computer ceases to function it is a technical problem. It is the responsibility of the computer department manager and his staff to fix it. The following are some of the factors characteristic of “pure” technical problems:

- The problem can usually be traced to within a department.
- The manager responsible normally has the competence within his sphere of influence to solve the problem.
- They respond to right answer solutions.

These simple technical and systems problems are usually self-contained and can be clearly isolated. They rarely affect productivity or quality for long.

Closer examination, however, of what often appears to be simple technical or systems problems reveals that what can be seen is only the tip of the iceberg. It represents only part of a more complex organizational problem. Such problems can prove much more resistant to solution than might be

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1 JIT (Just-in-Time); TQM (Total Quality Management); MAPICS (Manufacturing, Accounting and Production Information Control System).
assumed. Thus, buying a new machine to speed up production when the real problem lies in the way the production process is organized will only increase the amount of scrap. Bringing in a new management accounting system when the problem with the old one was the inaccuracy of the input data only accelerates the confusion.

Solving competency problems, ensuring that all employees are properly trained to do their jobs and are performing well against performance requirements, is one of the most difficult tasks managers must undertake. People are affected by events that occur both inside and outside work. Problems in a personal relationship - marital difficulties, for instance - may have a strong impact on work attendance. An operator may be reluctant to train a younger man on a particular machine because he believes that doing so will make him vulnerable to redundancy. As with technical problems, the issue of competency can be self-contained, i.e. it may relate specifically to one individual and his or her personal circumstances, attitudes and beliefs. Though time-consuming for the manager, such single incidents are normally relatively straightforward to solve through coaching and counselling.

It is more common, however, particularly where the competence of groups of employees is concerned, for poor performance to be linked with issues of operational climate. In such cases individual managers may be unable, by themselves, to improve performance. Indeed, even company-sponsored initiatives such as training in quality awareness may not, in themselves, lead to sustained productivity gains. Some of the factors that characterize combined competence and/or operational climate problems include:

- low morale - high level of labour relations problems;
- high sickness and absenteeism levels;
- high labour turnover;
- poor work output/quality;
- poor working relationships often characterized by high levels of tension between people; and
- high levels of rework; work having to be altered or done again.

The most difficult problems that managers face are the operational climate issues. They are intangible, yet they affect the whole organization and have a serious impact on its performance. They usually encompass both technical and personnel problems and it is often difficult to see which is really at fault. Is the machine breaking down because of poor maintenance, because it is being badly operated, because of what it is being asked to do, or is the machine itself at fault? This category of problem is also characterized by the fact that it usually involves more than one department, making it difficult to assign responsibility, and easy for people to avoid it. For example, in the order processing system of a company, the information flows from received order advice, through material requirements, production planning, building, testing, dispatching and invoicing. If errors are made at any stage, the system fails; all the inputs must be correct for the resultant documentation to be correct. But incorrect inputs at one stage usually show up at another. Thus failures in the planning process may show up in production, giving production managers problems they cannot solve on their own. It needs the willing support of all the managers in the chain to resolve them. Quality problems cannot actually be solved by the quality manager: the cooperation of other line and functional managers, not only from production but also from purchasing, R & D, etc. is needed. The following are some of the factors characteristic of operational climate problems:

- lack of planning and coordination;
- tendency to blame others for mistakes;
- high level of role confusion (who is supposed to be doing what?);
- strongly hierarchical structure, very little cross-functional teamwork;
- lack of performance goals at functional and/or individual level;
- management style either directing or abdicational;
- problems not really solved, but just circulate; and
- lack of implementation even when decisions are made.

Unless the operational climate problems are solved, investments in technology, systems or training are highly unlikely by themselves to tackle the performance problems that face organizations.

It is the issues inherent in the operational climate that complicate the problem-solving process. The most intractable problems are integrated: they affect more than one aspect of the P & Q equation and their solution invariably involves behavioural change.

A REAL CASE

A management consulting firm was recently asked to advise a client whose productivity had fallen behind that of their main competitors. The managing director perceived the initial problem as closed ended and had hired a firm of engineering consultants to solve it for him. They addressed two closed-ended problems concerning technology and systems.

1. Technology: They recommended the purchase of some new computer-controlled machines and some alterations to the way in which the product was made.

2. Systems: They reorganized the factory into a series of manufacturing "cells".

The work that the firm did was of a good technical standard. On completion of the contract the engineering consultants left the company. Output then fell even more steeply and the productivity situation worsened.

The firm was called in at this stage by a distraught management team (the managing director having left) to help them to find out what had gone wrong and to provide a programme to retrieve the situation.

The firm’s investigations uncovered both closed- and open-ended problems in the areas of competence and operational climate which were preventing the hoped-for productivity gains from being realized. These are briefly outlined below:

**Competence**

The new cell-manufacturing system (which was a good technical solution) was quite different in many ways from what had gone before. It transpired that most of the workforce simply did not understand its requirements or the information that the associated computer system produced. They were neither trained nor competent in its use.

The system was linked into other company systems, namely sales forecasts, purchasing and engineering. These areas had not been involved in the design and installation of the new computer system and continued to do their jobs as they had done in the past. As a result the cell system was being fed with inaccurate and inappropriate data.
EXERCISE

1. Ask several colleagues what they see as the key problems that need to be solved to improve productivity.
2. Classify your problems as open or closed.
3. Put these problems into the four categories set out in this unit. You may put a problem into more than one category.
4. Give each problem a score (0-9) based on the value of the potential productivity gain(s) if it were solved.
5. Give each problem a score (again 0-9) reflecting your view on the probability of its solution.

Assess the exercise to see what you have learnt. In most cases you will find that the problems that would yield the greatest benefit if solved are those which involve changing the operational climate and are the least likely to be undertaken.

Questions for discussion

1. Why is it important to understand the nature of P & Q problems?
2. Discuss the main factors influencing P & Q, and classify them into those which are under management control and those which are environmental.
3. What is the difference between symptoms and causes? Explain their interrelationships, providing examples.
4. What is the implication of classifying problems into open- and closed-ended for diagnosis, and what action should be taken?
UNIT 2:  MAKING DIAGNOSTIC PROPOSALS

UNIT 2:  LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and know how to get acceptance from top managers for making diagnostic proposals.

2. Be aware of the stages involved in producing and presenting diagnostic proposals.

3. Be able to write and present the diagnostic proposals.

UNIT 2:  CONTENTS

2.1 Selling the concept to management

2.2 Writing the diagnostic proposal

Annexes A, B, and C
UNIT 2:  MAKING DIAGNOSTIC PROPOSALS

2.1 Selling the concept to management

To be successful any diagnostic activity needs the acceptance of the top management. This means selling the concept before undertaking the study.

2.1.1 The initial contact

The initial contact between client and consultant is usually based on a request for help to resolve a specific problem. To understand the context of the request, the consultant needs good information on where the organization is now, the problems it faces and whether these are solvable. This unit outlines the steps involved in getting this information and in producing the diagnostic proposal.

2.1.2 Understanding the issues

Understanding the issues involved is crucial to the success of any intervention. Developing this understanding requires information in three key areas:

1. Where is the organization now? What are the actual problems facing the potential client organization, and what else may affect the area of concern, including attitudinal issues? The consultant needs a clear understanding of the problems themselves and the issues that surround them. A quality problem may show itself in a high scrap rate. However, discussion with those involved may highlight poor design, output pressures, inadequate inspection, etc. The consultant needs information on these ancillary issues in order to understand the problem(s) he or she is being asked to solve.

2. Why do the problems exist? The consultant needs to understand the background to the problems. Everyone and everything has a past. This past explains the present and indicates the future. Finding out about the history of client organizations enables consultants to understand the current situation more clearly and provides some insight into what is possible for the future.

3. Can the problems be fixed? Are there factors which make it either impossible or irrelevant to fix them?

P & Q problems are rather like boils: they cannot be burst until they are ready. There is no point in becoming involved in trying to solve problems that are not solvable. For example, there may be a personality conflict between two directors which no one has the will to sort out. The organization may not have the will to become competitive, management may not have the will to change, etc. Equally, it is irrelevant to help organizations to improve their productivity if they have lost the market.
2.1.3 Getting the facts

The first step is to develop an instrument against which to collect the required information. Experience shows that the following approach will provide consultants with the information they need to assess the client’s real situation:

- organizational structure and locations;
- management structure;
- number of employees;
- history of the enterprise;
- main activities;
- main products and services;
- main markets by product type;
- financial status, current and past trends; and
- key issues impacting current performance.

The information is normally gathered through one or more interviews with the client and his personnel. Analysing the answers to these questions enables the consultant to assess the current situation, the problems, the strengths and weaknesses of the company, and above all its culture (see Annex A to this unit for an example). This information forms the basis for developing the proposal.

2.1.4 Identifying the decision-makers and their needs

Identifying the decision-makers and those who advise them is a key part of the information-gathering stage. The multifunctional nature of productivity improvement interventions means that the senior managers of a company must support any initiative, if it is to be successful (normally the managing director and most of his or her direct reporters.) If the consultant is not working at this level and is not in direct contact with this group, it is unlikely that any proposal he makes will be successful even if it is accepted. Supporting the quality manager in putting in TQM, for example, without the commitment of the main board is a recipe for failure. A key goal for consultants at this stage is therefore to identify those in the potential client organization who have the power to promote programmes of this type and to gain access to them.

2.1.5 Testing the client’s appreciation of the problem

Sometimes clients have a clear grasp of the nature and cause of the P & Q problems they wish to solve. More often, however, the consultant is presented with symptoms of one aspect of a performance problem, normally formulated in a closed-ended manner. A client suffering from high scrap rates, for example, may see this as an operator competence problem, to be resolved by quality awareness training for the production operators. This “simple” approach often ignores the impact of the behavior of other departments on the problem. Perhaps there are design issues associated with R & D; material quality issues associated with purchasing; work method issues associated with engineering; payment issues associated with rewards for output, etc. In practice, virtually all P & Q problems that reach the stage where the client is seeking external help include a strong operational climate component. Training by itself is unlikely to be effective in solving
them. The attitudes of employees and supervisors to quality, for example, and the behaviour that
the organizational culture rewards, are usually more important determinants of current quality
performance than any lack of training (though appropriate training is of course important).

Consultants need to establish what the client believes the problem(s) to be, and why, as well
as the level of the client’s awareness of the underlying reasons behind the problems (if any). They
need to be ready to persuade clients of the need for a “whole system” approach to analysis in those
cases where the client does not fully appreciate this.

### 2.1.6 Understanding the constraints facing the client

Consultants work in the real world. This means working within the limits of what is possible
for the client. Before the consultant can sensibly make a proposal, it must be established what
these limits are.

Finance and time are two key limiting factors. There is little value, for example, in proposing
a programme of action costing US$250,000, and taking 12 months, if the client has only
US$50,000 and six months available. So be realistic.

### 2.1.7 Evaluating the politics

It is crucial to the success of any intervention that the consultant understands the relationships
between those with the power, and the client’s ability to manage them. This is a key determinant in
the success of any performance improvement programme where there is an operational climate
component. If the consultant believes that all senior managers are part of the problem, they must
be involved if there is to be a solution. But if the internal politics of the organization make this
impossible, the client is unable to deliver commitment and the consultant needs to find this out at
the outset.

### 2.1.8 Clarifying the expectation

Clients are not always clear about what they want from the consultants they hire, or in-
deed what consultants can or cannot do for them. They want action to be taken promptly to
solve the P & Q problems they face: they want the consultant to provide them with an answer,
a solution. Yet, given the operational climate component of P & Q problems, this is seldom
possible. Solving operational climate problems invariably means change (Boulden and
Lawlor, 1982). Changing attitudes means developing new methods of work, and this is really
effective only when employees are involved in both identifying the real problems and finding
solutions. Participation and involvement leading to commitment and ownership of new ap-
proaches and working methods is not something that consultants, or indeed managers, can
effectively impose on an organization.

In some situations clients need two types of consultancy in tandem. (see Boulden, The
consultant’s role). They need a technical consultant who brings specialist knowledge to help to
solve the closed-ended problem aspects of a productivity issue, e.g. reorganizing the factory to
achieve a more efficient JIT work system, putting in basic quality standards (ISO 9000, BS 5750, etc.). In parallel they also need a process consultant to deal with the open-ended problems: gaining the commitment of the workforce to changes, developing and implementing performance appraisal schemes, etc.

2.2 Writing the diagnostic proposal

The final step in this phase is to write a proposal. This outlines the current situation and proposes how the formal diagnostic stage will be carried out. Such proposals normally cover what will be done; how it will be done; what the action(s) will achieve, the expected results; how long it will take; and what it will cost.

Although some level of consensus and understanding will have been reached during the client/consultant discussions, it is only when the situation and proposals are formally written down that both parties can really be certain that they understand each other. It is only by clearly stipulating the objectives to be achieved, the underlying principles involved, who will do what work and when, that ambiguity and misunderstandings can be resolved. To solve P & Q problems successfully, consultant and client must work as a team. The client must not only accept the consultant’s recommendations, but must be a part of them, ready and willing to act on them. The proposal is the basis for a contract.

Proposals vary in length and complexity according to the situation, but normally four or five pages are sufficient. They normally contain the following sections (see also Annex B of this unit):

INTRODUCTION: Background to the request and the company, a statement of the problem(s) and the main concerns that the client has.

OBJECTIVES: The main aims and scope of the proposed diagnostic activity.

METHODOLOGY: An outline of the key issues as seen by the consultant and the presentation of a diagnostic methodology.

TARGET GROUP: An indication of those who will be involved with the programme.

WORK PLAN: A step-by-step guide to the work to be undertaken, including a timetable or an indication of what resources are to be supplied by whom.

EXPECTED RESULTS: An indication of what the “output” will look like.

BUDGET: Details of the costs involved, when, how much and under what conditions the consultant will be paid.

2.2.1 Selling the proposal - Making your case

Structuring your case

The final step in this procedure is to sell your ideas. (see Boulden and Boulden, Making effective presentations). Use the proposal as the basis for your case but structure it so that it presents proposition, definition, weaknesses, strengths and restatement of the proposition. Tell clients what you are going to tell them, then tell them, and then tell them what you have told them and ask for the go-ahead.

1 ISO = International Standards Organization; BS = British Standard.
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Proposition

This is a short statement which outlines:
- the problem;
- the “pain” caused by the problem;
- the underlying need the problem represents; and
- a clear call to action which indicates to the listener what you want him or her to do next. You should express all this in terms which indicate that they apply to the decision-makers highlighting the difficulties and problems for them, and the benefits that your proposed course of action will bring to them.

Definition

This should be a coherent, logical, sequential argument of your case, which clearly supports your proposed plan of action. Remember that facts and figures - particularly those concerning money - have far more power than an emotional appeal in influencing people in business situations. Take great care to ensure that the data are accurate; even very minor errors of fact, if exposed and commented on during a presentation, can be sufficient to undermine your credibility and to lose you your case. Avoid the temptation to include every point that you can bring to bear, but focus on only those key points that show clear benefits for the decision-makers. What is interesting and important to you may not be so important to the decision-maker: if you include too much, people who have limited interest in a topic may find it difficult to concentrate on the message you are presenting.

Pay attention to any assumptions to be made. Even if you think your manager should be able to draw the obvious conclusion from the facts you have presented to him, it sometimes pays to state the obvious.

By the time you have reached the end of this stage in your presentation of your case, the ownership of the problem and the responsibility for doing something about it should have been firmly transferred to the decision-maker.

Weaknesses

Acknowledge any snags or flaws in your arguments which might be put forward by the audience, and answer them.

Strengths

Put forward again, in brief, the key arguments in support of your case.

Restate your proposition

Restate your proposition and again emphasize what you want done and the benefits this will bring to the decision-maker.

If your case goes well, there should be a number of questions from the audience. If you are
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well prepared, your answers to these questions should further promote your case. In an external sales situation, it is standard practice to collect all questions/queries/objections before you begin to answer them, by asking something like: “Is this your only query on my proposal?” or “Are there any other queries?”, followed by “If I answer these questions to your satisfaction, will you buy ....?”. If the answer is negative, then ask: “What other reservations do you have?”

This encourages key objections to be voiced early on, and enables you to identify the people who are most resistant to your solution. Getting all queries into the open also allows you to make a considered “strategic” response to the reservations put forward rather than having to give ad hoc responses to individual questions.

A similar approach is advisable for internal case presentations, though the conventions of office politics and procedures may make it difficult to adopt quite such a rigorous approach to getting all the issues into the open at the earliest possible stage. For example, it is not always easy to ask the managing director whether he will accept your procedure if you answer his question to his satisfaction!

Making the presentation

When making case presentations and answering questions, it is important to be extremely tactful and to maintain a calm, logical manner. If you describe to your boss a current practice over which he has been presiding for five years as “stupid and wasteful”, you may well irritate rather than persuade. It would be better to emphasize the positive aspects of potential efficiency improvement than the current negatives of waste and neglect. Other things which are likely to irritate include the use of such phrases as “I think that’s very fair” (implying that, if your listener disagrees, he or she is being unfair), or “This is a very reasonable proposal!” (anyone who disagrees is unreasonable), or “I should have thought the presentation made that clear” (how stupid you are!), and so on. By definition, irritators annoy people; once annoyed, people stop listening; if people are not listening, they cannot be persuaded: the case presentation will fail.

Remember that, no matter how blind to logic, how inattentive, or how stupid someone in authority might be, losing your temper will always undermine your authority as a presenter. Your purpose is not to engage in argument but to have your plan accepted. A calm, friendly demeanour will aid this process.

Review

Finally, review the results. What went well, and what went badly? Make notes and refer to them next time you have to make a case presentation. If you failed, what would you do differently? Always consider how to do it better next time. See Annex C for a case presentation planning checklist.

2.2.2 Conclusion

The consultant’s key objective in this phase is to understand the problems facing the potential client and assess whether he or she can help the client to solve them. If the answer is “yes”, the consultant must then decide how to tackle the diagnostic phase. This means:
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- understanding the problem(s) facing the organization - where it is now?
- defining the outputs - where does it really want to be at the end of the intervention?
- establishing a rapport with the client on both the objectives and the style of the intervention;
- developing a methodology and work plan for the diagnosis; and
- writing the proposal - the plan which sets out what will be done in the diagnostic phase.

To do this the consultant needs to identify the real issues rather than the symptoms. Obtaining answers to the questions outlined in this unit will provide a good understanding of the company, its problems and the clients’ understanding of the problems they face.

Where there is a synergy between client and consultant over what should be done, the next phase is to develop the information-gathering instrument(s). In cases where the client has, for example, a limited view of both the scope of the problem(s) and the processes necessary to solve them, the consultant needs to help the client to see the broader issues. If he cannot influence the client or if the constraints are too severe, the consultant has to decide whether to take on the work or not. If in doubt, do not do so.

Finally, it is important for consultants to remember that, whilst they may plan the journey, they do not take the trip. The client’s team does. They take the risk and carry the can. The reality of the client’s situation must be taken into account in the proposal if the intervention is to be successful for all concerned.
EXERCISE

1. Choose a productivity or quality problem in your own organization and agree on a definition with the top management.
2. Use Annex A to interview two members of the management team.
3. Analyse the data against the key areas (see Unit 1) and decide:
   1. Do you have the right problem?
   2. Do you understand the operational climate?
   3. On the basis of your answers to these two questions, do you think the problem can be solved?
      If so, how will you handle the diagnostic phase?
5. Present your proposal to the manager who agreed on the problem definition and see if you can persuade him to authorize the study.

Questions for discussion

1. What does “selling the concept” to management mean and why it is important in problem diagnosis?
2. What are the main diagnostic stages?
3. What are the main elements of the written diagnostic proposal and why it should be written at all?
ANNEX A

EXAMPLE OF AN ORGANIZATIONAL INFORMATION QUESTIONNAIRE FOR THE DESIGN OF PERFORMANCE IMPROVEMENT PROGRAMMES

1. Name of the enterprise - XXX Textiles

2. Address - Mexico City

3. Telephone/Telex -

4. History of the enterprise
   Family business, managed by second generation entrepreneur.

5. Number of employees
   Directors/Senior managers 1
   Middle managers 3
   First-line managers/supervisors 12
   Employees 40
   Total 56
   Trend +/- Increasing and will add +30 per cent with new plant opening in two years time.

6. Structure of the enterprise - family tree

   MANAGING DIRECTOR

   PRODUCTION  |  SALES  |  FINANCE/ADMINISTRATION

7. Main activities
   Cotton spinning for home and export.

8. Major products/services
   Spun cotton thread for textile manufacture.

9. Financial status - last three years (in US$)

   Sales
   1993  1994  1995
   Total sales 448 000 505 000 510 000
   Cost of sales 395 000 450 000 480 000
   Profit/loss 53 000 55 000 30 000
   Trend - Declining in both actual and real terms.

10. Corporate planning
    The owner/director does it and seems to have clear ideas of what he wants but there is no communication or involvement downwards.
11. Current systems of performance measurement
   Weak. Top management only. No real production planning. No systems for measuring performance improvement. No involvement of junior management in goals, no feedback systems. Basic physical productivity measurement system, machine operation, quality, etc.

12. Major problems
   To improve productivity in existing plant.
   To improve management performance and attitudes

13. Problems expected in next 12 months - Internal/external

   External - Inflation
               Delivery of new plant
               Quality of raw materials

   Internal - Changing management attitudes
               Efficient installation of the new plant
               Developing the people to run the new plant whilst maintaining production of the old.
               Agreeing on realistic targets to improve performance of the existing facility.

14. Opportunities
   They will soon have a considerable increase in the amount of product for sale at a reduced sales price due to increased efficiency through automation.

15. Past/present work on performance improvement
   Only traditional exhortation methods.

16. Other -

   Comments

   This is basically a sound organization which wants to improve. The managing director is well aware that his problems stem from his commanding style of managing, which in turn produces a lack of involvement and commitment from his subordinates. The visit showed that the managing director, the first-line managers/supervisors and the workers are receptive to the OD/PIP² approach. The production manager, who is currently operating in the traditional management style, has some reservations because he perceives that the programme will undermine some of his executive authority. He may have a problem with the style and could, if he is unable to adapt, become a casualty of the programme. Equally the sales and finance/administration managers are both a little nervous as they feel they will be exposed by the open approach. This is not surprising as neither has held a management position before or had any formal training. They will require support but I am sure will find themselves stronger after the experience.

² OD = Organization Development; PIP = Performance Improvement Programme.
ANNEX B

TYPICAL PROPOSAL FOR PROBLEM IDENTIFICATION SURVEY

Introduction

This proposal results from a meeting with ... at ... on ... The meeting opened with a short presentation of a particular consulting approach to performance improvement. This was followed by a discussion on the problems affecting performance at the company. As a result it was agreed that we should start the programme with a survey designed to identify the key performance problems. The survey is designed to highlight the problems as perceived by the employees, their current attitudes towards the organization and their views on how the problems can be solved.

A representative sample of approximately 10 per cent of the workforce will either take part in depth interviews or be involved in a group problem identification session. In addition, all employees will have the opportunity to make their views known through a confidential questionnaire.

The survey

Information will be collected in three ways:

1. Personal interview - This will be done using a structured questionnaire on a one-to-one basis and will cover a representative cross-section of people from all functional areas.
2. Problem identification groups - We shall run a number of group problem identification sessions within the larger functions.
3. Confidential questionnaire - We shall circulate a questionnaire to all personnel. This questionnaire will be designed using the results of the face-to-face interviews and will ensure that all employees have the opportunity to contribute to the survey.

The subsequent report will outline the key problems and produce recommendations on how these can best be solved within the context of the existing situation.

Objectives

1. To collect information about the key problems facing the company through the eyes of those who work there.
2. To provide the necessary information about the current situation with appropriate recommendations, to enable management to make the “right” decisions on what action(s) it should take to improve performance.
3. To involve all personnel in performance improvement.

Method

The diagnostic phase will use structured interviewing, group problem identification and structured questionnaire techniques.
Programme of work

Week commencing 3 October:
- Initial interviews
- Design of structured interview format
- Design, testing and production of confidential survey questionnaire

Week commencing 10 October:
- Structured interviews
- Group problem identification sessions
- Issue and collection of confidential questionnaires

Week commencing 17 October:
- Process data
- Write report and produce recommendations.

Week commencing 24 October:
- Finalize and print report
- Presentation of report (27 October)

Budget

Consultancy
Work in consultant's offices
Design of confidential questionnaire
Printing of confidential questionnaire
Processing of data assuming 600 replies
Printing, binding, etc., ten copies of the report
Total
All plus expenses and VAT
ANNEX C

CASE PRESENTATION PLANNING CHECKLIST

1. Write down your objectives - what result am I looking for?

2. Identify the decision-maker/influencer

3. Think through what benefits will accrue to the decision-maker/influencer

4. Identify and quantify the problem(s)

5. Develop your solution
   - Outline your case
   - List benefits
   - List likely objectors and their objections
   - Produce counter arguments
   - Summarize

6. Assess the situation
   - When will you present?
   - Under what circumstances?
   - How long do you have?

7. Structure the presentation
   - Proposition
   - Definition
   - Strengths/weaknesses
   - Restate proposition

8. Practice
   - Test the presentation on a friend

9. Present

10. Review
    - How well did you do? Strengths/weaknesses?
    - What can you learn for next time?
UNIT 3: PROBLEM IDENTIFICATION

UNIT 3: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Identify the right approach for problem identification in a given specific situation.
2. Know how to select problem identification instruments and tools from the available range.
3. Adjust instruments or tools to specific requirements and situations.

UNIT 3: CONTENTS

3.1 Introduction to identification approaches and instruments
3.2 Direct approach and instruments
3.3 Indirect diagnostic techniques

Annexes A, B, C and D
UNIT 3: PROBLEM IDENTIFICATION

3.1 Introduction to identification approaches and instruments

At this stage the consultant has the client’s authority to carry out a diagnostic investigation into the productivity issues the facing organization. The consultant has:

- identified the key problems facing the organization;
- categorized them by type (closed- and open-ended);
- determined that the problems are solvable; and
- ascertained that the client, through his or her acceptance of the initial proposal, is amenable to detailed diagnosis.

The next step in resolving P & Q problems is to carry out a detailed diagnosis to identify the key issues. This activity has three major goals:

1. To ensure understanding of the real problem(s) by opening up the area under study so that all the issues can be brought out into the open.
2. To involve all those who will be affected by the solution(s) of the problems in the diagnosis in order to get their ownership and commitment.
3. To legitimize the actions necessary to solve the problems

This unit considers the design and application of the information-gathering instruments needed to undertake the diagnosis.

3.1.1 Determine the approach

The approach used to diagnose P & Q problems is determined by a number of factors:

- the characteristics of the problem;
- the size and scope of the area of study; and
- what the client believes is legitimate.

Let us consider these factors in detail.

The characteristics of the problem

The characteristics of the problem need to be taken into account when determining the design of the information-gathering process. If the problem is perceived as technical and local, group discussion (along with the common data collection techniques such as activity sampling, industrial engineering methods, etc.) may be the best approach. If it is seen as attitudinal and global, some form of questionnaire will be the most appropriate method.

Size and scope of the area of study

The size of the area under study has a major influence on the method(s) used. Getting
ownership of a problem that affects the performance of the whole organization means involving everyone. If the problem is localized to one department, only they need to be involved. The key question for the consultant at this stage is “Who will be affected by the solution to the problem?” These are the people who need to be involved in the study.

Collecting information on productivity issues from all members of a department of 25 people can easily be done in a couple of days using semi-structured questionnaires. The same approach is not possible, however, if the target group is 1,000 or more. In this case the only practical approach is through structured questionnaires. If the objective is to cover groups of 100-150, some form of problem identification group approach can be used. The method chosen is determined by the objectives for involvement and the numbers involved.

Recognizing what the client believes is legitimate

The consultant has made a proposal to the client based on views formed during the initial investigation phase. What was recommended in the proposal must be taken into account when deciding on the approach to the investigation. If the proposal recommended a localized approach, there is little value in the consultant now recommending an organization-wide survey. Equally, if the consultant believes that the problems stem from the way the management team work together, but the client believes they are working well, there is no value in suggesting a Top Team Development programme as the vehicle for identifying the key issues. The information-gathering process must be indirect. It aims to enable the consultant to prove his point. Once this is done the consultant can suggest a Goals and Controls programme.

3.1.2 Problem identification instruments

There are two main ways of collecting the information required for diagnosing productivity problems:

- the direct approach, asking those involved what they believe to be the main problems impacting productivity; and
- the indirect approach - through either observation of actual practice, or through simulation, creating actual behavior and assessing its implications for productivity.

Most problem identification surveys use the direct approach. Those involved are asked questions about problems, attitudes, communication, motivation, etc. These are either asked directly through face-to-face interviews and group discussions or elucidated through questionnaires. It is important, however, to recognize that this information can also be collected using indirect methods such as business simulations, Goals and Controls programmes, etc.

The direct approach has the advantage of being quick and reasonably cheap. The indirect approach has the advantage that it is normally more objective and focuses specifically on the problems affecting performance. Direct information on performance problems reflects opinion and contains many extraneous issues. It thus needs more screening than indirect information.
3.2 The direct approach and its instruments

There are five main types of direct information-gathering instruments that the consultant can use to identify the main productivity issues faced by organizations. These are:

- semi-structured interviews;
- standard instruments;
- customized standard instruments;
- purpose-designed instruments; and
- problem identification groups.

These approaches are not mutually exclusive. Most problem identification exercises involve the use of the first and last of these instruments, which are consultant driven. Use of the others, which are all respondent driven, will depend on the situation.

3.2.1 Semi-structured interviews

This is the simplest and most widely used method for diagnosing productivity problems. It is consultant driven and uses tailored questionnaires to provide the structure for a series of interviews. The consultant collects the information required directly through the interviews. This approach has the advantage that in addition to the direct information the consultant also finds out respondents' feelings about the issues facing the organization. There are many possible ways to produce customized problem identification vehicles. The following approach is based on our practice.

The first step is to decide what information is required to give a clear understanding of the client's problems. The consultant, on the basis of his initial interviews with the client and his experience, identifies the key topics/areas for investigation. Next, he or she must also decide how the information thus gathered should be classified to aid analysis. People from different departments may well have different perspectives, so "work area" would normally be a classification. The person's job (e.g. manager, supervisor), their age, their service in the company, etc., may affect their perception of the issues, and a classification enabling the data to be sorted by these categories would also be included. Having done this, the consultant produces the questionnaire that will serve as the basis for the subsequent structured interviews (see Annex A for an example).

The next step is to choose the sample size. On most occasions the consultant will be seeking views which represent the views of the target group, or the organization as a whole. When the target group is small it will be possible to talk with all members. Often, however, target groups are too large for this and a sampling approach must be used. There are two main ways of handling this problem. The consultant can subjectively identify key individuals (or a cross-section of individuals) to be interviewed in order to gain an insight into the productivity problems of the whole organization. Alternatively he or she can use a market research approach and scientifically arrive at a sample size. Given the time taken to carry out such interviews, numbers are usually limited to around 30 employees.

When a sample has been chosen, the consultant tests the questionnaire and changes it as necessary. For example, if the consultant is looking at the way in which a company develops
competence in its employees, one question might be "How important is it to you, as a manager, to coach your subordinates?" The test interview may show that an additional question might be useful: "What do you think is meant by coaching?"

Once the instrument is deemed to be satisfactory, the full-scale information-gathering activity can begin. Interviews are carried out individually, usually at a rate of six per day. The "normal" rules for effective interviewing apply (e.g. a room where the participants cannot be overhead, no interruptions, sufficient time allowed for the interview). The interviewer greets the interviewee, puts him or her at ease and outlines the procedure and the reason for the interview. He then asks the questions, answers any questions the interviewee may have, closes the proceedings and makes clear what happens next. High levels of interpersonal skill are required for this process to work smoothly and for the consultant to draw out all the pertinent information from the interviewee.

When all the interviews have been conducted, the responses, question by question, can be analysed and a report written.

This method has the advantage of being relatively quick. Those individuals with the greatest insight into the problems of the company can be targeted for interview. Respondents can say what they wish in answer to the questions, and the opportunity to follow up issues provides additional insights. This enables the consultant to obtain considerable in-depth information about the company, its people and its problems.

On the minus side, however, the fact that only a few people are involved may mean that commitment to future action is not immediately forthcoming from the majority of employees. Additionally, identifying the key P & Q issues from the various interviews, and successfully conducting the interviews, requires both skill and experience.

3.2.2 Standard instruments

These are tried-and-tested questionnaires designed to measure specific employee attitudes. The golden rule is "Don't reinvent the wheel if you don't have to."

Over the years a great many standard instruments have been developed to help consultants in identifying productivity problems. Such instruments usually have a front sheet for "classification" data. These are the fields by which the completed responses can be sorted. They normally include such items as job title, work area, time in the company, full/part time, etc. It is important to ensure that all the fields needed for sorting the data are identified before carrying out the survey; it is too late afterwards.

The front sheet is followed by the various sections covering the main categories for investigation. Each contains a number of questions about the specific topic under consideration. For example, a section seeking views on the individual's relationship with his superior might contain questions such as:
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To what extent does your supervisor give you regular feedback on your performance?

To a very great extent  To a great extent  To some extent  To a little extent  Very rarely

☐ ☐ ☐ ☐ ☐

To what extent does your supervisor keep you informed about what is going on?

To a very great extent  To a great extent  To some extent  To a little extent  Very rarely

☐ ☐ ☐ ☐ ☐

Tick the appropriate box.

Other sections aim to collect information on how respondents feel about their jobs, relationships with other work areas, the performance of higher management, etc. (See Annexes B and D for a sample instrument.)

The completed responses are analysed and the main issues highlighted. The consultant writes a report on his findings for the management team. They feed the information back to the respondents.

Confidentiality is often a key issue with attitude surveys. Many employees do not trust their organizations, at least in the first instance, to handle the information honestly. This problem can be solved by having employees send the replies straight to the consultant’s office in a reply-paid envelope.

3.2.3 Customizing standard instruments

The customizing of standard instruments allows the consultant to reflect specific situations. If the problem under consideration is the way in which different departments interact (for example, the sales department is selling a high percentage of “specials” on a short cycle time, causing considerable friction with the production, R & D and purchasing departments who must try to meet the promises to customers), the Lawrence and Horsch Conflict Management Questionnaire may form the basis for a suitable approach. A series of interviews would be conducted with key staff to highlight the main issues, and these would be written into the chosen instrument. Such an instrument might produce a series of questions as follows:

Have you been in conflict with others over short lead-times on customer orders in the last twelve months?

☐ YES ☐ NO

If YES, how was the conflict handled?
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Forcing - people use “power plays”
Smoothing - people try to gloss over the problem
Avoiding - people avoid dealing with difficult issues
Bargaining - people try to “split the differences”
Confronting - people openly discuss differences to find mutually acceptable solutions.

Usually this reveals that the person completing the questionnaire has a more favourable view of himself and a less favourable view of others. Analysis of the variance in results provides the means to identify key issues and to generate a means of dialogue in order to solve them.

It is possible to take almost any questionnaire which fits the context of your investigation and through the use of semi-structured interviews gain information with which to customize/modify it. Management literature is full of questionnaires that can be adapted for most topics (e.g. supervisor’s behaviour, management culture, quality, leadership style, etc.).

3.2.4 Purpose-designed questionnaires

This type of instrument is normally used when specific information is required, large numbers of people are to be involved, and the resultant data are to be processed.

With this approach employees are given a series of questions to answer but their responses are limited to a preselected number of options. There are a number of methods for developing such questionnaires and analysing them.

The first step, as with the customized questionnaires, is to decide the sort fields, e.g. department, job title, etc. Information for the design of such questionnaires is obtained through carrying out a number of semi-structured interviews as described above. A list of key issues is prepared from the data collected. Each issue is put in the form of a statement and respondents are asked to indicate their feelings on a five-point scale. If a key issue is training, we can ascertain if people feel they have been properly trained by asking them to respond to such statements as:

I have received the training I need to do my job well.

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

The questionnaire must then be tested. This is important for two reasons:
The questionnaire may be wrong in some way. Questions may be worded ambiguously or not yield the hoped-for information.

The more involved employees are with problem identification, the more likely they are to be committed to any action that results.

Again there a number of ways in which this testing can be done. The simplest is to bring together a cross-section of employees in groups of six to eight, and ask them to complete the questionnaire. They are then asked to discuss each question in turn. What does the question mean to them? Would a different wording be better? Are there topics missing that should be included? The questionnaire can then be amended accordingly.

The questionnaire is then distributed for completion. Generally speaking, the more widely the questionnaire is distributed, the better the results obtained. Where company attitude surveys are concerned, all employees are given the opportunity to participate. The returned questionnaires are then analysed and a report produced.

The advantage of using fully structured questionnaires is that it is possible to involve large numbers of employees in identifying the key productivity problems. It also provides quantifiable data on the employees' perception of the problems. If 95 per cent believe quality to be a problem, it is difficult not to accept that some action should be taken in this area.

On the negative side, the procedure takes time and costs money.

### 3.2.5 Discussion groups

The consultant has the option of using group discussions as the vehicle for defining productivity problems.

Numerous variations on the theme are possible, but cross-functional groups of about six to eight people usually work best. Numbers are kept low to ensure that everyone has a chance to speak, and the mix helps to provide a useful cross-fertilization of ideas and experience. The consultant's role is to provide a framework for the discussions to ensure that the talk stays focused on the matter in hand and to ensure that the output of the talks is in a format that makes analysis possible. This framework can be either structured, or unstructured as in brainstorming.

**Structured groups**

This approach is designed to give large numbers of people the opportunity to provide information on the problems affecting productivity as they see them. This information is collated and analysed to highlight common problem areas which will form the basis of the action group projects.

The three methods outlined here are the "logical" approach, force field analysis, and the "listing" method.

**The "logical" approach**
Step 1 Identification of performance problems

Start by identifying what individual group members see as the main problems affecting their performance. A useful way of starting the process is to ask group members to say what it is that stops them doing the best job they can. You will find it most helpful to use flip charts while working through the various stages of the process recording what has been agreed.

Step 2 Problem categorization

Here we are concerned with identifying what type of problem we are trying to solve and with ascertaining whether the ability to solve it is within or outside the enterprise. We need this information in order to use our energies most effectively.

The problems should first be categorized by type. Closed-ended problems - ones to which there is one unique correct answer - and open-ended problems, which have many possible answers and where success depends on the process rather than the specific solution (see Unit 1 of this module). The following are some examples of closed-ended problems: the computer has broken down, we are losing business because there is a lack of telephones, the production line has stopped. All these problems have one right answer, at least in the short term. With open-ended problems, however, such as poor staff morale, low productivity and bad quality work, there is no single right answer. Many actions can be taken, and success will depend more on the commitment of those taking the action than on the actions themselves.

Second, the problems should be categorized by location: internal, if they are within the control of the management of the organization who have the ability, if not the will, to solve them; and external, if they are outside the control of the enterprise.

Step 3 Importance and probability of solution

The next step is for the group to consider how important it feels the problems are. Which would have the most significant impact on performance if they were solved? The group is asked to award marks in the range 0 (low) to 9 (high) against each problem to indicate their views.

In any human endeavour a little success is a great motivator. It is therefore important to try to identify the chances of success before choosing the problems to work on. There is little point in putting effort into problems which cannot be solved. Use group consensus to allocate points, again in the range 0 - 9, to each problem. A low score indicates that the problem will be difficult to solve, a high score means a good chance of success.

Force field analysis

A series of individual interviews are conducted to identify the key problems. Groups are then brought together to analyse these problems in terms of the forces working towards improvement or change and those working to prevent change.
PROBLEM: Poor supplier

CURRENT SITUATION

<table>
<thead>
<tr>
<th>DRIVING FORCE</th>
<th>RESTRAINING FORCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition from other supplier</td>
<td>Emphasis on lowest price</td>
</tr>
<tr>
<td>Customer demand for better quality</td>
<td>Custom and past practice</td>
</tr>
<tr>
<td>Need to reduce high cost of inspection</td>
<td>Poor purchase specifications</td>
</tr>
<tr>
<td>High cost of reworking below specification product</td>
<td>Constant changes in delivery schedules</td>
</tr>
<tr>
<td></td>
<td>Lack of vendor approval system</td>
</tr>
<tr>
<td></td>
<td>Poor vendor rating system</td>
</tr>
</tbody>
</table>

The listing method

Alternatively, the group can be given key problems identified through interviews and simply be asked to discuss them and present topics for further investigation, in a specified reporting format:

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>IMPACT ON PRODUCTIVITY</th>
<th>IMPORTANCE</th>
<th>SUGGESTED ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier quality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-house inspection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer attitudes</td>
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<td></td>
</tr>
</tbody>
</table>

Unstructured groups

The simplest framework for unstructured groups is brainstorming. This means providing the groups with a copy of the brainstorming procedure, and a time frame to work in. Brainstorming guidelines are described in Module 10, “Industrial engineering techniques”.

The group method allows for considerable interaction between the consultant and the employees when identifying the key P & Q issues. Because of the two-way nature of the process, considerable insight can be gained by the consultant and commitment from the employees is generated as they have actively contributed to the definition of the problem.

Figure 3.3 provides a summary of the instruments discussed and indicates cases where they could be applied most effectively.
3.3 Indirect diagnostic techniques

Indirect diagnostic techniques are concerned with identifying P & Q problems in “real time”. There are two major approaches which can be used in this area:

- The use of large-scale simulation, either to examine the past or to forecast the future.
- The use of strategic management programmes to restructure the organization. These initiatives focus management's interest towards a “desirable” future and are used to identify issues likely to impede the journey.

They can be used only where the client has agreed to adopt them at the initial proposal stage.

3.3.1 Simulations

Large-scale simulation is a very valuable tool for demonstrating P & Q problems. There are a
variety of different instruments available, or the more sophisticated practitioner can develop his own. The objective is to create an environment in which participants behave in the way they do in the real world, including replicating the problems they have. This technique is particularly valuable for testing out next ideas. For example, if an organization decides to embrace the concept of Total Customer Satisfaction, it needs some way of predicting how this will work in practice: what training do people require, how will the new behaviour require conflict with the old, etc. These questions can be answered by working a representative group through a tailored simulation. Their behaviour identifies the potential problems. Similarly, if there are problems with the existing organization that everyone knows about but no one wishes to acknowledge, these can be brought out through the use of simulation.

3.3.2 Strategic management programmes

These focus on management on the future of their organizations and come in various guises. Top Team Building, Goals and Controls (see Annex C for an example), Competitive Achievement Planning (CAP), Operational Reviews, TQM, MBO, etc. This type of programme aims to focus management attention on a “desired” future and through this process helps them to identify and solve the problems that may impede their progress toward it.

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**DIAGNOSING PRODUCTIVITY PROBLEMS: INSTRUMENT DESIGN CHECK-LIST**

1. **Select the approach:** Carry out a top-level survey to identify productivity problems and to agree on the overall approach, i.e. tailor-made (questionnaire, interview or group discussion), standard questionnaire or semi-customized approach.

2. **Agree on participants and survey scope:** Identify who should participate in the survey. The more people involved, the better the commitment to any action(s) that result(s) from the problem identification stage. The guideline here is that those who will be affected should be involved.

3. **Choose the approach:** If the approach is to be direct, choose one or a combination of instruments from the direct list. If the approach is to be indirect, develop a simulation or an appropriate programme.

4. **Agree on a detailed timetable of events:** The client and consultant need to agree when and where interviews, surveys, discussions will be carried out, who will do what work (have questionnaires printed, books, venues, etc.) and when the completed report will be submitted.

5. **Plan the information session:**
   - For interviews and group discussions:
     - Secure rooms free from interruptions.
     - Sufficient time allowed for the meetings.
     - Necessary equipment available, e.g. flip chart.
     - Guidelines for the meeting - a structure for the discussion.
   - For questionnaires:
     - Distribution plan - to get the questionnaires to the respondents promptly.
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- Collection plan - to get back the completed questionnaire.
- Processing plan - secure computer time.

For indirect methods:
- Develop or choose your model.
- Organize the venue

6. Communicate about the survey or programme:
- Brief all participants about what will be happening during the problem identification phase, either by a memo from the managing director or through a series of briefing meetings run by the managing director.
- Brief individual participants about their attendance at specific events, e.g. a semi-structured interview (give at least two weeks warning).

7. Do it:
- Carry out the interviews.
- Send out the survey.

Whatever the approach to gathering the information, the next stage is analysis, conclusions, recommendations and writing the report.

EXERCISE

Take the productivity problem you identified in Unit 2 and follow the steps outlined in the above check-list to develop a diagnostic instrument.

Questions for discussion

1. What are the differences between approaches and techniques in problem identification?
2. What are the main goals of problem diagnosis?
3. What are the best approaches in selecting problem identification instruments?
ANNEX A

EXAMPLE OF A SEMI-STRUCTURED QUESTIONNAIRE

This questionnaire is designed to provide general information on how managers see their organization. It should be completed through interviews with a representative cross-section of managers including at least one senior manager from each main function.

Organization................................... Title...........................................

Name........................................... Date...........................................

1. Describe the structure of your division/department - Family tree
2. Describe your job. What are your main responsibilities, list and rank?
3. Show how you divide your time between these responsibilities.
4. How is your performance measured?
5. What do you like doing as a manager?
6. What do you dislike?
7. What are the main factors which reduce your effectiveness?
8. How do you measure the performance of your subordinates?
9. How effective is your team? What could be done to increase their effectiveness?
10. What do you see as the company's goals? How did you get this information?
11. What do you see as the main problems facing the company and yourself in the next 12 months?
    The Company
    You
12. What action(s) do you think should be taken to overcome these?
13. Comments.
ANNEX B

EXAMPLE OF A TAILORED QUESTIONNAIRE FOR AN ATTITUDE SURVEY

Organizations run on information: the better the information they have, the better their performance. The company wishes to improve communications and understanding within the organization. This means finding out where we are now in terms of the way we communicate in order to identify any necessary action(s). To achieve this, we should like your views on the following issues.

This survey is completely confidential, so please be frank and indicate how you really feel. You will see that the majority of the questions call for a “tick box” answer, but please feel free to make any additional comments at the end of the questionnaire.

Your completed questionnaire will be analysed by external consultants and will not be made available to anybody from within the company.

Thank you for your cooperation.

Job title
Manager  Supervisor/foreman
Salesperson  Production worker
Transport worker  Clerical/secretarial

Area you work in
Distribution  Quality
Production  Technical Services
Contract works  Finance/accounts
Engineering  Marketing/publicity
Personnel  Industrial engineering

Service with the company
1 - 3 years; 3 - 10 years; 10 - 20 years; 20+ years
1. FUNCTIONAL INFORMATION AND COMMUNICATIONS

Here is a list of statements which describe different types of communication within the organization. Please read each carefully and indicate how strongly you agree or disagree with it. Please tick only one column.

<table>
<thead>
<tr>
<th></th>
<th>Strongly agree</th>
<th>Tend to agree</th>
<th>Neither agree or disagree</th>
<th>Tend to disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) I am told what I need to know to do my job well</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(b) I have been given all the necessary training to do my job well</td>
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<tr>
<td>(c) I have clear performance targets</td>
<td></td>
<td></td>
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<tr>
<td>(d) My supervisor gives me regular feedback on my performance</td>
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<tr>
<td>(e) I feel I am properly rewarded when I do a good job</td>
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<tr>
<td>(f) I feel I am listened to and my views taken into account</td>
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<tr>
<td>(g) My immediate supervisor keeps me well informed</td>
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<td></td>
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<tr>
<td>(h) I know what my department’s goals are and how I fit in</td>
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<td></td>
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</tr>
<tr>
<td>(i) I know what the company’s goals are and how my department fits in</td>
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</tr>
</tbody>
</table>

Please list below any aspects to do with information and communication, not covered above, which you feel affect your job performance.
### Module 3
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<table>
<thead>
<tr>
<th></th>
<th>To a great extent</th>
<th>To some extent</th>
<th>No strong opinion</th>
<th>To a little extent</th>
<th>To a very little extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) How well do persons in your work group know each other’s jobs?</td>
<td></td>
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</tr>
<tr>
<td>(b) To what extent is your work group involved in solving problems related to your work area?</td>
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<tr>
<td>(c) To what extent are the purposes or goals of the group’s work clear to you?</td>
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<tr>
<td>(d) To what extent do you believe there is cooperation between your work group and other work groups that you regularly deal with?</td>
<td></td>
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<tr>
<td>(e) To what extent does your supervisor hold group meetings where you and your colleagues can really discuss things together?</td>
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<td></td>
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<tr>
<td>(f) To what extent do these meetings result in changes?</td>
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<tr>
<td>(g) To what extent does your group achieve its goals?</td>
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</tr>
</tbody>
</table>

Comments
3. SOURCES AND VALUE OF INFORMATION

Below is a list of sources of information. We should like to know from which of these sources you currently get your information about the company and other matters that affect you and your job, and how you feel about the information you receive.

<table>
<thead>
<tr>
<th>I receive information from</th>
<th>Very valuable</th>
<th>Quite useful</th>
<th>Useful</th>
<th>Of little value</th>
<th>Useless</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) My immediate supervisor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Notice boards</td>
<td></td>
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<tr>
<td>(c) Regular company-wide publications for employees</td>
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<tr>
<td>(d) Various committees</td>
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<tr>
<td>(e) Small group meetings such as briefing groups or team meetings with my supervisor</td>
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<tr>
<td>(f) The “grapevine” (other employees)</td>
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<tr>
<td>(g) Employee handbooks or other booklets/brochures/policy manuals</td>
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<tr>
<td>(h) My union, or workers’ representative</td>
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<tr>
<td>(i) Senior managers of the enterprise</td>
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<tr>
<td>(j) Other (please specify)</td>
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</tbody>
</table>
4. GENERAL INFORMATION

Please indicate whether you think the company gives you the right amount of information on each of the following. Please tick in one column only.

<table>
<thead>
<tr>
<th>(a) Organization structures</th>
<th>Right amount</th>
<th>Too much</th>
<th>Too little</th>
<th>None at all</th>
<th>The wrong information</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b) The company’s policies</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(c) Own employment conditions (including benefits)</td>
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<tr>
<td>(d) Job vacancies</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>(e) Career opportunities</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(f) Training courses available</td>
<td></td>
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<tr>
<td>(g) Customers and their requirements</td>
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<td></td>
<td></td>
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<tr>
<td>(h) Product quality requirements</td>
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</tr>
<tr>
<td>(i) Financial performance of the company as a whole</td>
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</tr>
<tr>
<td>(j) Financial performance of your department</td>
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<td></td>
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<tr>
<td>(k) General performance of your department</td>
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<tr>
<td>(l) Your own job performance</td>
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<tr>
<td>(m) The company’s plans for the future</td>
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<tr>
<td>(n) Reasons for major decisions</td>
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</tbody>
</table>
5. YOUR IMMEDIATE SUPERVISOR

This section is concerned with your views on your supervisor, the person to whom you report on a day-to-day basis.

<table>
<thead>
<tr>
<th></th>
<th>To a great extent</th>
<th>To some extent</th>
<th>No strong opinion</th>
<th>To a little extent</th>
<th>To a very little extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) To what extent do you have confidence in the fairness of your immediate supervisor?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) To what extent does your immediate supervisor set the standards for and communicate about performance?</td>
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<tr>
<td>(c) To what extent does your immediate supervisor back you up?</td>
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<tr>
<td>(d) To what extent does your immediate supervisor make you want to use your best efforts?</td>
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</tr>
<tr>
<td>(e) To what extent does your immediate supervisor criticize poor work?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(f) To what extent does your immediate supervisor compliment good work?</td>
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<tr>
<td>(g) To what extent do you feel at ease about approaching your immediate supervisor?</td>
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</tr>
<tr>
<td>(h) To what extent does your immediate supervisor understand the type of problems you face in doing your job?</td>
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<tr>
<td>(i) To what extent does your immediate supervisor set an example by working hard?</td>
<td></td>
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</tr>
</tbody>
</table>

Comments
6. SENIOR MANAGEMENT

<table>
<thead>
<tr>
<th></th>
<th>To a great extent</th>
<th>To some extent</th>
<th>No strong opinion</th>
<th>To a little extent</th>
<th>To a very little extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) To what extent do you believe senior management is aware of problems at lower levels of the company?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(b) To what extent do you feel it is important for senior management to visit your work area?</td>
<td></td>
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</tr>
<tr>
<td>(c) To what extent do you have confidence in the judgement and ability of senior management?</td>
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<tr>
<td>(d) To what extent do you feel the members of senior management are trying to communicate with you?</td>
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</tr>
<tr>
<td>(e) To what extent do you feel senior management has a real interest in your well-being?</td>
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</tr>
<tr>
<td>(f) How effective is senior management in dealing with an individual’s personal problem?</td>
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<td></td>
</tr>
</tbody>
</table>

Comments

7. VALIDITY OF COMPANY COMMUNICATION

How do you feel about the information you receive? Choose one of the following proposals:

(a) I always believe it
(b) I usually believe it
(c) I believe it some of the time
(d) I seldom believe it
(e) I never believe it

In hindsight, does the information you receive turn out to be:

(a) Always right
(b) Usually right
(c) Right half of the time
(e) Seldom right
(f) Never right

8. COMMENTS ABOUT THIS SURVEY

How do you feel about this survey? Please read the statements below and indicate your feelings by ticking the appropriate box.

<table>
<thead>
<tr>
<th></th>
<th>Strongly agree</th>
<th>Tend to agree</th>
<th>Neither agree nor disagree</th>
<th>Tend to disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Pleased to see this kind of survey done</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Like to know more about how this survey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>goes - hope we hear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Shows that the company is concerned</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>about what we think</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) I believe the company will act on the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>findings of this survey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) I think it should be done every year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. ADDITIONAL COMMENTS

If you have any additional comments you would like to make on communications within the company, please use this space to record them.

..........................................................
..........................................................
ANNEX C

EXAMPLE OF A GOALS AND CONTROLS PROGRAMME

FUNCTIONAL GOALS AND BUSINESS PLANS DEVELOPMENT PROGRAMME: A SENIOR MANAGEMENT TEAM-BUILDING PROGRAMME FOCUSING ON ORGANIZATIONAL PROBLEM-SOLVING AND COMMUNICATION (THREE MONTHS PART TIME)

INTRODUCTION

This programme is designed to improve the managerial performance of organizations: firstly, by helping the management team to understand its corporate goals, developing functional business plans and setting in process the necessary actions to achieve them; and secondly, by building the management team into an effective managing group through an enhanced understanding of each other’s functional goals/achievements and their differing styles of management.

The programme runs in three stages, followed by integration of the major achievements into the organization’s normal managing systems. The training programme starts with a two-day functional business plans and team building workshop. In Stage 2, which is a two-month action phase, participants work in their functional groups to develop the agreed goals. Stage 3 is a plenary review where individuals/groups feed back what they have achieved and agree on the integration programme.

OBJECTIVES

To agree a mission statement based on the corporate goals.
To develop functional roles which will clarify the major responsibilities and objectives of each business function.

To identify key activities requiring attention and initiate actions to solve them.

To engender a company management philosophy and provide the necessary problem-solving tools to make it work.

Team building and managerial development.

FOR

All senior managers and those who report directly to them.
METHOD

The process will use the learning-by-doing approach around the actual problem of developing and managing the business.

PROGRAMME

STAGE 1 - Functional Responsibilities and Goals Workshop - 3 days

Day 1
1800 - 1930 Introduction and Programme Objectives

Day 2
0830 - 1030 Defining the Mission Statement
1100 - 1230 Identifying Functional Responsibilities
1400 - 1600 Presenting Functional Responsibilities
1600 - 1830 Choosing a Management Style

Day 3
0830 - 1230 Functional Groups Agree on Responsibilities and Develop Performance Goals
1400 - 1700 Functional Groups Present what they have done and their plans to develop these within their own groups.
1700 Review and Close

STAGE 2 - Implementation - 2 months

Participants work to develop functional responsibilities with targets, monitoring and control systems down to middle management level. Functional groups will have the support of the consultant during this period as required. Two progress reviews will be held with functional managers and their direct reports during this period.

STAGE 3 - Review - 1 day

Functional groups present what they have achieved and agree on the integration programme.

Expected Results

It is expected that as a result of the programme participants will have:

1. A clear understanding of the Corporate Goals and a united commitment to achieving them.
2. Functional and individual role descriptions with targets and measurement systems.
3. A monthly functional reporting structure which is used for managing the organization.
4. Developed effective functional and cross-functional teams.
ANNEX D

ASSESSMENT OF QUALITY SYSTEMS TO BS 5750

This programme has been designed to allow organizations to carry out an initial self-assessment to BS 5750.

The objectives are to assess the management systems in place against the requirements of BS 5750 parts 1, 2, 3; ISO 9001 and EN 29001 parts 1, 2, 3.

ASSESSMENT - SECTION 5 OF BS 5750

Assess the current state of your organization, using the scale provided, by answering the following questions. Refer to the accompanying notes for more detailed information where required.

5.1 Management Responsibility

(a) Is there a documented quality policy?
   Yes ☐
   Partially ☐
   No ☐

(b) Do you have up-to-date job specifications for key staff which specify the quality functions for which they are responsible?
   Yes ☐
   Partially ☐
   No ☐

(c) Do you have someone specifically responsible for verification - someone whose job it is to monitor compliance with agreed standards?
   Yes ☐
   Partially ☐
   No ☐

(d) Do you have formally appointed Quality System Management Representatives?
   Yes ☐
   Partially ☐
   No ☐

(e) Do you have formal management reviews which consider matters affecting quality, e.g. scrap, rework, complaints?
   Yes ☐
   Partially ☐
   No ☐

5.2 Quality Systems

(a) Does a documented Quality Management System exist?
   Yes ☐
5.4 Design Control

Do you have a formal procedure for design control?
Yes □
Partially □
No □

5.5 Document Control

(a) Do document control procedures exist?
Yes □
Partially □
No □

(b) Is there a master list of standards available?
Yes □
Partially □
No □

(c) Are issue level/page controls in place?
Yes □
Partially □
No □
Module 3
Unit 3

5.6 Purchasing

(a) Is there an approved vendors list? Are documented purchase orders placed with service subcontractors?
   Yes □
   Partially □
   No □

(b) Are all purchases placed with service subcontractors documented by issuing formal purchase orders?
   Yes □
   Partially □
   No □

(c) Do purchase orders specify standards and technical requirements?
   Yes □
   Partially □
   No □

5.7 Purchaser-Supplied Product

Are there systems for controlling purchaser-supplied products?
   Yes □
   Partially □
   No □

5.8 Product Identification and Traceability

(a) Is there a record system for product identification and traceability?
   Yes □
   Partially □
   No □

(b) Does a recall procedure exist?
   Yes □
   Partially □
   No □

5.9 Process Control

(a) Do formal processes exist for turning a customer requirement into a product or service?
   Yes □
   Partially □
   No □

(b) Are special processes understood and "qualified"?
   Yes □
   Partially □
   No □

5.10 Inspection and Testing
Module 3
Unit 3

Do formal systems exist for inspection and testing?
Yes ☐
Partially ☐
No ☐

5.11 Inspection Measuring and Test Equipment

Do formal systems for calibrating inspection measuring and test equipment exist?
Yes ☐
Partially ☐
No ☐

5.12 Inspection and Test Status

Is there a formal system of inspection and test status identification?
Yes ☐
Partially ☐
No ☐

5.13 Non-Conforming Products

Are there formal systems for identifying and recording non-conforming products/services?
Yes ☐
Partially ☐
No ☐

5.14 Corrective Action

Are there formal systems for taking action to solve problems with non-conforming products/services?
Yes ☐
Partially ☐
No ☐

5.15 Handling, Storage, Packaging and Delivery

Are there formal systems for controlling the quality of handling, storage, packaging and delivery?
Yes ☐
Partially ☐
No ☐

5.16 Quality Records

Is there a formal system for the maintenance of quality records?
Yes ☐
Partially ☐
No ☐
5.17 Internal Quality Audits

(a) Are there procedures for internal auditing and are these carried out on a regular scheduled basis?
   - Yes [ ]
   - Partially [ ]
   - No [ ]

(b) Are there staff who have been formally trained as quality auditors?
   - Yes [ ]
   - Partially [ ]
   - No [ ]

5.18 Servicing

Are there quality procedures covering the servicing of products?
   - Yes [ ]
   - Partially [ ]
   - No [ ]

5.19 Training

(a) Are there quality standards for all training carried out in the organization?
   - Yes [ ]
   - Partially [ ]
   - No [ ]

(b) Have the training needs of all personnel involved in quality been identified?
   - Yes [ ]
   - Partially [ ]
   - No [ ]

5.20 Statistical Techniques

Are quality records kept which are then converted to statistics which can be used for compliance monitoring purposes?
   - Yes [ ]
   - Partially [ ]
   - No [ ]
UNIT 4: ANALYSING THE DATA AND DRAWING CONCLUSIONS

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Know how to analyse (prepare, code, process and edit) data.
2. Draw the main conclusions from your data analysis.

UNIT 4: CONTENTS

4.1 Preparation for analyses: Tidying up the data
4.2 Coding the data
4.3 Processing the data
4.4 Editing the data
4.5 Drawing conclusions
UNIT 4: ANALYSING THE DATA AND DRAWING CONCLUSIONS

4.1 Preparation for analyses: Tidying up the data

The information, whether on flip charts from group discussions, on forms from semi-structured interviews, or on completed “tick-box” questionnaires, must be checked to ensure that it is:

- complete - there are no obvious gaps;
- legible - it can be read;
- comprehensible - it makes sense;
- consistent - there are no obviously contradictory statements; and
- uniform - common units of measure and time are used throughout so that later comparison is possible.

Where the information is gathered through interviews and group discussion, these checks should be performed before the end of the meeting so that any points that arise out of the editing can be promptly dealt with. If, for whatever reason, this is not possible queries need to be followed up with those concerned at the earliest available opportunity.

Clearly, if large numbers of tick-box questionnaires are anonymously returned to the consultant, there is a limit to the amount of corrective action that can be taken. In such cases the testing stage of the questionnaire is crucial in identifying possible sources of error and eliminating them before the distribution of the instrument.

4.2 Coding the data

The primary objective in coding the data is to identify key issues.

This means linking “symptoms”, the manifestations of the problems with the root causes. With interview and group discussion data this means scanning the responses to identify patterns in the reply: for example, comments such as “I don’t know what is expected”, “I’m not told what to do”, “I’m not sure what my job is,” etc., indicate a lack of task communication. Thus these issues would be put under the heading “Job communication”. With structured questionnaires it is not possible to do this: there are too many data and they are difficult to read. The goal at this stage therefore is to code the data in order to make them readable.

4.2.1 Interview and discussion group data

With interview and group discussion data the consultant’s next step is to identify the patterns within the data. Once the specific categories are identified, the data are allocated to these. Key issues are usually self-evident, but categorizing the responses to the open-ended questions can be a more difficult task. The consultant’s job is to make judgements based on his or her experience and knowledge. Where a number of people are involved in analysing data they should deal with particular sections, or questions to code, rather than whole interview forms, in order to ensure
consistency across the sample.

Typically P & Q issues fall into the following broad categories:

- communication - this category includes any problems which are influenced by communication;
- planning - issues to do with the way things are planned or not, as the case may be, and the way these plans are carried out;
- management style - issues which reflect management attitudes;
- decision-making - issues concerned with the way the organization makes decisions;
- motivation - all issues affecting motivation;
- managing systems - issues concerned with the organization managing structures: the way things are organized, cross-functional relationships, etc.;
- personnel - any issues concerning people or Human Resource Management (HRM) systems;
- technical - technical issues to do with products and services; and
- miscellaneous - any other issues.

4.2.2 Structured questionnaires

The basic objective when coding structured questionnaires is to make the data interpretable. Numeric codes are assigned to the various fields to make it easy to identify and compare problems. The sort fields must also be defined (e.g. department, job title, sex, length of service, etc.). Answers are usually presented in the form of percentages. This makes it immediately clear what percentage of people are happy and what percentage are unhappy. We have found that adding additional scoring systems is very helpful: for example, allocating points to each possible answer (1: strongly disagree; 2: disagree; etc.).

Large samples generate large amounts of data, and most consultants use computers for this type of analysis. For example, an attitude survey is being carried out for a company with five departments. The survey has five sections, each covering a different aspect (e.g. supervisor’s performance, top management, pay and conditions, etc.). If each section contains five questions each, there will be 750 separate pieces of data to compute by however many fields are chosen. This could mean a report of the whole survey; a report by section (eight reports); a report by job title (six reports); a report by work area (eight reports); etc.

The appropriate data can also be graphed as a way of showing the distribution by category and question, or any other combination which will aid understanding.

4.3 Processing the data

The third stage of analysis of semi-structured questionnaires and group data is to allocate the raw data by category and count the number of times that data fall into a particular category. This can be done on computer, by hand, or through a mixture of the two (hand allocation which is then transferred to a word-processing package). The approach used will depend on the size of the sample and the use to which the results will be put. If they are to form the basis of a management
Below is an example of responses to a semi-structured questionnaire. These responses were received from 30 managers and supervisors in Company A to the question: “What do you see as the main problems facing this company manager over the next 12 months?” The responses have been categorized by business function and managerial issues in order to help to highlight what the respondents see as the major problem areas.

Manufacturing
Coordinating the production between our two factories ABC and XXX
Moving from Process Inspecting to Quality Assessment
Taking on and training new people
Getting the purchasing policy right
Sorting out my tooling problems
Changing the way we produce things and increasing mechanical handling
Being able to produce the required ABC plates by the end of next year
Keeping the production machinery running 24 hours a day
Realizing the need to redesign the factory
Meeting today’s needs
Being consistent - at present it is all peaks and troughs
Developing an effective shift system
Managing the expansion
Recruiting and training ancillary staff
Developing an agreed structure for manufacturing which will allow us to work effectively in today’s markets
Achieving completely new levels of production
Managing the product change programme
Improving relationships with hourly paid workers, treating them better
Overcoming the problem that the attitudes of workers are reinforced by the attitudes of management
Developing a better relationship between workforce and management, improving morale: we are currently on a stop/go system
Eliminating the lack of trust between workers and management
Doing away with “them and us” relationships
Avoiding situations where the staff make the decisions but it’s the workers who suffer every time
Reducing the over-involvement of production management in pay negotiations this creates relationship problems with the workforce and means that production managers are not doing the job they are paid for, i.e. supervising production
Giving supervisors the opportunity to take on the new shift supervisor’s jobs
Eliminating industrial relations problems caused by the change to three shifts
Changing the wages system
Bringing systems up to date - we have tinkered with them up to now, but not really changed anything
Changing the bonus payment systems to relate to volume of sales
Improving the control of work flow
Ironing out the order flow to allow us to manage the factory
Managing the product cycle
Improving mobility of labour
Cross-training operators
Increasing the number of setter operators
Training more trainers

**Marketing**
Facing up to the competition
Getting more work
Sorting out our selling relationship with ABC
Providing good local employment
Getting in orders - it's going to be a difficult year
Selling more products in an increasingly competitive situation
Maintaining market share
Bringing on board new products to combat the declining market
Getting our pricing policy right
Finding new markets; our current market is declining very rapidly
Retaining our market share
Reducing variety and getting more profitable work

**General management**
Rationalize the ABC and XXX operation in the United Kingdom
Producing profits
The market, the products, developing corporate goals, what does ABC want from XXX?
Managing our business effectively in a declining market
We shall lose people unless we pay them more
The market has changed significantly over the past four years, but we haven't changed the way that we manage the company - we need to
Maintaining an increasing bottom-line profit
Getting the business: it is there but not at our prices
Keeping the good people; to do this we must be properly organized
Getting away from the panic resulting from the threat of competition
ABC is seen as a threat; will our work go to them or theirs come here?
We need a permanent managing director to solve the current relationship problems between the executive and the part-time chairmen and the managing director
Coordinating the two factories

**Personnel**
Salaries
Career opportunities
Salary levels need to be sorted out: either do something or justify why not

**Engineering**
Get a maintenance-free cell into the market
Rationalize the product range
Actively develop new products
Bring new technology into the factory to assure our future
Rationalize products and processes
We need the right products to sell

**Finance**
Produce an effective cost system for special items of expenditure
Cut down on the administration memos

**Managerial**
(a) Attitudes of style
  - Bringing about change - people are very resistant to change particularly in XXX
  - Problems with some senior and many junior managers who need to be changed
  - Attitudes and atmosphere: we have an old system, old methods and old thinking
  - Improving our decision-making procedures: we must take all factors into account, not just profit
  - We must really solve our problems not “fudge” them
  - Many things are started but not finished; we must get better at seeing things through
  - Getting away from the old managing director’s style
  - Doing things right. We are always seen to do things in a way which upsets people; we have a natural gift for it
  - Getting over to the executive that the problems they see are theirs, not someone else’s
  - People must adjust their lifestyles to changes in the company

(b) Communication
  - Communication: decide where we are going and tell people
  - Ensuring that people understand what is going on
  - Produce better and more reliable information
  - Communication: we are inept at it and unwilling to be flexible, don’t want to give anything away but want everything in return
  - Communication: we do try occasionally but it always peters out
  - Communication: management take action before they think it through
  - Improve communication, tell people what is going on
  - Improve communication: people find things out, instead of being told

The answers to the questionnaire highlight a wide range of issues which are affecting the productivity of this organization. None of them is insurmountable in itself but, taken together against the background of daily survival, they offer a significant challenge. Seen at their most simple level they point to a lack of clear goals and direction.

**4.4 Editing the data**

Once the data are in table format, it is possible to identify and address any anomalies. Anomalies may include:

*Mistakes*, such as punching errors. Where computer input is concerned, such mistakes are
normally caught by punching all the data twice and then cross-checking that the two sets of information are identical. Simple arithmetical checks can also be made, e.g. if there are 100 people in the survey, each question should be answered 100 times.

**Non-response** - this is not an issue in one-to-one problem identification interviews, or group discussions. On structured "tick-box" questionnaires, however, it is usually a factor. It is most common with classification data, where individuals do not wish to be identified by job title and/or department. This in itself suggests something about those respondents' view of the company. It also leaves the consultant with three options:

(a) report those responses as a separate category;
(b) leave them out altogether; or
(c) if answers to questions rather than classification data are missing, allocate the average share to them.

The simplest option is (a), which gives the opportunity for significant non-responses to be highlighted and commented on.

**Unusual results** - occasionally a result occurs which is not an error but which is very different from the rest of the survey. It is useful to extract such data and report on them separately to prevent distortion of the results as a whole.

For most problem identification surveys this is where the analysis of the data stops. The consultant takes the information from the interviews, group discussions and structured questions as it is now organized and writes his report. It should be noted, however, that there are a great number of additional tests and analyses of a statistical nature which can be performed if this is felt to be necessary. This is quite common when considering marketing information but much less so for productivity improvement surveys, where the consultant is mainly concerned with providing a framework for future investigations rather than with proposing specific answers to specific questions.

### 4.5 Drawing conclusions

Once the data have been analysed, conclusions can be drawn. This means interpreting what the data mean by looking for patterns and significant issues.

#### 4.5.1 Semi-structured interview data

The approach taken with data obtained through semi-structured interviews is to analyse the categories to identify those which are having a significant impact on productivity. So, for example, if there is a category on "planning" on which there are a lot of comments, indicating planning problems, it is reasonable to conclude that fixing the planning problems would have a significant impact on P & Q.

The following sample conclusions are drawn from the Company A interview data shown earlier in this unit.
Conclusions of Company A survey

The survey indicates two different yet interrelated problems: the first one is technical, to do with markets, products and manufacturing processes; the second is behavioural, concerning the management philosophy of the business. Both stem from the same root cause, i.e. change. The world in and around the company manager has changed both in what it wants and in the way it does things. The company manager has not. The company is trying to get better at what it does, without recognizing that doing it differently is the key. The company manager has lost his or her visionary directing style leadership but has neither replaced it with a modern version of the same nor embraced a corporate style. The company now has the worst of both worlds:

- A lack of direction - people are not sure where they are going, or what is expected of them, and this goes to the very top level. There is currently no clear vision of the future, and so people are unsure what to do. The only corporate goals which currently exist are financial, and even these are not being handed down as functional goals to the different executive branches.
- A lack of managing systems - because the goals are not clear, there are no effective measurement or feedback systems in use. Managers are doing their best in their own areas, but there are no effective systems linking these activities to achieve the common good.

This situation produces the problems the survey has identified. Until they are solved and there is an agreed mission statement, clear corporate and functional goals and business plans reflected down through the supervisory level with the necessary managing systems to support them, and until these are used to manage the company, there is little chance of any improvement in performance, morale, or any other aspect of the business.

Other issues which were identified during the course of the survey are:

Manufacturing. The organization of the manufacturing area reflects the historical situation and needs to be updated to meet the requirements of today’s market-place. This means major changes in the philosophy and structure of the manufacturing organization.

Wages. The hourly payment systems, which are an integral part the manufacturing process, are, like the manufacturing process itself, outdated. The current system is not only complex and contentious, but also seems to be rewarding inappropriate behaviour. The feeling of a number of respondents was that the concept of the behaviour you are trying to create needs to be clearly identified before any further work is done on how to pay for it. Payment should reward desired behaviour, which in the current situation means finished goods through the door, not products through a process.

The market. The current problems with forecasting order intake are obviously creating major problems for the factory. Whilst all respondents accepted that the organization is in the business of producing specials, the vast majority felt there needed to be a more effective forecasting system if the factory was to be able to run a sensible manufacturing policy. It is obviously essential that a better relationship be developed between the sales and manufacturing functions.

Costing and budgeting. The question of whether the actual price charged for special items really reflected the cost was raised by an number of respondents, and there seems to be some doubt about
this. If it does not, the price obviously needs to be rectified. The question of expense budgets not reflecting wages and overtime costs was also raised a number of times. As this is a prime variable in manufacturing costs - one of the key factors that supervisors need to control if they are to manage the costs of manufacture - they obviously need to know what it is. Therefore it would seem sensible that this type of costing information be made available to those responsible for managing people and that their performance be measured on their ability to control it within agreed limits.

Products. A number of respondents had concerns in this area, the most important being the necessity for a rationalization of the product range, and the very real requirement for new products to compete with those now challenging Company A’s traditional market.

Performance appraisal. There is at present no formal performance appraisal system in the company. If there had been, many of the problems exposed by the survey would have been identified and could have been solved. The general view in reply to the questions about formal performance appraisal was that past experience of such systems has not been good. However, performance appraisal is an integral part of good personnel management, and past experience should not deter the company from trying again.

Management/union communication. It was significant to note that there is no formal channel for ordinary communication between the company and the trade unions. This means there is no route through which to develop effective interpersonal relationships. Thus, when management and unions do meet formally to discuss problems, they start from a basis of confrontation rather than from mutual understanding.

Computer system(s). A number of people raised the issue of the computer and the information system(s) currently being used. At present different parts of the business use different systems. This, predictably, gives rise to confusion: the information about order intake, for example, varies depending on its source. Some action is, it seems, currently being taken to link systems but a number of respondents felt that this was only a makeshift solution and that the whole system needed to be looked at, beginning with end users’ needs.
EXERCISE

Take the data you collected in the annexes to Unit 3 and:

1. Analyse them using the approach outlined here.
2. Draw conclusions from your data.

Questions for discussion

1. What are the main elements of data analysis?
2. Why do the data need to be coded?
3. What are possible methods and techniques for data processing?
4. What is the framework to be used for drawing conclusions?
UNIT 5: MAKING RECOMMENDATIONS AND PRODUCING THE REPORT

UNIT 5: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Make recommendations and produce proposals.
2. Write and present the report.
3. Evaluate the cost of consultancy services.

UNIT 5: CONTENTS

5.1 Making recommendations
5.2 Making proposals
5.3 Writing the report
5.4 Costing and budgeting
5.5 Presenting the report and selling the proposal(s)

Annex A
UNIT 5: MAKING RECOMMENDATIONS AND PRODUCING THE REPORT

5.1 Making recommendations

5.1.1 Points to be aware of

The recommendations are the basis for the action phase. They lay down what needs to be done. It is very important to avoid personal bias when making recommendations. This can be difficult for consultants because they are involved, and usually have a vested interest in the outcome. The following are some of the points to be aware of when formulating recommendations:

- Consultant bias - There is always a tendency for the consultant to recommend products or actions which will involve him in ongoing business. Clearly, where the evidence supports action(s) that the consultant can carry out, he has every right to recommend these. The important thing here is honesty. If the consultant cannot do the job, it is his responsibility to recommend someone who can.

- Shaping - Seeing the issues identified through the diagnostic activity as similar to some problem that the consultant has seen before and proposing the solution that worked last time. If they really are the same, this is clearly permissible: but before making such recommendations the consultant should always objectively reassess the facts.

- Needs and wants syndrome - There is always a temptation to give the client what he says he wants, even when what he really needs may well be different. For a consultant to recommend something that he believes the customer will buy, rather than recommending the “best fit” solution which he may not buy, is at the very least unethical, and may even border on the dishonest.

- Remember the art of the possible - Being realistic about what can and cannot be done is crucial to the success of your recommendations. This means taking into consideration such factors as time, cost, attitudes, etc.

These are the points consultants should bear in mind when considering their recommendations.

5.1.2 Deciding what to recommend

Listing

The first step is to go through the conclusions and separate them into closed- and open-ended problems. The findings of the Company A survey outlined in Unit 4 indicate the following:

Closed-ended problems

None - there are no simple “one right answer” problems identified in the survey.

Open-ended problems

- a lack of direction (leadership); and
- a lack of managing systems.

**Mixed** - Having both closed- and open-ended components

Wages.
The market.
Lack of performance objectives of appraisal.
Poor management/union communication.
Manufacturing problems.

**Problems rating**

The next step is to rate the problems in order of:

- significance - which problems, if solved, would have the greatest impact on productivity; and
- probability - which problems it is possible to solve.

This can easily be done by using a simple rating (0-9, or 0-7) scale. This method of rating is clearly subjective and the scores are based on the consultant's view of what is possible.

Having decided on the key problem(s), the consultant’s next step is to make the recommendation. The golden rule here is to keep it simple. Give the client something to decide on. Make a clear statement of recommendation(s) and proposed actions outlining what will be achieved if the recommendation(s) is/are accepted.

The following is the actual recommendation that was made to the Company A client:

**Recommendation** - The company should solve its leadership problem

The company is faced with a choice in the way it solves its leadership problem. It can either try to revert to the old visionary style of leadership, or it can opt for the corporate approach. In the circumstances the consultant believes the latter to be the more appropriate, for the following reasons:

- it will enable the organization to find effective solutions to its problems;
- it is flexible enough to meet the needs of personnel at all levels;
- it will create an open organization which will be able to adjust to future changes and survive in the longer term;
- it embraces open and participative styles; and
- it is the most effective way of managing a modern organization.

**5.2 Making proposals**

Proposals set out:

- how things will be done;
- what the action(s) will achieve, the expected results;
- how long it will take; and
- what it will cost.

They define how the problem(s) should be solved. The main considerations to be taken into account when deciding what to propose are:

- choosing the approach which will have the most significant impact on the problem(s); and
- being practical. Always bear in mind that if management accept your proposal you will be involved in implementing it.

Proposals must always be clear. They are the call to action, and busy managers do not have time to wade through a lot of paperwork. They want a simple proposal to achieve a specific goal. In the case of Company A we made four proposals, as follows:

**5.2.1 Sample proposal(s)**

The four proposals which follow are aimed at helping company’s senior managers to develop a corporate managing style:

1. **Develop a corporate managing system**
   This is a six-month programme designed to help the company’s senior managers to agree on their corporate and functional goals and to implement the necessary managing systems to control performance to achieve them. This programme will enable management to solve the major organizational and communication problems identified in the survey and will provide a sound basis for managing the company in the future.

2. **Real-time problem solving**
   The second recommendation, which supports the first, is designed to change attitudes through involving, initially, middle managers and supervisors, and later workers, in real-time problem solving.

3. **Most significant issue approach**
   This proposal aims to provide a quick response to some of the important issues raised during the survey, thus demonstrating that management is actually doing something.

4. **Restructuring of the manufacturing division**
   The last proposal is for a special programme designed to help manufacturing management to restructure the factory.

This example is intended to provide readers with a view of how conclusions can be presented. It is important to stress, however, that there are no right or wrong answers here. In the case of this example, we made four different proposals aimed at solving specific problems and allowing for political sensitivities. In the event the client accepted two proposals: Proposal 1, which the consultant supported, and Proposal 4, for which they used another consultant.

**5.3 Writing the report**

Once the consultant is clear about his conclusions and recommendations, the next step is to write the report. The following structure is fairly typical:
Module 3
Unit 5

1. Contents list
2. Summary - a miniaturized picture of the report as a whole, including a clear statement of the action(s) that the consultant is recommending.
3. Introduction - outline the purpose, subject matter, terms of reference and background to the report.
4. General philosophy - the consultant’s approach to the work.
5. Survey method - how the data were collected and why that method was chosen.
6. Main findings - one section per main survey finding presented in a logical, precise and systematic manner, with the support evidence for each point clearly highlighted.
7. Conclusions - summary of the main findings concentrating on objective facts as far as possible.
8. Recommendations - the writer’s subjective opinion on what action should be taken on the basis of the survey findings.
9. Appendices - detailed supporting data, clearly labelled and methodically laid out.
10. References and bibliography - where appropriate.

Senior managers, for whom such reports are intended, are very busy people. They have little inclination to study complex written material. All business reports, therefore, should be as accurate, brief and clear as possible, use simple straightforward language, and be written from the reader’s point of view.

If objections or queries that might arise can be anticipated, these should be discussed as part of the report. It should always be remembered that providing the facts is the most powerful way of persuading people to accept a different point of view.

As well as writing a report, the consultant will usually be expected to present the findings to the senior management team. This enables managers to explore issues fully and allows reservations to be dealt with quickly rather than being left, only to reappear once the action stage is under way. From the consultant’s standpoint this is the forum in which to gain acceptance of the proposals and a commitment to action.

5.4 Costing and budgeting

The client is bound to want to know what the proposals will cost. This means providing a budget for the proposed work. Budgets are based on the cost structure of the organization and its planned earnings.

The costs of running consultancy organizations fall into five main areas:

1. Wages and salaries - the money, including employment costs, tax, etc., that the consultancy must pay its staff.
2. Overheads, premises, heat, light, rates, etc.
3. Equipment and consumables, computers, photocopiers, stationery, etc. - the items that are the tools of the trade.

- Bank charges - these can be quite significant if the consultancy runs any reasonable level of overdraft, and need to be accounted for.

3 - 70
- Profit - the surplus you aim to make over the year.

These figures are annualized and the resultant total is the income plan. This sets out what the consultancy needs to recover to meet its income targets.

The next task is to assess how many workdays, the “product” of any consultancy, the group expects to work. These are then entered in the income plan and provide a daily rate, e.g.:

Income plan US$150,000 / 400 anticipated billable days
(two consultants)

= US$375 per day, plus an allowance for error:
Charge rate = US$400 per day

Most consultancies have differential rates which reflect what the market will bear. They charge more for senior consultants than for juniors. They charge higher rates for running formal training programmes than for straight consultancy and lower rates for working in their own offices. Expenses, travelling, hotels, meals, etc., and local taxes such as VAT are normally charged as extras.

5.5 Presenting the report and selling the proposal(s)

The presentation will follow the same outline as the report but only the most important points are included. All the detail and subsidiary information is, after all, in the report for those who wish to study it. As with the report, for the presentation to be successful it must consider the perspective of the audience. What is their level of understanding of the issues? Do they feel threatened by, or positive about, the recommendation and proposed actions? The following notes are designed to help consultants to develop and deliver their presentations effectively.

Case presentations can be distinguished from other types of presentation because they are aimed at persuading a third party to take action. The basic principles of case presentation are the same as those for general business presentations. The differences are largely in emphasis, especially in the fact-finding and structuring stages.

5.5.1 Initial preparation

As with any other type of presentation, the first step is to define your own objectives, followed by a definition of those of the audience. Defining the audience itself requires answers to some specific questions. First, to whom should you make your presentation? Who has the power to do what you want to be done? Who is the decision-maker? Secondly, what is the benefit for the person or people to whom you are presenting?

5.5.2 Structuring the case

Case presentation takes the same form as any other type of presentation: telling the audience what you are going to tell them; telling them; then telling them what you have told them.
However, it is now focused and refined to become *proposition, definition, weaknesses, strengths and proposition*.

**Proposition.** This is a short statement which outlines the problem, the effects of the problem, the underlying need the problem represents, and a clear call to action which indicates to the listener what you want him or her to do next.

You should express all this in terms which indicate that the proposition is directed to the decision-makers - highlighting the difficulties and problems for them, and the benefits that your proposed course of action will bring them.

**Definition.** This should be a coherent, logical, sequential argument of your case, which clearly supports your proposed plan of action. Remember that facts and figures - particularly those concerning money - have far more power than an emotional appeal in influencing people in business situations. Take great care to ensure that the data are accurate: even very minor errors of fact, if exposed and commented on during a presentation, can be sufficient to undermine your credibility and to lose you your case. Avoid the temptation to include every point that you can bring to bear, but focus on only those key points that show clear benefits for the decision-makers. If you include too much, people who have limited interest in a topic may find it difficult to concentrate on the message you are presenting.

By the time you have reached the end of this stage in your presentation of your case, the ownership of the problem and the responsibility for doing something about it should have been firmly transferred to the decision-maker.

**Weaknesses.** Acknowledge any snags or flaws in your arguments which might be put forward by the audience, and answer them.

**Strengths.** Put forward again, in brief, the key arguments in support of your case.

**Proposition.** Restate your proposition and again emphasize what you want to be done and the benefits that this will bring to the decision-maker.

If your case goes well, there should be a number of questions from the audience. If you are well prepared, your answers to these questions should further promote your case. In an external sales situation it is standard practice to draw out all questions/queries/objections before you begin to answer them, by asking something like “Is this your only query on my proposal?” or “Are there any other queries?”, followed by “If I answer these questions to your satisfaction, will you buy ...?” If the answer is negative, ask “What other reservations do you have?”

This encourages key objections to be voiced early on, and enables you to identify the people who are most resistant to your solution. Bringing all queries out into the open also allows you to make a considered “strategic” response to the reservations put forward, rather than having to give ad hoc responses to individual questions.

A similar approach is advisable for internal case presentations, though the conventions of office politics and procedures may make it difficult to adopt quite such a rigorous approach. For example, it is not always easy to ask the managing director whether he will accept your procedure.
if you answer his question to his satisfaction!

5.5.3 Making the presentation

When you are making case presentations and answering questions, it is important to be tactful and to maintain a calm, logical manner. If you tell your client that a practice he has been using for five years is "stupid and wasteful", you may well irritate rather than persuade. It is better to emphasize the positive aspects of potential "efficiency improvement" than the current negatives of waste and neglect. Other comments which are likely to irritate include such phrases as "I think that's very fair" (implying that, if your listener disagrees, he is being unfair), or "This is a very reasonable proposal" (anyone who disagrees is unreasonable), or "I should have thought the presentation made that clear" (how stupid you are!), and so on. By definition, irritators annoy people; once annoyed, people stop listening; if people are not listening, they cannot be persuaded: the case presentation will fail.

Remember that, no matter how blind to logic, how inattentive or how stupid someone in authority might be, losing your temper will always undermine your authority as a presenter. Your purpose is not to engage in argument but to have your plan accepted. A calm, friendly demeanour is more likely to have a positive impact.

5.5.4 Review

Finally, review the results. What went well, and what went badly? Make notes and refer to them the next time you have to make a case presentation. If you failed, what would you do differently? Always consider how to do it better next time. (See Annex A for a planning checklist.)

Selling the action phase to the management team through the report, presentations and discussions is one of the most difficult aspects of the diagnostic part of the consultant's role. There are many good reports gathering dust in managing directors' desk drawers. The gap between analysis and actually taking action is large. But the gap can be reduced by effective front-end planning. Obtaining agreement before starting the diagnosis helps to ensure a satisfactory result:

- Agree on the overall approach at the outset.
- Involve in the analysis all those who will need to be part of the solution.
- Agree that the final report will be presented to all who contributed. If all this is done well, the report is much more likely to be adopted and acted upon.

Finally, it is important that the findings of the report be communicated to all those who participated in the survey. With large-scale surveys this can either be done through a series of mass meetings at which the managing director gives a short summary of the findings, followed by a question-and-answer session; or the summary presentations can be passed down through the organization's briefing system, with each manager briefing those who report directly to him. The impact of this communication is always greater if it can be accompanied by a clear statement of what action will be taken as a result of the report.
EXERCISE

Take the conclusions you reached in Unit 4 and:
1. Follow the steps set out here to produce your recommendations.
2. Make proposals based on your recommendations.
3. Write a report summarizing what you have done.
4. Submit your report to senior management and try to sell your proposals.
5. Implement the proposals which are approved.

Questions for discussion

1. What are the most important things to be aware of before making recommendations and why?
2. How do you formulate recommendations about the possible choice of approaches to deal with the problems identified?
3. What is expected from proposals, and what are their differences from recommendations?
4. What are the main contents of the report?
5. Why do we need costing and budgeting at this stage?
6. What are the possible problems which the consultant could face while presenting and selling the proposals?
ANNEX A

PLANNING CHECKLIST

1. Write down your objectives ("What result am I looking for?").

2. Identify the decision-maker/influencer.

3. Think through what the benefits are for the decision-maker/influencer.

4. Identify and quantify the problem(s).

5. Develop your solution -
   - Outline your case
   - List benefits
   - List likely objectors and their objections
   - Produce counter-arguments
   - Summarize

6. Assess the situation -
   - When will you present?
   - Under what circumstances?
   - How long do you have?

7. Structure the presentation -
   - Proposition
     - Definition
     - Strengths/weaknesses
     - Restate proposition

8. Practice - Test it out on a friend.

9. Make the presentation.

10. Review -
    - How well did you do? Strengths/weaknesses?
    - What can you learn for next time?
BIBLIOGRAPHY

Boulden, G.P.: The consultant’s role (Rugby, United Kingdom, ALA International; unpublished).

Boulden, G.P.: Process consultancy (Rugby, United Kingdom, ALA International; unpublished).

Boulden, G.P.: Values and style (Rugby, United Kingdom, ALA International; unpublished).

Boulden, G.; Boulden, G.P.: Making effective presentations (Rugby, United Kingdom, ALA International; unpublished).


Revans, R.W.: Origins and growth of action learning (Bromley, Kent, United Kingdom, Chartwell Bratt; Lund, Sweden, Studentlitteratur, 1982).

Soeda, T.: “Every day, and in every way, I’m getting better and better ... (The Kaizen approach to JIT manufacturing)”, in Manufacturing Engineer (London, Institute of Production Engineers), Vol. 70, No. 9, Nov. 1991.
MODULE 4
PRODUCTIVITY MEASUREMENT
AND ANALYSIS
MODULE 4: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand and use operational definitions of productivity measurement and analysis.
2. Lead a team to develop a productivity measurement system.
3. Communicate data and information needs to develop the productivity information system.
4. Use and analyse measurement reports to make decisions for improving organizational performance.
5. Learn to measure partial and total factor productivity and relate them to profitability using price recovery.

MODULE 4: CONTENTS

UNIT 1: Why measure productivity?
UNIT 2: Developing a measurement system
UNIT 3: How TFPM relates productivity to profitability using price recovery
UNIT 4: Other approaches in assessing the company’s performance

Bibliography
UNIT 1: WHY MEASURE PRODUCTIVITY?

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and explain how performance improvement and performance measurement are interrelated.

2. Perceive the need to measure total factor productivity.

3. Understand and explain the main purposes of the measurement system, and distinguish data from information.

UNIT 1: CONTENTS

1.1 Introduction to the concept of measurement

1.2 Providing visibility to gain control and improve performance
UNIT 1: WHY MEASURE PRODUCTIVITY?

1.1 Introduction to the concept of measurement

Productivity measurement and analysis are important for sound decision-making in the productivity improvement process: indeed they are very effective tools for decision-making at all economic levels.

The success of productivity measurement and analysis depends largely upon a clear understanding by all parties concerned (enterprise managers, employers, workers, trade union organizations and government institutions) of why productivity measurement is important for the effectiveness of the organization. The answer is that it indicates where to look for opportunities to improve and also shows how well improvement efforts are faring.

In enterprises, productivity is measured to help to analyse effectiveness and efficiency. Its measurement can stimulate operational improvement: the very announcement, installation and operation of a measurement system can improve labour productivity, sometimes by 5 to 10 per cent, with no other organizational change or investment (see Prokopenko, 1987, p. 23).

Productivity indices also help to establish realistic targets and checkpoints for diagnostic activities during an organization development process, pointing to bottlenecks and barriers to performance. Furthermore, there can be no improvement in industrial relations or proper correspondence between productivity, wage levels and gains-sharing policies without a sound measurement system. Productivity indices are also useful in intersectoral comparisons designed to detect factors accounting for success or failure.

That is why productivity measurement and analysis should be among the first priorities of enterprise managers.

A common question that measurement practitioners have been debating is whether performance measurement should drive performance improvement or vice versa. Some contend that measurement is essential to know what and how to improve, while others argue that there is no need to measure performance if there are no improvement efforts anyway. Performance measurement and performance improvement are very closely interrelated and interdependent, and the important issue is how each can enhance and reinforce the other. The challenge is how to develop measurement systems to support improvement efforts.

Another issue deals with how productivity measurement should be done. Productivity measurement has traditionally been thought of as labour productivity measurement. While there is nothing wrong with measuring labour productivity, this constitutes only one of the factors of a firm’s productivity, and managers need to have a broader view of the factors affecting overall firm productivity. Hence, more productivity professionals have realized the need to measure total factor productivity rather than just labour productivity.

Generally, total productivity is measured as a ratio of output to input to resources. Total productivity measures reflect the relationship between the total output and total input of an enterprise:
Module 4
Unit 1

Total productivity = \( \frac{\text{Total output}}{\text{Labour} + \text{capital} + \text{materials} + \text{energy} + \text{others}} \)

By using "total productivity" measures all the partials are assessed and then combined, so that all resources are now taken into account. It is also possible to reconcile the results of productivity analysis with the actual profits of the business.

There are many approaches to productivity measurement and analysis. This is because different groups of people (managers, workers, investors, customers, trade unions) have different goals. Some simple and practical approaches to productivity analysis are:

- measurement systems for planning and analysing unit labour requirements;
- measurement systems of labour productivity aimed at the structure of the labour resource used;
- measurement of capital productivity; and
- value added productivity at the enterprise level, etc.

Normally the method of measurement is determined by the purpose of the productivity analysis. Three of the most common purposes are:

- comparing an enterprise with its competitors;
- determining the relative performance of departments and workers; and
- comparing relative benefits of various types of input for collective bargaining and sharing gains.

For example, if an organization's goal at a particular time is to maximize the return on invested capital and to expand its operations, the company should measure its cost and profit structures.

Among the most important requirements for sound productivity measurement, the following should be given specific consideration:

- The measurement results should indicate the source of profit, i.e. whether the profit comes from real productivity growth or inflationary pricing.
- The measurement system should be understood and trusted by management and employees.
- All resources and business activities should be included in the measurement.
- The results of the measurement should indicate accountability as much as possible.
- The results should provide clear signals for managerial decisions and actions in improving profitability.

The last point is particularly important since most companies include profit in their strategic objectives.

1.2 Providing visibility to gain control and improve performance

To know the results of one's efforts is an inherent human need. Managers in particular need
to know how the organizational system they are managing is performing. They need to measure the performance of what they are managing so that they can first gain *visibility*. This is the first purpose of management - to gather feedback or other data on the results of operations:

- What was the actual output?
- How many resources were consumed?
- Were the customers satisfied?
- Were innovative processes used?
- What is the employees' quality of working life?
- What is the bottom line?

Some managers and management systems are good at data gathering. In fact they often overdo it; that is why many managers are data rich and information poor. Instead of gaining better visibility from data gathered from measurements, their visibility is muddled by data overload. The point here is that managers must first have just enough data for them to have a good idea of how their organizational systems are performing before they can look into controlling and/or improving performance. This, however, means they have to decide what key information they need to know if they are performing as planned, and analyse how they can do better. These are the main purposes for developing a measurement system: *visibility, control and improvement*.

This module will tackle these two main issues by discussing how to develop a measurement system, in general, and Total-Factor Productivity Measurement (TFPM) methods and techniques in particular.

Let us digress for a while to make an important distinction between *data* and *information*. Data are what come directly out of measures, while information is the interpretation of the data. For example, if, at the end of a shift, a report comes out saying that 8.5 items were produced per workshift, this is data. We do not know if this is good or bad, high or low, acceptable or unacceptable. However, when we start comparing these data with a standard such as a budgeted production schedule, an industry standard, or even just with past performance, we can begin to say whether 8.5 is acceptable or unacceptable and we can think of what needs to be done to either maintain or improve performance. When data are compared with a norm so that they can be used for decision-making and initiating actions, we get information. As a result of measurement, we get data; after analysing and evaluating the data, we get information.

**Questions for discussion**

1. What is the essence of productivity?
2. What are the main reasons for productivity measurement?
3. What is total factor productivity?
4. How can managers gain from measuring productivity in their decision-making?
UNIT 2: DEVELOPING A MEASUREMENT SYSTEM

Once you have learnt this unit, you will be able to:

1. Understand and explain what is management system analysis and what is its main element.
2. Relate main management system elements to the performance criteria.
3. Make a simple assessment of your own management system.

UNIT 2: CONTENTS

2.1 Management System Analysis (MSA) as the framework for developing measurement systems

2.2 Seven performance criteria: A guide in generating countable measures
UNIT 2: DEVELOPING A MEASUREMENT SYSTEM

2.1 Management System Analysis (MSA) as the framework for developing measurement systems

MSA was adapted by Sink from Kurstedt’s Management System Model (MSM) (see Kurstedt, 1985; Sink and Tuttle, 1989). The MSM consists of three components: who manages (the manager), what is managed (the organizational system), and what is used to manage (management tools); and their interfaces: decision/action, measurement/data and information portrayal/perception (see figure 4.1). Managers make decisions that they transform into actions on what they manage. What they manage are operational tools, people, machines and systems, i.e. the organizational system. This organizational system is measured and data are collected and stored. Management tools are then used to retrieve, process, analyse and make decisions for improvement.

Take, for example, a foreman who meets his crew to discuss what needs to be done for the shift and what tools, equipment and supplies are available. He uses a planning and control board that lists the tasks to be done, who will do them, and what tools and materials will be used for each task. The foreman in this example is the manager of the management system. He manages his workers, materials and equipment. His planning and control board is one of the management tools he uses to manage his domain of responsibility.

MSA is designed to help you to establish and improve your management system. In particular, it helps you to define what you manage - your organizational system; identify interventions to improve your organizational system; and develop a measurement system to determine how your organizational system is performing. Notice that MSA is geared towards continuously improving the performance of your organizational system. Decisions and actions are focused on improvement interventions, and management tools are focused on performance measurement tools. Our main concern now is to determine the necessary steps for developing measurement systems.
2.1.1 **MSA Step 1 defines your organizational system**

Before the organizational system is even defined, it is necessary to identify the manager - the audience or user of the measurement system. In practice, it is almost impossible to develop a measurement system that will completely satisfy different people - what they want to measure and how they perceive data and information presented to them.

Once the manager has been identified, you can start defining the organizational system he or she manages. You can use Input/Output (I/O) Analysis to help you better to understand your organizational system. I/O Analysis is made by filling out a form identifying the desired outcomes, downstream systems (e.g. customers), outputs (e.g. products and services), transformation processes, inputs (labour, capital, materials, energy, etc.) and upstream systems (suppliers). This analysis will also help you identify what to measure later (see figure 4.2).

2.1.2 **MSA Step 2 identifies interventions made on the organizational system**

At first glance, MSA Step 2 may not look like an integral part of measurement system development. Why do you need to know what improvement interventions are being made to the system to measure its overall performance, as there are different measures for determining the impact of each improvement intervention anyway? While this observation may be valid, knowing the improvement interventions may give you an idea of what aspect of overall performance is being emphasized by management. Hence, it may be a good idea also to emphasize the measurement of these aspects of overall performance in determining what to measure.
Figure 4.2: Input/Output Analysis will help you identify what to measure

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Module 4
Unit 2

2.1.3 MSA Step 3 identifies what to measure

MSA Step 3 identifies what to measure. Various esoteric terms such as constructs, key success factors, performance dimensions, criteria, attributes, variables, indicators, surrogates, etc., have been used in this connection; but we shall instead take a pragmatic approach towards the question.

Review the I/O Analysis. The list of desired outcomes will give you an idea of what is deemed important to your organization's performance. However, this list may also give you measures that are not countable. How do you measure or count customer satisfaction, for example? You will have to break down your desired outcomes into countable measures. The other columns in the I/O Analysis will help you to do this. For example, measuring your outputs in terms of repeat sales/returns and volume trends may be good indicators of customer satisfaction.

Step 3 also involves developing the data collection process, which in turn entails identifying sources of data - present reports, databases, charts, documents, etc. Usually most of the data are stored in some form or another. The challenge has been to get the data into the form in which it is retrievable for the measurement system. The other important challenge is to persuade the people who own the data to make them available.

Before determining how to retrieve and process the data, you need to determine what to measure, the data sources and maybe even portrayal issues. Another consideration in organizing and presenting data is the cognitive style of the manager. Will tables be more appealing to him or her than graphs? This may have an effect on how useful a measurement system will be. Most measures are designed and presented in line with the discipline of the designer and presenter, not on the basis of what the user or audience will understand and be able to use for making decisions.

2.2 Seven performance criteria: A guide in generating countable measures

Performance is a function of seven interrelated criteria: effectiveness, efficiency, quality, productivity, quality of working life, innovation and profitability or budgetability (see Sink, 1985). Figure 3.4 shows the meaning of each of these criteria in relation to the organization's I/O Analysis. Effectiveness deals with outputs and outcomes. It is actual output over expected output. It is doing the right things, while efficiency is doing things correctly. Efficiency deals with inputs, i.e. actual resource consumption over expected resource consumption. Quality can be measured at five checkpoints:

- Q1 is the proactive selection and management of suppliers of your inputs.
- Q2 is ensuring that inputs meet or exceed your requirements (timeliness, cost, quality, quantity).
- Q3 is ensuring that your value-adding processes promote the improvement of productivity, innovation, and the quality of working life.
- Q4 is ensuring that your outputs (products and services) meet or exceed your customers' (internal and/or external) requirements.
- Q5 is knowing, meeting and/or exceeding customer needs, wants, expectations, desires, demands, requirements, etc.
Productivity is the relationship of outputs to inputs. Quality of working life is the affective response of employees to their working environment. Innovation is the creative effort to improve operations continuously. Profitability is the relationship of revenues to costs for profit centres, while budgetability is the relationship of actual to expected costs for cost centres. These seven criteria represent general categories of measures that the measurement development team needs to develop. More examples of countable measures can be found in Sink (1985) and Sloma (1980).

Breaking down your measures into countables may generate a very long list of measures that may be too many to handle. Hence, there will be a need to prioritize and audit your measures. Prioritizing your measures may be done in various ways. You may use a participative process such as the Nominal Group Techniques (see Delbecq et al., 1986), or the manager can make an autocratic decision on what high-priority measures to use.

The need to involve the manager/user/audience in the whole measurement development programme has been emphasized previously. There is also a need to train and develop a measurement system development team. This team will include the measurement system designer, the controller, other people who can provide data, people who can help in data retrieval and processing (such as information and computer systems people), and even the user of the measurement system. Understanding and acceptance from these key people are essential to the successful implementation of the measurement system.

Figure 4.3: Seven interrelated performance criteria
Questions for discussion

1. What are the main elements of a good productivity measurement system?
2. How is the productivity measurement system linked to management and organizational structures?
3. What are the seven main performance criteria and how do they relate to total factor productivity measurement?
4. What is the relationship between quality and productivity?
UNIT 3: HOW TFPM RELATES PRODUCTIVITY TO PROFITABILITY USING PRICE RECOVERY

UNIT 3: LEARNING OBJECTIVES

Once you have learned this unit, you will be able to:

1. Understand and explain what are TFPM, profitability and price recovery and the relationship between them.

2. Use the conceptual model of TFPM to measure and analyse total factor productivity.

3. Understand and use for decision-making purposes four levels of information derived from the TFPM.

UNIT 3: CONTENTS

3.1 Introduction

3.2 Basic productivity concepts

3.3 A conceptual model of TFPM

3.4 Total Factor Productivity Measurement (TFPM) Teaching Model

3.5 Common information needs

3.6 Case study: Mine Y
UNIT 3: HOW TFPM RELATES PRODUCTIVITY TO PROFITABILITY USING PRICE RECOVERY

3.1 Introduction

One of the major concerns in the world today is the ever-increasing, spiralling prices of goods and services - what is known as inflation. This is brought about by the traditional way of doing business, in which the costs of production/operations, plus a profit margin (usually determined by what the market can bear), are simply passed on to customers. This business strategy is often called price recovery. With the business environment becoming increasingly competitive, this strategy has been challenged. World-class competitiveness has usually been characterized by better and yet relatively lower-priced goods and services. World-class competitors are able to produce more and better goods and services with relatively fewer resources, i.e. they use productivity improvement rather than price recovery as a business strategy. Hence, it has become a necessity for firms to be more productive if they are to survive and compete, rather than just to rely on price recovery.

The scenario just described implies that firms also need to modify the way they measure their performance. Instead of just measuring profitability, which may be driven mostly by price recovery, there is a need to know whether a firm is able to produce more and/or better products and services with relatively fewer resources (improving productivity) to be competitive. And yet productivity measurement methods such as Total Factor Productivity Measurement (TFPM) are still underutilized.

As early as the 1940s and 1950s, accountants, economists, statisticians and engineers realized the need to measure productivity. This resulted in the development of the earlier Productivity Indices Model. This model did not gain wide acceptance because it failed to relate productivity directly with profitability. Managers found themselves with two independent measures that they could not easily integrate to explain changes in their performance fully. This situation was later remedied in the late 1970s with the introduction of the Profitability = Productivity + Price Recovery (PPPR) model by the American Productivity (and Quality) Center. Since then, at least five other versions have been developed to respond to particular needs from different applications. Most of the later versions seem to have become too complex for managers to understand and use as a management tool for decision-making. Hence, this module will discuss the common information needs of managers regarding performance improvement and develop a simple teaching TFPM model for first-time users.

Before going further into the details about TFPM, however, it would be useful to review some basic productivity concepts.

3.2 Basic productivity concepts

All references basically define productivity as output over input: e.g. kWh generated per tonne of fuel for power plants, tonne of ore mined per shift for mines, kilometres per litre of fuel for vehicles, yield per hectare in agriculture, and even Return On Investment (ROI), are all productivity measures. Three main points arise from this definition.
First, note from the examples that only single categories of both outputs and inputs were used. Many organizations, however, have multiple outputs and inputs, and different units can be used for measuring and comparing “apples and oranges”. For example, how can we measure the overall productivity of an organization that makes, sells and maintains computers using various inputs such as materials, energy, labour and capital?

Davis (1978) suggested the use of currency values as units of input and output. For example, if a computer firm has total sales of US$135 million and a total operating cost of US$100 million, its productivity is US$135/US$100 = 1.35, which is the same as its profitability (revenues/costs). Is profitability then the same as productivity? Definitely not, as profitability is affected by changes in prices of outputs and costs of inputs or inflation, while productivity should deal mainly with quantities of outputs and inputs. Hence, deflation methods need to be used so that the unit of measure will be in constant currency values that represent physical measures of outputs and inputs, with the effects of prices filtered out. This will be discussed in greater detail in the next section.

This leads to the second point associated with the definition of productivity: static measures and dynamic measures. Static measures are productivity ratios for a single period, e.g. if 30,000 tonnes of ore are mined by 1,000 employees in one shift, the static productivity ratio is 30,000/1,000 = 30 tonnes per shift. If in the following shift another 1,000 employees are able to mine 31,500 tonnes, their static productivity ratio would be 31.5 tonnes per shift. The dynamic productivity index would be 31.5/30 = 1.05, i.e. productivity would increase by 5 per cent from one shift to the next. Dynamic measures are ratios of static measures of two periods. They compare two periods and show changes.

The third point is the use of partial productivity measures against TFPM. Productivity is often equated with labour productivity. This is just a partial measure as it only considers one input. Total factor productivity considers all inputs, such as labour, capital, materials, energy, etc. The advantage of using TFPM can be illustrated by the following example on factor substitution. The productivity of a secretary may seem to increase as a result of changing machines from a typewriter to a word processor, even if the secretary has in fact not done anything to improve his or her productivity. If only labour productivity is measured, the outcome will be favourable; but if total factor productivity is measured, the outcome may turn out to be unfavourable as the additional output from using a word processor may not be enough to offset the higher input (capital) cost of using a word processor instead of a typewriter. Of course, one can argue that there are more reasons for using a word processor than productivity improvement, but the point is that TFPM can show a broader picture of a firm’s productivity than partial productivity measures. Hence, this module will focus on TFPM which uses dynamic productivity ratios and their effects on profitability in currency values.

3.3 A conceptual model of TFPM

TFPM directly measures and relates productivity with profitability. The problem with other productivity measures is that managers are unable to see the relationship of these measures with the bottom line. Hence, they also fail to see the impact of productivity improvement. TFPM establishes the relationship of productivity and profitability by using the concept of price recovery: the rate costs of production or services are passed on to customers, i.e. the ratio of output prices to
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input costs. Note that price recovery is a related concept but not the same as inflation. Inflation measures the aggregate changes in prices of both inputs and outputs over time in the entire economy, not just for a firm. Price recovery is the relationship of output prices and input costs in one firm. Inflation measures the general trend of costs of goods and services in the macro economy while price recovery measures the rate at which firms pass on the costs of their inputs to their customers through their product or service pricing. In this context, price recovery may be considered as the firm's contribution to overall economic inflation; a positive price recovery contributes to inflation, while a negative price recovery can help to prevent inflation.

Figure 4.4: Conceptual model of TFPM

Figure 4.4 shows the conceptual model of TFPM (see Loggerenberg and Cucchiaro, 1982). The top row shows the traditional relationship of changes in revenues caused by changes in output quantities and prices. The bottom row shows the changes in cost caused by changes in input quantities and unit costs. The middle column shows changes in profits caused by changes in revenues and changes in costs. These cause-and-effect relationships are provided by most accounting systems. TFPM adds another perspective to this analysis. The left-hand column shows the change in productivity caused by changes in output and input quantities. The right-hand column shows the change in price recovery caused by changes in output prices and input unit costs. The middle row shows changes in profits caused by changes in productivity and price recovery. This model

<table>
<thead>
<tr>
<th>Products</th>
<th>Quantity</th>
<th>Unit price (US$)</th>
<th>Quantity</th>
<th>Unit Price (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output 1</td>
<td>200 cans</td>
<td>5.00</td>
<td>250 cans</td>
<td>4.00</td>
</tr>
<tr>
<td>Output 2</td>
<td>200 bags</td>
<td>11.00</td>
<td>215 bags</td>
<td>13.50</td>
</tr>
<tr>
<td>Resources</td>
<td>Quantity</td>
<td>Total cost</td>
<td>Quantity</td>
<td>Total cost</td>
</tr>
<tr>
<td>Labour</td>
<td>80 hr</td>
<td>800</td>
<td>80 hr</td>
<td>960</td>
</tr>
<tr>
<td>Materials</td>
<td>80 kg</td>
<td>320</td>
<td>80 kg</td>
<td>400</td>
</tr>
<tr>
<td>Energy</td>
<td>1,200 kWh</td>
<td>60</td>
<td>1,300 kWh</td>
<td>65</td>
</tr>
</tbody>
</table>

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clearly shows the relationship of productivity, price recovery and profitability.

Perhaps a case study could more clearly illustrate these basic productivity concepts. Consider a plant with two main products: say, Output 1 and Output 2. The following are the simplified data available for the plant's operation for two comparable periods: a base period and the period under review:

The total capital employed for both periods is US$50,000 and the average cost of capital (interest rate) for both periods is 3.64 per cent.

Given the above data, how should the productivity of the whole plant be measured? If we look only at the outputs, we cannot aggregate the quantities, as one is measured in cans while the other is in bags. The same problem is true for the resources. One solution is to use US dollar values so as to have the same units of measure for all the outputs and inputs. Total sales for Output 1 are 200 cans x US$5.00 = 1,000 while total sales for Output 2 are 200 bags x US$11.00 = US$2,200, resulting in a total sales of US$3,200 for the two products for the base period. Labour productivity for the base period will then be US$3,200/US$800 = 4 or US$4 of sales per US$1 of labour spent. The same partial productivity measure can be taken for materials and energy productivity. To compute the total plant productivity for the base period, we first have to calculate the total cost of capital for the period. Given that the cost of money for each period is 3.64 per cent and the total capital employed for each period is US$50,000, the cost of capital chargeable to each period is then US$50,000 x 3.64 per cent = US$1,820. Hence, the total cost of the resources for the base period is US$800 + US$320 + US$60 + US$1,820 = US$3,000. The total plant productivity for the base period is US$3,200/US$3,000 = 1.067 or US$1.07 of sales per US$1 spent.

The same calculations can be made for the review period. However, note that what we have just used was the same measure as finance would use for profitability; and if we start comparing the total plant productivity for the base period against the review period, our comparison will now be diluted by the price changes and will not reflect only productivity. That is, the static measures we used for each period will have to be subjected to deflation methods to arrive at a pure dynamic productivity measure. How is this done?

3.3.1 Deflation method

What is usually done to account for pure productivity changes is to use prices from the base period for the review period, similar to the procedure in standard cost accounting. The total sales for the review period would then be 250 cans x US$5.00 = US$1,250 for Output 1 and 215 bags x US$11.00 = US$2,365 for Output 2. Total sales would then be US$1,250 + US$2,365 = US$3,615. For the resources, we first have to compute the unit costs for the base period. Using the relation total cost or value = quantity x unit cost, we get the following unit costs for the base period resources or inputs:
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<table>
<thead>
<tr>
<th>Total cost (US$) =</th>
<th>Quantity</th>
<th>Unit cost (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>800</td>
<td>80 hr</td>
</tr>
<tr>
<td>Materials</td>
<td>320</td>
<td>80 kg</td>
</tr>
<tr>
<td>Energy</td>
<td>60</td>
<td>1 200 kWh</td>
</tr>
<tr>
<td>Capital</td>
<td>1 820</td>
<td>US$50 000</td>
</tr>
</tbody>
</table>

The total cost for the review period if there had been no changes in unit costs from the review period would be:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Unit cost (US$) =</th>
<th>Total cost (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>80 hr</td>
<td>10</td>
</tr>
<tr>
<td>Materials</td>
<td>100 kg</td>
<td>4</td>
</tr>
<tr>
<td>Energy</td>
<td>1 300 kWh</td>
<td>0.05</td>
</tr>
<tr>
<td>Capital</td>
<td>US$50 000</td>
<td>3.64 per cent</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hence, total plant productivity would be $3,615/3,085 = 1.17 or US$1.17 of sales per US$1 spent. Since the total plant productivity for the base period is 1.07, the productivity change from the base period to the review period is 1.17/1.07 = 1.09. This is a pure dynamic productivity measure although it does not relate productivity to profitability. It is also a TFPM, not just a partial productivity measure as is labour productivity.

The following model is a dynamic TFPM model that also measures partial factors and at the same time relates productivity to profitability using the concept of price recovery. We shall call this the TFPM Teaching Model as it is a simplified version incorporating the essential features of the most advanced TFPM versions available. More advanced features will be presented later (see table 4.1).

3.4 Total Factor Productivity Measurement (TFPM) Teaching Model

Table 4.1 presents an example of the TFPM Teaching Model in spreadsheet format, where:

- Column A lists the outputs and inputs of the firm or organization being measured.
- Column B consists of the total revenues for the outputs and the total costs for the inputs.
- Column C contains the quantities of the outputs and inputs.
- Column D shows the unit prices of outputs and unit costs of the inputs.
- Columns E, F, and G are similar to Columns B, C, and D, respectively, for the review period.

Note that Column B = Column C x Column D, while Column E = Column F x Column G (V = Q X P). Given these relationships, the raw data requirements for each row will be any two of either the values (total revenues or total costs), quantities, or unit prices or costs. Note also that the data from table 4.1 come from the simplified case study discussed earlier and that the data presented in the case study consist only of any two of either the value, quantity or unit price. Given columns B to G, we have all the necessary data to run a TFPM application.
Table 4.1: TFPM Teaching Model in spreadsheet format

<table>
<thead>
<tr>
<th></th>
<th>Base period data</th>
<th>Review period data</th>
<th>Change ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>Vo(US$)</td>
<td>Qo</td>
<td>Po(US$)</td>
<td>Vn(US$)</td>
</tr>
<tr>
<td>Output1</td>
<td>1,000</td>
<td>200</td>
<td>5.00</td>
</tr>
<tr>
<td>Output2</td>
<td>2,200</td>
<td>200</td>
<td>11.00</td>
</tr>
<tr>
<td>Total</td>
<td>3,200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>800</td>
<td></td>
<td>10.00</td>
</tr>
<tr>
<td>Materials</td>
<td>320</td>
<td></td>
<td>4.00</td>
</tr>
<tr>
<td>Energy</td>
<td>60</td>
<td></td>
<td>0.05</td>
</tr>
<tr>
<td>Capital</td>
<td>1,820</td>
<td></td>
<td>3.64</td>
</tr>
<tr>
<td>Total</td>
<td>3,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Performance indices: $K = \Sigma H_0 / H_1$, $L = \Sigma L_0 / L_1$, $M = \Sigma M_0 / M_1$, $N = O_1 P_1$, $O = C_1 X_1 L_1$, $P = D_1 X_1 L_1$, $Q = R + S$, $R = (O - F) G$, $S = O (P - G)$

Constant performance data: $V_{np} (US\$) = Q_{np} P_{nr} ($)

Dollar effects of change: $\Delta Prof = V_{np} - V_{np}$

<table>
<thead>
<tr>
<th></th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
<th>O</th>
<th>P</th>
<th>Q</th>
<th>$\Delta Prof$</th>
<th>$\Delta Prod$</th>
<th>$\Delta PR$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>0.991</td>
<td>1.130</td>
<td>0.877</td>
<td>951.44</td>
<td>90.38</td>
<td>10.53</td>
<td>-8.56</td>
<td>124.50</td>
<td>-133.06</td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>0.951</td>
<td>0.904</td>
<td>1.053</td>
<td>380.58</td>
<td>90.38</td>
<td>4.21</td>
<td>-19.42</td>
<td>-38.50</td>
<td>19.08</td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>1.098</td>
<td>1.043</td>
<td>1.053</td>
<td>71.36</td>
<td>1,355.63</td>
<td>0.05</td>
<td>6.36</td>
<td>2.78</td>
<td>3.58</td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>1.189</td>
<td>1.130</td>
<td>1.053</td>
<td>2,164.52</td>
<td>564.84</td>
<td>3.83</td>
<td>344.52</td>
<td>236.03</td>
<td>108.49</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.100</td>
<td>1.100</td>
<td>0.99946</td>
<td>3,567.89</td>
<td>322.89</td>
<td>324.81</td>
<td>-1.92</td>
<td>37.8594</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit</td>
<td>237.86</td>
<td>37.8594</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Change in profit from base period to review period due to changes in performance and changes in operating level or production volume.

Columns H, I and J are change ratios of the values, quantities and prices, respectively. Column H = Column E / Column B. Column I = Column F / Column C except for the total output and the total input. Since the quantities are expressed in different units, we cannot get their total. The change in output quantities is therefore obtained by multiplying each quantity for both periods by the corresponding unit price of the base period. The sum of the products for the review period is divided by the sum of the products for the base period. This is called a Laspeyres Index. With this, we obtain a change ratio for the quantities that are not affected by the changes in unit prices or costs from the base period to the review period. The following computation was done in table 4.1:
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3,245/3,160 = 1.027

Column J = Column G / Column D except for the totals which are obtained by using a Paasche Index for the outputs and a Laspeyres Index for the inputs. The quantities are used as weights this time. For example, the change in output price, 1.053, is obtained as follows:

3,805.75/3,615 = 1.05277 = 1.053

To check your computations, the total change ratios use the following relationships: change in values = change in quantities x change in prices, i.e. 1.189 = 1.13 x 1.053 and 1.082 = 1.027 x 1.053.

Columns K, L, and M are the performance indices for the changes in profitability, productivity and price recovery. As the formula indicates in table 4.1, each entry is obtained by dividing the total outputs (abbreviated as Ho, Io, Jo) from Columns H, I, and J by each corresponding input entry (Hi, Ii, Ji) from the same columns. For example, change in labour profitability is 1.189/1.2 = 0.991 which means that labour profitability decreased by a little less than 1 per cent. Change in energy productivity is 1.13/1.083 = 1.043, which means that energy productivity increased by 4.3 per cent. Change in total price recovery is 1.05277/1.053 = 0.999, which means that changes in cost were almost completely passed on to customers. Note that aside from computing total-factor productivity, total profitability, total price recovery, partial measures are all computed in a simple
format that can easily be done using any spreadsheet software.

Columns N, O, and P are what should have been the total costs, quantities and unit costs, respectively, of the inputs in the review period if profitability, productivity and price recovery had remained constant from the base period to the review period. This is similar to the flexible budgets in standard cost accounting which uses standard unit costs (as in the base period unit costs) instead of projecting what the unit costs should be in direct proportion to the average change in output price. Column O is obtained by multiplying each entry of Column C by the total change ratio of the outputs in Column I. Recall that the total change ratio of Column I is the total change in output quantities. Hence, multiplying each entry in Column C by the total change in outputs from Column I yields the proportionate quantities of inputs that should have been consumed in the review period had productivity not changed from the base period to the review period. For example, the labour quantity for the review period should have been 90.38 if the labour input had increased in direct proportion to the total increase in output quantities (1.13), i.e. $90.38 = 1.13 \times 80$.

Column P is obtained by multiplying each entry in Column D by the total change ratio of the outputs in Column J. Hence, Column P shows what should have been the unit costs of the inputs in the review period if price recovery had not changed from what it was in the base period. For example, materials unit cost should have been 4.21 if it had changed in direct proportion to the change in total output price (1.05277), i.e. $4.21 = 1.05277 \times 4.00$.

Column N = Column O x Column P: what should have been the total cost of each input in the review period if productivity and price recovery had remained constant from the base period to the review period. Therefore, the change in profit from the base period to this hypothetical period (which is US$37.86 for the example in table 4.1) represents the change in profit resulting from the change in operating level or production volume.

The variances between the corresponding data of this flexible budget (Columns N, O, and P) and the actual data for the review period represent the changes in productivity, price recovery and profitability and are used in computing the effects in monetary terms shown in Columns Q, R, and S.

Column R: the monetary effect owing to changes in productivity is the difference between what input quantity should have been used if productivity had remained constant (Column O) and the actual quantity used (Column F), multiplied by the actual unit cost of that input during the review period (Column G). The unit costs of the review period are used rather than those of the base period since users need to know what the performance changes are costing them during the review period and not what they would have cost them during the base period. For example, the monetary effects of changes in capital productivity, $236.03 = (564.84 - 500) \times 3.64$.

The monetary effects of price recovery changes are computed by multiplying the difference between what the unit costs should have been if price recovery had remained constant (Column O) and the actual unit cost in the review period (Column G), by the input quantity that should have been used if productivity had remained constant (Column O). For example, the monetary effect of the change in labour price recovery, $-133.06 = 90.38 \times (10.53 - 12)$, i.e. price recovery for labour was not enough or the increase in labour cost was not fully passed on to customers.
Column Q: the monetary effects of changes in profitability is the sum of the monetary effects of changes in productivity (Column R) and changes in price recovery (Column S). For example, the total monetary effect of changes in profitability, 322.89 = 324.81 + (-1.92).

The total monetary effect of changes in profitability over all factors represents the total monetary effects of all changes, which is also the difference in profits between the flexible budget and the actual profit of the review period. The sum of the total monetary effects of all changes, and the difference between profits of the flexible budget and the profit from the base period, equal the difference in profits of the review period and the base period. From table 4.1 we obtain:

\[
\text{Change in profit from the base period to the flexible budget} = 237.86 - 200 = 37.86
\]

\[
+ \text{Total monetary effects of changes in productivity and price recovery} = 322.89
\]

\[
= \text{Change in profits from the base period to the review period} = 560.75 - 200 = 360.75
\]

As previously mentioned, the development of this TFPM Teaching Model was based on the ways in which TFPM responds to common information needs. The following discussion explains this in detail.

### 3.5 Common information needs

The following kinds of information needs for users of TFPM were identified by practitioners and different surveys (see American Productivity Center, 1985; Steedle, 1988, p. 15).

The first information needs are for planning, evaluating budgets, choosing strategic options, generating challenge budgets, improving resource allocation, or responding to fluctuations in the environment. Note that in the example presented earlier we talked about a base or reference period and a review period. For purposes of planning, the base period could be any typical past period, while the review period could be any period a management team is planning for. On the basis of the results from the base period, the budget for a period being reviewed could be evaluated in terms of its feasibility and reasonableness. By comparing the budget of a future period against a past base period, managers will be able to see if they have planned for productivity improvement, have given enough challenge to operating managers, or have set unreasonable targets.

For example, in table 4.1, the base period could be a past period performance while the review period could be the budget for the coming period. Table 4.1 shows a labour productivity increase of 13 per cent (Column L) and a 12.3 per cent loss in labour price recovery (Column M). Materials productivity would decrease by 9.6 per cent while materials price recovery would increase by 5.3 per cent. The 10 per cent increase in overall profitability will all come from a 10 per cent increase in total-factor productivity while holding price recovery constant. Managers could evaluate if this budget (the review period data) is reasonable and feasible. By using the spreadsheet developed in table 4.1, managers can make a sensitivity analysis of changes in the input and output quantities and prices and evaluate effects of fluctuations in the environment.
The second information need is a measure of past overall performance to know if the firm is improving and to assess the impact of improvement efforts on profitability. For example, in table 4.1, the total monetary effect of the improvement in productivity was US$324.81, with all resources contributing to an increase in productivity except materials productivity, which decreased by $38.50. The monetary effect of changes in price recovery totalled to -US$1.92, which meant that increases in costs of inputs were not passed on to the customers.

The third information need is measuring the performance of units within the firm and ascertaining their contribution to the overall performance of the firm.

The fourth information need is determining the contribution of partial factors (labour, materials, energy, capital) to total factor productivity, price recovery and profitability. From table 4.1, we can see that, while TFPM computes total factor productivity, partial factor contributions are all computed also.

Other information needs include productivity analysis by product as a basis for gainsharing. Analysis by product can be considered a special case of measuring units within a firm and ascertaining their contribution to total firm performance. Measuring past productivity performance, relating productivity to profitability and measuring the contribution of partial factors to total-factor productivity could provide a basis for gainsharing.

An important concern is the need to integrate TFPM with the existing systems in the organization. This concern serves many purposes. First, it deals with initially designing the TFPM application using data stored in existing data bases. Since TFPM is suited mainly for plant and firm levels, most of the data are available in some form or another and with minor processing could be used for TFPM. This facilitates TFPM development as people do not feel burdened by a new system. Secondly, the experience confirms that productivity tracking is facilitated when measures of productivity change are directly related to an operationally familiar measure such as profitability.

There is a need, though, to guard against the perception that TFPM duplicates existing systems without adding new data or information. Some accountants think TFPM duplicates Activity-Based Cost (ABC) Accounting or Standard Cost Accounting information. ABC Accounting improves the allocation of indirect and overhead costs. By identifying to what activities indirect and overhead costs should be charged, instead of the usual allocation of indirect and overhead costs proportional to direct labour and material costs, better product or activity costing is achieved. ABC Accounting will therefore make TFPM data more accurate, but will still not be able to measure productivity and price recovery and relate them to profitability. Standard Cost Accounting, on the other hand, explains variances of actual costs against a flexible budget based on standard costs. It is an efficiency measure in the sense that it portrays the difference between actual resources consumed against the expected resource consumption. It stops at explaining changes in costs.

The common information needs and issues were used to develop and evaluate the TFPM Teaching Model. This module does not go beyond the TFPM. For readers who would like to deepen their knowledge of the subject-matter, however, table 4.2 provides an overview of different TFPM models.
Table 4.2: TFPM models, versions and features

**MODELS**

**Productivity Indices**
(deflates all values to constant US dollars; productivity index = sum of all output values over sum of all input values)

**PPPR Models:**
Profitability =
Productivity +
Price Recovery

(Productivity is related to accounting profitability and price recovery)

**MAIN FEATURES**

- inclusion of all inputs (including capital)
- book value used for capital input
- lease value used for capital input
- productivity per product
- added details for computing input values
- firm productivity related to profit breakeven
- “challenge budgets”

**Econometric**

- use of Laspeyres and Paasche indices
- US dollar effects, partial productivities and price recoveries portrayed in base period US dollars
- capital compensation
- clarified conceptual models
- concept of resource variability to break down productivity into capacity utilization and efficiency
- strategic grids
- attributes: data aggregation/level of detail
- US dollar effects portrayed in current period dollars
- difference operators
- cumulative deflation
- multi-factor concept (capital may be excluded)
- graphics/portrayal development
- productivity, quantity, and price grids
- import/export of data with other software
- uses growth rates of outputs and inputs

The TFPM Teaching Model is actually a version of the PPPR model (see table 4.2). It computes and portrays change ratios and performance indices in the same manner as the APQC, VP and REALST versions. It differs from other PPPR versions in portraying the monetary effects of performance changes. First, the TFPM Teaching Model presents a flexible budget, i.e. the quantities, costs and total costs or values of inputs for the review period, assuming that productivity and price recovery remained constant as in the base period. This flexible budget is very similar to the Standard Cost Accounting flexible budget except that, instead of using the actual unit costs in the review period, normalized unit costs directly proportional to the change in unit selling price are used (i.e. for constant price recovery).

The variance between the profits of this flexible budget and the profits from the base period can be explained by the change in level of activity or production volume. The variances between the flexible budget and the actual costs in the review period are the monetary effects of changes in profitability, productivity and price recovery. These monetary effects are portrayed as the last three columns of the TFPM Teaching Model spreadsheet and are computed in the same manner as a REALST, i.e. monetary effects of changes in productivity are valued at the review period unit costs, and the monetary effects of changes in price recovery are valued at the normalized review
period unit costs; the monetary effects of changes in profitability are the sum of the monetary effects of changes in productivity and the monetary effects of changes in price recovery.

The TFPM Teaching Model, like all the versions of the PPPR model, provides a measure of the overall past performance in terms of indices and monetary effects of changes in performance (the second common information need). The monetary effects are in terms of the value of money during the review period, so they are more indicative of the actual value of money at the time the review is done and can, therefore, be more useful for purposes such as gainsharing and planning for budgets of succeeding periods, rather than valuing the monetary effects based on the base period value of money. The TFPM Teaching Model provides for the first common information need as follows: it can be used to evaluate budgets by using budget data as the review period data compared with some past actual period data. If needed, a computation could be done to generate challenge budgets using a productivity improvement target rather than a desired cost to sales ratio. The TFPM Teaching Model can be used to measure units within a firm and to ascertain their contribution to the overall performance of the firm (the third common information need). It also provides for the fourth common information need by showing contributions of partial factors to total-factor productivity, price recovery and profitability.

The introduction of the flexible budget into the spreadsheet of the TFPM Teaching Model helps in understanding how the model works. For some people it is difficult to reconcile and understand why the total monetary effects of change in profitability did not equal the change in profits from the base period to the review period. It is not immediately clear why the monetary effect of profitability change could be negative and yet have a positive review period profit. The flexible budget explains it and clearly portrays that the change in profits from the base period to the review period is caused by two factors: change in level of activity or sales volume and changes in productivity and price recovery.

On the basis of the reasons just presented, the TFPM Teaching Model could be used as a basic management tool by managers who are seriously concerned about performance improvement. It may indeed be very timely to introduce TFPM to managers who are beginning to experiment with cost accounting systems in search of better operational measures at the enterprise level. They observe that there is a growing dissatisfaction with cost accounting systems and that there is a need for better enterprise-level measures that support performance improvement efforts.

### 3.6 Case study: Mine Y

Mine Y has four products: copper, gold, silver and pyrites. The following table was obtained from last year's financial statement:

Mine Y employed 15,000 employees in 1989 and 14,000 in 1990. Energy costs increased from 1.15 in 1989 to 1.41 in 1990. The cost of materials and services increased by 12.6 per cent from 1989 to 1990. Cost of capital remained constant for both years.
Measure total factor productivity, using the TFPM Teaching Model explained in this unit. Compare your table with table 4.3 and discuss the results. During the discussion try to answer the following questions:

1. While Mine Y made more profits in 1990, was it actually more profitable?
2. What were the significant factors affecting Mine Y’s change in profitability?
3. Suppose that Mine Y’s data for 1989 were actual while the 1990 data were budgeted production, revenues and costs. Would you, as the manager of Mine Y, commit to and be challenged by that budget? What would you change in the budget to make it more challenging yet realistic?

Compare the results of your discussions with the answers to these questions given in the text following table 4.3.
### Table 4.3: Solution to Mine Y case study

<table>
<thead>
<tr>
<th>Products/Expenses</th>
<th>BASE PERIOD</th>
<th>REVIEW PERIOD</th>
<th>CHANGE RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>Q</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>REVENUES</td>
<td>QUANTITY</td>
<td>Unit Price</td>
</tr>
<tr>
<td></td>
<td>Cost</td>
<td></td>
<td>Unit Cost</td>
</tr>
<tr>
<td>Copper</td>
<td>5000</td>
<td>175</td>
<td>28.571</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td>1000</td>
<td>0.15</td>
<td>6666.667</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td>30</td>
<td>0.35</td>
<td>85.714</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrites</td>
<td>70</td>
<td>0.18</td>
<td>3888.889</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>6100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>650000</td>
<td>0.015000</td>
<td>43333.333</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>77000</td>
<td>669.565</td>
<td>1.150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>1300000</td>
<td>1300000</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>380000</td>
<td>380000</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Misc.</td>
<td>200000</td>
<td>200000</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>3300000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROFITS</td>
<td>2800000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### PERFORMANCE INDICES

<table>
<thead>
<tr>
<th>Profitability (Ho/Hi)</th>
<th>Productivity (Io/Ii)</th>
<th>Price recovery (Io/Ii)</th>
<th>TOTAL COSTS (O&amp;P)</th>
<th>TOTAL QUANTITIES (Ci&amp;Jo)</th>
<th>UNIT COSTS (Di&amp;Jo)</th>
<th>(R+S)</th>
<th>(O-F)+G</th>
<th>(P-G)+O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>0.9567</td>
<td>1.0247</td>
<td>0.9337</td>
<td>6697131</td>
<td>0.0143</td>
<td>46685.3956</td>
<td>-30.2869</td>
<td>17.2619</td>
</tr>
<tr>
<td>Energy</td>
<td>0.8815</td>
<td>1.0032</td>
<td>0.8787</td>
<td>7933525</td>
<td>1.2390</td>
<td>-1066475</td>
<td>7.8768</td>
<td>-109.5488</td>
</tr>
<tr>
<td>Material</td>
<td>1.0303</td>
<td>1.0768</td>
<td>0.9568</td>
<td>13394262</td>
<td>1.0774</td>
<td>394262</td>
<td>999040</td>
<td>281119</td>
</tr>
<tr>
<td>Capital</td>
<td>0.9788</td>
<td>0.9085</td>
<td>1.0774</td>
<td>3915246</td>
<td>1.0774</td>
<td>-84754</td>
<td>-365873</td>
<td>453698</td>
</tr>
<tr>
<td>Misc.</td>
<td>1.2122</td>
<td>1.2669</td>
<td>0.9568</td>
<td>206056</td>
<td>1.0774</td>
<td>360656</td>
<td>453698</td>
<td>-93043</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.9799</td>
<td>1.0371</td>
<td>0.9448</td>
<td>34000920</td>
<td>1.0774</td>
<td>369180</td>
<td>1288252</td>
<td>1987433</td>
</tr>
<tr>
<td>PROFITS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>849180</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Answers to questions on Mine Y case study

1. No, it was less profitable as it could not recover all the increases in costs by passing them to the customers.
2. While Mine Y was more productive, its price recovery was lower except for capital, i.e. the increases in unit prices of its outputs were not enough to offset the increases in unit costs of its inputs.
3. It could be improved by increasing productivity improvement targets. Productivity increases are only 2.47 per cent for labour or 0.32 per cent for energy, 7.68 per cent for materials, and -9 per cent for capital.

Questions for discussion

1. What are the most important basic productivity concepts?
2. What are the differences and relationships between total and partial productivity measures?
3. What are the most important benefits of TFPM for the company?
4. What are the main management decisions which could be derived from the analysis of the TFPM results?
UNIT 4: OTHER APPROACHES IN ASSESSING THE COMPANY'S PERFORMANCE

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Use Kurosawa’s and Lawlor’s approaches in designing your productivity measurement systems.

2. Use quick ways to assess productivity.

3. Understand and incorporate other “soft” measures to assess your general organizational performance, not only through productivity ratios.

4. Understand and explain the essence of inter-firm comparisons and benchmarking to involve specialists if necessary.

UNIT 4: CONTENTS

4.1 The Kurosawa structural approach

4.2 The Lawlor approach

4.3 A quick way to assess productivity

4.4 A “family” of measures of organizational performance

4.5 Inter-firm comparisons and benchmarking
UNIT 4: OTHER APPROACHES IN ASSESSING THE COMPANY’S PERFORMANCE

4.1 The Kurosawa structural approach

Dr. Kazukiyo Kurosawa’s approach focuses on the structure of the enterprise (Kurosawa, 1990). In accordance with his concept, productivity measurement in the enterprise helps to analyse the past and to plan new activities. It can be used to set up an information system for monitoring operations. For this reason it is important that productivity measurement be built according to the decision-making hierarchy. A very general system could be as shown in figure 4.5.

**Figure 4.5: Fundamental framework of productivity measurement in management**

![Diagram of productivity measurement framework]


Applying this equation over time, one can use this system as a kind of interlinked index system.

Value-added productivity also can be used meaningfully for productivity measurement in combination with various physical parameters as well as other related variables.

As can be seen in figure 4.6, value added at the enterprise can have several forms. The selection of the appropriate form depends upon management objectives.

In routine business activities, value added is usually evaluated at current prices. Value added at constant prices is estimated more for analytical purposes, using the double deflation method to eliminate the price effect on value added.
Figure 4.6: Structure of production value and value-added variants

Production value ($\sum PQ$)

- Material cost ($Ct$)
- Depreciation ($Cs$)
- Labour income ($V$)
- Net profit ($Mb$)
- Interest ($Mc$)
- Rent ($Md$)
- Tax ($M$)

Gross value added ($F^g$)

Net value added ($F^n$)

Business performance No. 1 ($F_{1b}$)

Business performance No. 2 ($F_{2b}$)

Business performance No. 3 ($F_{3b}$)

Real value added = $\frac{\sum PiQi}{Ip} - \frac{\sum SiLi}{Is}$

where

- $\sum PiQi$ = gross output for current period in current prices
- $\sum SiLi$ = industrial cost for current period at current prices
- $Pi$ = market prices
- $Qi$ = quantity of items sold
- $Si$ = price of the $i$ Item of intermediate input factor
- $Ii$ = quantity consumed of the $i$ Item of intermediate input factor
- $Ip$ = price index number of products
- $Is$ = price index number of intermediate input

Source: Kurosawa, 1980, P.111

4.2 The Lawlor approach

Alan Lawlor considered productivity as a comprehensive measure of how efficiently and effectively organizations satisfy the following five aims: objectives, efficiency, effectiveness, comparability and progressive trends (Lawlor, 1985, ch. 4).

Objectives can be met when the total fund is adequate to meet the demands of the organization and to measure the degree to which its principal objectives are achieved. This fund is called total earnings (TE).

$$TE = sales - materials = S - M$$

TE serve to buy services, to pay wages and salaries and to invest in fixed capital, profit and taxes.

Efficiency tells us how well actually needed output is generated from available input and indicates the use of available capacity. Efficiency measurement reveals the output-to-input relationship and the degree of use of resources compared with the total capacity (potential). This indicator should tell us where inefficiencies lie.
Effectiveness compares present achievement with what could be done if resources were managed more effectively. This concept includes an output target achieving a new standard of performance, or potential.

\[
\frac{Output}{Input} = \frac{Input + profit}{Input} = \frac{Profit}{Input}
\]

where

\[
\frac{Profit}{Input} = \text{Profit productivity ratio.}
\]

Productivity improvement involves a combination of increased effectiveness and a better use of available resources. It shows four basic ratios:

- actual output divided by actual input, the status quo;
- higher output divided by current actual input;
- actual current output divided by lower input; and
- the higher level of effectiveness; maximum output divided by minimum input.

Comparability is a guide to organizational performance, since productivity ratios alone tells us little without some form of comparison. Generally speaking, productivity measurement means comparisons at three levels:

- comparison of present performance with a historical base performance;
- comparison of performance between units: such a measure indicates relative achievement; and
- comparison of actual performance with a target: this is best, because it concentrates attention on objectives.

Trends, i.e. the aim of achieving progressive trends, must be associated with a comparison between current performance and a historical base in order to identify whether enterprise performance is moving up or down, and how quickly.

This approach calls for at least two levels of productivity measurement within the enterprise: primary and secondary. The primary level deals with total earning productivity (E) which is:

\[
E = \frac{\text{Total earnings}}{\text{Conversion cost}} = \frac{T}{C}
\]

where conversion cost (C) = total wages and salaries (W) + total purchased services (Ps) + depreciation (K). Thus, obtaining a high level of total earnings ensures a healthy organization.

Secondary productivity measurement provides the ratio of used resources to the total cost of all available resources. The total conversion costs include two main divisions:
the costs incurred when resources are used productively (Cd); these costs can be subdivided into productive work costs (Ce) and ancillary work costs (Ca); and
- unused or idle resources costs (Ci), when people and equipment are wholly idle.

The relationship between these costs is shown below:

Thus it is possible to state resource or conversion utilization productivity as follows:

\[
\frac{\text{Time or costs incurred on productive and ancillary work}}{\text{Total time (or conversion costs available including idle time)}} = \frac{\text{Cd}}{\text{C}}
\]

The basic resource productivity indicator is used to relate pure productive work (Ce) to total conversion costs (C).

Thus,

\[
\frac{\text{sts incurred on purely productive work}}{\text{(Total time or conversion costs available)}} = \frac{\text{Ce}}{\text{C}}
\]

Truly productive work, as distinguished from ancillary work, is what directly adds value to materials. The concept of productive work forms an important part of productivity measurement. There are two other secondary productivity measurements: working capital and inventory productivity.

Productivity of working capital = \[
\frac{\text{Total earnings}}{\text{Throughput materials + conversion costs}} = \frac{T}{M + C}
\]

This equation gives total earnings per unit of working capital employed or the rate of turnover of working capital. Similar ratios could be employed using sales (S) or profit (P) output, i.e.

\[
\frac{S}{M + C} \quad \text{and} \quad \frac{P}{M + C}
\]

The productivity of inventory (total materials, work in progress and finished stocks) is similar to working capital, but should include a carrying charge (Cinv) to cover the time the inventory
has been in the system:

\[
\text{Total earnings} \quad \frac{\text{Throughput materials + carrying charge}}{M + \text{Cinv}} = T
\]

A more conventional way of measuring the productivity of inventory is the rate of stock turnover, which is:

\[
\frac{\text{Sales}}{\text{Average stock carried}}
\]

Productivity potential

The potential total earnings of an organization are the earnings that would be gained if all input were fully used - with no idle capacity costs.

In other words, \( C_d = C \)

\[
T_{pot} = \frac{T}{\text{Total } C_d} = C
\]

For example, if total earnings are US$110,000, total conversion costs US$75,000 processing costs US$48,000 and productive work costs US$30,000, we can make the following calculation:

Utilization productivity \( = \frac{C_d}{C} \times 75,000 = 0.64 \)

Just under two-thirds of resources are occupied productively and about one-third are idle.

The existing and potential total earnings are:

Existing total earnings = US$100,000

Potential total earnings \( = \frac{T}{C_d} \times C = \frac{100,000}{48,000} \times 75,000 = \text{US$156,250} \)

It can be seen that productive work has a big lever effect on total organizational productivity, with a similar effect on profit. Comparisons made between potential total earnings productivity and total earnings productivity with idle costs reveal large differences.

Summarizing his approach, Alan Lawlor gives a hierarchical structure of productivity indices and a table for comparison of the degree of usefulness of the different productivity measurement indices from the points of view of organizational levels, complexity and basic aims of measurement (see figure 4.7 and table 4.4).
4.3 A quick way to assess productivity

Productivity measures need not be complicated. A systematic set of simple measures provides more useful indicators of the different problems. In order to monitor all aspects of productivity and the factors influencing it, a system of ratios is required. Canadian consultant Imre Bernolak suggests an example in the “List of Typical Ratios” (Bernolak, 1993, pp. 4-6). This list contains the typical productivity and profitability ratios that are necessary for the analysis of the variations and changes of profitability and productivity, as well as the factors which determine them. In most sectors, 30-35 ratios are sufficient for the combined productivity/profitability analysis.

Over time, the analysis of information from the base year can be greatly assisted by showing the relative movements of the relevant ratios in a trend-chart form, first showing the relative movements of the main ratios, then proceeding to analyzing the components of the main elements and factors.

Companies will produce reliable information only if the information is of interest to them. The main interest of most enterprises is to make a profit. In consequence, all want to evaluate how this objective can be accomplished. It is typically revealed by 15 commonly used financial ratios. Several of these financial ratios are closely related to productivity ratios. They provide a link between managerial actions and productivity measures. Some of the ratios relate output to capital investment, labour or other costs. Other ratios show the inputs in relation to sales. Examples of these ratios are profits (before tax) on capital employed, profits (before tax) on total income, cost-of-sales to sales, fixed assets to sales, and collection period (in days). All these ratios can be arranged in a pyramidal ratio system within which the corresponding productivity ratios help to analyse the causes of profitability variations at one point in time, and of its changes over time.
Several important adjustments have to be made to prepare the data for productivity analysis. The capital stock must be expressed in “constant” US dollars, so that the capital of various vintages can be added up. These are used for measures of capital intensity. For productivity measures, the capital input is the capital flow, i.e. the annual portion of the constant US dollar capital stock “depreciated” over the true “economic life” of the asset.

Another adjustment needed for productivity measures is to express both output and input in “operating” terms. This means that all revenues and expenses not related to the measured operation need to be excluded. The integrated analysis of profitability and productivity makes the application of productivity theory very practical for enterprise managers. While profitability measures indicate the combined short-term effects of both productivity and price factors, the long-run success of enterprises is determined by proper resource utilization, i.e. the productivity factor. In the short term, the analysis of productivity measures helps to explain the causes of performance results, and form the basis of productivity gainsharing.

### Table 4.4: Comparison of productivity measures

<table>
<thead>
<tr>
<th>No. Measures</th>
<th>Level</th>
<th>Complexity</th>
<th>Order</th>
<th>Five basic aims</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Macro</td>
<td>Micro</td>
<td>Simple</td>
<td>Complex</td>
</tr>
<tr>
<td>1. GNP per capita GNP/PC</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>2. GNP/PC+ GNP/PC of others</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>3. Added value per worker AV/Pw</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>4. Total earnings productivity T/C</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>5. T/C+ T/C of others</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>6. Profit productivity P/C</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>7. Total earnings potential T/Cd x C</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>8. Sales per worker S/TE over 3 years</td>
<td></td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>9. Profit per worker P/TE over 3 years</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>10. P/TE+ P/TE of others</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>11. Utilization productivity Cd/C</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>12. Cd/C+ Cd/C of others</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>13. Utilization productivity Ce/C</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>14. Working capital productivity T/M + C</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>15. Inventory productivity T/M + Cnv</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>16. Output per hour O/H</td>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

Legend:
- O = Objective
- Ef = Efficiency
- E = Effectiveness
- C = Comparison
- T = Trend

Source: Lawlor, 1985, p.88.
Enterprise profitability and productivity analysis starts from the finding that the most commonly used measure of the performance of an enterprise is Return on Investment (ROI). Since productivity (what we are trying to measure) expresses the physical relationship of output to input (i.e. what is produced from the resources in volume terms), all assets are therefore included in the denominator of the ratio. The Return on Assets (ROA) is consequently used instead of the ROI as the top performance ratio of the pyramid, and the main link between productivity and management.

The ROA ratio is then broken down into the other two commonly used "primary" ratios, namely, the profit-over-sales ratio and the sales-over-assets ratio. If these two ratios are multiplied by each other, they are equal to the top ratio (profit-over-assets). For practical considerations, the reciprocal of the sales-over-assets ratio, i.e. assets-over-sales, is used in the profitability/productivity analysis. In industries where the capital assets are relatively insignificant compared with the other inputs - for example in the mechanical contractors industry - the profit-over-sales ratio becomes the integrating top ratio.

Weaknesses revealed by either primary profitability ratio are then further analysed by analysing the financial and physical input-output relationships that affect the relevant primary ratio.

All cost data must be "observed" cost figures rather than "standard" costs. In addition to physical productivity ratios which can be built into the pyramidal analysis system, each financial ratio can be analysed in terms of its physical productivity and price components. First, the values are analysed; then, if the price element does not fully explain the variation in the financial productivity ratio, the analysis continues by exploring the factors that affect the physical productivity element.

**COMBINED PROFITABILITY AND PRODUCTIVITY ANALYSIS**
Example: List of Typical Ratios

<table>
<thead>
<tr>
<th>Performance indicators</th>
<th>Units</th>
<th>Company X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return on assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Operating profit/Operating assets</td>
<td>%</td>
<td>8.1</td>
</tr>
<tr>
<td>Profit margin, turnover of assets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Operating profit/Sales</td>
<td>%</td>
<td>6.2</td>
</tr>
<tr>
<td>3. Sales/Operating assets</td>
<td>No. of times</td>
<td>1.3</td>
</tr>
<tr>
<td>Gross profit margin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Gross profit/Sales</td>
<td>%</td>
<td>16.4</td>
</tr>
<tr>
<td>Production costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Production cost of sales/Sales</td>
<td>%</td>
<td>83.6</td>
</tr>
<tr>
<td>6. Materials &amp; components/Sales value of production</td>
<td>%</td>
<td>70.3</td>
</tr>
<tr>
<td>7. Direct production labour cost/Sales value of production</td>
<td>%</td>
<td>3.7</td>
</tr>
<tr>
<td>8. Indirect production labour cost/Sales value of production</td>
<td>%</td>
<td>4.6</td>
</tr>
<tr>
<td>9. Manufacturing overhead/Sales value of production</td>
<td>%</td>
<td>5.0</td>
</tr>
</tbody>
</table>
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**Operating expenses**

10. Total operating expenses/Sales % 10.2  
11. Warehousing & shipping expenses/Sales % 2.6  
12. Selling & promotion expenses/Sales % 2.2  
13. Administration/Sales % 5.4

**Asset utilization ratios** (per US$1,000 of sales)

14. Total operating asset $ 768  
15. Fixed assets $ 364  
16. Current assets $ 404

**Current asset utilization** (per US$1,000 of sales)

17. Total inventory $ 237  
18. Raw material inventory $ 73  
19. Work-in-process and finished goods inventory $ 164  
20. Accounts receivable $ 163  
21. Other current assets $ 4

**Fixed asset utilization** (per US$1,000 of sales)

22. Land and buildings $ 176  
23. Machinery and equipment $ 176  
24. Road vehicles $ 4  
25. Furniture and fixtures $ 8

**Productivity and supplementary ratios**

26. Sales increase (decrease) over preceding year % 34.6  
27. Sales per production employee $ 196 000  
28. Direct production labour cost/Direct production labour hours worked $ 7.59  
29. Value added/Direct production labour hours worked $ 56.57  
30. Value added/Production floor area $ 80.73  
31. Value added/Depreciation on machinery and equipment $ 16.77

32. Sales value of production/No. of production employees $ 34 402  
33. Sales value of production/No. of units produced* $ 6.56  
34. No. of units produced*/Direct production labour hours worked No. 31.2  
35. No. of units produced*/No. of production employees No. 66 860  
36. No. of units produced*/US$1 depreciation on machinery and equipment No. 9.3

*The "units produced" in Ratios 32, 33, 35 and 36 could be number of products produced, tonnes of products produced, litres of products produced, tonne-kilometres carried, etc.*
Some examples of relationships between ratios are given below:

1. Ratio 1 equals Ratio 2 multiplied by Ratio 3.
2. Ratio 14 equals 1,000 divided by Ratio 3.
3. The sum of Ratios 4 and 5 equals 100 per cent.
5. The sum of Ratios 2, 5 and 10 equals 100 per cent.
6. The sum of Ratios 6, 7, 8 and 9 equals Ratio 5.
7. The sum of Ratios 11, 12 and 13 equals Ratio 10.
8. The sum of Ratios 15 and 16 equals Ratio 14.
9. The sum of Ratios 18 and 19 equals Ratio 17.
10. The sum of Ratios 17, 20 and 21 equals Ratio 16.

4.4 A “family” of measures of organizational performance

Productivity improvement is the result of the combined efforts of many different stakeholders - managers, workers, shareholders, owners, clients, customers, communities, suppliers, etc. This means that results of measurement should be fed back to all participants to stimulate improvement.

A “family” of measures should be used everywhere where measurement is needed; no part of an organization is so simple that it can be measured adequately by one indicator. By drawing together a set of measurements of the organization from the perspective of its various stakeholders, an organization can avoid the shortsightedness that often results from focusing on a single measure of success. A family of measures could ensure a holistic understanding of organizational health and performance. The American productivity consultant Carl Thor (1993, pp. 2-3) believes that the art of managing is an art of balance. At any given point in the organization, there is a wide range of possible family measures from which a focused few (say, five or six) can be selected. Candidates usually include:

- labour productivity
- number of process steps
- cost of service
- resource utilization
- inventory turnover
- process variation magnitude
- on-time delivery
- process cycle time
- costs of (poor) quality
- worker skill mix
- team effectiveness/participation
- customer surveys
- service quality
- rework/scrap/returns
- energy productivity
- safety
- housekeeping audit
- documentation
- creativity/innovation
- market share
- new products/services

A family of measures may be aggregated through a technique such as the Objectives Matrix to give an overall improvement “score”, but the main diagnostic value remains with the family elements themselves (for more information, see Riggs and Glenn, 1983).
An excellent overview of the concept and practical application of a family of measures was provided by the American productivity consultants Lloyd Provost and Susan Leddick in the National Productivity Review. They also believe that a family of measures views the organization as a whole, as a single, complex and dynamic system. Although the system may be made up of what seem to be different parts, its members are unified by a common purpose. Accomplishing that purpose requires optimizing the performance of the whole system, not just its parts taken individually and summed.

If taking only single measures or a few measures concentrated in one dimension, almost any group can be successful in the short term by optimizing that measure at the expense of other important measures. ROI can be increased in the short term by decreasing investment in research and development. Volume of production can be increased by cutting back on preventive maintenance or tests of new products or increasing inventory. It is much more difficult to improve a family of measures than any individual measure.

A family of measures should serve as both an indicator of present performance and a predictor of future performance. The measures should relate to the organization from a variety of perspectives: customers, employees, business and financial, operations (including suppliers), and outside environment (including the community). (Examples of measures from each of the perspectives or categories are listed in table 4.5 - see Provost and Leddick, 1993, pp. 477-490). Taken as a whole, the set of measures should predict the future direction of the system. The job of the leaders is to plan and manage improvement efforts to upgrade the entire family of measures.

The categories of measures for most organizations are universal. But the specific measures for any one organization depend on factors of uniqueness. One way to develop a set of specific measures would be to use the purpose statement of the organization as a guide. Another approach might be to start with a list of stakeholders and ask what measure could predict their future satisfaction with the organization. Potential measures developed from these questions could then be researched for practicality, availability and potential.

It is best if most of the measures are developed by the people being affected by them. They know the most about the local processes and activities, and they will pay much more attention to measures they have had suggested.
Table 4.5: Examples of family measures of the system

Customers:
- Percentage of repeat customers
- Number of complaints from customers
- Warranties, claims or returns

Key performance characteristics of the product or service that are global in nature:
- Percentage of deliveries on time (distributor)
- Scores on standardized tests (school)
- Degree of return to normal physical or mental functioning (hospital)
- Time (to complete a service)

- Number of awards or compliments
- Number of recommendations by customers to others
- Market share

Employees:
- Level of experience or skills
- Absenteeism or turnovers
- The extent to which people take pride in their work
- Percentage of employees’ time allocated for education and training
- Number of suggestions submitted
- Number of grievances filed
- Education levels
- Number of personal accomplishments

Business and financial:
- Earnings or profits
- Costs (fixed, variable, controllable, etc.)
- Variance from budget
- Share of market
- ROI or ROA or return on capital
- Amount spent on research and development
- Amount of resources allocated for the improvement of quality

Operations:
- Throughput or cycle time for the system
- Percentage yield
- Efficiency
- Volume of production or sales
- Productivity
- Backlog of orders or work
- Levels of inventory
- Amount of overtime
- Amount of scrap or rework
- Number of errors, accidents, injuries, near misses

Outside environment:
- Time allocated to industry groups or advisory groups
- Amount of community service
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Amount of discharge of pollutants
Number of lay-offs
Accidents or injuries related to the product or service
Fines or violations from government agencies
Media coverage

To show the dynamic of changes among the measures, they should be used to develop a control chart for each measure, thus comparing the current values for the past periods (see an example in figure 4.8). Such multiple control charts could be extended to the entire system and provide a relatively simple overview of the company performance status.

4.5 Inter-firm comparisons and benchmarking

Productivity and profitability analyses could also be made through comparisons of variations from competitors or other standards at a certain point in time, and not only through direct productivity measurement of a single company or its elements.

When performance norms or standards are compared with the actual results for the period, variances are obtained which represent the difference between some standard or norm and the actual. These variances are usually described as being favourable or unfavourable. The norms used can be “hard” engineered standards or “softer” norms such as experience from previous years or industry averages. The success of this approach depends largely on the accuracy and consistency in deriving the norms.

The typical Inter-firm Comparison (IFC) is made when an enterprise is compared with the industry for which a profile is derived from a representative sample of a similar organization. Usually financial ratios, partial productivity measures and common size statements, e.g. resources expressed as percentage of sales or assets expressed as a percentage of capital employed, are used. This type of comparison will show whether the firm is more or less productive than its peers. If a profile for “good” performance, rather than average performance, can be developed for an industry, the comparison becomes more meaningful.

The following are the most important main objectives of IFC:

- to show management how its firm’s performance compares with that of similar enterprises;
- to draw management’s attention to areas of comparative weakness and strength within the business; and
- to give management an objective basis for judging progress and effectiveness;

Typically in the IFC programme, the gathering of about 100 pieces of raw quantitative data and about the same number of pieces of qualitative information has been found sufficient for producing the final 30-40 ratios with the accompanying analysis. IFC is usually carried by external consultants.

The most recent development of IFC is “benchmarking”. It is an early warning system of impeding problems. The Coopers and Lybrand consultants, in their latest book on this subject, define benchmarking as an emerging tool in leading-edge companies for obtaining the
Figure 4.8: Control charts for a family of ten measures of the system

The horizontal chart indicates dates starting from January 1994:

- **Revenues**: $MILLIONS
  - 60
  - 50
  - 40
  - 30
  - 20
  - 10
  - 0

- **Operating Profits**: $MILLIONS
  - 8
  - 7
  - 6
  - 5
  - 4
  - 3
  - 2
  - 1
  - 0

- **Market Share**: PERCENT OF SALES
  - 25
  - 30
  - 20
  - 15
  - 10
  - 5
  - 0

- **Customer Complaints**: HOURS
  - 70
  - 60
  - 50
  - 40
  - 30
  - 20
  - 10
  - 0

- **Percent of Repeat Customers**: PERCENT OF SALES
  - 100
  - 80
  - 60
  - 40
  - 20
  - 0

- **Absenteeism**: PERCENT OF DAYS
  - 8
  - 7
  - 6
  - 5
  - 4
  - 3
  - 2
  - 1
  - 0

- **Time Allocated to Industry Groups**: HOURS
  - 120
  - 100
  - 80
  - 60
  - 40
  - 20
  - 0

- **Percent of Employees Time in Training and Education**: % EMPLOYEES TIME IN TRAINING AND EDUCATION
  - 5
  - 4
  - 3
  - 2
  - 1
  - 0

- **Production Cycle Time**: HOURS
  - 70
  - 60
  - 50
  - 40
  - 30
  - 20
  - 10
  - 0

- **Total Waste Disposed**: TONS
  - 100
  - 90
  - 80
  - 70
  - 60
  - 50
  - 40
  - 0
information needed to support continuous improvement and gain competitive advantage. It is an external focus of internal activities, functions or operations in order to achieve continuous improvement (see McNair and Leibfried, 1992, p.1). It is a process of measuring product, services and practices against the toughest competitors and leading companies in the industry.

A framework for benchmarking is presented in figure 4.9 (McNair and Leibfried, 1993, p. 38).

**Figure 4.9: The benchmarking framework**

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identity core issue</td>
<td>- Unmet customer needs</td>
</tr>
<tr>
<td></td>
<td>- Performance gap</td>
</tr>
<tr>
<td></td>
<td>- Problem areas</td>
</tr>
<tr>
<td></td>
<td>- Strategic advantage</td>
</tr>
<tr>
<td>Internal baseline data collection</td>
<td>- Overview of process</td>
</tr>
<tr>
<td></td>
<td>- Current measures</td>
</tr>
<tr>
<td></td>
<td>- Potential drivers and external organizations</td>
</tr>
<tr>
<td></td>
<td>- Benchmark questionnaire</td>
</tr>
<tr>
<td>External data collection</td>
<td>- Compare and contrast benchmark data</td>
</tr>
<tr>
<td></td>
<td>- Implementation plan</td>
</tr>
<tr>
<td></td>
<td>- Issues</td>
</tr>
<tr>
<td>Analysis</td>
<td>- External company(s)</td>
</tr>
<tr>
<td></td>
<td>- Process analysis, performance assessment and measures</td>
</tr>
<tr>
<td>Change implementation</td>
<td>- Gap</td>
</tr>
<tr>
<td></td>
<td>- Process improvements/reengineering opportunities</td>
</tr>
<tr>
<td></td>
<td>- New flows, policies, procedures</td>
</tr>
<tr>
<td></td>
<td>- Implementation plan</td>
</tr>
<tr>
<td></td>
<td>- Outstanding issues</td>
</tr>
</tbody>
</table>

Thor (1993, p.2) distinguishes “strategic benchmarking”, when business units are compared with competitors' performance, from “operational benchmarking” i.e. comparing business processes. The first comparisons need to be in words rather than numbers.

The benchmarking provides the following types of data:

- financial comparisons;
- personnel by functions, type and location;
- development cycle times; and
- quality and service performance.

It also provides an insight into the gaps between the status and objectives, builds the basis for recommendations or changes and improvements, and helps the executive to focus on what should be done and what kind of strategic decisions should be taken.

One point that distinguishes benchmarking from the traditional IFC is that benchmarking deals not only with financial data, but also with the improvement of product design, and of the manufacturing of the product by selecting the best features and approaches of competitors.

One of the most important benchmarking principles is to provide a distinction between the following levels of performance:
- current level;
- next level;
- leadership;
- today's world class; and
- tomorrow's world class.

This methodology makes it possible to differentiate between the performance of a superior and an average company in an industry. It challenges companies to determine how answers from a benchmarking effort will be translated into actionable items.

A good example of benchmarking competitor ratings is provided by Werner Kreuz (1992, p.5).

The starting-point of this top-down benchmarking approach was an assessment of the technical, product and business know-how of the top ten players in the market (see example, figure 4.10). This subjective rating done by executives of all key competitors made it possible to obtain a quick overview of the perceived importance the big players had gained in the market - based on the judgement of industry experts. In addition, the "market opinion" could be matched with an internal ranking of such critical success factors as product application, product reliability, delivery time, service, perceived relative pricing, product training, product range, quality of sales force, image and advertising. The best thing is about such ranking is that it is made by internal specialists and customers at the same time. It makes it possible to place a strategic emphasis on those critical success factors perceived as important by the customers and on closing the performance gaps to major competitors.

Similar benchmarking could be done in such areas as technology, costs, etc. When dealing with costs benchmarking, A.T. Kerney uses the following steps:

1. Develop unit cost claim for selected products.
2. Separate cost sub-elements.
3. Identify key cost drivers.
4. Analyse competitor data.
5. Discuss with internal and external experts.
6. Compare the results with the competitor cost sharing.

An example of the result of the final step 6 is shown in figure 4.11.

The conclusions to be drawn from this benchmarking example are obvious. The key factor for low unit costs was the degree of outsourcing which was reflected in the higher amount spent by competitors A and B for purchased material as well as in the high raw material and manufacturing cost of the client. The key factor for the market success seemed to be the R & D effort, which was - despite lower total costs - significantly higher for the two leading competitors. An advantage of cost benchmarking through cost chains and cost-driving factors is that it makes it possible to calculate the effect of increased volume or alternative processes on unit cost. Companies who have conducted benchmarking studies agree that benchmarking makes managers more sensitive to strategic resource and performance requirements, and creates broader acceptance of the rationale for change as well as motivation and commitment to its implementation. Benchmarking also assists in strategic decision-making through better assessment of market attractiveness.
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Figure 4.10: Competitor ratings on technical, product and business know-how
(average scores of ten interviews)

<table>
<thead>
<tr>
<th>Key players</th>
<th>Key result areas for powerful performance</th>
<th>Total score</th>
<th>Overall ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technical know-how</td>
<td>Product know-how</td>
<td>Business know-how</td>
</tr>
<tr>
<td>A</td>
<td>★★★★★★</td>
<td>★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>B</td>
<td>★★★</td>
<td>★★★★</td>
<td>★★</td>
</tr>
<tr>
<td>C</td>
<td>★★★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>D</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>E</td>
<td>★★★★★★</td>
<td>★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>F</td>
<td>★★★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>G</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>H</td>
<td>★★★★★★</td>
<td>★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>I</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Client</td>
<td>★★★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
</tbody>
</table>

Low cost producer | Product focus | Channel control | Performance | Power

COST PREMIUM REVENUE

Figure 4.11: Comparisons with competitor cost chain
driving factors, evaluation of key technologies and required innovations, identifying critical resources and cost factors as well as needs for change.

Questions for discussion

1. What are the common and different features between other approaches to productivity assessment discussed in this unit and TFPM?
2. When can you use a quick way to assess productivity? What are the positive and negative sides?
3. Why do more and more companies use a “family” of measures of organizational performance, not merely productivity?
4. When it is useful to use IFC and benchmarking?
BIBLIOGRAPHY

American Productivity Center: *Total productivity measurement gaining use in diagnosis, screening or corporate performance*, newsletter (Houston, Texas, Jan. 1985).

Asian Productivity Organization: *Corporate culture and productivity: Case studies in Asia and the Pacific* (Tokyo, 1994).


Lester, R.K.: *Global cooperation and productivity for mutual consultancy and learning* (Tokyo, Japan Productivity Center, 1994).


MODULE 5

DESIGNING A COMPANY PRODUCTIVITY IMPROVEMENT PROGRAMME

(PIP)
MODULE 5: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand and explain the need for PIPs in productivity and quality improvement.
2. Identify the main reasons for introducing a PIP, and its main objectives.
3. Be aware of the different kinds of PIP and take an active part in their design.
4. Negotiate and discuss PIP issues with external and internal consultants.

MODULE 5: CONTENTS

UNIT 1: How to start a PIP
UNIT 2: Definition of programme aims
UNIT 3: Setting up the steps of the PIP
UNIT 4: Common elements of the PIP
UNIT 5: Designing the different kinds of programme
UNIT 6: Summary
UNIT 1: HOW TO START A PIP

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and explain the nature of a PIP, and its difference from conventional management.
2. Identify and explain the main (typical and specific) reasons for initiating a PIP in a company.
3. Be aware of the main potential areas for savings, productivity and quality improvement through a PIP.

UNIT 1: CONTENTS

1.1 Why start a PIP?
1.2 The major reasons for starting a PIP
1.3 The main potential areas for PIPs
UNIT 1: HOW TO START A PIP

1.1 Why start a PIP?

Managers have the permanent task and responsibility of improving the performance of the systems which they manage, and, this being so, it could be argued that there is no need to carry out a specific programme for productivity and quality improvement. In fact, PIPs have proved to embody a very successful approach, since changes in the business environment and technological innovations may call for some dramatic restructuring rather than merely fine-tuning existing systems. A PIP embraces many areas and system elements, using the project management approach and providing better optimization and horizontal integration.

1.2 The major reasons for starting a PIP

There are many reasons for beginning a PIP, for instance:
- financial losses;
- new products;
- new equipment;
- new technologies;
- new materials;
- introduction of computerized information technology;
- stronger competition;
- demand for more flexibility in production;
- demand for higher quality; and
- the fact that an organization has not introduced a PIP for a number of years, so that inefficiency may well have been increasing.

The decision to start the PIP should be taken as for any other investment: i.e. the cost of the investment needs to be compared with the benefit and the risks. A PIP should normally show profitable results in less than one year.

1.3 The main potential areas for PIPs

In deciding whether to invest in a PIP, the first step must be the identification of potential savings. The best way is to look for the major outputs and the most costly items.

Usually, large potential savings are directly related to product costs: the consultant should take the “products” with the highest output and look into their cost elements, such as material, value added per production area, tooling, design cost, overhead cost and distribution cost.

After having identified a good reason for a project and after finding out where the areas for large potential savings might be, the framework for the PIP has to be drawn up. Table 5.1 shows the typical main areas of responsibility of a company and the six different approaches for a PIP. As can be seen from the table, no part of the PIP touches only one functional area.
If, for example, the reason underlying a PIP is the implementation of new software for material requirement planning (MRP) and if the potential savings come from rationalization by software application and new methods of work, a PIP project will have to cover the whole administration in the area of materials management, part of finance and administration (accounts payable) and part of personnel administration (direct wages) (see table 5.1, item 3).

In identifying the right PIP approach, three steps should be followed:

1. Find a reason for starting a PIP, which will make it easier to commit people to the programme.
2. Carry out an analysis over one or two days to identify where the potential savings are to come from, what the value of the potential savings is and what risks have to be taken to obtain these savings.
3. Draw up the framework for the PIP:
   - by concentrating on those areas from which most of the potential savings will come;
   - by making sure that managers who make major decisions are convinced; and
   - by covering those elements and functions in the organization which can facilitate or hinder the achievement of results.

### Table 5.1: Potential areas for a PIP

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<tbody>
<tr>
<td></td>
<td>Analysis phase</td>
<td>Implementation phase</td>
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<tr>
<td>Sales and marketing</td>
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<tr>
<td>Finance and administration</td>
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<tr>
<td>Materials management</td>
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<tr>
<td>Personnel administration</td>
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<tr>
<td>Design and development</td>
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<tr>
<td>Production</td>
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</tbody>
</table>

Ranking of the organizational measures by intensity:

- **Rough**
- **Detailed**
- **Very detailed**

Table 5.1 also indicates the degree of intensity of different measures and the efforts which should be allocated to different areas with the highest and lowest intervals, depending upon the approach adopted.
Questions for discussion

1. What is a PIP, and why it is unlike conventional management? What is the main advantage of a PIP?

2. Discuss the main reasons for starting the PIP. Relate them to your company’s experience. Try to list your company’s problems which could be important enough to initiate the PIP. Compare your experience with that of your group members.

3. Identify and discuss the main potential areas for savings and productivity and quality improvements mentioned in this unit. Relate them to your company’s situation, and compare them with the conclusions of other group members. Identify common potential areas within the group; try to place them in order of priority.

4. How do the main potential areas of the PIP relate to the functional areas of your company?
UNIT 2: DEFINITION OF PROGRAMME AIMS

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Know and explain the main approaches in the selection of PIP aims.
2. Set up PIP aims for companies requiring revitalization or turn-round measures.
3. Set up PIP aims for companies to benefit from economies of scale production.

UNIT 2: CONTENTS

2.1 Main approaches in aims identification
2.2 Defining the aims of a PIP for turn-round management
2.3 Defining the PIP aims to benefit from the experience curve
UNIT 2:  DEFINITION OF PROGRAMME AIMS

2.1 Main approaches in aims identification

The results of a PIP may be seen in changes in the cost/output relationship, depending on which strategy has been adopted (see figure 5.1).

- higher output with a cost increase that is less than the output increase;
- higher output with less cost;
- same output with less cost; and
- lower output with even lower costs.

Figure 5.1: The cost/output relationship

Higher output can be measured quantitatively (more products) or qualitatively (higher or better services resulting in higher prices). At the start it has to be clear in which direction the results of the project will move.

If it is necessary to reduce cost, the project should be organized in such a way that decisions will be taken to eliminate cost factors or capacities which will become redundant. It is essential that the aims of the programme be translated into results.

Three approaches are possible in the aim to improve productivity (see figure 5.2). These approaches can be applied in all forms of PIP, in production as well as in services.

Where a high proportion of costs cannot be related to direct saleable output, Approach A will apply. Before starting with this approach we have to look carefully at all indirect and overhead tasks in order to analyse which of them can be related to direct output (for example, maintenance cost to machine running hours, or finance administration cost to number of invoices): for these tasks Approaches B or C would be applied.

Approach A, in general, is a value analysis approach. For each function, task or asset or indirect cost the question: "Is it necessary and what are the risks in eliminating it?" is asked. This approach, generally speaking, requires decision-making rather than organizational changes.
Approach B is the industrial engineering approach for rationalization. It aims to lower unit cost by:

- reducing waste;
- reducing material per unit;
- reducing handling per piece or per order;
- combining workstations;
- reducing administrative steps;
- controlling the process; and
- avoiding any delays.

**Figure 5.2: Three approaches to improve productivity**

Direct cost: all costs related to output (material cost per unit)

Indirect cost: infrastructure (building, rent, fixed assets, indirect functions)

Units of output: product, invoice, shipment, order line, any saleable work

Approach A: cut assets and indirect functions, tasks

Approach B: reduce cost per unit (waste of material, handling cost, etc.)

Approach C: reduce numbers (e.g. 10 per cent final cheque instead of 100 per cent)
To get an idea of the cost-saving potential of this approach, we can use the "economy of scale" formula: when output is doubled, the potential for savings is at least 10 per cent (if no extra measures are taken; if output is doubled again there is a further 10 per cent cost reduction, and so on).

Approach C brings the best results in many projects, and these results can be significant and achieved quickly.

The approach is simply to reduce numbers: for example, the number of tasks, orders or operations. To define the aims of the PIP, one looks for the numbers, meaning that a higher saving potential can be found with a larger number of goods, operations, actions, etc.

This approach requires answers to questions such as:

- Can the quality control of all pieces of output (100 per cent control) be turned into a sampling operation (statistical control)?
- Can the control operation on all pieces of output be turned into an automated in-process control?
- Can order confirmations to customers be avoided, if incoming orders are despatched the same day, or the following day?
- Can incoming goods partly bypass the stores, going directly into the production area, avoiding stores handling?
- Can production output partly bypass the warehouse, being shipped directly to customers?

In defining the aims of a PIP, the initial statement is

\[ \text{Spend less! Sell more!} \]

The project team has to know from the beginning of the programme (and before individual projects are delivered) whether the PIP aims only at "spending less" or at achieving extra capacity which can be "sold", or whether it aims at both.

In the first stage productivity and quality improvement bring idle capacity of both staff and facilities. For the second stage it must be clear from the beginning whether the idle capacity can be used for additional output, which can be "sold", or whether the more difficult objective of cutting idle capacity, reducing costs and spending less is to be aimed at.

Already at the design stage of a company PIP, one has to define the potential areas for attention and to express the aims in quantitative terms. Examples of the range of quantified aims for the three approaches to improve productivity are shown in table 5.2.
2.2 Defining the aims of a PIP for turn-round management

Of the many reasons for starting a PIP, the most urgent one is when, owing to substantial losses, the survival of the enterprise is threatened.

Designing a PIP for a company that is in the red and defining aims for individual projects implies that productivity must be improved sufficiently to put the bottom-line figures into profit again. For example, we can consider the case of a company producing heavy machinery for the paper industry.

2.2.1 Case study: PH Machinery Company

In order to define the aims for a PIP, a survey consisting of interviews with management, a site visit and an analysis of sales and cost data has to be carried out as a first step. Some characteristic data are explained in the following tables.

Table 5.3 shows the progress of a company’s results over four years. As can be seen, the company experienced constant losses with their maximum in 1991 (15.7 per cent). Losses remained at a high average level of over 9 per cent in relation to sales.

<table>
<thead>
<tr>
<th>Approach</th>
<th>Aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Reduce indirect cost by 15% - 20%</td>
</tr>
<tr>
<td></td>
<td>Reduce direct cost by 10%</td>
</tr>
<tr>
<td></td>
<td>Reduce direct cost by 15% - 30%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5.2: PIP aims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>A</td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
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<tr>
<td>B</td>
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<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td>C</td>
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<tr>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5.3: Economic results for 1990-93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
</tr>
<tr>
<td>Loss</td>
</tr>
<tr>
<td>Cost</td>
</tr>
<tr>
<td>Loss as percentage of sales</td>
</tr>
</tbody>
</table>
Additional information could be obtained by looking into the cost distribution. The data in the “Costs” column of Table 5.4 can be used to construct a break-even diagram.

**Table 5.4 Distribution of sales and costs by item**

<table>
<thead>
<tr>
<th>Sales (millions of US$)</th>
<th>Costs (millions of US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machines</td>
<td>42</td>
</tr>
<tr>
<td>Tools</td>
<td>16</td>
</tr>
<tr>
<td>Spare parts</td>
<td>8</td>
</tr>
<tr>
<td>Total sales</td>
<td>66</td>
</tr>
<tr>
<td>Loss</td>
<td>7</td>
</tr>
<tr>
<td>Total cost</td>
<td>73</td>
</tr>
</tbody>
</table>

Looking at the company’s cost/revenue ratio using a “break-even” analysis shows clearly that an increase in sales cannot be the right therapy: today’s break-even point is US$123 million annual sales, and to achieve this figure would mean doubling today’s sales and keeping all overhead costs fixed.

The break-even chart shown in Figure 5.3 takes into account the fact that all material costs and all personnel costs are variable and that only depreciation and finance costs are fixed.

To turn the company round, the PIP must bring down the company’s break-even point to US$60 million at the most, which would mean no losses at the present sales level of US$66 million.

**Figure 5.3: Break-even analysis (before PIP)**
Following this break-even analysis, we have to look into ways of reducing both fixed and variable costs.

2.2.2 Looking at potential areas for improvement

Our examination of the data has already revealed some potential areas for productivity improvement. These potential areas have to be highlighted by the analysis made in Phase 1 of the PIP, and calculated and checked in detail before starting to design the PIP.

In our example the potential areas of improvement are as follows:

- Guarantee and liability expenditure. An expenditure of more than US$3 million per annum for guarantees and liabilities on sales of US$40 million is extremely high (2 per cent of sales is already a bad figure). The project aims to reduce this expenditure by at least US$2 million.
- Machine capability. The low margin of the machine sales indicates that the capability of the machines given to customers is high, as they are willing to pay for it, and probably higher than is needed. Therefore, another aim of the project is to reduce the functions built into the machines, by about 10 per cent. The aim is 10 per cent less cost at the same prices. Based on US$40 million annual sales, the potential saving is US$4 million per annum.
- Material cost. The biggest single item of expenditure in the company is US$36 million for materials. Two potential areas should be explored:
  - by renegotiating the source of materials and concentrating on “just needed quality”, a 4 per cent reduction on the supply cost of US$36 million could be reached: this would save about US$1.5 million per year; and
  - the increase in capacity gained through productivity improvements could be used for the in-house production of those goods which are supplied from outside, or to increase sales.
- Labour productivity improvement. Expenditure on personnel is the second large potential area for savings. The aim in this project must be an improvement in labour productivity of 10 per cent, which should result in savings of 10 per cent in personnel expenditure, i.e. US$2 million.

2.2.3 Overall concept

The first rough definition of the aims for the project does not take into account many other potential areas such as distribution cost, capital cost, depreciation of stocks, etc. The target results for this project are calculated for the four areas mentioned above: table 5.5 illustrates potential savings, broken down by material and personnel expenditures.
The defined aim of improving profit by US$9.7 million per year can already be met by implementing the measures described so far. As there are additional areas for potential productivity improvement inside the company, which will be analysed during the programme, turning round the PH Machine Company within two years seems to be a very realistic aim.

Given these figures, it is realistic to aim for a break-even point of US$55 million annual sales. With sales of US$66 million, as in 1993, the profit would then be US$3 million. Therefore, it is suggested, a 5 per cent profit on given sales may be aimed at through the above-described measures. A higher profit rate may be reached later by company growth, keeping the break-even point at US$55 million as shown in figure 5.4.

<table>
<thead>
<tr>
<th>Potential area (millions of US$)</th>
<th>Material</th>
<th>Personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guarantee and liability expenditure (&gt;3)</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Machine capability Machine design (10% of 40)</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Material expenditure (4% of 36)</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Productivity improvement (10% of 22)</td>
<td></td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4.5</strong></td>
<td><strong>5.2</strong></td>
</tr>
</tbody>
</table>

The defined aim of improving profit by US$9.7 million per year can already be met by implementing the measures described so far. As there are additional areas for potential productivity improvement inside the company, which will be analysed during the programme, turning round the PH Machine Company within two years seems to be a very realistic aim.

Given these figures, it is realistic to aim for a break-even point of US$55 million annual sales. With sales of US$66 million, as in 1993, the profit would then be US$3 million. Therefore, it is suggested, a 5 per cent profit on given sales may be aimed at through the above-described measures. A higher profit rate may be reached later by company growth, keeping the break-even point at US$55 million as shown in figure 5.4.
2.3 Defining the PIP aims to benefit from the experience curve

One of the best examples proving that productivity improvement potential can be drawn from the experience curve is the electronic calculator, which today costs just 0.5 per cent of its price around 20 years ago. And the only companies to survive in producing electronic calculators were those that applied the economy of scale and improved productivity by following the experience curve. The experience curve rule (the same as the learning curve rule) says that with each doubling in the number of items produced, there is a potential rise in productivity of about 15 per cent. For example:

<table>
<thead>
<tr>
<th>Cumulative number of pieces produced</th>
<th>Cost per piece (in US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 000</td>
<td>1.00</td>
</tr>
<tr>
<td>2 000</td>
<td>0.85</td>
</tr>
<tr>
<td>4 000</td>
<td>0.72</td>
</tr>
<tr>
<td>8 000</td>
<td>0.61</td>
</tr>
<tr>
<td>16 000</td>
<td>0.51</td>
</tr>
<tr>
<td>32 000</td>
<td>0.43</td>
</tr>
<tr>
<td>64 000</td>
<td>0.36</td>
</tr>
<tr>
<td>128 000</td>
<td>0.30</td>
</tr>
</tbody>
</table>

As the numbers increase, the economy of scale effect becomes higher and higher. And this effect applies everywhere. The next case provides a good illustration.

2.3.1 Case study: UTM United Tool Manufacturer

The company's situation. UTM produces and sells a wide variety of tools for professional use. The company, with more than 300 employees, has more than 100 years of tradition and experience. As it concentrates on a few major products, it almost resembles “craft manufacturing”. Especially in the forging department and in mechanical equipment, there has been no visible major technological development for many years. Instead of investments in productivity improvement, large investments were made in erecting buildings for stocks and offices.

Production is batch oriented; there is no flow orientation. There is a high volume of work in progress, and production control is costly. The efficiency of mechanical engineering is low, because it has to handle too many products in small batches.

The export of goods is becoming more difficult because of low margins, and competition, from developing as well as developed countries, is increasing.

But there are three promising product groups where UTM has a good share of the home market and a good reputation for quality. Concentrating on these products, and using the opportunities from the experience curve, opens the way for a successful PIP. The three main product groups already account for about 65 per cent of total production output.

Definition of aims. It is suggested that UTM should continue to offer its customers the complete range of tools for professional use. Those product lines with low volume, however, will have to
be cut, and these products should be purchased rather than made, because the possibilities of cost-effective productivity improvement are low. On the other hand, for the main product lines the manufacturing costs have to be substantially reduced, so that even at lower sales prices the margin will be acceptable. The strategy is to gain an extra share of the market through low prices and also to supply these products to those competitors who cannot replicate such economies of scale.

A preliminary survey by the consultants indicated that in all three main product lines there had been no significant changes or reductions in operations, operating time, routing plans and materials. The product costs were the same as before, when half of today's cumulative production was reached. Therefore, the project aimed at a 15 per cent cost reduction. At the same time a PIP had to aim for the next 15 per cent cost reduction, which had to come from the next doubling of cumulative output. This point could soon be reached by concentrating on the top three products, following the strategy outlined above.

As a reduction of product costs by 30 per cent may require larger investments, the project team should first look for opportunities to increase productivity which do not need large investments in equipment. Therefore, the aim of the project will be limited to a reduction of product costs by 20 per cent for the three main product lines.

To reach this overall aim three strategies should be pursued:

**Strategy A.** By analysing all tasks in the area of indirect costs which can be related to the product range, identify that proportion of indirect costs which can be saved by discontinuing all small volume products. Use the capacity set free in production preparation and product development to improve productivity of the main product lines.

**Strategy B.** By analysing product design and all production operations, identify the unused opportunities for productivity improvement, provided by the rules of the experience curve. For example, from one piece of raw material in a double die the two parts of a pair of pliers can be forged in one stroke, doubling the output and using less raw material per part; also, at the burr-removing machine the output can be doubled (the new double die and double tool for burr removing pay off because of the higher number produced).

**Strategy C.** By analysing the positive influence of a streamlined product range on all direct capacity units, the capacity gain will be identified. Production capacity can be gained because there are fewer set-ups and fewer production tools to be maintained, as well as fewer control and transport operations. Capacity gains have to be used to increase output or to cut direct costs.

Following this strategy will lead in the first stage to free capacity to be used in the PIP and in the second stage to an actual productivity improvement of at least 20 per cent.

**Questions for discussion**

1. Discuss the major objectives of the three approaches (A,B,and C) in productivity improvement. Is it better to use them separately or in combination? Explain why.
2. What are the main differences between the turn-round management and experience curve approaches? How would you decide which approach to use?
UNIT 3: SETTING UP THE STEPS OF THE PIP

UNIT 3: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Know the three main PIP phases and explain their purpose.
2. Identify the main PIP steps (within the three phases) and the time framework.

UNIT 3: CONTENTS

3.1 The main PIP phases
3.2 PIP steps in the “Royal Road”
UNIT 3: SETTING UP THE STEPS OF THE PIP

3.1 The main PIP phases

When designing a company PIP we have to bear in mind that results must become visible in less than one year. The rule is that a typical lead time for a PIP is about nine months.

If a PIP already in the design phase seems to have become too large and too long, the programme has to be broken down into different smaller programmes. Very often this occurs in the implementation phase of the programme.

The chart “Steps of a PIP” (figure 5.5) shows that the programme is always designed in three phases:

Phase 1: The Survey phase, to identify aims and to sell the programme to management.

Phase 2: The Analysis phase, to select certain goals and secure the commitment of area managers to the project.

Phase 3: The Implementation phase, to design and develop the performance improvement tasks in detail, to implement the measures for improvement and to check the results.

The lead times for each phase, given in the chart, should be seen as empirical rules when designing the PIP.
Figure 5.5: Steps of a PIP

PHASE 1: PIP SURVEY
- identify the right approach
- define the programme's aims
- design the programme's tasks
- define the areas to cover
- design the project organization
- schedule the programme

PHASE 2: PIP ANALYSIS
- inform all participants
- collect data
- describe the basic situation
- agree on a reference period
- analyze potential goals
- design rough concepts
- design detailed programmes
- set up task forces
- schedule implementation
- report on anticipated results

PHASE 3: PIP IMPLEMENTATION
- inform all participants
- set up programme controls
- implement measures
- get results
- report on results obtained
- implement next measures

MAINTAIN HIGH PERFORMANCE
To run a successful PIP it is absolutely vital to get management involved in the decision-making process of the project. By putting "stop/go"- decision milestones in the programme after each main step, management should become very much involved in the decisions on:

- direction to follow;
- aims to go for;
- results to aim at;
- changes to introduce; and
- investments to make.

3.2 PIP steps in the "Royal Road"

The chart "Royal Road for a PIP" (figure 5.6) shows which activities have to be carried out, in which sequence and where to put a decision milestone. By following this Royal Road there are at least two decision milestones in each phase of a PIP.

All reports given by the project team to management are focused on the decision-making process. This aspect makes it easy to understand which data have to be collected and checked and in which way measures for productivity improvement have to be presented: as basic information, preparing decisions for results.

The project team of a PIP prepares the decisions, the management decides on the results of a PIP. The programme design has to support this process. A similar Royal Road designed for Phase 3 of a PIP leads to the implementation of performance improvements (see Module 6, "Implementing a company productivity improvement programme (PIP)").
Figure 5.6: Royal Road for a PIP, Phases 1 and 2

Listen carefully to problems
Identify the approach for a PIP
Define the aims
Have management decide on PIP approaches and aims
Design the programme
Define areas to cover in specific projects
Organize the task force
Schedule the programme
Have management decide on the PIP design
Inform all management staff affected by the PIP
Inform all staff involved in the PIP
Collect data
Check all information
Define a "reference period" to calculate results
Agree on data and reference period
Analyse potential for performance improvement
Define the measures for change, following the approaches A, B and C
Design the concept for performance improvement
Define the goals
Design the programme(s) projects for implementation
Have management decide on the implementation of the PIP
Follow "Royal Road" for the implementation (Phase 3)
Questions for discussion

1. Discuss the main phases of the PIP, to make sure that everybody understands and agrees with their roles, and the sequence of operations. Try to find out the reasons for breaking down a PIP into these specific phases.

2. Discuss the steps of the PIP for Phases 1 and 2 and try to find out if some of them are unnecessary or if some of the steps are missing. Why is it suggested that certain steps be given priority? What are the main activities in each phase?

3. What are the main characteristics of the Royal Road?

4. What is the ideal duration of a PIP and why?
UNIT 4: COMMON ELEMENTS OF THE PIP

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Point out common elements of any PIP programme design and explain their functions and roles.

2. Plan and schedule the main PIP activities.

3. Understand and explain the PIP organizational framework and coverage.

UNIT 4: CONTENTS

4.1 Common elements in programme design

4.2 Programme phases

4.3 Programme coverage

4.4 Programme organization

4.5 Preparing to start the programme

4.6 Analysis

4.7 Concepts
UNIT 4: COMMON ELEMENTS OF THE PIP

The major steps of a PIP are in general the same for each programme, and when designing a programme you should follow the Royal Road (figure 5.6) shown above. But there are many ways of starting a programme. Table 5.1, “Potential areas for a PIP”, provides six approaches.

The main difference between these various approaches is in the detail needed to carry out the survey and in the degree of detail with which changes of operations or changes in the organization have to be planned to achieve significant productivity increases. Another aspect in which the functional areas of a company become involved is Approach 1 (Revitalization) and Approach 6 (Overhead cost-cutting programmes). Table 5.1 covers almost all areas of a company’s structure. Therefore, the approaches to analyse and to develop changes for performance improvement will merely skim the surface of problem areas, as otherwise such a wide field could not be covered in a single programme, within a reasonable time and with a manageable team.

But if the programme has to be run in a single functional area - e.g. one or two implementation programmes of a turn-round project - the approach to develop the changes needed for performance improvement must be very detailed. A case for such very detailed work in a PIP is given in Approach 3 (EDP project). In programmes like this, where only sub-areas are covered, operations and information flows have to be analysed in great detail.

How it is possible to design different PIPS that nevertheless have numerous points in common can be seen from the six examples provided in Table 5.1.

4.1 Common elements in programme design

Following Phase 1 (the survey phase) a programme is presented to management, covering seven main elements (table 5.6). These seven common elements are a “must” because management has to base its decision to start the PIP on each of these elements.

Table 5.6: Seven common elements of a PIP

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Definition of <em>programme phases</em></td>
</tr>
<tr>
<td>2.</td>
<td><em>Programme coverage</em></td>
</tr>
<tr>
<td>3.</td>
<td><em>Programme organization</em> (operation, control, decisions, etc.)</td>
</tr>
<tr>
<td>4.</td>
<td><em>Programme plan</em> (scheduling and plan capacities)</td>
</tr>
<tr>
<td>5.</td>
<td>Steps for <em>preparing the start-up</em></td>
</tr>
<tr>
<td>6.</td>
<td>Steps for <em>analysing</em></td>
</tr>
<tr>
<td>7.</td>
<td>Steps to develop the <em>concept</em></td>
</tr>
</tbody>
</table>
The programme as designed must be presented in a written proposal. This report is the basic document for all participating in the PIP. Therefore, all seven elements of the programme have to be clearly described in the report, which also has to contain all information on its organization. A general idea on how this information should be structured and how it can be presented to management is given below.

4.2 Programme phases

In the proposal report, this first element describing the programme has to make clear that to be successful the PIP needs a clear structure, including decisions to be taken after each step. It has to be shown that there will be a well-defined output at the end of each step on which the decisions can be based. As the proposal report is written and presented at the end of the survey phase, it is already the first tangible output for management and for those starting to run the project. The programme phases can be visualized as shown in figure 5.7.

Figure 5.7: Phases of a PIP

Aims
Programme
Proposal

Data
Reference period
Facts

Potentials
Measures for change
Concept for
Improvements
Commitments

SURVEY

Analysing

Improvement Planning

Improvement Preparation

Improvement, result, control

Phase 1, proposal report presented here
4.3 Programme coverage

Before a PIP is initiated, it has to be quite clear which parts of an organization will be concerned, so that everybody participating in the programme knows from the outset which functions are to be affected by the programme besides those which are directly involved.

A standard organizational chart can be used to clarify the programme coverage. Figure 5.8 gives a typical example of how to display the units involved.

![Figure 5.8: Project coverage](image)

4.4 Programme organization

It was already clear in Phase 1 who would be the sponsor of the PIP and who had to be involved in the decisions to be made during the whole programme. With the staff of Phase 2 the PIP should be broken down into a set of projects according to the analyses to be made or according to specific objectives (e.g. reduction of delivery lead time) or in relation to the functional units involved. A project organization has to be set up. An example of such a project organization is displayed in figure 5.9.
The managers nominated for the steering committee do not work directly on the project, but they have to take responsibility for the results of the PIP and must be in a position to make all decisions needed during the project. The steering committee could be made up of just one manager, but it should not have more than three members in order to be operational. A representative of the outside management consultants assisting with the PIP should also be part of the steering committee.

The project manager is nominated for the whole duration of the PIP. He or she must have had experience in project management. Therefore, an external management consultant is often nominated, who reports to the steering committee and prepares the decisions to be made. He or she is the head of the project group, defines and controls the activities to be carried out in the project and has the responsibility of meeting the aims set out in the survey phase.

The members of the project group have either to have experience from similar projects (consultants or industrial engineers) or to be trained to carry out the project activities. They must be able to spend at least half of their working capacity for project work during the whole PIP.

The activity teams are composed of members from the main areas to be surveyed. They must provide the know-how from their area, they should understand what is going on and later they will have to do much of the implementation work. They should be able to spend about 25 per cent of their time on the project work.
4.4.1 Programme planning and scheduling the PIP

At the end of Phase 1 (survey) a bar chart should be drawn scheduling the main activities or steps of the PIP and showing the capacity needed (in workdays), and setting the dates for presentations and decisions.

The rough plan, drawn on a single piece of paper, should show the lead time and the human resources needed for the PIP. A programme plan may look like that illustrated in figure 5.10. In this case the programme lasts, in all, for 30 weeks. The project manager is an external senior consultant, giving one-third of his individual capacity to the project (typically a senior consultant manages three projects of this type in parallel). The project group members are one full-time consultant and two half-time internal staff. The part-time capacity of the team members comes from five line managers. Knowing the sources of the project capacity needed, it is easy to calculate the staff cost of the PIP. When calculating the staff cost it is wise to add a 15 per cent reserve for unforeseen activities on top of the calculated workdays.

Figure 5.10: Sample PIP plan

<table>
<thead>
<tr>
<th>Activities</th>
<th>Schedule</th>
<th>Work Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHASE 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre Survey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHASE 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare start-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inform</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collect data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Define reference period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyse potentials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Define measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decide implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHASE 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference period report</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminate project</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

W = Week  P = Project manager  
G = Project group  T = Project teams
4.5 Preparing to start the programme

The activities of a PIP need to be given high priority by all involved in the programme. To make this happen and to obtain the results aimed at, the sound preparation of the programme start-up is a key success factor. A checklist for these preparation activities is shown in figure 5.11.

**Figure 5.11: Preparation of start-up programme**

- Restate aims to communicate objectives of the programme
- Nominate members of the project group
- Nominate members of the activity team
- Organize all facilities needed for the project group
- Schedule programmes/projects in detail
- Prepare the mentor (speaker) of the steering committee for the initial meeting
- Have an initial meeting

All those nominated to take part in the programme must be invited to the initial meeting, together with all departmental managers and the foremen of all cost centres directly or indirectly affected by the project. The responsible members of the works council or company unions must also be invited. *The more communication there is from the beginning, the fewer the awkward questions and resistance that have to be overcome during the PIP.*

4.6 Analysis

When Phase 2 is designed, information is already available from the survey on as regards which data, operations and information flows have to be analysed and in how much detail; also, the analysis tools to be used should have been determined. For this step in a PIP we have to design a “vehicle” to drive along the Royal Road of a PIP. But there is a basic design which all vehicles have in common. Figure 5.12 shows the main activities of this part of the programme.

**Figure 5.12: Analysis**

- Define the “productive output”
- Classify the “cost input”
- Classify material input
- Classify operations input
- Collect relevant data
- Cross-check data
- Find and define weakness
- Define a representative reference period
The analysis has to be designed in such a way that the members of the project group obtain a sound understanding of the main factors influencing the cost or the quality of output as well as productivity. Data have to be collected in such a way that the effect of improvement measures can be easily calculated.

Good common tools to think about when designing the programme for the analysis steps include all kinds of Pareto (A, B, C) analysis and all kinds of flow analysis, such as operations flow, material flow, information flow and also material utilization analysis (waste factors) per operation. (For methods and techniques to be used, see Module 10, “Industrial Engineering Techniques”.)

We must be aware that we cannot design a programme which automatically leads to performance improvement. But one can design a step-by-step programme which helps to discover the potential for improvement. The project manager or the experienced member in the project group will have to ask questions such as:

- What could the highest possible material utilization be (theoretically or best example)?
- Which could be the fastest flow? What are the reasons for each step in a process, and can any be eliminated?
- Which operations can be bound together (or centralized)?
- Which operations are standard, and which are additional (caused by what)?

Answering these questions by using the data from the analysis makes it possible to visualize improvement potential. When answering the next question, “How can all factors hindering the highest possible performance be eliminated?”, the experience of the project manager, combined with the know-how of the team members, is needed to define the necessary measures. To make this major step a successful one, the project group and the activity teams have to work together with an open, creative attitude.

4.7 Concepts

The most common activities in the conception phase of a PIP are shown in figure 5.13.

Figure 5.13: Concepts

- Define ideal solutions
- Compare ideas to present
- Redefine aims
- Calculate potentials
- Define measures of improvement
- Design a master concept
- Plan activities for realization
- Prepare an implementation plan
- Check anticipated results against reference period data
Questions for discussion

1. Why is it important to know the common elements in the programme design, when applying them to specific cases?
2. Have a brainstorming meeting to see which other elements could be added. Perhaps some elements should be eliminated instead: if so, why?
3. Discuss the place of the seven elements in the whole design and implementation of the PIP.
UNIT 5: DESIGNING THE DIFFERENT KINDS OF PROGRAMME

UNIT 5: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and explain the framework of the PIP design for different areas: turn-round management, production, electronic data processing (EDP), product development, logistics and cost cutting.

2. Put this knowledge to practical use in designing a PIP.

UNIT 5: CONTENTS

5.1 Designing a PIP for turn-round management.
5.2 Designing a PIP in production
5.3 Designing a PIP around an EDP project
5.4 Designing a PIP in the area of product development
5.5 Designing a PIP in the area of logistics
5.6 Designing a PIP to cut costs
UNIT 5: DESIGNING THE DIFFERENT KINDS OF PROGRAMME

5.1 Designing a programme for turn-round management

5.1.1 Case study: PH Machine Company

In Unit 2.2 ("Defining the aims of a PIP for turn-round management") the case of the PH Machine Company was taken to show how project tasks can be described in a proposal as a result of a survey (Phase 1). Following this case of a PIP for turn-round management, we shall see that the programme proposed to the management was conceived in very much the same way as the approach described in this Module. The programme, however, has to take into account the urgent pressure for change, especially when the survival of the company is threatened. In the following pages the programme design will be described. Already when designing the programme, which has fairly quickly to stop the company from making losses, we have to consider two points:

- At the end of Phase 2, the improvement plan must prove that productivity can be raised (with a high probability of reaching the anticipated results) high enough to bring the company quickly back into the black; otherwise the project manager has to force a decision to shut down the business, if there is no realistic way to reach the avowed goal.
- The implementation plan, Phase 3, will consist of five to ten subprojects, which have to be handled in parallel.

The phases and their definitions follow the common approach described above.

Programme coverage. In this case of turn-round management the project had to cover all areas of the company’s organization to discover any areas of potential improvement and select five to ten potential cases bringing speedy improvements to be implemented in Phase 3 of the PIP.

Project organization. In cases of turn-round management such as this, a top manager should act as head of the steering committee. In this case it was a major success factor to have the general manager of the parent and shareholder company in that position. At the end of Phase 2 it became obvious that part of the PH Machine Company’s management would not be willing and able to run the implementation phase of the PIP, with all that this entailed. After these managers were replaced, all the necessary decisions could be taken and the anticipated results were reached. This example shows how vital it is for a PIP to have a strong project organization and a powerful steering committee.

Scheduling the PIP. In general, a PIP should last for more than nine months. When designing a PIP to turn a company round, as in this case, one has to accept that it will take two years to have all the needed improvements made. But the PIP will only run successfully if significant results are achieved and communicated before nine months have elapsed.

In the PH Machine Company case the PIP was scheduled as follows:

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Survey</th>
<th>2 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 2</td>
<td>Analysis, diagnosis</td>
<td>5 weeks</td>
</tr>
</tbody>
</table>
Phase 3  Implementation, organized in
8 subprojects of which:
4 subprojects are finished within  9 months
2 subprojects are finished within  12 months
2 subprojects need more than  18 months

Start-up preparation. For turn-round management the activity plan is similar to that shown in figure 5.11. When designing and scheduling the programme, however, we should be aware of the weight that has to be given to preparing the objectives of the programme for communication. The results usually aimed at are very demanding, and therefore must be broken down into bearable objectives for individual sectors of the organization, showing a logical step-by-step approach and a realistic time schedule. This information has to be prepared in a way which is easy to understand; moreover, it has to be presented to different audiences (management, shareholders, works council). What will be communicated to whom has to be discussed with the steering committee.

Analysis. As the project covers the whole organization the analysis has to be very broad, yet not too detailed, because there is a limited lead time for this phase of the PIP. The activity plan for analysis for turn-round management of a machine company will consist of tasks similar to those shown in figure 5.14.

Figure 5.14: Analysis, PH Machine Company

- Analyse organizational structure
- Analyse the main information flows
- Analyse product structure
- Analyse resource utilization
- Classify material input
- Classify order results/losses
- Classify cost and analyse cost fluctuation
- Analyse position against competitors
- Find and define weaknesses
- Define a representative reference period

Concepts. In turn-round projects medical terms such as "diagnosis" and "therapy" are used when talking about improvement concepts to cure a seriously ill company. The activities covered by both terms are shown in figure 5.15.
5.2 Designing a PIP in production

5.2.1 Case study: UTM United Tool Manufacturer

For a long time the production area was the field of a company’s operation where potential PIP applications could be foreseen. Therefore, the common approach to designing a programme - as described in Unit 5.4 - is a good guide in this case. For a real example let us return to the case of the UTM United Tool Manufacturer (see Unit 2.3). The definition of the aims for the PIP were drawn from the experience curve in that case and it was agreed to aim at a 20 per cent improvement performance. Even in companies which have a well-equipped industrial engineering department and a permanent productivity improvement of 2 or 3 per cent per year, the extra effort of a PIP will result in an additional increase of about 10 per cent. To achieve this result some integrative aspects have to be observed already at the design stage.

Programme phases. The survey (Phase 1) of the programme has to be done in more detail than in common projects. One has to define where the results may come from, plan the activities in more detail and structure Phases 2 and 3 into sub- or parallel projects.

In the UTM case, one subproject had already to be defined for Phase 2: the improvement planning for the PIP in the production area was seen as being dependent on restructuring the product range and redesigning some products. The project phases were designed as shown in figure 5.16.

---

**Figure 5.15: Concepts, PH Machine Company**

- Find the factors which cause negative results
- Define opportunities to improve
- Classify improvement opportunities
- Select the ten most promising and realistic improvements
- Define by what measures the potential improvements become results
- Cast the measures into perhaps ten subprojects
- Design a master plan
- Calculate the improvements on a time schedule
- Check anticipated results against reference period data
- Propose and communicate the therapy (implementation programme)
Figure 5.16: Programme phases, UTM

Module 5
Unit 5

SURVEY

Phase 1

Analysis

Phase 2

Product range
Product design
Improvement planning

Production
Improvement planning

Phase 3

Improvement Preparation

Implementation
Product line A

Implementation
Product line B

Implementation
Product line C
In designing the programme coverage, the areas to be surveyed should include:

- accounting: the invoice checking group and the accounts payable group (those who were directly affected by the new system)
- purchasing: all supply order handling groups
- incoming goods area: the administration group
- personnel: the quality control group
- personnel: the administration group

By enlarging the coverage, after the introduction of the information system, five times more functions were included into the programme than were directly covered by the new system. The goal of the PIP was to reach 30 per cent higher savings than those claimed when starting the EDP investment.

In the standard project organization for the PIP the staff assigned were all different from those in the EDP project, except for the steering committee, where two of the three members were the same. The time schedule of the PIP had to follow closely that of the EDP project.

This meant that Phase 2 of the PIP had to be finished when the new software went into the testing stage and that the implementation of measures for performance improvement took place simultaneously with the application of the new software.

In the environment of new EDP applications a heavy start-up or initial meeting is not necessary. But the objectives of the PIP have to be communicated to all involved.

Planning the project activities. All steps of the elements in the programme such as, preparing start-up, analysing and concept development, can be taken from a common solution, following the general guidelines of the Royal Road (figure 5.6).

5.3 Designing a programme around an EDP project

EDP projects with investments in software and hardware are usually launched after an investment calculation showing a short payback time. Tremendous savings are promised. Installation often takes two years and longer; after that, nobody cares to harvest the savings promised, and usually no PIP programme is planned.

Most big EDP projects provide the chance to start a PIP where the results to aim for are already indicated, e.g. the specifications of the EDP project.

To make the PIP independent from the EDP project, it is necessary to enlarge its coverage compared with that of the EDP project. An example showing this is the installation of a big software package for "accounts payable" with automatic invoice control and automatic payment. Savings were planned for those two accounting departments, where invoices are checked manually and payments are released manually.

All information flows which carry information to invoice checking and to payment were included in the PIP. To check an invoice one needs the supply order (from the buying department),
the goods received notice from the incoming goods department and the invoice. Travel expenses forms prechecked by the personnel administration department are also recognized as invoices.

Programme coverage. As mentioned before, the success of a PIP in the production area is often dependent on an integrative approach. (One has to overrun "fences" - something that the industrial engineer, tied up in some organizational structure, is not able to do.) In the UTM case it was proposed to include in the main area to be surveyed - besides the whole production process - the design and drawing office and marketing (responsible for the product range). Material management was included as the secondary area to be surveyed, as well as the packing and dispatch area. This approach helped to track all potential improvements from the experience curve to the actual results. (For example, small changes in product design opened up the opportunity to apply new technologies in the forging department.)

Project organization. No special aspect: the common approach can be used.

Scheduling the PIP. Productivity improvement in the area of production usually goes along with some investment on new tooling or equipment. Long delivery times for machine tools and a shortage of financial resources may cause prolonged lead times for the PIP. Therefore, one has to design Phase 3 with the programme implementation consisting of two or more steps. In the UTM case all three projects for implementation (product lines A, B, and C) were planned to have three steps:

Step 1: based on minor modifications of tools and equipment
Step 2: based on new tools and new machine equipment
Step 3: based on new technologies (new forging equipment)

The three projects were planned to start with three months offset time. The whole programme was planned to take 27 months.

The element "Analysis" is quite specific in a PIP such as this, because the database is mainly related to information flows. An example of this part of the programme is shown in figure 5.17.

![Figure 5.17: Analysis](image)

The element "Concepts" can be designed as in a standard PIP. But the steps "Define the ideal solution" and "Compare ideal with present" should be planned already for each main information flow. Planning the activities for implementation has to be synchronized with the EDP project.
5.4 Designing a PIP in the area of product development

A PIP in product design and development does not aim at the lowest acceptable product cost; the tool to reach this is “value engineering” (see Module 10, “Industrial Engineering Techniques”). A PIP in this area aims at an increase of productivity in the process of product development. This means:

- getting more products developed from the same resources;
- reducing the time taken to market new products; and
- avoiding misdevelopment at an early stage.

The project will be phased in the usual way. It has to cover all departments involved in the product development process. Usually the main areas to be surveyed are the design and drawing offices, the testing department and the production preparation departments. Secondary areas to be surveyed are sales/marketing, the product-costing department and (sometimes) the purchasing department.

The project organization will be designed in the common structure, where one should try to bring the marketing manager into the steering committee, besides - of course - the design and development manager.

For Phase 2 the project plan should not exceed four months, as the implementation of the improvement concept (Phase 3) will take longer when a complex EDP system for development project planning has to be installed.

The start-up preparation is easy to design, because the results aimed at are easy to “sell”: more and better new products for the company to sell, without increasing development capacity.

When designing the analysis in this case we have to recognize some special activities (see figure 5.18) and a special tool, the RAIi Matrix, which is explained below.

**Figure 5.18: Analysis in the case of product development**

- Classify product developments (new, partially new, face-lift)
- Define a reference period for output
- Analyse hours taken up for product development, product maintenance, etc.
- Analyse the activity flow of the classified development processes
- Classify a sample of developed products (good or bad)
- Analyse decision points for “go ahead” or “stop”
- Find and define weaknesses in the development processes
A development process is characterized by tight decisions at the right point in this process and by the involvement of many individuals providing input or working together. To analyse this process the tool to use is a RAI Matrix (the letters mean: R, responsible for output; A, active in that step of the process; I, involved in that step of the process; and I, informed about the activity.

When analysing a product development process, one follows the whole process and records each activity, in sequence, from start to finish. For each group or individual in the development process and for each activity, a note is made of which person or group is R, A, I or I. Using this tool at the analysis step already makes clear where responsibilities should lie or if someone else should be made responsible for certain tasks.

When designing the concept for improvements, we can use a similar matrix as a tool. Potential for improvement can very often be found by looking carefully into the activities and capacity used for product maintenance (which is often done without proper control) and by looking into the processes for decision points (stop early before it is too late!); lead time; planning and control of hours per activity; and decisions for starting development activities.

As a result of the analysis, in many cases a project management system is installed to improve and permanently to control the performance of the product development system.

### 5.5 Designing a PIP in the area of logistics

The logistics function in a company can always be described as a flow of information and a flow of goods. As both flows are very complex, we have to design the project frame for a PIP carefully. As a check-list we recommend using a graph including all logistics elements and marking on the graph all the elements to be covered by the project. The example shown in figure 5.10 is taken from a company producing and maintaining equipment which wanted to improve the logistics for spare parts. The defined aims for this project were: decrease stock by 30 per cent; decrease handling costs; increase delivery performance; and decrease administration costs.

The programme coverage for this PIP is shown in figure 5.19, using a standardized layout for designing a logistics PIP.
Figure 5.19: Coverage of a logistics PIP

Planning and control
- Sales planning
- Order handling
- Production planning
- Requirements planning
  - Gross requirement
  - Net requirement
- Inventory control
  - Raw material
  - Semi products
  - Finished goods
  - Stocktaking
- Material planning
  - Availability control
  - Allocation
- Ordering calculation
  - Order quantity
  - Order point
- Capacity planning
  - Machine
  - Personnel
- Purchase handling
  - Ordering
  - Surveillance
  - Receiving
- Supply market research

Warehousing
- Warehouse capacity planning
- Location planning
- Layout planning
- Equipment planning
- Bin management
- Warehouse automation

Material and goods flow
- Physical goods flow
  - Receiving
  - Staging
  - Allocation
  - Packing and dispatch
- Expedite
- Transport planning
- Transport routing
- Optimal distribution
- Distribution information systems

Information flow
- Customer
- Sales
- Finished goods stocks
- Production
- Semi product stocks
- Purchasing
- Raw material stocks
- Supplier

Main area to survey
Secondary area to survey
Not to survey
5.6 Designing a PIP to cut costs

This kind of PIP is also well known under the name of “overhead value analysis”. The design of the programme can follow very much that described for cases of turn-round management: the analysis is rough and covers most of the activities of the company.

In this case one can follow the three approaches (A, B and C) to improve productivity and use all of them when designing a programme.

As an application of the present module, think of the company you know best, use the three approaches (see Unit 2) and design the seven elements outlined in table 5.6.

Design the programme in such a way that you can present it to the management of the company you have in mind and feel confident that the management will decide to start a PIP. You will be the project manager.

Questions for discussion

1. Identify the most important specifics in the PIP design for each of the areas discussed in this unit.
2. Reflect during the discussion upon similarities and differences in the PIP approaches.
UNIT 6: SUMMARY

UNIT 6: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Overview the whole module content, including the essence of a PIP, its role in productivity and quality improvement and the main design factors and styles.

UNIT 6: CONTENTS

6.1 Action guidelines
UNIT 6: SUMMARY

There are many reasons for entering into a Productivity Improvement Programme (PIP). Before initiating a PIP a reason for doing so has to be identified with the management and commented on and the overall goals have to be discussed. Management has to decide whether it wants a PIP just as for any other investment. But the payback period of a PIP has to be less than one year! To make a PIP successful, you have to involve more than one area of responsibility, to agree with management on realistic and quantified aims and to involve management in the programme by focusing on agreed objectives.

A powerful methodology to identify potential for savings is to follow the three approaches for productivity improvement:

Approach A: Focused on indirect costs, to identify unnecessary functions, tasks or assets.
Approach B: Focused on direct costs or costs per unit of output, to identify reductions of material, operations or handling
Approach C: Focused on direct costs, to identify reductions in numbers of output or unnecessary operations.

Usually a combination of the three approaches leads to high potential savings, to an identification of the aims which make management interested in starting and to obtain management’s involvement in the PIP.

The programme should have three phases:

Phase 1: A short survey phase, to agree on the aims, to design the programme and to sell it to management.
Phase 2: The survey phase proper, to analyse the potential improvements in detail, to define the concepts of improvement and to agree on the goals with all responsible area managers.
Phase 3: The implementation phase, to design the performance improvements in detail, to implement the measures for improvement and to check the results.

When designing a PIP you can follow a Royal Road to success. This is a sequence of tasks and activities to be followed, and points of decision have to be built in to involve management in the programme.

After management commitment has been secured, the PIP may be designed to include seven common elements. The content of the elements should be designed according to the approach chosen, as shown by cases discussed in this module (see table 5.7).

The PIP results in different cases, relating to three different approaches, are summarized in table 5.7, and the graph in figure 5.20 provides illustrations of the PIP’s possible impact on the relationship between costs and sales.
Figure 5.20: Dynamics of total costs as a percentage of sales

![Graph showing dynamics of total costs as a percentage of sales.]

Table 5.7: Summary of different PIP cases

<table>
<thead>
<tr>
<th>Cases</th>
<th>Three approaches to improve productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Revitalization</td>
<td>15%</td>
</tr>
<tr>
<td>Production</td>
<td>x (do first)</td>
</tr>
<tr>
<td>EDP project</td>
<td>20%</td>
</tr>
<tr>
<td>Product development</td>
<td>10%</td>
</tr>
<tr>
<td>Logistics</td>
<td>x</td>
</tr>
<tr>
<td>Overhead cost cutting</td>
<td>15%</td>
</tr>
</tbody>
</table>

5 - 43
6.1 Action guidelines

1. Find a reason to start a PIP which is convincing and easy to understand.
2. Identify potential savings areas and quantify the project aims.
3. Set the framework for the project by covering areas with high potential for improvements, involving managers with sufficient decision-making power and covering functions that may provide barriers.
4. Find out whether the productivity improvement will be achieved by spending less or selling more, or by a certain equilibrium between the two.
5. Set realistic aims and obtain management's commitment.
6. Secure management's involvement by built-in decision milestones in the PIP.
7. Prepare decision steps as checkpoints for results.
8. Design the seven elements of the PIP and obtain management's commitment.
9. Communicate the PIP's objectives and methods from the beginning so as to avoid resistance during its implementation.
10. Involve the functional management in the concept steps in order to answer questions such as:
    What could be the highest possible material utilization?
    What could be the most direct process flow?
    Which operations can be linked together?
    What are the causes of additional operations and how can they be eliminated?
11. Look for reference data from the very beginning so as to be able to check and show the results of the PIP.
12. Compare the results obtained with the agreed aims, and communicate them.
BIBLIOGRAPHY


MODULE 6
IMPLEMENTING A COMPANY
PRODUCTIVITY IMPROVEMENT PROGRAMME
MODULE 6: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand and organize the implementation of a PIP.
2. Organize PIP activities and working groups.
3. Obtain a commitment to improve and motivate teams.
4. Control the qualities and activities of a PIP to achieve results.

MODULE 6: CONTENTS

UNIT 1: The implementation plan
UNIT 2: Achievement of results
UNIT 3: Case study
UNIT 4: Summary
UNIT 1: THE IMPLEMENTATION PLAN

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Organize activities and working groups.
2. Define PIP sub-objectives.
3. Understand how to ensure the quality of a PIP.
4. Use the implementation phase of the Royal Road.

UNIT 1: CONTENTS

1.1 Organizing activities and working groups
1.2 Defining subgoals
1.3 Project quality assurance
1.4 The Royal Road
UNIT 1: THE IMPLEMENTATION PLAN

As described in Module 5, designing a Productivity Improvement Programme (PIP) calls for creativity and the ability to set up activity plans and time schedules. When you come to Phase 3 of the PIP, the implementation phase, a strong determination to obtain results is needed. Project organization no longer involves merely providing the open atmosphere which is required at the design stage. The activities of the programme should also be focused on improvements and results. Because of this new emphasis and because the implementation phase usually takes some months, a detailed implementation plan must be drawn up which involves all those participating in the programme. Individuals have to be made responsible for carrying out activities in a certain time to reach a predetermined result. On the way to reaching the goals defined in the first phase, it is often wise to set "milestones". This is essential when the implementation phase lasts for more than six months. Subgoals have to be defined which can be controlled at each milestone.

The timespan between these milestones should not be longer than a month, and the milestones should be synchronized with the time schedule. This enables the project manager to report regularly on implementation activities and on results achieved. As a result the project plan becomes demanding, and the PIP retains its importance for management. When starting the implementation phase of a PIP, one has to bear in mind that at the end of the programme the report that has to be written should be a success story, showing results which were defined as aims when the PIP was started.

1.1 Organizing activities and working groups

In the first stage of the implementation phase the most vital step must be for the managers who made the decision to proceed with the programme to be made responsible for its success. These managers must be part of the steering committee of the PIP. When entering the implementation phase a PIP can easily fail if top-level management tries to delegate responsibility to second-line management. In fact, it must be the other way round: when focusing on goals achievement, top-level management has to take more responsibility, thus steering the programme to success.

The same approach is vital for the project team (see section 4.4 in Module 5). You have to make sure that the experienced, powerful and skilled members of the team stay in the project: they must retain responsibility for realizing the productivity improvement they have planned. If an external consultant was part of the project team in the first two phases of the programme, he should stay in the team, for two reasons: first, he tries hard to obtain good results, because it is his job to do so; and second, as he is independent, it is easier for him to force through unpopular decisions.

The activity teams of the PIP need other staff in the implementation phase. When the programme is designed, those assigned to the project should have a good understanding of everything that is going on. Usually in the design phase they have to spend about 25 per cent of their time on the project. In the implementation phase more detailed work is needed. Therefore, people have to be able to spend 50 per cent or more of their time on the programme. Compromises in this respect are dangerous; people who dedicate only 25 per cent of their time to the project will seldom work on the programme when they are needed. Their activities cannot be controlled and
delays will ensue. When starting the implementation phase, you have to show great determination with the organization of the project and the people assigned to it, because determination is one of the most important success factors in PIP implementation.

When the staff have been assigned to work in the teams to implement the PIP, all activities planned for the implementation phase in Phase 2 (PIP survey) have to be replanned in more detail and scheduled precisely. The results from each activity have to be communicated to those responsible for carrying the activity through. The results expected must be broken down into subgoals and these subgoals must be allocated to specific milestones in the PIP.

When the project organization and all the activities are allocated to all the project team members, information about the implementation of the PIP is given to all staff of all departments involved in the programme. The aims of the programme and the results expected from productivity improvement must be communicated from the beginning of the implementation phase. After a wide-ranging information campaign at the beginning of the implementation phase and after the aims of the programme have been made clear, it is absolutely essential to keep everyone informed of the progress of the PIP. Providing this information must be part of the implementation plan.

1.2 Defining subgoals

The implementation programme should clearly answer questions such as:

- What is to be achieved? and
- Who is responsible for doing so?

Therefore, the document to oversee the commitments should be prepared. To do so, the commitments have to be converted into clear objectives, specifying:

- What has to be done, and how?
- Who has the task and the responsibility of doing it?
- What will the result be (give the degree of productivity improvement expected) of the activity in general, and after each step?
- What are the starting and finishing dates of each step of the activity?

**Table 6.1: Activity data in an implementation plan**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Person responsible</th>
<th>Start</th>
<th>End</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase material utilization</td>
<td>R. Jones</td>
<td>1 Feb.</td>
<td>30 Sep.</td>
<td>From 84% to 93%</td>
</tr>
<tr>
<td>Step</td>
<td>R. Jones</td>
<td>1 Feb.</td>
<td>30 Apr.</td>
<td>From 84% to 87%     or 3 points</td>
</tr>
</tbody>
</table>
An example of showing the minimum information which should be included in the implementation plan of a PIP is outlined in table 6.1. This information should be put into a project management system, which should contain information on each step.

1.3 Project quality assurance

The main tools for quality assurance are the project control and the allocation of clear responsibilities, as outlined in sections 1.1 and 1.2.

A particularly systematic approach is to draw up a monthly report on quality in the project. This should only emphasize and highlight exceptions. Activities running in accordance with the plan must not be mentioned. A report of this kind provides information to the project manager and to the steering committee about:

- activities or steps not started;
- activities or steps to be finished late;
- results below (or above) approved goals;
- who is responsible for donations;
- what has been done or initiated to keep the project running according to plan; and
- what the effect will be on the whole programme.

The leader of each project team or working group in the programme provides input for the report. Quality is everybody’s responsibility.

1.4 The Royal Road

The steps of the three phases of a PIP were outlined in figure 5.7 in Module 5. For Phase 3, on PIP implementation, the steps are:

- inform all participants;
- set up a programme control mechanism;
- implement step by step, section by section;
- obtain results;
- communicate the results obtained.
**Figure 6.1: Royal Road of a PIP, Phase 3 (implementation)**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>decision for implementation</td>
</tr>
<tr>
<td>2.</td>
<td>get the decision-makers into the steering committee</td>
</tr>
<tr>
<td>3.</td>
<td>get experienced, skilled people into the teams</td>
</tr>
<tr>
<td>4.</td>
<td>get manpower allocated to the programme</td>
</tr>
<tr>
<td>5.</td>
<td>agree on programme organization</td>
</tr>
<tr>
<td>6.</td>
<td>replan activities of long duration into steps</td>
</tr>
<tr>
<td>7.</td>
<td>allocate results to be obtained in each step</td>
</tr>
<tr>
<td>8.</td>
<td>define how to control/report the results</td>
</tr>
<tr>
<td>9.</td>
<td>make individuals responsible for activities (certain time, certain results)</td>
</tr>
<tr>
<td>10.</td>
<td>structure the programme to milestones</td>
</tr>
<tr>
<td>11.</td>
<td>commit the implementation programme</td>
</tr>
<tr>
<td>12.</td>
<td>fix reporting dates</td>
</tr>
<tr>
<td>13.</td>
<td>communicate results at first milestone</td>
</tr>
<tr>
<td>14.</td>
<td>check fulfilment of programme</td>
</tr>
<tr>
<td>15.</td>
<td>replan the programme</td>
</tr>
<tr>
<td>16.</td>
<td>activate the next steps</td>
</tr>
<tr>
<td>17.</td>
<td>communicate results at second milestone</td>
</tr>
<tr>
<td>18.</td>
<td>check fulfilment of programme</td>
</tr>
<tr>
<td>19.</td>
<td>replan the programme</td>
</tr>
<tr>
<td>20.</td>
<td>activate next steps</td>
</tr>
<tr>
<td>21.</td>
<td>finalize programme</td>
</tr>
<tr>
<td>22.</td>
<td>write report on productivity improvements achieved</td>
</tr>
<tr>
<td>23.</td>
<td>plan follow-up activities</td>
</tr>
<tr>
<td>24.</td>
<td>terminate PIP at a final presentation</td>
</tr>
</tbody>
</table>
Questions for discussion

1. Discuss the most important results of Module 5, “Designing a company Productivity Improvement Programme (PIP)”, and outline the essential information obtained from that module serving as the input into Module 6.

2. Why do we need working groups? Is it not enough just to allocate extra responsibilities to the line managers?

3. What are the differences between objectives and sub-objectives in the PIP? Provide examples.

4. What do “quality assurance” for the PIP and the Royal Road (implementation stage) mean?
UNIT 2: ACHIEVEMENT OF RESULTS

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and describe the five most common approaches used in a PIP.
2. Decide when to use one of these approaches (or other combinations) to obtain better results.

UNIT 2: CONTENTS

2.1 Economy of scale/The experience curve effect
2.2 Product structuring
2.3 Manufacturing for pre-identified markets
2.4 Delivery quality and service organization
2.5 Flow-oriented manufacturing process
UNIT 2: ACHIEVEMENT OF RESULTS

The implementation of a PIP will be successful if the project team is motivated to achieve the projected results. It becomes easy when one gives the team a "vehicle" which they can "drive" to the changes wanted.

In what follows, ten short examples of PIPs are given. All of them have one of five different "vehicles" to lead to productivity improvement. These five general "vehicle" approaches, shown in two cases each, are:

- economy of scale/the experience curve effect;
- product structuring;
- manufacturing for pre-identified markets;
- delivery quality and service organization; and
- a flow-oriented manufacturing process.

The common feature of all these cases is that the productivity improvement obtained was significant, though the results had different dimensions. The objective was clearly set out at the beginning of the implementation phase of the PIP. The teams succeeded in effecting major changes and were motivated by applying advanced organizational tools. At the end of the implementation phase the results should be documented as quantitative achievements.

2.1 Economy of scale/The experience curve effect

2.1.1 Case 1: Calculation of cost-saving potential in a "strategic planning process"

The result. The identification of the cost-saving potential (see figure 6.2) leads to:

- a PIP aiming at cost leadership in the European market; and
- an activity plan, obtaining the anticipated results by making the best use of existing human resources within the company.
The industry. A metal industry company with about 250 employees producing four different product families of tools.

The task of the programme. By the "economy of scale effect" we mean that each time the cumulative amount of pieces produced is doubled, the cost per piece can be reduced by 20 to 30 per cent. A PIP was designed and implemented to that end and using this approach. The task was to mobilize all existing resources to use the potential for cost savings and to obtain a bigger share of the market.

The solution. To solve the problem two methods were used: an analytical method to define the potential and the aims in detail; and a synthetic method for setting priorities in resources allocation. As a first step for all product groups, the cumulative number of products produced in the past was determined. It was then ascertained at which dates in the past a doubling of the cumulative number had occurred. To analyse the cost per piece, the possible influence of inflation had to be eliminated; therefore bills of material and product routings (time per operation) were taken as a basis for calculations with unit cost rates (per kg of material, or per minute of operation). An analysis of the cost per piece gave an indication of those product groups with a high potential for cost savings. The activities needed to realize the potential were defined by coordinating all the expertise and experience of clients, management and staff.

As the second step, a task analysis was made by the consultants to find out which of the day-to-day routine tasks could be eliminated or reduced in order to gain the capacity needed for the extra activities included in the programme. The organizational structure was then changed in such a way that routine tasks were restricted to the relevant production units; at the same time some full-time capacity became available to realize the potential for bringing down the product costs significantly. Sales management's task was to secure a higher proportion of the European market. With these extra sales the cumulative output was doubled earlier than expected, and the next potential cost reduction could be initiated.
2.1.2 Case 2: Structured production to apply the "economy of scale" effects

The result.

- reduction of throughput time from eight to four months;
- narrowing the planning horizon for the finished product to one-third;
- saving 35 per cent of set-up times on semi-product operations; and
- halving the stock of finished goods.

The industry. A metal industry company producing a broad variety of products with a wide spectrum; 16,000 medical tools are produced for stock.

The task of the programme. Instead of producing a finished product with all operations carried out within one production order, the aim was to make the product differentiation at the latest possible stage. The result should be small production orders with a short throughput time for finished products, and bigger production orders for semi-products, which cover a large variety of finished products.

Figure 6.3: Steps in product differentiation

The solution. The main steps in the programme were to:

- analyse in what way the raw parts of products in a family differ and how these can be combined in a single raw part;
- analyse which finished articles already have the same raw part;
- analyse in what way those articles with the same raw part differ;
- find the latest possible operation in which the product variants have to be determined;
- analyse the possibilities of combining operations in the production flow of the variants, if slight modifications to the product are allowed;
- harmonize the operation routings of similar products in each product group;
- define semi-products at additional levels of the product structure/production structure, that meet the requirements of groups of finished products or semi-products at the next level; and
- use a higher volume per production order to automatize/rationalize each operation in the specific routings.

2.2 Product structuring

2.2.1 Case 3: Integrated material management by parameter-based automatic generation of bills of material

The result.

- 15 per cent less stock of raw material and components by demand-controlled material planning of A parts (see figure 6.3);
- 30 per cent lower cost of planning operation; and
- automatic precalculation of material cost per order.

Figure 6.4: Design for automatic materials billing

![Diagram of material management](image)
The industry. An electric industry company with 130 employees, producing transformers in a range of about 20 different product families. Production of made-to-order products in small batches or single pieces.

The task of the programme. Productivity improvement in order administration and material planning through the development of a tool for the automatic generation of an order-related bill of material. The high variance of customer-specific electrical dimensions and of connectors has to be handled systematically, aiming for the integration of product calculation, requirements planning and allocation of resources.

The solution. For the first step, groupings to determine variants were defined. These groups are (a) basic components with parameters of electric capacities, and (b) connector components with parameters of customer needs. For the second step, rules were drawn up to describe customer requests by parameters. The third step was the design of a programme which makes the calculation (parameter based) to define the electric-related dimensions and, from that and all other parameters, generates the order-specific bill of material.

One significant improvement was already obtained when this “bill of material generator” became active: about 80 per cent of all orders could henceforth be handled by the order entry department on the day the orders arrived, so that these orders were prepared for material planning and for production within one day. Only about 20 per cent of all orders had to go into the design and drawing office for technical definition, technical calculation and drawing; these orders still have an administrative throughput time of two weeks.

The order-specific bill of material, which is generated automatically, is organized for three levels of requirements planning:

Level 1: Parts per basic product, which are independent from electrical data and customer needs (order independent/standard parts per product).
Level 2: Variant parts, dependent on calculated electrical dimensions or on customer-defined needs.
Level 3: Fabricated components required for electrical components or subassemblies.

This complete bill of material per order is then used for requirements planning and to allocate requirements for stocks, to open production or supply orders and to plan production orders.

For the final step the main production cost centres from the routing were added to the bills of material, with the time needed for these operations. By this, the daily requirements provided planning information on capacity requirements. After that, the production order release was controlled in such a way that a steady flow of orders, with a steady workload, was put into the factory. Work in process can be kept at a low level, which leads to a rapid flow of orders. The short production lead time became a very positive argument for the customers.

2.2.2 Case 4: Flow-oriented production, based on product and order structure

The result. By introducing flow orientation of the production lay-out and by redesigning the product structure, in accordance with manufacturing needs, the results obtained were:
- a 30 per cent productivity improvement;
- a significantly higher level of customer service; and
- a 12 per cent increase in material utilization.

The industry. A company producing wooden and plastic elements for the housing industry. The market is shrinking and prices are very much under pressure.

The task of the programme. All productivity improvement reserves have to be mobilized for each operation and during the whole process of production. Scrap and wastage of material has to be brought to a minimum. In total, the manufacturing cost of the products must come down by 20 per cent (to 80 per cent of the present cost).

The solution. A detailed analysis of product structures and order variants made some standardization possible, and all manufactured components were standardized, with a limited number of variants. This led to bigger production batches or even a process-oriented steady production of plastic profiles. Defective products and scrap came down to less than 1 per cent. The next step was to define how the structure for subassemblies had to be modified so that about 80 per cent could be produced as a buffer stock, without a need for specifications from customer orders. The product structures could be changed in such a way that product variances for 80 per cent of the products - i.e. about 92 per cent of all orders - appeared in the assembly line. This meant that most products could be made up of standard components plus some variant supply parts in the final assembly.
The production process and production layout were designed as follows:

The assembly of semi-finished goods and the production of standard parts were organized in flow-oriented production lines. Demand fluctuation from the market was buffered in stocks in a warehouse for semi-finished parts/products, so that high productivity was maintained by a steady production process.

The assembly of finished goods was organized in two very different areas:

- The larger area was again flow-oriented in processing lines for product families. Customer orders were combined into lots, wherever possible. All parts and subassemblies were taken from the buffer stock into a staging area per assembly line, in a day-to-day sequence. Productivity increased with much better quality and customer service.

- The smaller area of the assembly department, where the special products made to customer order were assembled, was organized in islands, where small groups of two or three workers carried out all operations. This includes alterations to standard parts as well as variants of subassemblies. In this area productivity could not be greatly improved (only by about 7 per cent). But the area where only a small proportion of all orders was assembled was separated from the main area, so that the production of special variants (representing only 10 per cent of the total) no longer disturbed the production flow of the main 90 per cent.

2.3 Manufacturing for pre-identified markets

2.3.1 Case 5: Semi-autonomous groups increase flexibility

The result. The installation in the assembly department of partly autonomous groups responsible for the full range of assembly operations led to:

- high flexibility, even with an increasing product range and broader demand variances;
- a 20 per cent productivity improvement;
- 50 per cent less production lead-time; and
- a 30 per cent lower cost of scrap and reworking.

The industry. A toy manufacturing company with 1,800 employees and with most of the parts produced in-house; there are no standard items. The manufactured toys are of the highest quality and precision.
The task of the programme. To defend the position in the market; to increase the flexibility to react to market demands. To attain this objective, all assembly operations of one product family were to be concentrated in one specially designed assembly department. (At the beginning of the programme the sub-assembly and assembly of that product family were spread over different departments and even separate factories, and mixed with other product families.)

The solution. Data for the reorganization of the assembly operations of this product family (15 percent of the whole production) were collected and analysed by product structure, operation times, capacity profiles and sequence of assembly operations (ideal routings).

Each operation was then analysed to find opportunities for amalgamation and automation, to guarantee zero defects by in-process control and to place several operations together in one assembly job. As a result operation times were harmonized. About 150 small productivity improvements could be defined; they were introduced into the new layout of the whole assembly for the product family in question.

The main step in implementing productivity improvement in this case was to agree on some new but essential principles:

- concentrate all assembly activities in one production facility (sub-assembly and assembly);
- stores with components should be directly adjacent to the assembly area;
- have the management of the department inside the department (foreman, production planning, materials management, production control, production preparation for new products); and
- build the new layout into a room with a clean atmosphere, optimal lighting conditions and a flexible electricity supply system.
After these principles were decided upon, the project team and the consultant made a detailed layout plan for each group of products. This was to place groups of three to five persons in one island/autonomous group, where in one group (or three at the most) a product is completely assembled. The project team helped to install the new layout and material flow, and subsequently the foreman and his management became responsible for preparing for the next assembly order (average lot size, 3,000; average production of a group per day, 500). This involved selecting from the stores the components needed for the lot in question or for one day’s production, preparing the assembly desks with assembly devices for that product and putting the components in place. The group leaves one island, where they have finished an assembly lot, and moves to the prepared island. With 55 staff in the department the management prepares about two islands per day. The project team helped the groups to organize autonomously who works where, how to change speed during the day, and how to find defects early and do the rework within the assembly process. The most significant result at the end of the programme was that the total number of rejections came down to almost zero. To reach this degree of productivity improvement the groups were organized as autonomous and self-controlled units, without financial incentive.

2.3.2 Case 6: CIM, integrated process from order entry to CNC (Computer Numerical Control) manufacturing line

The result. In spite of the tremendous increase in the number of production orders (150 per cent), CIM application results in:

- 10 per cent less personnel needed for order entry and order promising; and
- a 20 per cent reduction in process and stocks.

The industry. A company with 1,200 employees in three divisions producing wood, fibreboard, door-frames and doors. The PIP was implemented in the doors division, producing 15,000 doors per week. The range of products was enlarged to 50,000 variants.

The task of the programme. The order entry should be organized so that order data are entered into the system on-line by the salesman, in communication with the customer. The product data should be generated automatically from a product description in such a way that they can be passed directly to production order processing. A new flexible CNC-manufacturing line (13 stations) should be integrated into the computerized information network.

The solution. All products and their variants can be referred to by codes assigned to each distinct product feature. Twelve standard features and some special options suffice to describe each product in each customer order. The programme for order entry generates the product dimensions by formulas and tables which are easy to maintain. The programme then generates the specific bill of material and the specific routing. This is done on-line. The next step in the programme is to check and reserve the material required and the capacity needed. The delivery date from this calculation is shown in relation to the data wanted by the customer, and the salesman can give his approval while the customer is still on the phone.

The order is then sequenced into the other orders for one shift per day. The day before the orders are manufactured, the system calculates an optimum sequence by bundling grouping together similar materials, colours and special features. The digitalized order product data are
transmitted by file transfer (per shift) from the mainframe computer to the production-processing computer. The CNC programmes are generated from standard programme modules and the product data are automatically transmitted to the process-line computers. At the end of the shift the order data file is actualized and data are transferred to cost accounting and invoicing by file transfer from the process computer to the mainframe.

In this case the PIP was implemented by arranging for all departments involved in the order-handling process to take part in building and implementing the CIM system. The best incentive for all involved in the programme was to aim at being the best in the market in terms of profit, delivery performance and service. The PIP was the right means to reach these targets.
2.4 Delivery quality and service organization

2.4.1 Case 7: Fast customer service by organizing an order-processing centre

The result. Setting up and organizing an order-processing centre:

- expedites the order handling from one production step to the next and cuts the throughput time of made-to-order products and specialities by one-half; and
- increases productivity by about 15 per cent in order entry.

Figure 6.8: Production flow-chart

The industry. The company, the European subsidiary of an American undertaking with 410 employees, manufactures high precision, high quality metal and iron products. Products are made to order or in batches for stock.

The task of the programme. The programme aimed at shorter delivery times and at cutting costs by productivity improvement. The implementation of the programme should be enforced by designing and implementing a process-oriented order-processing centre.

The solution. The analysis phase of the PIP had shown a segmentation of the order entry operation. In each little section of the operation the sales and planning people had to read and to understand the whole order. The amount of work was thus doubled. All staff in the sales departments were first asked to classify the orders or products into groups, to be defined in such a way that they could be processed in a "flow" especially designed for that group. The next step was to organize
the order entry control and the tasks of the order-processing centre: the team decided which tasks had to remain centralized and which should be allocated to the different “channels” for order processing. Four lines were defined, not only in the order-processing centre but also in the warehouse and dispatch department.

An outside consultant acted mainly as the supervisor for the team, which was composed entirely of people from the order-processing department.

2.4.2 Case 8: Avoid poor delivery by Kanban control

The result.

- reduction of labelling faults by 80 per cent;
- total avoidance of lading faults by “in-system control”; and
- total avoidance of transmitting faults by system integration.

**Figure 6.9: Main causes of poor delivery**
The industry. A large company with 5,000 employees, producing metal and plastic parts for the motor vehicle industry. Most of the customers are supplied under a “just-in-time” procedure.

The task of the programme. Suppliers to the motor vehicle industry are qualified as A, B or C suppliers. This qualification is given on the basis of delivery performance and product quality. The company downgraded from B to C by two major customers because of poor delivery, caused by lading and labelling faults. Extra checks in the dispatch area did not help - indeed, they decreased total productivity. Therefore the PIP aimed at bringing down the percentage of wrong deliveries to zero and at increasing productivity by avoiding all activities not adding value to the products.

The solution. All apparent faults were analysed and classified in the first step. In the next step the source and cause of each fault were analysed in detail. The project team then worked out, together with the staff in-line, how to eliminate the sources of the faults. The most significant changes made in the goods-handling procedure were:

- The production order is now given to the line managers in the format of a modified Kanban card. The Kanban card is also used as a label on the container, which prevents the wrong label from being picked.
- The inclusion of a bar-code on each label makes it possible for the product to be identified by optical reading. These computerized data are transferred to the order file of those orders due to be dispatched that day and checked by comparison. Faults in the lading list are impossible.
- Containers coming to the lading area without having a bar-coded label cannot pass the check-point.

This organization of the information flow and the goods flow in one closed circuit makes manual interference impossible, and therefore the fault rate is reduced to a minimum.

After about six months with virtually no delivery faults, the company was upgraded from a C to a B supplier. This is also a kind of productivity improvement, because A and B suppliers can negotiate higher prices and greater volume.

2.5 Flow-oriented manufacturing process

2.5.1 Case 9: Ideal flow of material cuts lead time and stocks

The result.

- a 30 per cent reduction in throughput time;
- a 50 per cent reduction in raw material and sub-assembly stocks; and
- 60 per cent of the production output is shipped directly, without passing through a warehouse.

The industry. A company producing small colour television sets in factories all over Europe.

The task of the programme. The real aim of this project, besides productivity improvement, was to gain space for a 50 per cent increase in production, without any new building or extra space being required.
The solution. Phases 1 and 2 of the PIP determined that the programme’s results should be a much faster flow of material in all areas, a compact use of space and a proportion of finished goods to be shipped directly from the end of the assembly lines.

In the implementation phase a wide range of tasks was defined by the project team so as to make up to 3,000 square metres of empty space available for extra production volume. The tasks and measures implemented can be described by the examples which follow:

- Modification of the safety stock concept: i.e. keeping a safety stock of parts and sub-assemblies for only two types of products of the whole product range. These were the two best-selling types, and thus were in almost every week’s production programme and could be used for flexible reactions to programme changes, without putting long-lasting stocks of finished goods at risk. Safety stocks of all the other products in the range were no longer held.
- High-volume parts were purchased as and when required and delivery dates were tightly controlled.
- Transport for incoming goods and for shipment was organized so that the flow of goods was spread evenly over ten hours of a day.
- The sequence of products in the daily production programme for each assembly line was planned in such a way that sub-assemblies could be produced directly into the assembly line without causing buffer stocks.
- The material flow from unloading, via quality and quantity control, into the warehouse was improved.
- The organization of quality control was changed to in-line control, covering the two shifts of production.
- The distribution planning for finished goods was improved by an on-line application between
sales planning and production planning.
- New technologies were installed in the sub-assembly lines for wooden and plastic cases, thus cutting lead times and stocks.
- The implementation of these many tasks was coordinated by a master plan, showing the dependence of each activity on the others.

2.5.2 Case 10: Speeding up production flow by flow-oriented layout

The result.

- reduction in the number of work centres and cost centres;
- a 30 per cent reduction of transport from one cost centre to the next operation; and
- reduction of throughput time from six months to three months.

Figure 6.11: Flow-oriented layout

The industry. The company produces tools and systems for operative Products less than five years old account for 20 per cent of the turnover.

The task of the programme. The highly function-oriented production layout, with many small
operations, had to be reorganized, aiming at faster throughput, combining operations, and flow orientation in product lines.

The solution. The entire range of products was classified by similar production technologies and similar sequences of operations into product families in the first step of the implementation phase. On the basis of a capacity requirements matrix, showing the product family on one side and the cost centres on the other side, the segmentation of the production was planned. Factors in this planning phase were:

- concentration of one or two product families in cost centres (areas of competence and responsibility);
- shifting operations into the main cost centre of each product family;
- linking of smaller cost centres to larger production centres;
- material flow-oriented layout of the work centres; and
- integration of quality control in the manufacturing lines.

By this means most of the articles could be produced in the main cost centre of the product family, without leaving it for any operation. Transport between cost centres was reduced by a third and the delay between operations was reduced more drastically.

Questions for discussion

1. List and discuss the common and different features of all five approaches in PIP implementation, and their advantages and disadvantages.
2. Is it possible to combine two or more of the five approaches into one PIP? If yes, how?
3. Try to identify other PIP approaches which could not be classified under the five groups mentioned.
UNIT 3: CASE STUDY

UNIT 3: LEARNING OBJECTIVE

Once you have learnt this unit, you will be able to:

1. Understand the PIP process and its work elements in a real company.

UNIT 3: CONTENTS

3.1 PH Machines Company
UNIT 3: CASE STUDY

3.1 PH Machines Company

In Module 5, the case of the PH Machines Company was described as an example of how to define the aims of a PIP in the case of a “revitalizing concept”. The design of the programme for that case is also described in this module.

For Phase 3, the implementation phase of a PIP, a step-by-step approach was chosen for the PH Machines Company. The whole implementation plan was organized in seven subprojects.

Following the Royal Road for the implementation phase, it was vital for this kind of project to bring the decision-makers into the steering committee and also into the project organization. The structure of the project organization is shown in table 6.2. The names given in the chart represent top management positions in the PH Machine Company:

- Mr. Plu - Managing Director
- Mr. Sho - Managing Partner of the external management consulting company
- Mr. Bre - Senior Consultant, external project manager
- Mr. Elb - Sales Manager
- Mr. Kar - Technical Manager
- Mr. Gor - Finance and Control Manager

The members of the task force teams are line managers and highly experienced people from the company, assisted in some teams by skilled external consultants.
Table 6.2. Structure of the project organization

<table>
<thead>
<tr>
<th>Organization</th>
<th>Implementation Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr. Plu</td>
<td>intra Consultants</td>
</tr>
<tr>
<td>Guarantees and Service</td>
<td>Implementation Team</td>
</tr>
<tr>
<td>Mr. Elb</td>
<td>PH Engineers</td>
</tr>
<tr>
<td>Product (Mach.) Capability</td>
<td>Implementation Team</td>
</tr>
<tr>
<td>Mr. Kar</td>
<td>PH Design Engineers</td>
</tr>
<tr>
<td>Planning and Control Systems</td>
<td>Implementation Team</td>
</tr>
<tr>
<td>Mr. Gor</td>
<td>PH Controller, intra Consultants</td>
</tr>
<tr>
<td>Material and Supplied Services</td>
<td>Implementation Team</td>
</tr>
<tr>
<td>Mr. Gor</td>
<td>PH Multi Functions Team</td>
</tr>
<tr>
<td>Order Administration</td>
<td>Implementation Team</td>
</tr>
<tr>
<td>Mr. Gor</td>
<td>intra Consultants, Sales Engin.</td>
</tr>
<tr>
<td>Market Research</td>
<td>Implementation Team</td>
</tr>
<tr>
<td>Mr. Elb</td>
<td>intra Consultants</td>
</tr>
<tr>
<td>Investments</td>
<td></td>
</tr>
<tr>
<td>Mr. Kar</td>
<td></td>
</tr>
</tbody>
</table>

* intra = in-house
After it had been agreed who would take part in the project organization, the next step was to have the necessary staff allocated to the project and to have the personnel budget assigned by the external management consulting company. Table 6.3 shows the personnel allocated to the programme.

A significant step in organizing the implementation phase is the definition of each manager's role, especially the definition of real activity and responsibility of top managers in the PIP organization. One of the reasons that made the PIP at the PH Machine Company a success story was that all management staff at the top two levels of the company became involved in the programme and in each of the subprojects; besides the manager responsible, at least one more manager gave active assistance. Table 4.6 gives the different categories of roles planned for the subprojects. In this case, it is significant that in each subproject the management was coached by an outside consultant.

After the organization of the implementation phase of the programme was decided, the subprojects were planned in detail by the implementation teams. The complete schedule of the programme was laid down in a timetable as shown in table 6.5. Progress was reported to the steering committee every four weeks. The next and the following reporting dates were fixed at each meeting. A final report after two years showed results very close to those defined as aims for the PIP at the beginning.

**Table 6.3: Implementation of staffing plan**

<table>
<thead>
<tr>
<th>Subproject</th>
<th>Resources PH Machine Co.</th>
<th>Internal resources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Workdays</td>
<td>Investments</td>
</tr>
<tr>
<td>Organization</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Guarantees and service</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Product (machine) capability</td>
<td>220</td>
<td>20</td>
</tr>
<tr>
<td>Planning and control systems</td>
<td>60</td>
<td>Software</td>
</tr>
<tr>
<td>Material and supplied services</td>
<td>60</td>
<td>-</td>
</tr>
<tr>
<td>Order administration</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>Market research</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td>Investments</td>
<td>30</td>
<td>Interim solution for warehouse</td>
</tr>
<tr>
<td>Total project coordination</td>
<td></td>
<td>90</td>
</tr>
<tr>
<td>Total</td>
<td>560</td>
<td>360</td>
</tr>
</tbody>
</table>
Table 6.4: Responsibilities in subprojects

<table>
<thead>
<tr>
<th>Subproject</th>
<th>Responsibility</th>
<th>Mr. Elb</th>
<th>Mr. Gor</th>
<th>Mr. Kar</th>
<th>Mr. Plu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>•</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sho</td>
<td>Sho</td>
<td>Bre</td>
<td></td>
</tr>
<tr>
<td>Guarantees and service</td>
<td>•</td>
<td></td>
<td>X</td>
<td>X</td>
<td>(X)</td>
</tr>
<tr>
<td></td>
<td>Sho</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product (Machine) capability</td>
<td>(X)</td>
<td>(X)</td>
<td>•</td>
<td></td>
<td>Bre</td>
</tr>
<tr>
<td>Planning and control systems</td>
<td>X</td>
<td>•</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bre</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material and supplied services</td>
<td>X</td>
<td>•</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Sho</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Order administration</td>
<td>X</td>
<td>•</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bre</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market research</td>
<td>•</td>
<td></td>
<td></td>
<td></td>
<td>(X)</td>
</tr>
<tr>
<td></td>
<td>Sho</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investments</td>
<td>(X)</td>
<td>•</td>
<td></td>
<td></td>
<td>Bre</td>
</tr>
</tbody>
</table>

Legend
- • responsible for subproject
- X integrated in the implementation team
- (X) part-time active
Questions for discussion

1. Discuss the structure of the case study and relate it to your own company.
2. Using the unit format, try to simulate a similar PIP for your own company.
UNIT 4: SUMMARY

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Describe the PIP implementation process, main approaches and activities as well as preparing an implementation plan.

UNIT 4: CONTENTS

4.1 Action guidelines
UNIT 4: SUMMARY

The results of a PIP are defined in Phase 1 and planned in Phase 2 of the programme. In the third, implementation phase, the results must be obtained.

To make the implementation phase a success, five aspects must be followed by the person ultimately responsible, i.e. the person who started/initiated the PIP:

- inform;
- control;
- implement;
- get results; and
- communicate.

For a consistent implementation of productivity improvement, sound authority is needed. Therefore the decision-makers have to be found and become involved/responsible.

The implementation programme needs a great deal of commitment, and to obtain this a Royal Road has to be followed, which gives firm deadlines and checkpoints as a kind of milestone.

Ten examples are given above of “vehicles”, on which one can ride to success. The tools that can be used to organize the implementation phase vary widely; all project management tools are useful. The case study described in Unit 3 gives just a few examples.

4.1 Action guidelines

1. Create an environment that is conducive to obtaining the previously defined improvements.
2. Plan in detail how you will obtain the results.
4. Plan reporting dates, communicate results.
5. When starting the implementation phase, plan the final report and the results to be reported.
6. Bring the most influential people into the team (present the success story they will take part in).
7. Obtain the personnel needed (N.B. quantity and quality).
8. Apply effective control mechanisms to keep the project in line, especially for implementation phases lasting more than six months.
9. Apply appropriate mechanisms to ensure good quality standards.
10. Follow the Royal Road; design an implementation programme which also contains all the specific activities and checkpoints necessary for the solution or system to be applied in order to improve productivity.
BIBLIOGRAPHY


Calzado, M.; Nagata, Y.: Pathways to productivity: Increasing productivity of small and medium scale food processing enterprises (Manila, ILO, 1994).


Ramsay, M.R.: Enterprise productivity measurement and international labour productivity handbook (Sydney, ENDESCO, 1995).


MODULE 7
ORGANIZING A COMPANY
P&Q MOVEMENT
MODULE 7: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand and describe how overall organizational culture and management styles are related to the productivity and quality (P&Q) movement.

2. Evaluate a company’s P&Q movement using the Seven Cs concept in developing a corporate productivity culture.

3. Identify the main components of a company P&Q movement and know how to keep it going.

4. Integrate the P&Q components into a company’s organizational framework.

MODULE 7: CONTENTS

UNIT 1: Ensuring continuous P&Q improvement

UNIT 2: Developing a company P&Q movement

UNIT 3: Case study: Bharat Heavy Electricals Ltd. (BHEL)

UNIT 4: Summary and review

Bibliography
UNIT 1: ENSURING CONTINUOUS P&Q IMPROVEMENT

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand the importance of P&Q movements.

2. Explain the interrelationships between an organizational structure, culture, management style and P&Q movement success.

3. Describe the main seven components in developing P&Q cultures.

4. Describe the main characteristics of high-performance work systems:

UNIT 1: CONTENTS

1.1 Organizing for P&Q

1.2 The Seven Cs to develop a company P&Q culture
UNIT 1: ENSURING CONTINUOUS P&Q IMPROVEMENT

1.1 Organizing for P&Q

The way in which a company develops a P&Q movement, defines the organizational structure of the movement and allocates resources and responsibilities, is dependent on the overall organizational approach of the firm. In considering how to organize for productivity, we must take into account two aspects:

- the overall organizational approach to business and operations management of the company;
- the organizational provisions which are aimed at achieving continuous P&Q improvements.

The organizational structure and procedures of a company P&Q movement therefore have to reflect the overall organizational approach of the company. Many firms had to learn, for example, that the introduction of Quality Circles in an autocratic and very hierarchical organizational structure is not successful. On the other hand, organizational approaches which enhance teamwork, participation and decentralized decision-making contribute to P&Q improvements. Figure 7.1 outlines these interrelationships schematically.

**Figure 7.1: Organizing for productivity and quality**

The fact that enterprise performance is closely related to organizational approaches seems obvious. In table 7.1 this is proved by the example of motor vehicle assembly plants throughout the world.

In an international survey of motor vehicle assembly plants, Japanese firms in Japan, Japanese transplants in North America, American manufacturers in North America and European assembly plants were compared. Table 7.1 shows that the best performers in terms of P&Q are those plants which have a high percentage of the workforce working in teams, practice frequent job rotation, have encouraged their employees to make improvement suggestions, have a reduced number of job classes compared with their competitors, and emphasize training for new production workers. The best performers have made the transition from a Tayloristic production system
to the new paradigm of "lean" organization (cf. Womack et al., 1990). Similar observations have been made in a number of studies concentrating on improving the performance of organizations (cf. Peters and Waterman, 1982; Lawlor, 1986; Gladstone and Ozaki, 1991).

Inherent in the concept of a lean organization is the assumption that responsibility for P&Q lies with everyone. This does not mean, however, that there is no longer a need for productivity specialists such as industrial engineers. In the traditional Tayloristic approach, an industrial engineer would have acted as the specialist for defining the optimal job design. In the new approach to a lean organization, the industrial engineer acts more and more as a facilitator channelling the ideas emerging from the shop-floor into viable solutions. This fact must be taken care of in the organization of a company P&Q movement. The organization and methods department of a company, rather than centrally setting time and method standards, will act more as a coordinator of Small Group Activities and project groups all over the company.

**Table 7.1: Performance related to organizational approaches of motor vehicle assembly plants, 1989**

(averages for plants in each region)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Japanese in Japan</th>
<th>Japanese in North America</th>
<th>American in North America</th>
<th>All Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Productivity (hours/vehicle)</td>
<td>16.8</td>
<td>21.2</td>
<td>25.1</td>
<td>36.2</td>
</tr>
<tr>
<td>Quality (assembly defects/100 vehicles)</td>
<td>60.0</td>
<td>65.0</td>
<td>82.3</td>
<td>97.0</td>
</tr>
<tr>
<td><strong>Layout</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space (sq. ft./vehicle/year)</td>
<td>5.7</td>
<td>9.1</td>
<td>7.8</td>
<td>7.8</td>
</tr>
<tr>
<td>Size of repair area (as % of assembly space)</td>
<td>4.1</td>
<td>4.9</td>
<td>12.9</td>
<td>14.4</td>
</tr>
<tr>
<td>Inventories (days for 8 sample parts)</td>
<td>0.2</td>
<td>1.6</td>
<td>2.9</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Workforce</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of workforce in teams</td>
<td>69.3</td>
<td>71.3</td>
<td>17.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Job rotation (0 = none, 4 = frequent)</td>
<td>3.0</td>
<td>2.7</td>
<td>0.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Suggestions per employee</td>
<td>61.6</td>
<td>1.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Number of job classes</td>
<td>11.9</td>
<td>8.7</td>
<td>67.1</td>
<td>14.8</td>
</tr>
<tr>
<td>Training of new production workers (hours)</td>
<td>380.3</td>
<td>370.0</td>
<td>46.4</td>
<td>173.3</td>
</tr>
<tr>
<td>Absenteeism</td>
<td>5.0</td>
<td>4.8</td>
<td>11.7</td>
<td>12.1</td>
</tr>
<tr>
<td><strong>Automation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welding (% of direct steps)</td>
<td>86.2</td>
<td>85.0</td>
<td>76.2</td>
<td>76.6</td>
</tr>
<tr>
<td>Painting (% of direct steps)</td>
<td>54.6</td>
<td>40.7</td>
<td>33.6</td>
<td>38.2</td>
</tr>
<tr>
<td>Assembly (% of direct steps)</td>
<td>1.7</td>
<td>1.1</td>
<td>1.2</td>
<td>3.1</td>
</tr>
</tbody>
</table>

The challenge of organizing a company P&Q movement, therefore, is to solve the following questions:

- How can the dynamism of a project or programme approach be combined with the continuity of a permanent organizational structure to enhance productivity?
- How can participation of employees be enhanced and effective ways of putting their ideas into practice be developed?

After some of the basic requirements for a company P&Q movement have been defined, this module will deal with the questions of how to set up a company P&Q movement and how to run it effectively.

1.2 The Seven Cs to develop a company P&Q culture

Whatever solutions a company develops to enhance P&Q, they will need to respond to the following requirements:

1. **Confidence and trust.** P&Q will be improved in a long-term perspective only if there is confidence between management and the workforce. If there is no mutual trust, workers will tend to resist the proposals for productivity improvement made by management, and management will not sufficiently delegate responsibilities to the workers in order that they can develop their own initiatives. Mutual trust is a precondition for concerted action towards productivity and the enterprise. A precondition for mutual trust is mutual respect. Peters and Waterman (1982) stress that “There was hardly a more pervasive theme in the excellent companies than respect for the individual... We are talking about tough-minded respect for the individual and the willingness to train him, to set reasonable and clear expectations of him, and to grant him practical autonomy to step out and contribute directly to his job.”

2. **Cooperation and commitment.** Once there is a certain amount of confidence between management and workers, both will be committed and will cooperate to improve P&Q. Productivity improvement will be seen as a common cause, securing rather than endangering jobs. The vital part of a company P&Q movement is the development of adequate labour/management cooperation, for example via joint productivity committees and the signing of agreements between works councils and management (cf. Module 15, “Industrial relations and participation for productivity improvement”). Cooperation is required not only between labour and management but also between different departments of an enterprise and between the workers themselves. A teamwork approach will promote this cooperation and commitment.

3. **Communication.** The major obstacle to a P&Q movement becoming successful is very often a lack of communication in the enterprise. First of all, clear targets have to be endorsed and communicated to the employees by top management. The organization of the reporting system has to ensure that there is a continuous comparison between real and anticipated targets and that management at all levels and the workforce are informed of achievements and shortcomings. Workers need to be informed of what is happening in the enterprise and how they can contribute to improve the enterprise’s performance. The organization of information management (see Module 22, "Information management") is therefore a precondition for a successful productivity movement.

4. **Coherence.** P&Q improvement must be based on a coherent organizational system where the rules of the game are clearly defined. This applies not only to organizational structure and responsibilities, but also to procedures and decisions. For example, when an incentive scheme or
productivity gain-sharing is introduced, it must be clear to all participants how the system works and they must be able to predict how much more they will be earning if they perform better. The criteria of coherence also applies to decisions in managing the enterprise. Workers on the shop-floor, for example, will not understand why efforts are made to reduce production times whereas administrative lead times remain unchanged. Incoherent actions and systems lead to demotivation and are thus counterproductive to improving the enterprise’s performance.

5. Continuity. Successful enterprises have demonstrated that the P&Q level they have attained results from continuous improvement efforts over the years. This is perhaps the most difficult aspect of a productivity movement which will have to be part of a culture of continuous change in the enterprise (see Module 8, “Managing organizational change”).

6. Creativity. Notwithstanding new organizational arrangements, no improvement of productivity will be seen if there is no creativity on the part of managers and workers. Small Group Activities seem to be particularly suited to promoting the unrestricted development of new ideas. There are a number of methods to promote creativity which are described in Module 10, “Industrial engineering techniques”. Creativity, however, will not develop if insufficient time is allowed for Small Group Activities.

7. Continuous training. Together with the development of favourable relationships between labour and management, the setting-up of a continuous education process at all levels of the enterprise is perhaps the most important task in organizing for P&Q. Training programmes have to be in place for all levels of management as well as for workers and their representatives. Given the importance of middle management in improving P&Q, these people often form the main target group for P&Q training. Workers and their representatives are another important target group. Workers’ representatives will be more prepared to enter into discussions on proposals for P&Q improvements with management if they fully understand the consequences for the workforce.

These Seven Cs in developing a corporate P&Q culture can also be used as evaluation criteria for existing company P&Q movements or as guidelines for developing new forms of P&Q improvement.

Questions for discussion

1. What is the importance of the P&Q movement?
2. What is the role of the “Seven Cs” in developing a P&Q culture?
3. What are the main characteristics of high-performance work systems?
UNIT 2: DEVELOPING A COMPANY P&Q MOVEMENT

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Describe the main components of P&Q movements.
2. Develop and introduce the company P&Q movement programme.
3. Understand the main conditions for successful P&Q movements, including employee participation.
4. Actually manage or participate in P&Q movement efforts.

UNIT 2: CONTENTS

2.1 The main building blocks
2.2 Introduction of P&Q into mainstream enterprise functions
2.3 P&Q improvement through employee participation
2.4 P&Q support services
2.5 Coordination and network
2.6 Connecting with outside P&Q sources
2.7 How to keep the company P&Q movement going
UNIT 2: DEVELOPING A COMPANY P&Q MOVEMENT

2.1 The main building blocks

In the previous unit we saw that a company P&Q movement should fulfil a set of criteria, the so-called Seven Cs, in order to contribute to sustainable performance improvements. What should the structure of a company P&Q movement look like in order to fulfil these criteria?

There are many solutions to the problem, depending on the company’s organizational structure and development and the main components of a company P&Q movement as well as their interrelationship. Each company will have to match these components with its organizational development strategy. Figure 7.2 displays the structure of a company P&Q movement in a simplified manner. The movement is characterized by the following five major components:

- introduction of P&Q into mainstream enterprise functions;
- Small Group Activities to improve systems performance;
- specialized support services such as industrial engineering, training and welfare services;
- a P&Q coordination network; and
- relationships with outside sources such as productivity services, clients and suppliers as well as employers’ organizations and trade unions.

These components are interrelated as shown in figure 7.2, and will gain momentum only if they are well coordinated. Let us now consider these components in more detail.

2.2 Introduction of P&Q into mainstream enterprise functions

Rather than installing support services, project groups and steering committees to improve a malfunctioning bureaucratic organization, it is preferable to develop a new form of organization that integrates a P&Q attitude into all the mainstream functions of a company. This means that P&Q should be built into research and development, materials management, production and administration, just to mention a few of the departments concerned.

The mainstream activities of an enterprise need to be transformed into high-performance work systems which are characterized by the features mentioned in figure 7.3.

Each staff member should aim at:

- satisfying clients;
- reducing lead times;
- avoiding unnecessary bureaucratic paperwork;
- saving energy and materials; and
- making the best use of production capacities.

Only if there is a general attitude that P&Q is everyone’s task will the company’s P&Q movement gain momentum. This is the kind of permanent climate needed to develop ideas for improvement, e.g. through Small Group Activities and suggestions schemes.
Figure 7.2: Main components of a company P&Q movement

- **Advice by employers' organizations, chambers of commerce, manufacturers', associations**
- **Client and supplier relationships**
- **Benchmarking with competitors**

- **Company Board**
- **Coordination Network**
- **Works Council**

**Business Units & Functional Departments**
- **Integration of P&Q attitude into all mainstream functions of the company**
- **Coordination Unit**
- **Workers' Representatives**
- **P&Q Improvement Groups**
- **Workers' Representatives**

**Support Services**
- **Industrial Engineering**
- **Training**
- **Welfare Services**
- **Occupational Safety and Health**

**Collective bargaining, union policy and advice**
- Use of productivity service from outside consultants
- Training institutions
- Community services
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Figure 7.3: Characteristics of high-performance work systems

- clearly expressed and communicated “management philosophy”
- emphasis on training, career planning, personal development
- flat management hierarchy
- salaried status with common fringe benefits package
- skill-based payment system with gain-sharing
- allocation of meaningful “whole pieces of work” to teams
- self-managing teams with elected leaders
- team responsibility for goal-setting and task allocation
- team control over quality and absenteeism
- teams select new members
- multiskilling, skill-sharing
- team review of skills and salaries
- provision of team meeting-rooms with personal facilities
- common entrance and car parking
- common plant eating and recreation areas
- process layout supports teamwork and communications
- some support functions carried out in teams
- fewer support personnel in engineering, scheduling, quality control
- support staff become consultants/trainers

Source: Adapted from Lawlor, 1986.

2.3 P&Q improvement through employee participation

Apart from building P&Q into all ongoing tasks, additional provisions need to be made to ensure a continuous process of improvement. To this end, Small Group Activities (SGAs) and suggestions schemes have been installed in a great number of companies in order to make more use of the employees’ experience.

2.3.1 Small Group Activities (SGAs)

SGAs are often mentioned in relation to Total Quality Control (TQC). Even though Quality Circles are an important part of TQC, they have a much broader application, for instance job design, environment-friendly production practices, energy saving and virtually all possibilities of improving productivity and quality in an enterprise.

SGAs complement the normal top-down approach of running an enterprise with a bottom-up system of organized experience exchange. In figure 7.4, two different types of SGAs are displayed: “Organizational Small Group Activities” and “Autonomous Small Group Activities”. Quality Circles, zero defects groups, value analysis teams, total productivity improvement circles, for example, are autonomous SGAs, whereas task forces, working groups and project teams set up by management are organizational SGAs. The latter would contribute, for example, towards improving the information flow between functional departments, coordinating production planning or setting up new computer systems. This organizational SGA would normally be
Small group activities

(1) Activities of small number of people

(2) Includes both organizational and autonomous activities

(3) Supported by different organizations

*QC: quality control
ZD: zero defects
TPM: total productivity management

Figure 7.4: Comparison of Small Group Activities

Organizational Small Group Activities

(1) Objectives are directly connected to profit

(2) Several to several dozen of people

(3) Members come from many departments

(4) Managerial level and non-managerial level personnel coexist

(5) Dissolve when the objective is achieved

(6) Controlled by organization

Autonomous Small Group Activities

(1) Objectives are limited to profit-making

(2) Four to ten people

(3) Members are limited to the same workshop

(4) Consists basically of non-managerial personnel

(5) Closely related to the workplace; not dissolved

(6) Autonomous control (free from organizational control)

interdepartmental in character and would also involve specialists from support services, such as industrial engineering, training or even outside consultants.

Organizational SGAs form part of the “formal organization” of the enterprise, and have been established for two main purposes: to ensure better coordination of activities, and to solve specific problems which need input from different enterprise units. Organizational SGAs, therefore, should concentrate on a specific objective and should be dissolved after the objectives have been reached. Typically, organizational SGAs are established in order to implement productivity improvement programmes (PIPs) (see Modules 5 and 6).

While organizational SGAs are focused on a concrete objective, preselected by management, autonomous SGAs define their own targets. Inohara (1991) describes these types of SGA as follows: “In principal, these employee groups parallel corporate formal organization on a voluntary basis. Keys to successful operation include a will of top management to develop small groups and the practice of cooperation between workers’ representatives and management.”

The merits of SGAs, as shown in figure 7.5, are various. Tangible results include the improvement of productivity, product quality and the company’s financial condition, as well as a shortening of working hours. Intangible results include employees’ pride in the job, an improvement in attitudes to work, interpersonal communications, a strengthened team spirit and an improvement in occupational safety and health.

**Figure 7.5: Merits of Small Group Activities**

<table>
<thead>
<tr>
<th>TANGIBLE</th>
<th>INTANGIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvement of productivity</td>
<td>Pride in job</td>
</tr>
<tr>
<td>Improvement of quality of product/service</td>
<td>Motivation</td>
</tr>
<tr>
<td>Improvement of financial condition</td>
<td>Improvement of communications</td>
</tr>
<tr>
<td>Shorter working hours</td>
<td>Promotion of cooperation</td>
</tr>
<tr>
<td>Improvement of safety</td>
<td>Improvement in work attitudes</td>
</tr>
<tr>
<td></td>
<td>Strengthening of team spirit and teamwork</td>
</tr>
<tr>
<td></td>
<td>Improvement of hygiene consciousness</td>
</tr>
</tbody>
</table>

Source: Inohara, 1991, p.73.

What needs to be done to set up autonomous SGAs company-wide?

On the basis of experiences with the establishment of productivity improvement circles (PICs) in the Philippines, Vasquez et al. (1983) propose five major steps:

- orientation for top management;
- workshop for middle management;
- selection and training of circle leaders;
- establishment of pilot circles; and
- company-wide implementation of the programme assisted by a coordination mechanism, e.g. a productivity improvement committee (see also the summary of the Philippine PIC approach in Prokopenko (1987)).
Apart from the allocation of working time for the meetings, as well as of convenient meeting rooms and an appropriate follow-up of proposed actions, the life of an SGA greatly depends on the conduct of its meetings. Vasquez et al. (1983) define the role and activities of the meeting as follows:

All the circle members learn more about themselves, their fellow workers, their work and its significance, and their workshops.

Meetings conducted as SGAs should at least comprise the following:

1. **Study group sessions.** These regular meetings enable SGA members to learn more about a specific subject in which they are interested.
2. **Circle leaders' meeting.** Leaders share problems, solutions and experiences encountered in facilitating the meetings.
3. **Exchange visits.** Visits to other firms are organized and encouraged. These give SGA members of different companies an opportunity to exchange ideas and experiences.
4. **Problem-solving activities.** These enable workers to identify, analyse and formulate solutions to problems, the results of which are formally presented to management which in turn has to decide on the implementation of the circles' recommendations. If these recommendations are approved, the circle members themselves implement them and if they are effective they become standard procedure.

SGAs will be effective and its members motivated to participate only if management follows up proposals systematically and does not delay the implementation of decisions. Senior management will have to know how to induce continuous processes of change and how to adapt continuously to a changing environment.

Even though, in theory, SGAs are carried out on an entirely voluntary basis, following initiatives of the employees, in reality it is often management which takes the lead to establish SGAs on P&Q in a company. Referring to the development of Quality Circles (QCs) in Japan, Uy Onglatco (1988) concludes that, though QCs are officially not a duty, in reality employees have no choice but to participate. Thus SGAs become a formalized way of channelling employees' participation and the sustainability of SGAs is viewed as a management problem. This issue is dealt with later in this module.

### 2.3.2 Suggestions schemes

Apart from SGAs - which are joint efforts to improve P&Q - there are suggestions schemes to collect individual contributions to improve P&Q. Suggestions schemes have a long-standing history in many enterprises. Although staff suggestions cover a wide variety of subjects, most of them aim to improve products or resolve work-related problems in a particular workplace. Suggestions are generally rewarded financially and sometimes also in kind or in some other way. The employer in return acquires the right to exploit the suggestion. Financial awards given to the employee can be very substantial; the same is true for the economic benefits of suggestions schemes. In Japan, for example, staff suggestions brought total economic benefits of some 225.4 billion yen in 1980. In the former Federal Republic of Germany overall savings amounting to DM 9.4 billion were made as a result of approved staff suggestions during the period 1974-83. More recently,
published figures show that, in 1986 alone, Daimler-Benz saved more than DM 14.5 million in this way (Klotz, 1988). In many countries there exist associations or institutes for staff suggestions which assist companies in setting up and running such schemes, as well as in keeping records of the results.

In the following sections we shall deal with the most important points which should be considered in setting up and running suggestions schemes (cf. Fernau, 1982; The Industrial Society, 1986; Klotz, 1988).

**Management support.** It is little use expecting the suggestions scheme to be effective in an organization where employees are not encouraged to express their views. Experience has shown that management support at all levels is essential if a scheme is to succeed. Management has to make clear that suggestions are not regarded as implied criticisms of the person within whose field of responsibility the suggestion falls.

**Selling the scheme.** To ensure a continuous flow of suggestions there can be no doubt as to the importance of positive publicity in maintaining the interest and improving the response of employees. There are numerous ways of drawing attention to the suggestions schemes. There could be a section on suggestions and awards in the enterprise journal, and suggestions forms could be periodically enclosed in it. Other common forms of promoting the suggestions scheme are posters and special notice boards as well as a distribution of suggestion boxes at strategically well-located places. Booklets on the functioning of the scheme should be issued and newcomers to the company should be given an introduction to it. Award-winning ceremonies are a useful way of promoting the scheme. Some organizations operate lotteries or prize draws in order to promote participation.

**Organization and administration.** Most enterprise suggestions schemes have three main elements:

- a suggestions scheme office which is responsible for receiving all suggestions, registering them and submitting them to management and to the evaluation committee;
- an evaluation committee which decides whether the suggestion is to be accepted or rejected, and in the case of acceptance the action to be taken as well as the sum to be awarded to the person who suggested it; and
- the appeals mechanism which the suggestor may use if he or she feels that the suggestion was unfairly rejected or inadequately awarded. Figure 7.6 shows the suggestion review and acceptance procedure in the case of the British company Lucas Industries plc.

**Eligibility.** The question of who is to be allowed to participate in the staff suggestions scheme, and who is entitled to receive an award, can be a source of controversy. In most cases agreements specify that the making of suggestions should not be part of an employee’s normal duties and expected work tasks. Some companies have adopted a rating system where the less related the suggestions are to the work a person performs, the higher the level of rating.

**Awards.** In the kinds of compensation awarded to suggestors, we may distinguish between two broad categories: (a) awards based on calculable savings (say, for example, employees were to receive a percentage of the first year’s savings or so many months savings; in cases where the full value of the suggestion cannot be accurately assessed before it is used, an interim award can be
Figure 7.6: Handling of suggestions at Lucas Industries plc.

**SUGGESTIONS BOX**

Upon receipt, your suggestion will be dated and recorded. The white copy will be filed for reference, the blue copy sent to the appropriate department for investigation.

**INVESTIGATION**

Your suggestion will be followed through the investigation procedure by the Suggestions Investigator. He will obtain all the necessary reports and any samples which may be required to present a complete case study of your idea to the Suggestions Committee.

**SUGGESTIONS COMMITTEE**

The Committee considers all the investigation reports and does its best to ensure that the suggestion is properly rewarded.

**SUGGESTIONS SCHEME OFFICE**

If your suggestion is rejected, you will be notified in writing of the reason why.

If approved you will receive a written notice of final approval. Awards of £50 and over will be presented by cheque.

given and a definitive award could be calculated later); and (b) suggestions where it is impossible to calculate savings accurately. In this case, a kind of point-rating system is often used, which includes other criteria such as originality, ingenuity, care in presentation, improvement of safety and health or environmental protection. For minor suggestions a lump-sum payment could be made.

Legal implications. Arrangements should be made to cover the possibility of the employee putting forward a suggestion which may be patented. Another issue is the taxation of awards. In many countries awards are not taxed, provided that they do not exceed a certain sum and that they stem from a formally constituted scheme.

Workers' participation. In recent years suggestions schemes have increasingly been included in collective agreements. They have also been the subject of legislation determining the rights of workers in respect of suggestions which lead to new production methods or patentable inventions. Workers' representatives should be given the chance to participate actively in setting up and running the scheme. In some countries there are legal provisions for this. For instance, in Germany, works councils have an explicit right under the Works Constitution Act to co-determine the principles concerning suggestion procedures.

A company respecting the above-mentioned points should expect its suggestions scheme to run reasonably well and lead to benefits both for the company and for the employees.

2.4 P&Q support services

P&Q support services are needed in a company to:
(a) carry out specialized organization and methods (O&M) analysis;
(b) act as internal consultants with specialized know-how;
(c) monitor success and failure of P&Q initiatives;
(d) facilitate work groups;
(e) assist in project management;
(f) train staff on all levels; and
(g) assist staff in solving personal problems.

2.4.1 Industrial Engineering (IE)

In the development of a company P&C movement, IE plays a leading role in carrying out the tasks mentioned. A detailed description of IE tasks and techniques can be found in Module 10. In the organization of IE functions, we can find a number of solutions. One approach puts the IE unit in the position of an in-house consultancy service, the use of which is based on the "marketing" of IE services to the functional departments or business units. This approach gives IE an independent position as arbitrator or facilitator, but does not always help to ensure continuity and the implementation of unpopular measures.

Another approach, therefore, consists of integrating industrial engineers into functional departments and business units, so that IE know-how is integrated continuously into all mainstream activities. A combination of both approaches can also be found in many companies.
Independent from the issue of finding the right place for IE in an organization, the way industrial engineers act has changed with the decline of Taylorism.

While traditionally industrial engineers performed O & M studies, and subsequently defined the “best method” to carry out a task, today they act more and more as facilitators of work groups or leaders of SGAs, channelling shop-floor expertise into viable solutions. The industrial engineer not only has to be an O&M expert but also has to have the skills to moderate group activities, evaluate the feasibility of proposals and sell them to management and staff.

2.4.2 Training

A second set of supporting services is related to training. The role of training in developing a company P&Q movement cannot be overemphasized. High-productivity countries such as Germany and Japan attribute a great deal of their success to practice-oriented and high-quality training inside and outside the enterprise.

Apart from providing the necessary technical organizational problem-solving and managerial skills, training for P&Q improvement has to tear down communication barriers in the enterprise and develop an understanding of how the productivity improvement process works and how each individual can contribute to this process. High-productivity countries are taking this fact into account by offering productivity training for staff in all levels of the enterprise, from the shop-floor to top management. P&Q training should also be provided for workers’ representatives and union activists as they play, in most countries, the decisive role in facilitating change.

The quality and practical orientation of vocational training plays a crucial role in achieving and sustaining a high level of P&Q. As priority action to improve P&Q companies of high productivity and quality, countries such as Germany, Japan and Switzerland give attention to their apprentice schemes, the main feature of which is a well-coordinated integration of theory and practice (the so-called “dual system”).

In most productive countries of the world, middle and junior management plays a crucial role in improving P&Q; hence the reason why they often form the main target group for productivity training. These managers, especially supervisors, must be prepared to act as mediators between senior management and the workforce to solve the problems systematically and to motivate their staff. The ILO has prepared a specific modular programme for supervisory development for this purpose (Prokopenko and White, 1981).

Senior management will have to know how to induce continuous processes of change and how to adapt continuously to a changing environment.

What are the most appropriate forms of productivity training? There are several answers to this question. Programmes to raise productivity awareness should convey theoretical concepts and convince by explaining practical cases. Specialized training programmes to obtain the necessary skills to improve P&Q must validate these skills in practice. Adequate training forms are, for example, action learning or training courses combined with project works in companies. The latter have proved especially successful in enterprises where there is as yet no productivity infrastructure and expertise.
Figure 7.7 gives some examples of project work and SGAs which can help staff to acquire P&Q improvement skills without formal training. In project work team members will acquire or improve such skills as communication, moderation of groups, presentation of results, and leading groups; and they will reach compromises between conflicting views, develop creativity, and acquire a basic knowledge of other disciplines.

**Figure 7.7: Acquiring P&Q improvement skills through project work and SGAs**

<table>
<thead>
<tr>
<th>Type of project</th>
<th>Main characteristics</th>
<th>Role and development of team members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task force</td>
<td>High-priority problem solution</td>
<td>Project leader</td>
</tr>
<tr>
<td>New venture team</td>
<td>Search for new business opportunities (e.g. following SWOT* analysis)</td>
<td>Team leader</td>
</tr>
<tr>
<td></td>
<td>Joint management of product development and improvement</td>
<td>Team member</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderator of meetings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Presenter of solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coordination officer</td>
</tr>
<tr>
<td>Product team</td>
<td>Improvement and process with a multidisciplinary group of specialists</td>
<td></td>
</tr>
<tr>
<td>O &amp; M group</td>
<td>Voluntary meetings of staff interested in P&amp;Q improvements</td>
<td></td>
</tr>
<tr>
<td>SGAs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* SWOT = Strengths, weaknesses, opportunities, threats.

Source: Adapted from Domsch, 1991, p.349.

2.4.3 Occupational safety and health (OSH)

Unhealthy and unsafe working practices are generally not only less productive and lead to lower quality but are also a source of accidents and occupational diseases. For this reason companies should not forget occupational safety and health (OSH) support services when organizing a company P&Q movement. Workers would consider any attempt to launch a P&Q movement campaign in poor working conditions as "one more management manipulation to increase exploitation" and would stop cooperating with this movement.

In upgrading OSH, a company has to consider two main points: the functioning of an OSH
system to prevent and monitor health hazards, and the incorporation of safe working practices in all mainstream activities.

**Compliance with OSH standards.** P&Q will rise along with the level of workers’ health if the following general OSH principles are respected and the company complies with OSH standards. Although compliance with current OSH health and safety regulations is essential, many high P&Q companies adapt higher internal standards which incorporate a more stringent safety factor.

Compliance with standards requires close cooperation with labour inspectors as well as with the OSH committee within the company. In this respect, labour inspectors might be used as “free of charge” P&Q counsellors for the enterprise because of their wealth of experience from different companies.

Members of OSH committees within a company should be trained in P&Q improvement techniques, so that their suggestions could take care of workers, health and safety as well as of P&Q where appropriate.

**Prevention of health hazards.** Instead of rectifying unfavourable working conditions, it is far more effective to consider OSH criteria already during the design phase of systems in order to prevent the conditions for accidents from emerging.

**Regular screening of the workforce.** Regular medical screening of the workforce and of those workers with long-term and high-dose exposure to specific hazards is a prerequisite for the preventive measures outlined in the following paragraphs.

**Monitoring of exposure levels.** It is not enough only to screen workers. Their medical status report must be associated with the working conditions to which they are exposed. Workplace analyses and evaluations are also helpful in improving working practices. In this respect the IE and medical services, as well as OSH units, should collaborate closely.

**Elimination or reduction of workers’ exposure to health hazards.** To achieve this, there are basically four principles which may be applied: (a) first priority is to control, eliminate, substitute or reduce hazards at source; (b) if this is not possible, the health hazard should be isolated, for example, by machine guards, to avoid or restrict its propagation and transmission; (c) again, if this is not feasible or not enough, the worker has to be protected from or (d) be completely taken out of the hazardous environment: protective gear, air-conditioned cabins or even remote control are solutions which are often adopted in order to make productive work possible under adverse conditions (for example, in the processing industry).

Some of the measures which might be taken to improve OSH, along with P&Q in key production areas are shown in figure 7.8. There are a number of ILO publications which can be consulted by those interested in improving OSH, including:

- Thurman, J.E.; Louzine, A.E.; Kogi, K.: *Higher productivity and a better place to work: Practical ideas for owners and managers of small and medium-sized enterprises* (Geneva, ILO, 1988); and
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**Figure 7.8: How to improve key areas of production in a company**

<table>
<thead>
<tr>
<th><strong>Materials storage and handling</strong></th>
<th><strong>Control of hazardous substances</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Better organized storage</td>
<td>- Replace a dangerous substance with a less dangerous one</td>
</tr>
<tr>
<td>- If in doubt, take it out</td>
<td>- Use lids, covers, maintenance and isolation or processes to control hazards and reduce losses</td>
</tr>
<tr>
<td>- Avoid placing materials on the floor</td>
<td>- Save energy used to overheat chemicals</td>
</tr>
<tr>
<td>Save space by introducing multi-level racks</td>
<td>- Clean properly, don’t spread dust</td>
</tr>
<tr>
<td>Provide a “home” for each tool and work item</td>
<td>- Make local ventilation cost-effective</td>
</tr>
<tr>
<td>- Fewer and shorter transport and handling operations</td>
<td>- Use fans properly</td>
</tr>
<tr>
<td>The more you use it, the closer it should be</td>
<td>- Use push-and-pull ventilation</td>
</tr>
<tr>
<td>Use mobile storage</td>
<td>- Use natural air flow</td>
</tr>
<tr>
<td>- Fewer and more effective lifting operations</td>
<td>- As a last resort use personal protective equipment</td>
</tr>
<tr>
<td>Don’t lift loads higher than necessary</td>
<td>- Don’t eat or bring home dangerous substances</td>
</tr>
<tr>
<td>Move materials at working height</td>
<td></td>
</tr>
<tr>
<td>Make lifting more efficient and safer</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Work station design</strong></th>
<th><strong>Lighting</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Keep materials, tools and controls within easy reach</td>
<td>- Make full use of daylight</td>
</tr>
<tr>
<td>- Improve work posture for greater efficiency</td>
<td>- Avoid glare</td>
</tr>
<tr>
<td>- Use clamps, jigs, levers and other devices to save time and effort</td>
<td>- Choose an appropriate visual task background</td>
</tr>
<tr>
<td>- Improve displays and controls to minimize mistakes</td>
<td>- Find the right place for light sources</td>
</tr>
<tr>
<td></td>
<td>- Avoid shadows</td>
</tr>
<tr>
<td></td>
<td>- Ensure regular maintenance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Productive machine safety</strong></th>
<th><strong>Premises</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Give your machines a productivity check</td>
<td>- Protect your factory from outside heat and cold</td>
</tr>
<tr>
<td>Eliminate the hazard; or install guards; or as a last resort, use personal protective equipment</td>
<td>- Let nature help you</td>
</tr>
<tr>
<td></td>
<td>Improve the heat reflection of the walls and roof</td>
</tr>
<tr>
<td></td>
<td>Improve heat insulation</td>
</tr>
<tr>
<td></td>
<td>Use shades to protect against heat from the sun</td>
</tr>
<tr>
<td></td>
<td>Let natural air-flow improve ventilation</td>
</tr>
<tr>
<td></td>
<td>Make better use of horizontal air-flow</td>
</tr>
</tbody>
</table>

Source: Based on Thurman et al., 1988.
2.4.4 Work-related welfare services

Work-related welfare facilities such as canteens, rest areas, sanitary areas, drinking-water facilities, transport and recreational and child-care facilities are often ignored in discussions about P&Q. Already, the famous Hawthorne experiments of Elton Mayo have shown that productivity increases if workers feel that someone cares about them. Apart from the psychological effect, it is clear that workers will not perform well if they are hungry, thirsty or already tired when they reach the workplace. Personal and family problems also influence work performance. This is why when organizing a company P&Q movement the availability of work-related welfare facilities, either provided by the company itself or through access to facilities of the community, is an important point to be considered. Some of the facilities a company should take care of are:

*Drinking water.* Drinking water is essential for all types of work, especially in a hot environment. There are several types of arrangements for drinking water: for example, water bags or bottles, drinking-water containers, drinking fountains.

*Sanitary facilities.* Sanitary facilities are generally required by law but with a little investment companies could make them attractive and clean.

*Rest areas.* As workers are not just idle during rest breaks but are recovering from fatigue and preparing for continued productive work, rest areas should be detached from the work station and be free of disturbances.

*Working clothes and changing facilities.* In some cultures the wearing of work uniforms decorated with the factory emblem can contribute to company loyalty and work discipline; specially designed work clothes might often help to reduce accidents. Facilities for the safe storage of clothes and other personal belongings will assist workers with their personal hygiene and avoid anxiety about the theft of personal possessions.

*Canteens and eating areas.* Establishing canteen services is the best way to guarantee that workers eat sufficient nutritious food during a reasonably short break from work.

*Transport facilities.* Getting to and from the workplace may be difficult, lengthy and tiring, and this in turn can cause fatigue, anxiety and financial hardship for the workers and result in undue lateness, increased worker absenteeism, high labour turnover or declining labour efficiency for the enterprise. This is why enterprises should find a solution by providing their own company transport or by supporting other means of transport in order to ease the possibility of getting to the company.

*Recreational facilities.* One important result of recreational facilities, apart from the physical and mental well-being of the workers, is that social relations within the enterprise are improved. If supervisors or managers participate in recreational activities, this may greatly help in terms of communication and mutual understanding. If a company does not want to establish its own recreational facilities, it could rent facilities available from the community or from sports clubs.

*Child-care facilities.* Many employers find that working mothers are especially loyal and effective workers, but that they often need help with the problems of caring for children. This is why a company, depending on its size, could opt for installing its own child-care facilities or co-finance
services of the community, which in turn would provide a certain number of places for children of company staff.

*Staff counselling.* Workers who come to the workplace with a number of personal and family problems, who take drugs or alcohol or smoke excessively are generally not so productive as those without such problems. This is why mainly bigger companies have set up staff counselling schemes where staff with problems can consult a social worker or psychologist.

### 2.5 Coordination and network

The description of the main components of a company P&Q movement would not be complete without an examination of the various forms of coordination of the above-described P&Q activities and support services.

P&Q councils or committees, steering groups or coordinators have two main tasks to fulfil:

- ensure that the different P&Q improvement activities and support services relate to each other in such a way that the P&Q movement in the company gains momentum, and measurable results are obtained and sustained throughout the company; and
- create a constructive dialogue between management and workers’ representatives concerning a long-term P&Q improvement strategy.

The task of a corporate P&Q network to ensure full workers' participation cannot be overemphasized. From the above it becomes clear, however, that the better P&Q improvement is integrated into all mainstream activities of a company, the less central coordination is needed.

The tasks and responsibilities of the bodies forming the P&Q coordination network differ quite significantly from company to company, depending on their organizational philosophy. We may, however, define some main tasks which a corporate P&Q committee is supposed to carry out. These tasks are described in figure 7.9. Normally, such a committee has no wide-ranging decision-making powers, but has to submit its proposals to the company board. In large enterprises there might be a P&Q coordination unit, also at business unit level, which liaises with the corporate P&Q committee.

Shetty (1982) describes an American example where the P&Q programme involves a corporate P&Q committee, a P&Q coordinator and divisional P&Q committees. Members of the corporate P&Q committee are selected from different parts of the company and given the responsibility of getting the programme under way. Each divisional committee consists of representatives from management, office workers, sales personnel and production people, sometimes including union leaders. The divisional P&Q committee formulates a plan of action, sets goals, discusses techniques and follows up on the progress of P&Q improvement efforts. At Honeywell, according to Shetty (1982), a corporate administrator is responsible for assisting in the day-to-day implementation of P&Q programmes. The P&Q steering committee includes five top officials, and the administrator shares the responsibility for developing a programme to educate and assist divisions and functional groups in measuring and improving P&Q. The Honeywell organization includes coordinators in its various divisions, plants and departments, who chair the group meetings with workers in this unit. Top management at the corporate level
Figure 7.9: Main tasks of a corporate P&Q committee

1. Formulate a P&Q policy of the company.
2. Raise P&Q awareness.
3. Assess systematically P&Q improvement needs.
4. Set guidelines for reporting and monitoring.
5. Define a P&Q training policy.
6. Establish priority improvement areas and corresponding P&Q improvement objectives.
7. Prepare agreements with the works council on the means of P&Q improvement and related workers' participation.
8. Ensure that P&Q improvement activities at unit level correspond with overall objectives and with the business plan of the company.
9. Avoid duplication of work.
10. Act as an arbiter in case of conflicts between business units or between labour and management.
11. Monitor the achievement of P&Q improvement objectives and report on action required to top management.

are expected (a) to establish overall P&Q goals; (b) to develop and refine the P&Q programme; (c) to monitor and evaluate the effectiveness of the programme; and (d) to provide staff support to divisions. Each operating division and its managers are responsible for (a) disseminating P&Q goals to sub-units or departments; (b) planning its programmes; (c) making studies of and gathering data on the department and divisional programmes; (d) monitoring and evaluating the programmes; and (e) providing staff support for departments.

Functions of P&Q committees vary widely. Therefore, it is difficult to say who should be a member of such a committee. Certainly both management and labour should be represented, as well as the main specialists in charge of P&Q improvements in industrial engineering, quality in management and occupational safety and health.

Even though in many companies a P&Q coordination network is needed, the aim in organizing for P&Q should be to set up as few additional bodies as possible. The ideal that a company should pursue is to integrate all P&Q improvement activities into the mainstream functions of the company, without creating additional services, units and coordination networks.

2.6 Connecting with outside P&Q sources

In improving P&Q an enterprise does not stand alone but forms part of the business community. Experiences exchanged within the business community are a valuable source of learning from other enterprises. Such an experience exchange could be organized by chambers of commerce, manufacturers' associations and professional management as well as by industrial
engineering associations. The motivation for P&Q improvements very often stems from lessons learnt from competing or related companies.

Clients and suppliers are another driving force in improving P&Q. Feedback from after-sales services and the know-how of suppliers should be used in P&Q development and improvement.

Furthermore, companies do not need to rely only on their in-house P&Q support services but should make extensive use of consultants, training institutions or community services. But the use of these outside groups does not automatically lead to P&Q improvement. Consultants have to be well selected and companies have to use their services well. To facilitate this task, the ILO has prepared a client’s guide, How to select and use consultants (Kubr, 1993).

In consultations and bargaining on P&Q issues, the works council is advised by union officers and exchanges experiences with works councils of other companies.

In organizing a company P&Q movement, therefore, this complex network of influences and information has to be taken into account.

2.7 How to keep the company P&Q movement going

Earlier in this unit we saw that the continuity of P&Q improvement efforts is a key factor towards sustainable levels of P&Q improvement. However, how can we ensure that workers continuously perform at a high level, that new ideas are produced in SGAs and that a suggestions box will not remain empty after some years? In other words, how do we keep the staff motivated to perform at a high level and to contribute to P&Q improvement in the company?

A source of demotivation is often the way in which proposed P&Q improvements are implemented: sometimes the solution is incomplete, ideas do not work or workers resist the implementation, just to mention some of the obstacles encountered. For this reason, the successful implementation of P&Q improvement ideas is the best advertisement and motivation for further improvements. Figure 7.10 provides short guidelines on how to implement P&Q improvements successfully.

Continuous training is another source of motivation and high-level performance, but this is true only if the skills acquired in the training can be applied in the work situation. If the training, however, leads to the insight that, for example, the present work situation is inefficient and there is no means to change, the training leads to demotivation rather than to P&Q improvements.

Furthermore, the decentralization of decision-making, giving responsibilities to workers and lower management as well as practising participative leadership, are all important assets in motivating people to contribute to the company’s success.

If P&Q improvement requires more significant changes in the enterprise, such as closing a plant or heavy investments in new technologies, a careful change management is required to protect staff from demotivation. Module 8, “Managing organizational change”, deals in detail with these aspects.
Don’t waste your time and money implementing important improvements in a careless way. Even simple improvements often fail because of a lack of foresight and planning. This guide gives five simple rules that will help you to be successful. In addition, they will help you to make improvements happen frequently instead of stopping after three or four have been completed. Continuous improvement is the road to survival and growth.

**Develop a complete solution**

Improvements sometimes don’t work because they are incomplete. What additional changes may be necessary to make the improvements work well:

- in materials storage and handling?
- in work station design?
- in work organization?
- in control of hazardous substances?
- in lighting?
- in welfare facilities?
- in premises?
- in work organization?

**Make sure your ideas will work**

Very often, even improvements which seem simple do not meet your expectations in practice. Anticipate design problems and make sure that all important factors have been taken into account.

Ask yourself what makes you believe that this improvement will work well:

- because you have tried out different ways of solving the same problem and this one works best.
- because you have tried it out in a small way and it works well.
- because you have seen it work in the same conditions in another enterprise.
- because you have the advice of someone who has done the same thing.
- because _____________________________

**Mobilize worker support**

Your programme for improvements will fulfil your expectations only with the goodwill and support of those who are directly affected by the changes. Your workers will be on your side if they fully understand that the changes are in their interests as well as yours.

Are you sure that the improvement will not cause any problems for your workers? Ask yourself:

Who will be directly affected by this change?
In what ways will they be affected?

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What will you do to eliminate or reduce negative effects?
Module 7
Unit 2

In order for workers to support what you are doing, they need to understand your intentions. They may have the idea that the changes will affect their job security or pay or make their work more difficult.

What techniques will you use to make sure that your workers are ready for the change and that they give you credit for what you are doing?
- Prior explanation and discussion.
- Involving workers in the design and introduction of the improvement.
- Showing how this innovation works in another shop or factory.
- Provision of additional training.
- Financial rewards.

Make improvements which will last

Four innovations out of five eventually disappear because no specific actions were taken to make them last. There are two main strategies which help to counteract this:
- Change people's habit and behaviour.
- Build the change into equipment and facilities.

For most changes you will need to do both to be successful. If you follow this method carefully and involve workers fully, you should make considerable progress in changing workers' habits and motivation. However, if the improvement is fully dependent on the behaviour of the worker (for example, the use of protective goggles when sharpening tools on a grinder, or preventing the cluttering of passageways), it is very likely that it will not last long. Old habits are very strong. To prevent this, we have to find ways of incorporating the change into machines and facilities, so that the equipment itself would reject the old routine (for example, install a permanent transparent screen on the grinder, or provide storage racks and bins, or clearly mark passageways).

Manage change

Be sure that changes will be effectively implemented. Foresee the following steps:

- Establish a firm deadline.
- Make someone responsible for implementation.
- Allocate adequate resources (time, materials, money).
- Request regular reports on progress.
- Check that the implemented improvement works well, is accepted by the workers and has no unexpected results.
- Make sure that you and your supervisors lead the way by following rules and by frequently praising workers who respond correctly to the improvement.

An important management responsibility is to make sure that improvement becomes a permanent part of the way work is done. Ask yourself:

- Do you receive a constant flow of ideas from your staff and workers?
- Is everyone in search of ways for more productive or higher-quality work?

Each individual improvement is an opportunity to become a real manager of change. The following steps will help make your company more dynamic. How many will you take?

- A suggestions scheme with rewards for the best idea.
- Regular meetings at which workers are encouraged to explain their problems and give their ideas.
- An exercise in which groups of workers use the checklist and make proposals to you.
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Unit 2

Which steps will you take to make the change last by building it into your plant and equipment?

- Remove any tools or equipment which make it possible or easier to return to the old situation.
- Build the improvement into machines so that it cannot be removed.
- Design new or modified equipment so that it is easier to use and maintain in the new way.
- Provide barriers, painted lines, or make other changes which make the improvement easily visible and natural to follow.

Source: Based on Thurman et al., 1988.

Many companies detect the need for their workers' participation only in situations of required adjustment measures. To keep the company P&Q movement going, workers' representatives need to be continuously informed and consulted.

Remuneration and incentive schemes to reward high performance and improvement are perhaps what first come to mind, if the sustainability of P&Q improvements is discussed. Apart from the traditional incentive schemes, productivity gainsharing has become a widespread practice in enterprises. This aspect is dealt with in Module 14, "Productivity motivation and gainsharing".

Even though the staff may be content with their remuneration, there is always the factor of adaptation to the status quo and staff do tend to lose their interest in improvements. For this reason, from time to time, the interest of the staff in P&Q issues has to be aroused by, for example, specific campaigns, information leaflets, posters, articles in the company journal, statements by the chief executive officer or board members.

If P&Q improvement requires more significant changes in the enterprise, such as closing a plant or heavy investments in new technologies, a careful change management is required to protect staff from demotivation. Module 8, "Managing organizational change", deals in detail with these aspects.

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We saw earlier that creativity is a major asset for P&Q improvement, and this is certainly true for ensuring that the improvement of an enterprise's performance is maintained.

Questions for discussion

1. What are the main building blocks of a company P&Q movement?
2. What are the merits of Small Group Activities?
3. What are the most important steps in introducing P&Q movement schemes into the company’s operations?
4. How does employees' participation contribute to the success or failure of a P&Q movement? What are the main forms of employee participation?
UNIT 3: CASE STUDY: BHARAT HEAVY ELECTRICALS LTD. (BHEL)

UNIT 3: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand a practical system of P&Q movement in a real company.
2. Analyse the advantages and disadvantages of the P&Q movement in the company concerned.
3. Relate the BHEL experience to your company’s P&Q movement and the necessary conditions to start one.

UNIT 3: CONTENTS

3.1 Background
3.2 Organizational framework
3.3 Planning and project identification
3.4 Reviewing and monitoring
3.5 Generation of awareness
3.6 Suggestions scheme
UNIT 3: CASE STUDY: BHARAT HEAVY ELECTRICALS LTD. (BHEL)

3.1 Background

BHEL is a producer of all kinds of electrical equipment with a workforce of over 70,000 people. BHEL’s P&Q improvement efforts have repeatedly been recognized by the Indian National Productivity Council’s award for the best productivity performance. The success of the BHEL P&Q movement is proved by savings of over 50 million rupees in 1985/86 as a result of productivity projects. On the basis of BHEL documentation, we shall describe how this company organizes its P&Q movement.

3.2 Organizational framework

In BHEL the P&Q movement started with a joint labour-management committee meeting in 1982. To coordinate the efforts of the units as well as to draw up overall corporate guidelines, a corporate productivity group was formed. The group is headed by a senior industrial engineer and has the following tasks:

- developing policy guidelines and strategies;
- identifying thrust areas;
- assisting in planning P&Q improvement projects in units;
- developing a budgetary system related to turnover for a minimum predetermined return;
- developing a reporting and monitoring system for units;
- propagating the concept through contact with national and international bodies and productivity networks, and through a special newsletter on productivity;
- organizing development and awareness generation programmes; and
- training productivity coordinators in units.

Business units were given freedom to build up their own method of planning, organizing, coordination and control. A network of volunteer coordinators started to form a productivity cell consisting broadly of people from:

- finance and accounting;
- engineering and design;
- materials management;
- production and maintenance; and
- industrial engineering/management services.

The unit cells have now been strengthened and are headed by a full-time senior executive (unit productivity coordinator). The main functions of productivity cells in business units are:

- to plan and periodically review a P&Q improvement programme for the whole business unit;
- to assist in planning and implementing P&Q projects by departments;
- to follow up the actions recommended by top management of the business unit;
- to coordinate lead agency role (if any) given to the unit;
- to organize and participate in inter-unit productivity coordinators’ meetings;
- to coordinate with the corporate productivity group on all matters related to P&Q;
- to implement a suitable suggestions scheme wherein a satisfactory number of useful suggestions can be obtained from all sections of employees;
- to prepare monthly management information reports;
- to identify newer potential areas of savings and inform unit management periodically of these;
- to promote P&Q concepts amongst employees; and
- to organize large-scale training programmes to cover all employees.

3.3 Planning and project identification

Several areas have been identified for P&Q improvement. The areas with the greatest potential are material utilization, value engineering, indoctrination (use of locally made parts) and energy conservation.

Projects in these areas have been identified and schedules and responsibilities have been fixed. To have specific know-how on P&Q improvement available and to avoid duplication, specific areas have been created and units have been designated as lead agencies, their role being to:

- share experiences;
- keep up with the latest trends in that area;
- review the existing system;
- introduce bigger projects;
- organize seminars/workshops; and
- collect company-wide data concerning the area requiring attention.

3.4 Reviewing and monitoring

The reviewing and monitoring system operates at two levels. At business unit level, unit management reviews the progress of the P&Q projects once a month, while the unit productivity coordinator receives regular feedback from the departmental productivity groups. At the corporate level the link with the corporate productivity group is formed through the monthly management information report. Projects are classified into A, B and C categories, depending on the savings they generate. A progress evaluation review of projects at the shop-floor level is carried out periodically by representatives of the corporate productivity group. Besides this, inter-unit productivity coordinators' meetings are organized once a quarter to review progress, discuss operational problems and share information on P&Q.

3.5 Generation of awareness

Through special training programmes organized in the business units, all employees have been covered by the “generation of awareness” programme. In addition to training, posters and stickers are distributed, slogan and essay competitions run, a special house journal and information on P&Q are provided in local languages, together with talks, seminars, workshops, exhibitions and information-sharing and problem-solving forums.
3.6 Suggestions scheme

The creative potential of the employees and their intellectual participation in every sphere of work activity for P&Q improvement is being used in BHEL through various suggestions schemes operating in the units, all of which lead to higher productivity.

Apart from being rewarded for their suggestions they may receive an award such as the "Inter-departmental Productivity Shield for Best Productivity Enhancement Group" at unit level, and case studies are presented in the house journal.

Questions for discussion

On the basis of the information given above, discuss the BHEL organizational approach to P&Q management, bearing the following guidelines in mind:

1. Does the organizational set-up fulfill the Seven Cs for developing a corporate P&Q culture?
2. Evaluate, on the basis of the limited information you have, the strengths and weaknesses of the BHEL organization in improving P&Q.
UNIT 4: SUMMARY AND REVIEW

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Provide an overview of the essence and content of the complete module, including the full process of the P&Q movement in the company.

2. Use action guidelines to plan your work in P&Q movements.

3. Consult the available literature to improve your competence in this field.

UNIT 4: CONTENTS

4.1 Summary

4.2 Action guidelines
UNIT 4: SUMMARY AND REVIEW

4.1 Summary

Organizing for P&Q means matching the overall organizational approach of a company with the building blocks of a P&Q movement.

First priority in organizing for P&Q improvements is the development of a lean organization which incorporates a P&Q attitude into all mainstream functions. This requires the development of a corporate P&Q culture, the main features of which are confidence and trust, cooperation and commitment, communication, coherence, continuity, creativity and continuous training (the Seven Cs).

Within this framework an effective system of employee participation has to be developed: Small Group Activities and suggestions schemes are viable solutions. Workers' participation also requires the establishment of a permanent consultation process between workers' representatives and management. This is often done through the establishment of joint committees.

P&Q support services are needed in a company in order to carry out specialized organization and methods studies, act as internal consultants, monitor the success or failure of P&Q initiatives, facilitate work groups, train staff and assist in project management.

Using external productivity sources such as consultants' training institutions and community services, as well as the coordination of P&Q activities within a company, are further elements contributing to sustainable P&Q improvements.

4.2 Action guidelines

1. Develop a lean organization. Do not try to cure a malfunctioning organization by setting up numerous project groups and coordination committees.
2. Incorporate a P&Q attitude into all mainstream functions by developing a corporate P&Q culture.
3. Do not expect employees to participate without an adequate reward system.
4. Make use of outside productivity sources as much as possible, as they could bring in fresh ideas and solutions.
5. Adopt a long-term perspective of P&Q improvement which is integrated into your company's strategy.
6. Establish a continuous dialogue with workers and their representatives.
7. Train everybody in the company for P&Q improvement.
BIBLIOGRAPHY


Fernau, C.N.: *Suggestions schemes* (Geneva, ILO, 1982).


MODULE 8
MANAGING ORGANIZATIONAL CHANGE
MODULE 8: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand why organizational changes are necessary for productivity improvement, identify and analyse the sources of resistance to change.

2. Plan and manage the change process, and distinguish the developmental approach from other change strategies.

3. Use the most important diagnostic tools.

4. Make use of different group work activities in implementing changes.

MODULE 8: CONTENTS

UNIT 1: Why change organizations?

UNIT 2: Targets of change

UNIT 3: What does “change” in organizations mean?

UNIT 4: Diagnostic process and tools

UNIT 5: How to design the organization of the future and manage change

UNIT 6: Supporting the change process

UNIT 7: Module summary and review

Bibliography
UNIT 1: WHY CHANGE ORGANIZATIONS?

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand the main reasons for change and its links with productivity.
2. Appreciate the role of management in initiating and managing change.
3. Distinguish three major strategies for change and explain their relationship.

UNIT 1: CONTENTS

1.1. Change as a task for management
1.2. Different approaches to managing change
1.3. Practical exercises
UNIT 1: WHY CHANGE ORGANIZATIONS?

Despite the number of valuable concepts and practical tools for improving productivity, most organizations fail to improve their output effectively. Even good ideas are often rejected. Failure to understand proposals for change or unexpressed distrust prevent many people from accepting new ways of working or a new organizational framework.

The main reason for rejecting change is not that the aims and objectives are bad, but that the way that changes are introduced is not appropriate. Thus, the strategy of change must be given due consideration.

1.1 Change as a task for management

It may sometimes seem that everybody tries to avoid organizational change - although change is there, always and everywhere. From the time that a business is first founded, it will constantly improve its products or offer additional services to attract new customers; new competitors in the market will require modern sales techniques; the original machinery will be replaced by better equipment; employees will have to improve their skills to be competitive. Changes in marketing, technology and personnel require new ways of organizing and managing a business. This means disorder, discomfort, tension and insecurity - while most people prefer stability and tranquility. In effect, therefore, management must fulfill two basic functions very consciously and must keep them in reasonable balance:

- management must innovate (improve or renew its products, working methods, organizational structures, employees' knowledge and skills);
- it must maintain its achievements (it must consolidate and build up order and stability).

If the maintenance function is overemphasized, the organization will be too rigid and conservative and will have difficulty meeting future requirements. After a while it will become inflexible and even bureaucratic. But, if the innovative functions become dominant, the organization will be confusing, people will lose their orientation, energy will be wasted by unconcentrated and uncoordinated efforts, exciting plans and projects will be started but not completed. Thus the art of effective change management is to balance the two basic functions of innovating and maintaining.

Because change takes place continuously, it is obvious that high-level skills for the management of change are vital for all organizations. The speed and effectiveness of organizational change are important elements in the competitiveness, profitability and survival of enterprises.

Unfortunately, most managers are well-trained in technical and financial matters, but not in change skills. Many of them introduce change in an unprofessional way and cause problems such as:

- open or invisible resistance;
- waste of money, time and energy;
- demotivation of the workforce because of insecurity or conflict.
This module describes a few basic concepts of organizational change and provides some elementary and practical skills for the effective management of change. Positive change improves the quality of working life and the environment, thus leading to improved productivity.

1.2 Different approaches to managing change

Uncontrolled growth and change

Uncontrolled growth and change means that things are just allowed to happen without any steering or planning. For example, a new production line was built yesterday, new machinery is ordered today and some kind of training in “new management methods” will be organized tomorrow. There is no clear direction and no consideration of unintended side-effects. Such a situation arises when managers accept that they go where they are driven.

Uncontrolled change may have been acceptable in the past. But competitors look further ahead these days and make long-term plans for the future. Therefore, reactive behaviour is too short-sighted and irresponsible for modern business or public administration (see figure 8.1).

There are structural approaches to change discussed by Chin and Benne in Bennis et al., (1961). Renewal can either be brought about by the use of expert strategies, or power strategies, or a combination of both, or by organizational development. We will discuss these approaches below.

Figure 8.1: Planned and unplanned change

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<th>Approaches to planned change</th>
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<td>Wild and unintended growth and change</td>
<td>Expert strategy</td>
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<td>Power strategy</td>
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<td>Organizational development</td>
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Expert strategy

As a rule, top management hires experts to carry out a proper and rational analysis of existing problems and to make proposals for change. Unfortunately, in most cases only top management really knows what the experts are expected to investigate, while lower level managers only receive general information about “some surveys to be done in the next few months by experienced consultants”. Such an approach gives rise to rumours about cost cuts, redundancies, higher productivity standards, etc. Employees notice that strangers are standing around observing them, which causes distrust and makes them reluctant to give full information to the experts. Managers and workers in the unit do not participate in an active way, and as a consequence they may deny responsibility for the findings. Nevertheless, this approach has the advantage that experienced and well-qualified consultants can present consistent and logical diagnostic results.

However, there are dangers in calling in outside experts. When the results of the survey are
presented to top management, many people in the organization will reject the conclusions: “How can external people understand our problems? Did they really listen to what we had to say?” When employees are alienated from the diagnosis, they tend to react as victims.

The next step in a typical expert approach is to produce solutions. External consultants draw on their experience in other companies and try to apply it to the organization in question. Normally this has great advantages for clients, because they can benefit from a wide range of experience. Internal experts may be blind to new ways of thinking, for they are used to their own organization and accept the status quo. External consultants, however, may recommend new concepts based on a new philosophy - without any compromise. At the same time, the advantage implies a danger: new ways of thinking often provoke resistance.

As a next step, top management will have to approve the expert proposals and convince the whole management team that the suggestions are very helpful and should be carried out as soon as possible. As a rule, managers argue on a rational basis only and if there are no valid and strong arguments against the consultant’s recommendations they are accepted. But the problem of acceptance is never merely rational. People make an unconscious “win-lose assessment” of the effects of the changes on them. They will find many arguments against even the soundest proposals - if only to hide their real motives for rejecting them.

Experience shows that expert strategies cannot usually solve problems of implementation. The diagnosis and the recommendations may be excellent but implementation is not the responsibility of outside consultants. In order to solve this particular problem, consultants may hold meetings with the people concerned in order to present their proposals and discuss the advantages and disadvantages. Sometimes such meetings are organized as an internal sales activity, using psychological selling methods to get the people concerned to agree.

To sum up, the three basic steps of expert strategies are: analysing and diagnosing; developing new proposals as solutions for problems; transferring (diffusing) and implementing the solutions.

Power strategy

The basic idea of a power strategy is not to build up a consensus on change, but to influence the people who may be affected. Incentives may be offered for accepting the proposed changes and actively supporting their implementation. Incentives might take the form of higher status, prestige or salary, career opportunities, more influence or more subordinates. Alternative means are: threats of reprisals if the intended changes are not carried out, job loss, no career advancement or even demotion, etc. In case of almost equal power, one can bargain about mutual give-and-take, so that both sides derive some benefits.

There are many ways of initiating a power strategy. The most powerful people in the organization - representatives of the owners, politicians, top managers or shop stewards - will decide what kind of problems they would like to solve. Occasionally surveys are carried out by internal (or external) experts in order to provide arguments and a legitimate base for further decisions.

Another starting point could be a change in the power relations between two parties. For example, top management and the works council of a company may become equally powerful and
Module 8
Unit 1

need to negotiate changes which confirm their new power status. They have to share power and must take into account the other party’s interests.

Since it is the people who initiate the changes who are powerful, they can directly use this power in implementing their ideas. Therefore power strategies are often rather rigid and quick acting. They may even use an element of surprise: the more powerful party acts and confronts the weaker party with accomplished facts. Those with the power to make the first move can dictate conditions, forcing the weaker partner to react.

At first sight, the use of power seems to be very simple and effective. But in reality any power will provoke a show of counter-power. If top management exceeds its power by using primitive forms of coercion, moral pressure or even violence, the employees may consider a strike, maybe with the support of unions and other political groups. The simple mention of necessary changes may then prove difficult or, because of increased costs, even impossible.

According to the logic of power strategies, people will calculate the gains and losses resulting from resistance or obedience. This means that power strategies have to be continued to enforce further compliance, which may cause an endless cycle of autocratic leadership and permanent controls. A power strategy typically creates an “in-group”, which is close to the real power centre and helps to suppress dissenting opinions in the organization. It is clear that an organization that is reshaped by power strategies will not improve its creativity nor the skills and motivation of employees. To sum up, the main characteristics of power strategies are that:

- a clear and centralized power position makes it possible to implement changes quickly;
- active power will provoke counter-power;
- employees may obey but they will not be convinced or motivated, so that the continuous use of power means that controls and sanctions become necessary.

Better quality will never be achieved by power strategies, because a quality attitude requires that employees be self-motivated.

Combination of expert plus power strategies

Expert and power strategies are seldom used alone. Very often a combination is applied in an attempt to benefit from the strengths of both. Nowadays many change processes start with the first two steps of an expert strategy. At this stage, the experts may have almost unlimited independence. But when the results of the expert approach are presented, power is used in order to implement the expert recommendations quickly. For this reason, experts are often asked to assess potential resistance in the organization.

Experts often identify themselves with powerful people and work mainly in their interests, even though this may harm the organization. This is certainly the reason for the general strong distrust of external (and expensive) consultants among trade unionists.

Organizational development (OD)

During the late 1930s social scientists tried to learn from negative experience with the strategies described above. They concluded that a change strategy can be much more effective if the
following requirements are met:

a) A clear explanation must be given of the problems in the present situation: this means that employees must be involved in self-diagnosis (see Unit 4).
b) A clear orientation must be given with regard to future solutions: this means participation in developing goals, concepts, plans and solutions for the future (see Unit 5).
c) Changing a few elements affects other elements of the organization as well; therefore a holistic concept of organization must be used for both diagnosing and designing changes (see Unit 2).
d) Training must be part of all change activities, to give the people concerned new knowledge and new skills to handle the requirements of their future work situation (see Unit 6).
e) While diagnostic work is being carried out and action is being planned, tensions and resistance should be addressed by interventions in the psycho-social realm (see Unit 7).

A change approach should integrate all the above in an overall strategy. If a high degree of open and honest participation is offered, people can learn how to analyse problems and how to solve them. In this way, an organization can manage to comply with the changing demands of customers, of technology, ecology and the economy and adapt itself accordingly.

An expert strategy may do excellent work in analysing and designing, a power strategy may be able to push implementation even against the understanding and will of the people concerned - but by limiting itself to these two approaches, an organization will never learn to change according to new needs.

The main goal of the participative strategy of organizational development (OD) is to empower the employees of an organization to define their own working conditions, i.e. the structure of the organization, its goals and policies, in order to fulfil the task which is its reason for being. Thus, an organization can use the help of a consultant to manage the process of self-development through its own sources and resources. In this case, an OD consultant has to offer concepts and methods for diagnosing and managing the problem-solving process while at the same time teaching the organization how to change with less or no external help in the future. If the organization becomes aware of the methods and concepts for change, it will move into a new stage of its development. For more information on organizational development see Kolb, 1960; Beckhard, 1969; Blake and Mouton, 1969; Schein, 1969; French and Bell, 1973.

1.3 Practical exercises

Exercise 1. Participants' experience with organizational change

Small groups talk about their own experience of change, in situations which they experienced as “victims”. Discuss the questions:

a) What did I like when my organizational unit was changed by experts?
b) What did I dislike when my organizational unit was changed by experts?
c) What could we recommend to people who are responsible for planning and managing change?
The groups report in a plenary meeting and agree on the ten most important criteria for effective change.

**Exercise 2. Design for changing an organizational unit**

Three groups are formed to design the first steps of a change strategy in their own organizational unit. Each group concentrates on a different strategy.

The task for group A is:
Plan some change activities on the basis of an expert strategy.

The task for group B is:
Plan some change activities on the basis of a power strategy.

The task for group C is:
Plan some change activities on the basis of organizational development.

Each group presents conclusions:

- What are the advantages of this approach?
- What are the disadvantages of this approach?

The report in the plenary meeting leads to general conclusions with regard to the basic strategies.

**Exercise 3. How to argue in favour of organizational development**

A role play can help deepen understanding of the pros and cons of organizational development.

The role play can be done in two versions:

a) One trainee plays a consultant who argues in favour of OD; another trainee plays a top manager who is convinced that only an expert approach is appropriate.

b) One trainee plays an OD consultant, another plays a top manager who is convinced that only a power approach will work.

The players have ten minutes to work on their roles, while the other trainees prepare themselves to observe the role play, looking for specific points. The role play lasts for 20 minutes. After that the players are asked to describe their feelings and thoughts, then the observers add their observations. The conclusions are collected: What were the strong and the weak points? Where is deeper understanding still needed?
UNIT 2: TARGETS OF CHANGE

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand the role of the seven basic elements of an organization and their interrelationships in the change process.

2. Identify three organization subsystems with their main components and explain their role in the change process.

3. Trace the implications of change in one organizational element for the other elements.

UNIT 2: CONTENTS

2.1 The identity of an organization

2.2 Policy and strategies, concepts and programmes

2.3 The overall structure

2.4 People (individuals, groups, relations, leadership, climate)

2.5 Individual functions (jobs, tasks)

2.6 Work processes, work flow

2.7 Physical means (buildings, money, machinery, instruments)

2.8 Practical exercises
UNIT 2: TARGETS OF CHANGE

An organization is a very complex interplay of many elements including machinery, procedures, jobs, people, values and ideas. We are faced with that complexity if we want to change one element in particular, perhaps by introducing quality circles (QCs). Before deciding we have to consider how QCs are hindered or supported by other elements of the organization, which we do not intend to change directly. Such elements might include production technology, structure, methods of planning and control, and attitudes of workers and supervisors. Can QCs be successful in a tough hierarchical management structure? May we expect quality improvement if the analysis of failure shows that the speed of operations is unrealistically high, while the production technology does not allow any alteration in the work speed?

Thus, if we want to install quality circles, we must first undertake a comprehensive diagnosis of many elements and their relationships. For example: What is the attitude of management and workers to quality issues? What is the interface of a production line with materials supply, with maintenance, production, planning, transport, etc.? All these elements together influence the quality of work.

In order to address the complex reality of life we use a holistic model of organizations. This method consists of seven elements, which are interrelated in many ways and which form subsystems. The elements are listed in the box below.

- 1. Identity
- 2. Policy and strategies, concepts and programmes
- 3. Overall structure
- 4. People (individuals, groups, relations, leadership, climate)
- 5. Individual functions (jobs, tasks)
- 6. Work processes, work flow
- 7. Physical means (buildings, money, machinery, instruments)

Let us discuss these elements and their relationships. The treatment in this module is necessarily brief. For more information see von Bertalanffy, 1971; Emery in Davis and Taylor, 1990; Krone in Adams, 1974; Miller and Rice, 1967; Trist in Bennis et al., 1961.

2.1 The identity of an organization

If we diagnose an organization, we have to look at its “reason for existence”. Questions are:

- Is the basic function which the organization fulfills in society really clear?
- Has the main “reason for existence” changed in recent years?
- Do contradictions exist between major goals?
- Are the major goals known to employees?
- Do employees believe in them? Do the goals make sense to them?
- Which customer needs are considered as relevant? Which needs are not seen? Why not?
- How does the environment see the organization (image)?
- How does the company present its history or "biography"?
- What is the relationship with cultural, political, economic groups?

What is defined as the existential goal of the organization and how this is defined is a matter of identity. Each organization follows a certain way of thinking, which past experience has shown to be correct and successful. The search for new markets and new products is determined by those patterns of thinking as well.

In many companies the real goals are unknown, sometimes even secret. Often there were convincing and clear goals in the past but they have become vague or completely irrelevant. In many cases the main goals are mere "legends" or meaningless conventions.

And yet, all matters of productivity are rooted in the basic goals of the organization. There can be no improvement if the goals do not appeal to the people. Lack of identity causes confusion or detachment.

N.B. The term "corporate identity", as used for public relations purposes, means only image building through corporate design. It should not be confused with the usage here.

2.2 Policy and strategies, concepts and programmes

The major goals mentioned above need to be translated and adapted to the employees in their various functions and to different time spans; long-term concepts, strategic plans, short-term plans, and action programmes.

With regard to policy making and planning, we should ask the following questions:

- Are there gaps between general goals and concrete activity plans?
- Do policies exist for all areas (market, product, R&D, finance, personnel, investment, technology)?
- Do people know and believe in these policies?
- Are there contradictions, gaps, or discrepancies between various programmes?
- How rigid or flexible is programme implementation?
- Are the principles of policy inspiring and motivating?

In all organizations unwritten principles and guidelines exist beside explicitly expressed policies and strategies. They represent a kind of "customary law" of the enterprise; and very often the unexpressed principles and strategies are stronger than those on paper because they correspond to attitudes, i.e. convictions and beliefs. It is obvious that a conflict between unwritten principles and proclaimed policies causes distress and confusion resulting in inefficiencies. For more information on this topic see Ansoff, 1979 and Mintzberg, 1978.
2.3 The overall structure

All individual functions, committees and organizational units are held together by the overall structure of the organization. The structural concept of an organization determines how much centralization or decentralization is necessary. It provides guidelines for the number of hierarchical levels and criteria for the configuration of functions in departments. A good diagnosis is led by the following questions:

- What is the basic concept underlying the formation and configuration of organizational units?
- Do employees still consider this basic concept to be relevant and helpful?
- Do changes in the environment require a new conceptual foundation?
- What is the basis of hierarchical levels? Is it still valid?
- Is the organization generally static or dynamic?
- How does the organization handle matters of differentiation (division of labour), coordination and integration?
- Is the basic concept of the entire organization based on mechanistic thinking, organic thinking, or on fighting and power games. Is that appropriate?
- Are the organizational units transparent? Can staff identify with them?

We can only mention a few questions here, but they will reveal some basic strong and weak points of the structure. For more information see Mintzberg, 1979; Blau and Schönherr, 1971; Child and Mansfield, 1972; Etzioni, 1961; Lawrence and Lorsch, 1969.

2.4 People (individuals, groups, relations, leadership, climate)

All organizations live and act through people, either as individuals or in groups. For a diagnosis one must ask mainly:

- What is the standard of knowledge and skills? Do people want to develop themselves further or not?
- What ambitions do the employees have? Is the workforce flexible and mobile? What is the motivation for work? Do employees feel that good performance is rewarded by the company?
- Are there good relations between teams and departments? Are they helpful and supportive to each other?
- Do conflicts occur?
- How important are status, prestige, power?
- Is there a great variety of leadership styles? Which style is predominant? How is that appreciated?
- How do the employees in general feel about the organization?
- How can the climate be described?

Although tensions and conflicts occur between individuals and groups, their roots may lie in a lack of identity, contradictions between policies or problems in the work processes. The symptoms are evident in people and between them, but very often the causes are to be found elsewhere. For more information see Argyris, 1964; Brown, 1969; Dunnet, 1976; Tannenbaum, 1969; Wexley and Yukl, 1975.
2.5 Individual functions (jobs, tasks)

Individual functions in an organization have the same importance as single cells have in a living organism. So the philosophy that underlies job design is significant for the philosophy of the whole organization. A diagnosis must raise the following questions:

- What are the guiding principles dividing tasks between individuals?
- To what extent are planning and controlling separated from or integrated in a job?
- What is the balance between tasks, i.e. required activities and the scope of influence (to get information, to give recommendations, to make decisions)?
- Is the responsibility equal to the authority given to that function?
- Do the jobs form a meaningful entity which appeals to thinking, feeling and willing, or are many tasks meaningless?
- Do people have a short or a long work cycle?
- Do workers/managers really accept their tasks and responsibilities?
- Are jobs challenging, repetitive, routine, boring?

The concept of Taylorism insisted on the maximum differentiation of specialist tasks. A worker had to be trained more and more for less and less complex activities. On the other hand the philosophy of job enlargement and job enrichment emphasizes self-planning and self-controlling for people on the shop floor to increase job satisfaction. For more information on this topic see Davis and Taylor, 1972.

2.6 Work processes, work flow

The output of organizations depends on the work process, in which ideas are worked out, decisions are made, or raw materials are transformed into new products. Work processes bring about a “transformation” of either material or immaterial inputs. Whenever we have to cut costs or improve the effectiveness and efficiency of an organization, we have to make a very critical investigation of the work processes.

The following questions are relevant here:

- Is there a good flow of work or are there bottlenecks, areas of slowing down or speeding up?
- Are the work phases “just in time”?
- Does the process include bypassing, looping, detours?
- Are all the steps of the work process oriented towards the objectives of the work or are there activities which make no direct contribution to achieving the objectives?
- How is the process planned and managed? Who is responsible for coordinating the steps in the process?
- Are the procedures rigid or flexible? How much standardization or improvisation is possible - and necessary?
- The division of labour establishes dependencies: how do workers assess their interdependency?

Work processes are directly related to job content and employee attitudes. Therefore problems in work flow are immediately mirrored in relationships between people. Again the
symptoms become visible in interpersonal relations, but the causes may be found in work processes and their problems. For more information on this topic see Holstein and Berry, 1970; Mintzberg, 1979.

2.7 Physical means (buildings, money, machinery, instruments)

Industrial organizations depend much more on investment in machinery than service organizations, which have to invest permanently in human capital (knowledge, attitudes and skills).

For a diagnosis of problems caused by the physical infrastructure one must look at the following points:

- Is the machinery a real help - or does it sometimes cause difficulties?
- Is the equipment appropriate in ergonomic terms?
- Are there machines which may cause accidents?
- What is the relation between workers and machines?
- Should human labour be replaced by mechanization or automation?

The sections above have emphasized that the elements of an organization are interrelated in many ways. If we prepare some limited organizational changes, we must be aware of the visible and invisible side-effects on the other elements (see Hunt, 1970).

Thus one can understand that a holistic view is important for diagnosing and developing an organization. Without such a view we may search for problems in the wrong place and risk curing symptoms rather than causes. Several elements can be seen as clusters, which form subsystems as shown in figure 8.2.

**Figure 8.2: The seven elements in three subsystems**

<table>
<thead>
<tr>
<th>1. Identity</th>
<th>Cultural subsystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Policies</td>
<td></td>
</tr>
<tr>
<td>3. Structure</td>
<td>Social subsystem</td>
</tr>
<tr>
<td>4. People</td>
<td></td>
</tr>
<tr>
<td>5. Functions</td>
<td>Technical subsystem</td>
</tr>
<tr>
<td>6. Work processes</td>
<td></td>
</tr>
<tr>
<td>7. Physical means</td>
<td></td>
</tr>
</tbody>
</table>

The so-called “corporate culture” (Deal and Kennedy, 1982) is the totality of ideas, values, norms, aims, beliefs, and thinking patterns which are put into practice in everyday life and work. Therefore organizational culture is reflected in the way that technology is handled by managers or staff specialists, how money is used, how people are treated and how they respond. The invisible but powerful “soft” basis of the organization is its culture. Experience shows that we face organizational culture whenever we try to change some “hard” elements of an enterprise. If we introduce new technology which requires different guiding principles, the organization will react
against it because of culture. In numerous companies which have computer programmes for many activities the old system of manual operations is continued, because the old pattern of thinking and doing is too strong.

A proper diagnosis means determining where the real roots of the problem lie. The symptoms occur in the social subsystem - but they may be caused by discrepancies between the cultural subsystem and the technical subsystem. And for “therapy” we may compare organizational changes with curing a headache. The pain is in the head, but perhaps treatment must start with the feet (better shoes, massage) or with the digestion (different eating habits) or with general lifestyle. All that is true for organizations as well.

2.8 Practical exercises

Exercise 1. Distinguishing the seven basic elements of an organization

We can use the training site in which the participants are working to look at the seven basic elements. For this purpose very small groups of two or three people are formed. After an explanation of the seven elements of an organization, each group concentrates on one of the elements. The groups are asked to walk through the building and observe the characteristics of their specific element in the real situation. First, the members of the small groups observe individually, then they share their observations and agree on the most significant. These are reported back to the plenary group and discussed.

Exercise 2. The interrelationship of the seven elements of an organization: “Plexodrama”

The trainees are split into seven groups. Each group identifies with one of the seven elements of the conference hotel or the training department. Now the trainer announces that there is going to be a change in the teaching facilities (OHP, video etc.), going back to the equipment available in the 1950s. The trainer asks the groups to express what this would mean to them. The “work process” group starts by saying “The work process would change...”. Then the “functions group” describes what it means to them, etc. So the groups can interact and realize how they influence each other. This method illustrates how the elements of a system are related to each other in a network. At the end of the exercise conclusions are discussed and summarized.

A second exercise can be organized, based on the training situation. For example: “What will change if the learning objectives and the teaching methods are decided together by trainers and trainees?” “What would change if we had to teach 80 trainees in one training group?”

Exercise 3. Effects of three basic change strategies on the seven elements

Three small groups are formed: trainees with some experience of expert strategies form group A, others with experience of power strategy form group B, those with experience of organizational development form group C. The trainer gives a matrix to each group, for example for group A:
(a) **Expert strategy**

<table>
<thead>
<tr>
<th></th>
<th>positive=+/negative=-/neutral=0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect of expert strategy on ...</td>
<td>Why do you expect this effect?</td>
</tr>
<tr>
<td>1. Identity</td>
<td></td>
</tr>
<tr>
<td>2. Policy/strategy</td>
<td></td>
</tr>
<tr>
<td>3. Overall structure</td>
<td></td>
</tr>
<tr>
<td>4. People</td>
<td></td>
</tr>
<tr>
<td>5. Individual functions/jobs</td>
<td></td>
</tr>
<tr>
<td>6. Work processes</td>
<td></td>
</tr>
<tr>
<td>7. Physical means</td>
<td></td>
</tr>
</tbody>
</table>

A similar matrix is also given for the assessment of (b) power strategy and (c) organizational development. Each group discusses the effects of their strategy on the different elements of the organization. The groups then present their findings in a plenary session, where the group presentations are followed by a general discussion.
UNIT 3: What does “change” in organizations mean?

UNIT 3: Learning Objectives

Once you have learnt this unit, you will be able to:

1. Understand the meaning of change and explain the difference between the adaptation and development approaches.

2. Understand and describe the evolution of the change process from its simplest form (growth) to its most sophisticated form (self-development).

3. Understand the three phases of organizational development and relate them to real organizations.

UNIT 3: Contents

3.1 Change: Adaptation or development?

3.2 The evolutionary change of organizations

3.3 Awareness for development

3.4 Practical exercises
UNIT 3: What does “change” in organizations mean?

In the preceding unit we looked at organizations as more or less static entities, consisting of seven basic elements. But during their life all organizations change their size, their products, their technology and many other aspects, in order to fulfill their tasks in a changing environment. If we want to manage change, we must have a closer look at various meanings of the word “change” for they require a different approach (see figure 8.3).

3.1 Change: Adaptation or development?

Figure 8.3: Different meanings of the word “change”

Adaptations are fairly superficial changes, which demand activities such as:

- **Growth**: the number of employees grows from 10 to 30 within the first year of existence.
- **Exchange**: an old piece of machinery is changed for a new one of the same type and technology.
- **Improvement**: new lamps are bought, which give better light for lower energy costs.
But the changes may also have a deeper impact: such changes represent development which includes:

- **Transformation**: revision of structural forms (size of departments, number of hierarchical levels) by internal or external consultants.
- **Renewal or innovation** of guiding principles, when the concept of an organization changes from “functional departments” to an overall structure of “strategic areas”, and the whole firm becomes customer oriented in all its procedures and structures, in its policy and strategies - but all inspired and managed by external resources.
- **Self-development** of organizations, mainly using their own ideas, own diagnosis, own resources. This means that the members of an organization are able to analyse the needs of customers and to design new organizational concepts, adequate models of management, suitable technology, etc. The members of the organization themselves implement all this effectively. For self-development external experts are not essential, although their help can be very important in finding the optimum solution. Self-development implies that the identity of an organization can be developed by management and employees themselves.

What is the benefit of these distinctions?

**Adaptation** of an existing system is mainly a question of rational and technical thinking and does not deeply affect people’s feelings and motivation. Real improvement means that people have to change their habits, learn new techniques and working procedures.

When it is a question of development, changes meet much more resistance. Development depends on a change in the thinking patterns of the people involved, in the attitudes and motivations of every member of the workforce.

How deeply we must intervene and how much time we must invest depends on the sort of change. But the effects of adaptation or development will also be significantly different, for employees will learn through participation how to change their working situation in order to comply with changing requirements.

### 3.2 The evolutionary change of organizations

As they grow, organizations move through phases similar to the individual’s development from birth to childhood, youth and puberty to adolescence, later to full personal and social maturity. An organization may also fade away, because it has lost its primary goal and people no longer identify with it.

This evolution goes through stages and crises. It is not just a repetition of the same pattern, but development of the ability to manage problems of increasing complexity. Figure 8.4 shows how an organization develops different concepts for leadership and management, for the division of labour and its coordination, for planning and control. We can say that evolving from one phase to another is not just a transformation or a renewal (innovation), but a change of paradigms, of basic values and guiding concepts. Self-awareness is different from phase to phase.

A good understanding of these phases and the laws of evolution helps us to manage the
transition from one phase to the next. The following paragraphs give some more details. For a comprehensive review of this topic see Bos, 1969; Greiner, 1972; Lievegoed, 1980; Carlisle and Parker, 1989.

The pioneer phase

The whole organization is determined by the personality of the pioneering entrepreneur. Pioneers have a strong intuition and vision and lead by their personal charisma. Other people - even managers - identify closely with the pioneer and the pioneering spirit. Internal and external contacts are personal and informal, as in a big family. Everybody knows the customers and their needs. There is almost no formal hierarchy, although there is an informal ranking order of influence.

The company is flexible and effective through continuous improvisation. Crisis occurs when the pioneer loses inspiration and charisma and in-fighting starts at the next echelons; as improvisation fails the organization becomes chaotic as people are too dependent and do not dare to decide on their own.

The differentiation phase

After the crisis everything is done to make the organization transparent, logical and manageable. The main principles of "scientific management" are applied: specialization, coordination, rationalization, standardization, formalization, centralization, mechanization, etc.
Thus the whole organization is expected to run as smoothly as a well-constructed piece of machinery. The market is approached in a cool and detached way, loyalty to customers is abandoned if it does not bring profit. Jobs are designed in such a way as to separate planning, control and execution as much as possible. This allows the workforce to acquire better knowledge and skills in a very restricted area. Job descriptions are created. When people apply for a job, they are judged on their experience, not on their personal qualities.

The formalized hierarchy of management emphasizes different and separate responsibilities: top management sets the goals and the strategic direction as well as the general framework of business and organization; middle management organizes the available resources and lower management gives orders to the workforce. Each manager has a restricted span of control and can therefore concentrate on key tasks. The system works if everybody restricts their activities to their own tasks and does not intervene in other jobs. The division of staff- and line-functions makes it possible to optimize analytical jobs as well as decision-making jobs. Coordination becomes a job on its own and is transferred to specialists.

Improvisation is banned in general. Planning specialists prepare the work and draw up standard procedures which have to be strictly obeyed to avoid any arbitrary actions. Control specialists check whether procedures are applied correctly and they judge the output of work.

Because of a strong task orientation, the whole climate in the organization is less personal. The leadership style is cool and detached, rather bureaucratic and technocratic because of the rational orientation. A crisis occurs when differentiation, separation and specialization are exaggerated and create “independent kingdoms” within the company; coordination becomes more and more bureaucratic; procedures become more important than output; middle- and lower-management lose sight of directions and goals, because they have no influence on them; overspecialization leads to loss of synergy; shop floor workers become demotivated through the strict division of tasks which are controlled by others, and have difficulty seeing the meaning of their jobs.

The integration phase

Resolution of the crisis requires a new concept and a new way of thinking. The organization does not need further centralization and external coordination. Inner orientation is necessary. Brainstorming sessions are organized to look at the main goals, and the mission of the company. Managers at all levels are involved in defining the vision for long-term activities. Vision has to be developed not by one person (as in the pioneer phase), but by many people working together. All business is customer directed: “We are here to solve our customer’s problems!”.

The structure of the organization is shaped by market orientation: organizational units have clear customer groups and employ various specialists for the same target groups. Central departments are no longer command centres but service units, which support the business units. Decision-making power and responsibility for output and resources are given to smaller units and lower levels of management.

Policy and strategy are a permanent concern for cooperative management. The clearer the policy, the more employees can use their own creative resources to take the right decision. Jobs are designed according to principles of job enrichment and quality of working life, i.e. to give as
much responsibility as possible for planning and control to non-managerial positions; to give expression to the thoughts, feelings and interest of the employees. This is in strong contrast to the purely instrumental approach of the differentiation phase. Using the potential of employees and their readiness to develop it further is an important element in the integration phase.

The style of leadership is appropriate for different situations. It can and must vary from a rather directive style, to a participative and cooperative style. This makes it possible to find strategies which fit both the worker and the task. Developing an effective leadership style is a challenge for managers and their teams.

3.3 Awareness for development

It is clear that developing an organization means more than changing a few isolated elements. Problems could mean that the organization is on the verge of moving into the next phase of its development. Problems of low productivity in a differentiation phase are usually treated in the same way as before: more precise job descriptions, more specialization, more planning and control, more coordination by central departments. But we must ask whether the whole philosophy of "scientific management" in the differentiation phase is still appropriate. Then we must do more than improve planning procedures and introduce more rigid control. We must find new concepts, which requires new thinking, knowledge and skills, new habits, perhaps new job content and work procedures.

An expert strategy or power strategy may lead to the introduction of new structures and technologies, but will have no real impact on thinking and attitudes. Only a developmental approach, i.e. organizational development, can be effective in changing the "soft" elements in the organization.

The next units demonstrate methods for diagnosis and for developing solutions.

3.4 Practical exercises

Exercise 1. Understanding kinds of adaptation and development

After studying the six change concepts (from growth to self-development) groups can discuss:

What kind of change is:
- an exchange of the wooden office chair for a modern chair on wheels?
- a change from checking all goods to taking a 10 per cent sample?
- a change from shift planning by a supervisor to shift planning by the working teams themselves?
- a change from improvisation to systematic planning?
- a change from autocratic leadership to a cooperative leadership style?
- a change from central departments responsible for purchasing, sales, and personnel to smaller product groups with decentralized purchasing, sales and personnel functions?
The plenary report and discussion can clarify the meaning of the different notions of change.

Exercise 2. Deepening the three development phases of organizations

Select some problems in the company. Groups discuss:

- How do we see the situation now?
- How should it be improved? What should be changed? How?

Then discuss the following questions:

Does our situation correspond to the pioneer phase, the differentiation phase or the integration phase? Which phase should our organization move into?

Exercise 3. Applying the three phases of development to different areas

After discussing the developmental phases of an organization trainees can select a department, for instance, personnel services and consider the following questions:

a) What tasks are fulfilled by personnel?
b) What are the obvious principles of work in carrying out these activities?
c) Which concept implicitly underlies the course of action? Is it a pioneering philosophy, a differentiation philosophy, or an integration philosophy?
d) Which philosophy would we like to be applied in personnel?
e) What should be the guiding principles?

Parallel groups can work at the same time. While one focuses on personnel services, the next can investigate sales, a third can look at finance. If the different results are reported and compared, it will become clear where the organization stands - and what the next development steps could be.
UNIT 4: DIAGNOSTIC PROCESS AND TOOLS

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand the main elements in the diagnostic process and explain their role.
2. Differentiate between expert diagnosis and self-diagnosis and make the right choice in any specific case.
3. Make a systematic diagnosis of the seven basic elements of an organization.
4. Provide proper feedback from the diagnosis.

UNIT 4: CONTENTS

4.1 Expert diagnosis or self-diagnosis?
4.2 Involving the people concerned
4.3 The step-by-step approach
4.4 Systematic diagnosis of the seven elements
4.5 Feedback of the diagnosis results
4.6 Deeper diagnosis
4.7 Practical exercises
UNIT 4: DIAGNOSTIC PROCESS AND TOOLS

4.1 Expert diagnosis or self-diagnosis?

If we start a change process a fundamental decision has to be made regarding the diagnostic approach. Should the diagnosis be carried out by (internal or external) experts? Should the diagnosis be organized as a self-diagnosis, i.e. using experts to help the people concerned investigate their own situation?

At the beginning the two approaches are quite similar, as management must define the aims and objectives of change, which determine the aims and objects of diagnosis. In requesting a diagnosis management will state explicitly:

- which problem areas will be investigated;
- what management wants to achieve by the diagnosis;
- who will do it;
- who will receive the results of surveys;
- what will happen after the diagnosis.

If the diagnosis is intended as a self-diagnosis, the information should be given to managers and other employees. A good way is for management to publish a "statement of intent", saying what is going to happen, why and how. This will help prevent rumours and fear. For more information on this topic see Alderfer, 1975 and Levinsons, 1972.

4.2 Involving the people concerned

For an expert diagnosis the goals and methods will normally be agreed by top management. But for self-diagnosis lower-level management should be involved in defining the objectives at a very early stage. An agreement can state:

- which problem areas will be investigated, and which will not;
- what will happen if we discover unexpected problems which may have consequences for the whole diagnostic approach;
- how to work step by step;
- how to guarantee the anonymity of interviews;
- who will receive the results of the diagnosis, in what form (written or not), and in which way (report, conference etc.);
- what will happen after the diagnosis.

It is important to involve many people from different levels, because their perceptions of strong and weak points will guarantee a more complete result. It might also be useful to create a small task force (three to five members) as a "diagnostic team". Its main tasks are:

- planning and managing all diagnostic activities;
- organizing an information campaign to prevent misunderstandings;
- deciding which survey methods should be used;
- adapting existing survey methods to specific requirements;
- selecting people for interview;
- extending or limiting the planned activities;
- planning and managing time, money and other resources.

4.3 The step-by-step approach

Whenever possible, we should start with simple steps and methodology, with clear methods and outcomes. A diagnostic process can begin by holding unstructured interviews with individuals or groups, where we learn what people have already been thinking about their situation. We could ask them to talk about two things, which form a polarity:

- Signals of discomfort, where they talk about obstacles and problems, and weak points in the company. People say what they think should be changed.
- Aspects we are proud of, where they talk about strong points and say what they think should be maintained.

We have to be aware that our questions create an atmosphere of either hope or despair with regard to changes. If we were only interested in failures, problems and weak points, we would create a negative attitude and people would believe that everything was wrong – and difficult to change. Suffering and pain can cause awareness of the need for change, but will also create negative energy to resist. To see weak and strong points together enables people to mobilize their positive energy to change their own situation themselves.

A second polarity is important for the questions we ask. This is:

- concern for the present;
- concern for the future.

In interview and written survey questionnaires we ask what people think about their situation at present (strong and weak points) and what changes they would like for the future. The second polarity (present and future) prevents us from creating critical awareness without motivation to act. In many cases we can see that employees are very conscious of problems and their causes, but they lack any perspective on how to change the situation. If awareness is growing stronger and stronger it may - paradoxically - even prevent changes! For very often this super-awareness leads to intellectual and detached criticism, as a kind of escape from the situation.

The next step is to sort out the comments and suggestions we have collected. We may discover clusters of problems such as quality standards, managerial style, work flow, cost awareness, and we may discover interrelations among them. Answers on future options may show two tendencies in thinking: one group hopes that problems can be solved by more formalization and standardization of work processes and job content, while another group wants to abandon formalization and standardization as bureaucracy which makes the organization inflexible and ineffective.

Preliminary results can be used to continue with a more systematic diagnosis, using a holistic concept of the seven basic elements.
4.4 Systematic diagnosis of the seven elements

For this diagnostic tool we have to design a specific method for each organization. Together with the diagnostic task force we hold a brainstorming session to identify 15 to 20 aspects of each element. Our example relates to the identity of the organization. The following aspects should be studied.

- main goals of the company;
- clarity of main goals for employees;
- adequacy of main goals for present customer needs;
- reputation of the firm in the market;
- reputation of the firm with customers;
- image of the firm in the community;
- image of the firm for competitors;
- image of the firm for the finance world;
- image of the firm for unions;
- general position of the company;
- self-presentation in the market;
- presentation of the company’s history;
- basic philosophy of the company.

All these aspects are part of the firm’s identity. The members of the group identify them by brainstorming, not because they feel that they are problems, but to help their colleagues think about them and to indicate which they perceive as strengths or weaknesses.

The next step is to select two aspects for each element, i.e. 70 altogether. To indicate whether these are felt to be strong or weak points the group decides on a rating scale:

0 = no opinion
1 = extremely bad
2 = rather bad
3 = unsatisfactory
4 = acceptable
5 = quite good
6 = very good
7 = excellent

For all 70 aspects members of the group indicate in the questionnaire what they think about each item.

At the end they choose between five and ten aspects, to which they give the highest priority for change. As a result everybody indicates how they perceive all aspects of the entire organization, and which would rate the highest priority for change. The priorities can be rated on a scale from 1 (lowest) to 10 (highest).

The answers are shown in tables 8.1 and 8.2:
Table 8.1: Tables of ratings

<table>
<thead>
<tr>
<th>Aspects</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main goals of the firm</td>
<td>22</td>
<td>2</td>
<td>14</td>
<td>38</td>
<td>22</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Clarity of main goals</td>
<td>22</td>
<td>2</td>
<td>8</td>
<td>22</td>
<td>26</td>
<td>18</td>
<td>2</td>
</tr>
<tr>
<td>Adequacy of main goals</td>
<td>4</td>
<td>10</td>
<td>22</td>
<td>36</td>
<td>16</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Reputation of the firm for ...</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>68</td>
<td>20</td>
<td>10</td>
<td>-</td>
</tr>
</tbody>
</table>

The priority order becomes visible by multiplying the priority score by the number of people who gave priority to that aspect, as shown in table 8.2.

Table 8.2: Priorities for change

<table>
<thead>
<tr>
<th>Aspects</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>etc.</th>
<th>sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main goals of the firm</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Clarity of main goals</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td></td>
<td>160</td>
</tr>
<tr>
<td>Adequacy of main goals</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>12</td>
<td></td>
<td>479</td>
</tr>
<tr>
<td>Reputation of the firm for ...</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>7</td>
<td></td>
<td>89</td>
</tr>
</tbody>
</table>

In addition to the quantitative scores we ask questionnaire respondents to describe for each high priority aspect:

- how they see the problem and its causes or backgrounds;
- how the situation should be improved in future.

Each person gives a one-page description of all the high-priority items. Sometimes we get very detailed descriptions of about five pages for specific matters. The diagnostic team studies these descriptions and summarizes the characteristic trends and main directions.

A systematic diagnosis of the entire organization (seven elements) will show clear problem areas as seen by the people in the organization themselves. By reporting the results of the survey we can achieve clarity on how the people involved think about their organization. Therefore:

- we can come to an agreement on which aspects we should diagnose further and deeper;
- we can decide which people should be approached for further diagnostic activities;
- we see how problems are related to each other;
- we can agree on the urgency and priority of activities, and thus concentrate our efforts much better.

The findings of the first diagnostic activities should be reported to all the people who have been interviewed. On the basis of that report and discussion we can decide on the next step.
4.5 Feedback of the diagnosis results

What form should the report take? Should we hand out a written report without any explanation or discussion? This will save money and time, because people read it in their own time. But there are certain disadvantages in a written report as the only method of feedback:

- parts of it may not be understood;
- we do not know how people will interpret the findings and what conclusions they may draw;
- it is difficult to achieve consensus on further activities and their priorities.

A verbal presentation during a meeting or a conference will cost much more time, money and energy, but the advantages are evident:

- a dialogue can clarify different interpretations immediately;
- during the meeting a consensus about problems and key areas of activities can be achieved;
- through discussion a real commitment to further activities can be established and confirmed;
- committed people are visible to all, and thus gain better support;
- insight into the diagnosis can be deepened by detailed discussion and analysis;
- the diagnostic process can be supported by some learning activities if necessary.

For good “digestion” of the diagnosis the programme should have a mix of (a) presentation of results and (b) contributions by participants. The organization of a one-day meeting to discuss the diagnosis is illustrated in the figure below. For more detailed information on feedback see Baumgartel, 1959; Bowers in Pfeiffer and Johns, 1974.
Figure 8.5: One-day meeting for discussion of the diagnosis

1. General diagnosis:
   1.1 Presentation of an overview of the survey findings
   1.2 Collecting questions:
      - What is unclear for me?
      - What information do I need to understand the overview?
   1.3 Answers to questions and general discussion

2. Looking deeper at specific problem areas (A, B, C)

   Problem area A: Coordination
   2.1 Input: “Conceptual models for coordination” for a deeper understanding of
      problems and their solutions
   2.2 Presentation of details for problem area A: Coordination
   2.3 Discussion in subgroups, following the questions:
      - Which conceptual models are applied in the present situation?
      - How are the specific strong and weak points of coordination related to the
        general diagnosis?
      - Which of the concepts is our “preferred future”?
   2.4 Plenary reports from subgroups and discussion
   2.5 Summary: Recommendation for next steps:
      - Further and deeper diagnosis is necessary for...
      - Action is necessary for...

   Problem area B: Leadership styles and cooperation
   3.1 Conceptual input: “Styles of leadership”
   3.2 Presentation of details for problem area B: Leadership
   3.3 Discussion in subgroups etc., as for 2.3, 2.4., 2.5

   Idem for problem area C
   4.1 till 4.5

   General conclusion of the meeting:
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4.6 Deeper diagnosis

Discussion of the global results indicates the elements and aspects for which a more detailed investigation seems to be necessary (see Weisbord, 1978). This may apply to one or several of the seven elements and subsystems. Within this module we can only mention a few possibilities, which may be relevant for productivity improvement.

Some questions for further diagnosis are:

- What are the basic values and ideas of the company?
- Which values or ideas are proclaimed - which are applied in reality?
- Do the existing basic values support or impede productivity improvement?
- What is the internal image (self-image) of the company as seen by its employees?
- Does top management have real credibility in questions of productivity?

Some questions for a further diagnosis of policies and strategies:

- Do plans or campaigns for productivity improvement already exist?
- What has been successful - what has failed?
- How consistent has the application of plans and programmes been up to now?
- Are the policies and programmes consistent with the basic values?
- How do employees identify with such programmes?

Experience shows that very often there is a contradiction between “appeals” and “practice”. The following instrument (figure 8.6) shows the contradictory or even paradoxical principles at work at the same time in an organization:

**Figure 8.6: Contradictions and paradoxes**

<table>
<thead>
<tr>
<th>On the one hand we appeal to our employees ...(in terms of imperatives)</th>
<th>and on the other hand people behave according to the unwritten rule that ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>to be creative</td>
<td>deviation from corporate rules is not wanted at all!</td>
</tr>
<tr>
<td>to work unbureaucratically</td>
<td>everything has to be done in writing!</td>
</tr>
<tr>
<td>to be responsible for managing their own time</td>
<td>the manager’s wishes must be carried out immediately!</td>
</tr>
<tr>
<td>to be open and critical</td>
<td>it is dangerous to doubt the manager’s ideas and decisions!</td>
</tr>
</tbody>
</table>

Statements such as these are collected by groups and discussed in a plenary meeting. These statements show where further progress in improving the organization is blocked by contradictory appeals. Change can be effective only when the people see that they themselves contribute to the contradiction and understand that they must change their own behaviour.
Diagnosing the first two elements, identity and policy, provides an analysis of some of the most important aspects of corporate culture. A company’s culture consists inter alia of basic values and assumptions, goals, symbols, myths and legends, heroes and anti-heroes, all of which are usually expressed through metaphors. Therefore a diagnosis of these aspects must also use metaphors. We may invite members of organizational units to draw pictures of the organization as they perceive it: houses or castles, peasants or knights, horses or elephants etc., as colourful as fairy-tales. Symbolic expressions reveal a lot about the emotional side of the corporate culture, and emotions play an important role in a process of change.

If problems with the work process are indicated, they can be investigated by using a simple analysis as shown in figure 8.7.

**Figure 8.7: Analysis of critical work processes**

<table>
<thead>
<tr>
<th>Steps of the work process</th>
<th>Who is involved?</th>
<th>What is going wrong?</th>
<th>What would help?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Person, department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Many diagnostic questions will deal with the human and social side of the company. This includes techniques and styles of leadership, patterns of cooperation and teamwork, matters of influence and power. Experienced trainers and consultants may stimulate people to express their worries and tensions in a diagnostic conference. But any activity in this field requires professional experience in handling group situations.

### 4.7 Practical exercises

**Exercise 1. Working out a “tool” (plan) for diagnosing the seven elements**

The diagnostic tool is applied to the training situation.

a) Form three small groups. One group brainstorms to collect 10-15 ideas for aspects of elements 1 and 2 (cultural subsystem), another group collects 10-15 aspects for elements 3, 4 and 5 (social subsystem), and the third group collects 10-15 aspects for elements 6 and 7 (technical subsystem). The groups discuss the various rating scales and agree which they prefer for their own method.

b) The subgroups meet and present their ideas. After the discussion they select only seven aspects per element.
c) The groups select the appropriate rating scale.

d) The final plan is written out and copies are given to each trainee.

e) The individuals rate all 49 aspects.

f) Each individual chooses three of the most important aspects and places them in priority order.

g) The trainer collects all data and makes a summary.

h) The aspects with the highest priority are chosen for discussion.

Exercise 2. Working out a tool for the training hotel

This exercise is exactly the same as No. 1, but applied to the hotel where training takes place.

Exercise 3. Working out a tool for a particular working unit

As in exercise No. 1, the trainees apply this to their real working situation.

Exercise 4. Data feedback exercise

The training group is split into two. Each group prepares a presentation for the other group on the following points:

- how we have observed the working of the total group up to this point;
- who participated a great deal - who participated less;
- who has had a real influence;
- who has been leading the group.

The groups should invest some time in designing an interesting way of presenting the results of their diagnosis. After the first presentation, the discussion should cover these points:

a) What was unclear? (Ask for clarification only)
b) What is new for us?
c) What is not acceptable to us? Why not?
d) Which aspects need to be explored deeply?

After the second presentation the same procedure is followed. Then the different results are compared. The evaluation answers the questions:

- How did the group handle “facts” or “observations” and “interpretations”?
- How did the method of presentation influence the other group?
- What can we learn from that with regard to presentation and feedback methods?

Exercise 5. Contradictions and paradoxes

We apply the method illustrated in figure 8.6 to the training situation. The contradictions can be collected by small groups first, then put together in the plenary meeting. In pairs participants
pick up those sentences which particularly strike them. They are invited to discuss:

- What did I personally contribute to these contradictions?
- Is it in my interest NOT to change these sentences? What do I gain from them?
- Which of the sentences will be changed by changing my own behaviour?

The pairs can make concrete agreements on how to help each other change.

Exercise 6. Analysing a critical work process

We can use our observation of the training centre to analyse the work process “lunch-time in the canteen”. We use the diagnostic tool shown in figure 8.7 and the results may be communicated to the manager of the canteen. This reporting can be an exercise for a data feedback session. Therefore, it must be prepared carefully.
UNIT 5: HOW TO DESIGN THE ORGANIZATION OF THE FUTURE AND MANAGE CHANGE

UNIT 5: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand the process of developing a company vision and mission statement and use them to plan change.

2. Follow the main steps in planning change and appreciate their importance for managing change.

3. Involve the whole workforce in planning and managing change.

UNIT 5: CONTENTS

5.1 Developing new vision and a mission statement

5.2 How to plan and manage a change process

5.3 Phase 1: Contacting and contracting, starting

5.4 Phase 2: Global diagnosis and global future directions

5.5 Phase 3: Projects for deeper diagnosis and future design

5.6 Practical exercises
UNIT 5: HOW TO DESIGN THE ORGANIZATION OF THE FUTURE AND MANAGE CHANGE

5.1 Developing new vision and a mission statement

In describing the diagnostic process we recommended paying attention to two different polarities:

- signals of discomfort;
- aspects we are proud of.

To avoid creating a mood of discontent and even depression it is useful to talk about:

- concern for the present;
- concern for future possibilities.

The latter aims at both a critical attitude and a readiness for change, to be kept in balance. During the diagnosis the interview respondents will have given many ideas for shaping the future. We should not separate these ideas from the diagnostic activities (see Block, 1981).

From statements made during the diagnosis we can draw many conclusions for the “desired future”. This leads to the development of vision, to missions and long-term goals, future concepts and models and plans for change activities.

We can use this material to answer the question: “What should the improved situation be like in the future?” When we present the options for solutions and directions, we can summarize as shown in figure 8.8.

**Figure 8.8: Statements about direction for change**

<table>
<thead>
<tr>
<th>We want to get away from a company which ...</th>
<th>... and we want to move towards ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>is very bureaucratic</td>
<td>a flexible and creative firm</td>
</tr>
<tr>
<td>uses human capacities as instruments</td>
<td>an organization which respects the dignity and potential of its employees</td>
</tr>
<tr>
<td>does not see the individual customer</td>
<td>a company which does everything to provide useful services for customers</td>
</tr>
</tbody>
</table>

When groups have produced these “statements about direction for change”, we can ask them to go further and to describe what kind of general philosophy is expressed by these statements. This is a first formulation of vision and anti-vision and could be phrased as shown in figure 8.9.
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Figure 8.9: General philosophy, anti-vision and vision

<table>
<thead>
<tr>
<th>We will get away from ...</th>
<th>and we will get closer to ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>internal orientation</td>
<td>openness to the environment</td>
</tr>
<tr>
<td>extreme specialization of jobs, as if for robots</td>
<td>integrated jobs for human beings</td>
</tr>
<tr>
<td>product orientation</td>
<td>orientation to customer needs</td>
</tr>
</tbody>
</table>

This is the material for generating vision. It is worth making a note of all the ideas mentioned when the discussion is held, because very often the real authentic values are only stated incidentally.

Visions are never simply a matter of rational thinking. They have a strong influence on social life if they use images and metaphors. It is well known that the leader of the US civil rights movement, Martin Luther King, expressed his vision by saying: “I have a dream...”. Then he gave his goal of a multiracial society based on respect, trust and love. Great leaders in business are also aware of the effect of metaphorical language. The next instrument (figure 8.10) is a guide for preparing a vision statement.

Figure 8.10: Practical help for vision statements

- Get into a helicopter, look down on your company
- Don’t look at details but at the totality
- Forget for a while all “ifs” and “buts”
- Think 10 to 12 years ahead
- Use simple images, symbols, metaphors
- Appeal to many senses (hearing, smell, vision, touch, taste, etc.) in one statement
- Remember that feelings are often stronger than logical thoughts
- Check whether you really do what you are talking about

This practical help for vision statements is useful in finding the right form of expression and communication. The following method (figure 8.11) describes the content of a meaningful mission statement.
Figure 8.11: Content of a mission statement

1. How do we describe the basic needs of our customers?
   "We, the customers, basically want from you ..."

2. How do we describe the idea or theme which is the basis of our product/service for the customer?
   "Above all, we will care for you ..."

3. What are the basic values which we offer to satisfy the basic needs of our customers?

4. Our external relationships will be ...
   Describe our responsibility in the following realms and the image we want to achieve
   a) ecological problems
   b) cultural institutions in our environment
   c) social and political affairs
   d) our competitors
   e) our capital owners

5. How do we treat our internal resources?
   Describe what kind of image we want to achieve among:
   a) employees
   b) managers
   c) workers' representatives
   d) sales force
   e) financial team

A general mission statement is not a short-term issue: it covers a period of at least 12 years, even up to 30 years. The findings of the diagnosis can be interpreted in the light of the three developmental phases of an organization. Many isolated symptoms will then appear to be connected by the same pattern of thinking, which, for instance, may be typical of the differentiation phase. The "desired future", as expressed by the employees themselves, may, for example, correspond to the integration phase. So, conceptualizing the present situation and the desired future is a great help in getting a clear idea of what one stands for.

After the middle- and long-term perspectives of future concepts (vision, mission, direction for change etc.) we should define in more detail what we want to achieve in one or two years' time (see Learned et al., 1965; Ansoff, 1979). A good method is to work out scenarios of the desired future. We might take 31 December two years ahead and then describe the future as if we were writing a report about the results achieved by that date. We can use the seven basic elements of an organization and describe how they should be after two years.

This method is a variation of the well-known management technique "management by objectives" as shown in figure 8.12 (see Schleh, 1961; Miller, 1966; Humble, 1967). When objectives are agreed, one never speaks about "we should..." or "we want..." or "we are striving for...". This would be too vague. Instead, the results which should be achieved at the end of the chosen period
are described in such a way that it is possible to measure whether the objectives have been realized or not. If you are not sure of being able to make a clear judgement on whether the result has been achieved as promised, the objective is not formulated in the right manner.

**Figure 8.12: Management by objectives**

<table>
<thead>
<tr>
<th>Key activities</th>
<th>Results per date ...</th>
<th>How to measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Most of the diagnostic tools we have shown so far are fairly rational. But sometimes we need more creative or even artistic methods to make people “dream” of possibilities other than those they know already. Existing thinking patterns prevent the imagination from seeing other options.

There are some methods for stimulating the creative imagination. A few possibilities are outlined below:

a) Small groups think of a scene and perform a short play called “dealing with a customer in two years’ time”. After the performance groups define and compare the values which have been revealed through the role play.

b) Small groups get some simple material (paper, glue, wood, clay etc.) and produce a model called “what our company will look like in five years”; this is organized as a “competition for architects”.

c) The same as (b), but organized as a competition for an exhibition, where our most important competitors will be represented.

d) Small groups produce a folder and describe in colourful text what the company will be like in two years.

All designs for the “preferred future” need to be confirmed by management. In Unit 6 we will give some guidelines for this.

5.2 How to plan and manage a change process

Management of the change process requires a good plan and structure. The actual steps required depend on the specific situation. The following considerations should be taken into account before starting the planning process:

- How large and complex is the organization?
- How much experience in change management is available in the organization?
- Are there any extraordinary difficulties or crises, which require quick action?
- Are there conflicts which make it difficult to communicate and to achieve agreement about change?
Within this module we cannot deal with more complex situations. First of all it is important to learn how to manage an "ordinary situation". The points below will provide better understanding of how to approach the change process:

a) If the organization is very big, we can arrange a sequence of activities for smaller groups and share the results from group to group. If many different organizational units are involved, we can start a kind of advisory committee which looks at proposals critically and checks that specific circumstances are taken into consideration.

b) If there is little experience of managing a participative process like this, then we must invest more time in the first phase of the change process “contacting and contracting”, to involve more people in active participation.

c) In case of a survival crisis we recommend engaging an experienced consultant who can look at the process as a whole. It will be too risky to manage the process without external assistance.

d) Conflicts should be managed first to establish a good base for further activities.

The scheme presented in figure 8.13 shows the elementary steps. They can vary according to circumstances. At some of the steps it is useful to establish a project- or steering-team to manage the overall process or for specific activities.

**Figure 8.13: Scheme of project activities**

<table>
<thead>
<tr>
<th>Phase 1: Contacting and contracting, starting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Management: order</td>
</tr>
<tr>
<td>2. Management: contact with project members for diagnosis</td>
</tr>
<tr>
<td>3. Management: decision to start “diagnostic team”&gt;</td>
</tr>
<tr>
<td>5. Diagnostic team + management: information to company and feedback</td>
</tr>
<tr>
<td>6. Diagnostic team + management: establish “sponsoring group”&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 2: Global diagnosis and global future directions</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Diagnostic team: plan for diagnosis and visions</td>
</tr>
<tr>
<td>8. Diagnostic team and subteams: diagnostic activities</td>
</tr>
<tr>
<td>9. Diagnostic team: collecting data</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>10.</th>
<th>Diagnostic team + management: decision for organizing diagnostic meeting or conference</th>
<th>Method of data feedback, role of management during meeting, how much participation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>Diagnostic team: conference (or meeting) for data feedback</td>
<td>Conclusion: strong and weak points, main problem areas, draft vision, priorities</td>
</tr>
<tr>
<td>12.</td>
<td>Diagnostic team + management: decision on further activities</td>
<td>Is direction still OK? information to company? priorities and resources, “statement of intent”: mission</td>
</tr>
<tr>
<td>13.</td>
<td>Management: vision/mission</td>
<td>Announced to the company</td>
</tr>
</tbody>
</table>

**Phase 3: Projects for deeper diagnosis and future design**

| 14. | Management: establishes a “steering group” | To follow up diagnostic team, for planning, evaluating, coordinating all activities, support by training? what can be implemented now? |
| 15. | Steering group: subproject groups | Diagnosis and proposals for specific topics, deepening, exchange of findings, coordination of diagnostic, designing, training, implementation |
| 16. | Steering group + management: decisions (strategic conference) | Priorities, resources, information to company “sounding board” necessary? |
| 17. | Steering group: information campaign | Participation for more people, commitment, management’s vision. |
| 18. | Management + steering group + “sounding board” | Representatives of various parts of the company check proposals, give recommendations to management for decisions |
| 19. | Steering group + subproject groups | Continuation of projects, evaluation, coordination, implementation, etc. |
| 20. | ... | |

This scheme shows typical key activities. However, it should not be taken as a ready-made recipe. For each organization one must find an appropriate way, deviating from the typical scheme.

What really happens at the various steps of this scheme?

**5.3 Phase 1: Contacting and contracting, starting**

All the steps in this phase aim at creating clear starting conditions (see Weisbord, 1973; Block, 1981). The activities have been described in Unit 4, where we explained in detail what one should do and why. At the end of this phase it is evident who will be members of the diagnostic
team and who will be responsible for phase 2. At step 6 it may be useful to establish a "sponsoring group". If the managers responsible for the whole project are not at top management level, we recommend asking an individual at the very top to sponsor the whole process. This should be a person of high prestige, or it could be a very small group.

By virtue of their personal prestige sponsors give moral and political support to the project group. They show their commitment to the matter and give a sort of personal guarantee that the project will be supported. If problems arise they may help by using their personal prestige and influence in the organization. In exchange for their support the sponsors will get regular reports on the project and they will answer questions. However, they should not intervene directly in the project.

Managers responsible for the project have the role of decision makers. Of course, members of the management team may also be part of the diagnostic team. But the diagnostic team must refer its plans to the formal decision makers.

The diagnostic team is responsible for planning, carrying out and evaluating all diagnostic activities. At the end of phase 2 the diagnostic team will be disbanded and will hand over some of its tasks to the steering group.

During this phase we may come across problems which could be solved immediately. These may be problems of discomfort at the workplace (drafts, bad light, annoying behaviour). We strongly recommend solving these problems quickly, because it shows the people involved that we are really going to change. Otherwise they may believe that everything will stay as it is despite a lot of talk. Immediate help emphasizes that the commitment for change is serious. So at any stage of the work we can ask: "What does not need long discussions but could be done at once?"

5.4 Phase 2: Global diagnosis and global future directions

During phase 2 a good diagnosis is the basis for well thought-out change activities later on. But here the polarity between diagnosing and designing future directions is obvious.

As soon as the diagnostic team has collected its material, interpreted and drafted it an agreement must be made with management on how the diagnosis will be presented and discussed in the organization. In Unit 4.5 we gave an example of a one-day conference. In large organizations we can plan a series of diagnostic conferences, in which we discuss the results and the desired directions for the future in small groups. Each conference group will have to accept that it can only come to preliminary results, which are then handed over to the next group and discussed again. Sometimes after a series of conferences we organize a plenary meeting with all participants, in which we integrate and discuss all preliminary results.

Step 12 is to take decisions on further activities. It will be here that the mission statements are prepared. The diagnostic team can suggest an appropriate way of announcing the mission to the company; the way in which this is done tells employees what the mission really means. A good and practical way is to communicate it down the hierarchy as the presence of top level managers indicates real commitment.
Step 13 is the announcement and discussion of the mission statement throughout the company. There are several ways of doing this.

Management organizes a meeting with the next management level.

Statements are presented by the managers. Discussions can follow - or else very small groups (three or four people) prepare their questions and make their own personal statements. Management can also invite individuals to present their own statements with regard to the mission statement. These are shared afterwards. Members of the next management level then communicate with their own teams and so on.

An "information market" is organized

Members of the management team present their mission to groups. The groups have a dialogue and add their own ideas. After 20-30 minutes people move on to another member of the management team and listen to the presentation. After discussion, they can go on to a third presentation. Finally, managers summarize their conclusions in a panel discussion.

A printed "vision paper" is given to all employees and discussed in ordinary departmental meetings. The results are communicated up the line to the top.

The best way is to use a company celebration to communicate and discuss the mission statement.

The diagnostic team finishes its task at the end of this phase. Further activities are concerned with developing goals, objectives and practical solutions. If we know by the end of phase 2 what the subprojects will be, we can organize overall project management from the bottom up. Look for competent people in the subprojects, appoint a coordinator for each group and ask the coordinators to form a steering group. A representative of higher management may take the chair in the steering group.

5.5 Phase 3: Projects for deeper diagnosis and future design

This phase builds on the results of earlier activities. The diagnostic team should be succeeded by the steering group because there are new activities which go far beyond diagnosis. Thus it is better to install a new group, which bears responsibility for progress in this phase.

The tasks of a steering group are mainly:

- taking initiatives for new subprojects;
- global planning of subprojects;
- checking the progress of subprojects;
- helping subproject groups to overcome obstacles;
- raising awareness of links with other projects in the company;
- coordinating all subprojects;
- evaluating subprojects;
- raising awareness in the organization of the principles of organizational development;
Module 8
Unit 5

- supervising the use of resources for change projects;
- relating change projects to management;
- reporting to the “sponsoring group”, and asking for help;
- submitting proposals to the “sounding board”;
- preparing decisions for management with regard to the progress of projects;
- receiving signals of tensions or conflicts caused by the change projects;
- supporting projects by training activities;
- planning and implementing an internal information strategy as support for the change process.

It is clear that the steering group has great responsibility and its members should be selected carefully. A steering group should be very small, about five members with experience in project teams. Many steering groups fail because too many departments want to delegate a representative to take care of their political interests. If representation is a real need, we recommend establishing a “sounding board”. Clear criteria should be announced for the selection of the steering group to avoid rumour and distrust. The most important criteria are the following:

- some experience of working in a project team;
- time available in addition to the ordinary job;
- representing different departments and management levels;
- acceptance by colleagues (opinion-leaders).

There is always the risk that a competent steering group may become a kind of a “shadow government”. From time to time the group should evaluate its role and ask whether some tasks should be given to other bodies.

All subprojects work as ordinary task groups (see Elmaghragy and Dodin, 1981, Martin, 1976). They are linked to the steering group as mentioned above. Each member is responsible for the operational coordination of one or more subprojects.

Step 18 mentions a “sounding board” as a group which has no decision-making authority and no responsibility for managing the change process. In large and complex organizations it may be useful to establish such a group. A “sounding board” is an advisory board for decision makers with regard to change projects. Members of this board are the managers (or their assistants) of various departments or profit centres. Ten to 20 members can mirror the whole spectrum of departments and managerial levels, disciplines and influential people. Shop stewards may also be on this board. It will work best if its members are invited by management. Whenever management has to make crucial decisions about change projects it asks the sounding board group to give comments and recommendations on proposals made by the steering group. So the organization can benefit from a small and competent steering group and a large one.

The key tasks of a “sounding board” can be summed up as:

- evaluating proposals made by the steering group;
- making recommendations to decision makers on the change process;
- giving signals of the mood in the organization;
- giving feedback to management and the steering group on the effects of change activities in the organization.
Figure 8.14: Selecting change projects

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed project</td>
<td>5 = high interest 1 = very low int.</td>
<td>1 = little time necessary for preparation</td>
<td>1 = little time necessary for implementation</td>
<td>1 = little money necessary for preparation</td>
<td>5 = can be done by small units</td>
</tr>
<tr>
<td>Job rotation in production units</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Self-control of production units</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Group premium</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

The activities in phases 1 and 2 will stimulate many suggestions for subprojects. We need criteria for selecting projects and finding priorities. A simple method (see figure 8.14) can help to reach a realistic selection.

In this example we have only given criteria B - F and scores 1-5 to express how “heavy” a proposal is. Further criteria for selection are possible, such as:

- needs no support by staff (none = 5, a lot = 1);
- has good positive financial effects after implementation (= 10);
- has high symbolic meaning for many people (= 5);
- other projects can build on it (a great deal =10).

In each separate situation we must decide how many criteria we need and which scores are appropriate. For scoring, a big group can be split to discuss the proposals. Group scores can then be reported in the plenary meeting. The total scores for each proposal indicate the importance and feasibility of a project.

For each subproject the objectives, timetable and available resources are defined and checked several times while the work is in progress.

At the end of phase 3 management has to decide whether project organization should be handed over to existing line management or should continue its work as an “innovation organization”. This decision is a real milestone for every change process because it means that the organization has integrated innovative activities into its normal life. And if we have also supported the process by training and social interventions, the organization will really have improved its capacity for self-innovation. And this clearly means self-development.
5.6 Practical exercises

Exercise 1. Statements of direction for change

The diagnostic tool in figure 8.8 can be applied to small organizational units. It can build on other diagnostic exercises. As the next step, we can characterize the overall idea behind all the statements (we want to get away from ... we want to move towards ...) by describing a certain person “A”, who has the negative characteristics of the “get-away” statements and a second person “B” who has all the positive characteristics of the “move towards” statements. An example: Mr. “A” is a grey gentleman, without any hobbies, who lives in a dull ...
Mrs. “B” is a vital lady, fond of interesting friends (artists etc.) and living in a pretty ...
The last subject is: What must change in me if the general situation is to change?

Exercise 2. Vision exercise

In figure 8.9 we gave hints for creating good vision statements. We can focus on the metaphorical qualities.

Small groups are asked to prepare a New Year speech for their department, using metaphorical language only:

a) Think of the message that you want to get over to the department - use ordinary business language (profit, costs, personnel, time etc.) for this step!
b) Now imagine that the team is not an ordinary working team but a group which is preparing an expedition to the Himalayas, or the crew for a 20-day sailing trip over the Atlantic, or a football team, etc. Choose one of these metaphors and identify your team with it: who is in this group?
c) Now prepare a speech for the chosen expedition/sailing/football team, just before the whole adventure starts. Use metaphorical language only, use drawings or cartoons or dramatic gestures, whatever you like. A speech may last for 15 minutes.
d) Deliver this speech to the other group members.
e) Each speech gets feedback: What appealed to the listeners? What was unclear? What did they understand as the key message? What would you recommend to the speaker?

Exercise 3. Management by objectives

A good way to formulate prospective goals is to look back to the last full working week which was a typical “average working week”. The next steps should be done individually:

a) List seven or eight key activities that you worked on during that week.
b) For each key activity describe in a few words the results you achieved at the end of the week (describe them so that they are absolutely clear to somebody who does not know what you are doing).
c) For each key activity and for the result achieved, define how you could prove that this result was really achieved: how could this be measured?
Steps (a) to (c) will take 30 minutes. Participants then discuss the results in pairs. In the plenary discussion any remaining questions will be dealt with.

Exercise 4. Job descriptions for task forces in a change project

Draft a job description for a diagnostic team, a steering group, or a sounding board.
Role play a dialogue between management and the steering group.

Exercise 5. Selection of change projects

The group is invited to define the criteria which would be relevant for their situation. Some possible activities should be listed and selected.
UNIT 6: SUPPORTING THE CHANGE PROCESS

UNIT 6: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Identify and deal with resistance to change.
2. Understand the most common reasons for resisting change and be able to explain them.
3. Balance dynamic (positive) and retarding forces in the change process.
4. Use training to support change.

UNIT 6: CONTENTS

6.1 Dealing with resistance during a change project
6.2 Supporting the change process by training
6.3 Practical exercises
UNIT 6: SUPPORTING THE CHANGE PROCESS

6.1 Dealing with resistance during a change project

Involving employees in open and honest participation is the best way to prevent resistance to change. We often tend to view negative opinions or activities as "resistance to change". Implicitly we assume that our goals and interventions are correct, and that people who resist them are wrong.

Change agents should ask themselves whether they have done a good job in preparing, designing, managing and implementing change. Perhaps the change agents have a one-sided perception of problems? Perhaps they have pushed too much, showing a lack of understanding of other people's concerns? If they look at things this way, they can use signs of resistance to improve their approach.

Resistance means that energy is invested, both on the part of the change agents and on the part of resisters. It is useful to find out how this energy could be used constructively. In spite of all efforts to minimize friction during a change process, sources of resistance can often be a positive factor.

Motivation and resistance

It is helpful to use the concept of human needs developed by Abraham Maslow, although more advanced concepts have been developed since his work was first published (see Maslow, 1954; Hertzberg, 1966). According to Maslow we can divide human needs into three different types:

- physical needs (drinking, eating);
- psycho-social needs (security, contacts, prestige and appreciation by others);
- spiritual needs (influence, self-realization, development of potential, longing for meaningful work and life).

Individuals or groups may fear that change would give them fewer opportunities to fulfil their needs. Therefore, it is important to look at proposals for change through the eyes of people who are expected to live with the consequences later. And we should ask questions relating to all three types of need.

Physical needs:

- Do people fear that they will lose their job?
- Do they expect to earn less later?
- How flexible are their financial needs and expectations?
- Are physical working conditions worse than before the changes?
- Are there possible accident risks?

If people fear major disadvantages in this sphere, we should reconsider our approach or provide better information about the implications of change. Very often people resist because of lack of information, unclear proposals, or general fear and distrust.
Psycho-social needs:

- Do people fear loss of job security, a different salary system, unclear working conditions?
- Do they fear new contacts and loss of the social environment they know?
- Will they have to work in isolation instead of in a team?
- Does the new work give them lower status?
- Do they feel that the change in their work is a criticism?

Again, good information and honest discussion can cure some of these problems. But if new working conditions mean a less favourable situation for the people concerned, we must reconsider the proposals and increase opportunities for active participation.

Spiritual needs:

- Have we produced a status orientation which may prevent people from developing their potential?
- Do the changes offer more room for autonomy and self-management, or will external factors and constraints increase?
- Did we offer career counselling before the proposed changes were confirmed?
- Did we offer training? And did the training really comply with the needs of those concerned?
- Did we provide help for decisions?
- Are people aware of how the changes might benefit them?
- Is the new job content meaningful?

The answers to these questions will indicate many ways to improve the situation.

Influencing the balance of dynamic and retarding forces

There are always factors working in favour of change, as there are reasons for opposing it. Kurt Lewin (1961) has developed a practical concept for understanding and influencing the balance of positive and negative factors, as shown in figure 8.15.

Let us look at a pattern of habits: for example, Mrs. Brown smokes 15 cigarettes per day. We can think of some factors that make her smoke so much:

- she likes the taste of tobacco;
- it relaxes her;
- she can offer cigarettes to others and easily make contacts.

If these “positive factors” were the only ones at work, she might smoke even more. But on the other hand there are factors which prevent her from smoking more:

- fear of cancer;
- complaints about the smoke;
- the price of cigarettes.

These forces work in opposite directions. Both factors, positive and negative, may be within Mrs. Brown (fear) or in her environment (expectations of others). Both positive and negative
factors exist and there is an equilibrium between them as long as they remain equally strong (see figure 8.15). But suppose we make the positive side stronger, as the tobacco industry is doing by showing TV spots of jet-set-people who enjoy smoking. Mrs. Brown will probably smoke more heavily. But if the Ministry of Health emphasizes the dangers of smoking much more, thus increasing the negative factors, Mrs. Brown will probably try to cut down her smoking.

Figure 8.15: Balance of favouring and retarding (opposing) factors

<table>
<thead>
<tr>
<th>Positive factors (pro-smoking)</th>
<th>Negative factors (against)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like the taste of tobacco</td>
<td>Fear of cancer</td>
</tr>
<tr>
<td>I feel relaxed</td>
<td>Other people say that they suffer from smoke</td>
</tr>
<tr>
<td>By offering cigarettes to others I can easily make contacts</td>
<td>Cigarettes are expensive</td>
</tr>
</tbody>
</table>

If we want to change a working situation, we have to change a stable pattern of thinking, feeling, and behaving. This change in pattern may come about by strengthening the positive factors; this is called “pushing”. Or we can do everything to weaken the negative factors, so that - more or less automatically - the positive factors become dominant. This is called “sucking”. A combination of both will be even more effective.

On the basis of this concept, Lewin explains that implementing change involves three phases:

- “unfreezing” the situation, i.e. getting the stable equilibrium of positive and negative factors out of balance;
- “moving” the unstable situation in the desired direction either by pushing or by sucking;
- “refreezing” the situation, so that it becomes stable again.

Unfreezing can be done by shocking people into seeing that “things are not as we thought”. If we shake people’s frame of reference, new experiences may be perceived in a new way. Using power, punishing or “buying” people may persuade them to leave common patterns and thus upset the given equilibrium. Simulating reality by playing a business game may also cause critical thinking or dissatisfaction with the present way of doing things.

Moving can be achieved by training: new thinking patterns are offered via new information and discussions; new behaviour is taught and practised; a company which has used new working techniques for some time may be visited by opinion leaders; participative diagnosis and problem solving will help people explore alternatives; experimental projects foster exploring and learning.

Refreezing means that we confirm the new order achieved by moving: we make a new organization chart and formalize the structure developed by experiments.

This way of thinking can be very helpful for understanding the many possible sources of resistance. But it is probably true that human beings prefer stability. For more information on this topic see Coch and French, 1948; Bennis, Benne and Chin (eds), 1961; Block, 1981.
Organizational development goes beyond introducing an isolated change, for it aims at managing a permanently changing and dynamic world. The situation will always be moving. Freezing and refreezing are almost impossible. We must develop new forms of orientation in that changing world. Conflicts are not bad in themselves: we should look at them as opportunities for development. Old patterns and new patterns of thinking, feeling and behaving are fighting against each other but contradictory ideas and values cannot coexist in one person. We need to face these signs, not suppress them or run away from them. A crisis can help a new world to be born, although we have to go through a period of uncertainty and pain. Confronting tensions means that we are very close to the sources of energy.

6.2 Supporting the change process by training

Training activities play an important role in the change process. They help to prepare change, to support it and to follow it up, for they perform two important functions:

- transferring knowledge;
- developing skills.

Transferring knowledge

Knowledge gives people a different perspective on their own situation. Various diagnostic activities can be accompanied by a transfer of knowledge “in small pieces”: even an interview may offer a new concept or model to the partners. Through the interview they will be able to understand their situation in a different way.

If we add inspiring concepts to the survey material, the diagnosis will be much deeper. Discussions about vision, mission, scenarios and objectives can be supported by the concepts we have mentioned already:

- the holistic model of the seven basic elements and three subsystems of the organization;
- the concept of the three evolutionary phases (from pioneering to integration) in the development of organizations;
- motivation theory.

With appropriate inputs we can help to “reconceptualize” the situation in question and the desired future. Elements which seemed to be separate are now related and form a pattern. The human mind perceives and identifies not single isolated objects but patterns. If we present conceptual models we help the mind to recognize patterns, to remember them and work with them. Experience with strategic development suggests the same conclusion: if we describe strategic goals and means only in a detailed way, managers are confused and cannot work with them unless they recognize a cognitive structure or pattern. We therefore add intuitive methods to the analytical and cognitive inputs, using drawing, painting, acting and other artistic means.

Developing skills

Skills training should start at a very early stage. When management sets up a diagnostic team it should offer training in teamwork and project management so that as the new diagnostic team
starts to define its own goals, working procedures and roles, it acquires new skills for the new job. When the diagnostic team is disbanded these skills have a valuable pay-off for the organization and its members. In order to involve many people actively in self-diagnosis activities, we give interview training to managers at different levels, to shop floor workers and to shop stewards. We can also train people in self-observation. Other training which is essential for the early steps of change projects includes:

- communication skills;
- management techniques (planning, management-by-objectives, delegating);
- presentation techniques (visualizing, speaking, reporting etc.);
- conflict handling;
- quality circle techniques.

**Developing a training strategy**

Already during discussions on vision, mission, and scenarios we can think ahead and develop a training strategy to address the following questions:

- What does the change mean for various job profiles in the company?
- What will be required in terms of knowledge, attitude and skills from management and from workers?
- What kind of (re)training can be designed and implemented quickly?

The training needs foreseen are the basic material for defining learning and training objectives. They make it possible to plan a training strategy at a very early stage.

If we make training and job consultation an essential part of the change strategy, we can give clearer perspectives to the workers. This will also prevent resistance, and create trust.

Supervisors play an important role in this, as they are responsible for guiding their staff and making them aware of possibilities for retraining or switching career. The skills needed for such counselling must be taught to supervisors at a very early stage of the project.

**Different training methods**

The most common form of training is off-the-job-training, where the content offered is based on the trainer’s concept of what is useful. This may be good, but it may also neglect the real needs of the working situation. Or it may not allow the new skills to be tested in the normal work situation.

We have to bring learning and working much closer together, by using on-the-job training methods. For example, an instructor explains how to use a new tool and workers try it out: then they work on their own, doing a meaningful job. So the supervisor becomes an instructor, a trainer, a guide and an assistant during on-the-job training.

Reginald Revans (1982) developed the concept of “action learning”, which offers a variety of methods and tools for on-the-job-learning. Our recommendations for the diagnostic team or the steering group were based on this form of built-in training. In this approach, different roles
become closer: the boss is a trainer and counsellor as well; the trainee is not just a student or pupil, but is working and learning at the same time.

Another form of on-the-job-learning is the creation of experimental pilot projects. Instead of long research work and endless discussions an experiment can be run for a limited period to test a new idea. The necessary conditions for a successful pilot project are to:

- describe the desired results of the experimental situation;
- explain when the experiment will be evaluated;
- give clear information to all departments which will have direct contact with the experimental unit;
- invite volunteers to participate in the experiment;
- define clearly what is going to happen, if the experiment succeeds or if it fails.

6.3 Practical exercises

Exercise 1. Analysing motivation factors and sources of resistance

Groups can take a simple example of a change activity and analyse it according to Maslow’s concept. They should consider what this may mean for them and their real motivation. What would demotivation mean?

Exercise 2. Analysing positive and negative factors

Use the tool as given in figure 8.13 and apply it to two simple but opposing possibilities of change (no time control, much more time control).

Small groups may list the factors by brainstorming first, then judging each factor listed and assessing how strong it seems to be. The strength of each factor is indicated by an arrow as in the figure below.

**Figure 8.16: Positive and negative factors**

<table>
<thead>
<tr>
<th>Positive factors</th>
<th>Negative factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel appreciated</td>
<td>I fear misuse</td>
</tr>
<tr>
<td>I can use my time autonomously</td>
<td>I fear a waste of money</td>
</tr>
</tbody>
</table>
In the next step we can look at the opposite change: rigid time control. What will this mean to me? After that we can look at the common factors in both examples. It is important to note that these factors must not be confused with arguments in favour of or against change: they are a reflection of reactions, whether they are rational or not.

The exercise can be continued. The groups are asked to think of those two or three factors which they can influence on their own. What are they? How can they stimulate unfreezing? How can they reach a stable equilibrium?
UNIT 7: MODULE SUMMARY AND REVIEW

UNIT 7: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Make a brief overview of the whole module and explain the change process, its structure, and its role in productivity.

UNIT 7: CONTENTS

7.1 Module summary

7.2 Questions

7.3 Action guidelines
UNIT 7: SUMMARY AND REVIEW

7.1 Module summary

Organizational changes can be achieved by four different approaches: expert strategy, power strategy, a combination of expert and power strategy or by organizational development (OD). The chosen strategy will have different effects on hard and soft aspects of the organization.

A change in isolated aspects of an organization may not have the effect intended if attention is not paid to related aspects. Therefore organizational changes must use a holistic concept of organizations, which works on the cultural subsystem, the social subsystem and the technical subsystem of an organization.

Diagnostic activities should be connected with designing the desired future, i.e. vision, mission, goals and objectives. The module presents ways of working in a participative way on diagnosis and future design, so that successful implementation and acceptance are guaranteed.

All change activities need to be supported by training (off-the-job and on-the-job) and signs of resistance must be investigated, because they show where the approach has to be improved. By following this participative approach to change an organization learns to innovate itself in order to comply with the challenges of the future.

7.2 Questions

1.1 To what extent does the chosen change strategy affect the results of change?
1.2 Describe the basic approaches to change: What is the role of the people involved?
1.3 Describe three advantages and three disadvantages of each of the basic approaches to change.

2.1 What does the “holistic concept of an organization” imply?
2.2 How does a change in work processes affect other elements of an organization?
2.3 What is the effect of the three basic change strategies on the elements of an organization? (which elements will be changed and which will not be changed).

3.1 What is the difference between the “adaptation” and the “development” of an organization? What does this imply for a consultant?
3.2 Describe the main characteristics of the three phases in the evolution of an organization.
3.3 What would go wrong if one attempted to move directly from phase 1 of the development of an organization to phase 3?

4.1 Describe five basic differences between expert diagnosis and self-diagnosis.
4.2 What are the tasks of a diagnostic team? What can it decide on its own?
4.3 Why should a “sponsoring group” be organized?
4.4 How can people in a large organization be involved in steering the process of change?
4.5 How could a 2-day diagnostic conference be designed?
4.6 Describe three different ways of participative information-sharing.
4.7 What is meant by "polarities in a diagnostic process"?
4.8 To whom should the results of a diagnosis be reported?

5.1 Why is a statement of direction for change necessary? How can one achieve it?
5.2 What is helpful for developing a vision statement which is not merely rational?
5.3 Describe the relevance of management-by-objectives techniques for change.
5.4 How could we stimulate creative ideas about future perspectives?

6.1 Describe the main phases of a change process.
6.2 How big should a steering group be?
6.3 Describe the main tasks of a steering group.
6.4 What are the key tasks of a "sounding board"?

7.1 What are the main motivating factors according to Maslow?
7.2 What does the motivation concept of Maslow tell about resistance?
7.3 Give an example of the meaning of positive and negative factors.
7.4 Describe the three phases of change according to Lewin.

8.1 What should be taught during the very early stages of a change process?
8.2 What do we need to design a training strategy which supports change activities?
8.3 What is meant by on-the-job-training?
8.4 What is the use of pilot projects?

7.3 Action guidelines

1. Before starting change activities ask yourself whether you want to increase the ability of the organization to change itself by using its own resources. If so, a strategy of organizational development is recommended. If not, expert strategies or power strategies can be tried.
2. Before implementing change, identify which phase of evolution the organization is in. This helps to interpret diagnostic results and to formulate meaningful future options.
3. According to the chosen change strategy the role of the internal/external change agent, i.e. consultant, is different. For a process of organizational development a consultant must be able to act as an expert with regard to diagnostic tools and roles and give critical contributions during implementation.
4. Change activities need to be coordinated by a special team. The functions of the team members change during a longer process of change. A diagnostic team coordinates early activities; later a steering group integrates all activities.
5. A complex change process needs the support of an information strategy. People who are not involved in diagnosing or designing, or who are less active, receive periodic information on the progress of change.
6. Diagnosing and designing the future should be combined in various activities, rather than diagnosing first and developing solutions later. Training and implementing activities should also be integrated as much as possible in the early stages of the change process.
7. Diagnosis should investigate both the weak and the strong points of an organization, never the weak points alone. This prevents a negative flow of energy during the whole process of change.
8. During a change process the basic aims of the change should be restated from time to time.
in order to give reorientation. A change process is complex. While people look at their situation critically and while they discuss improvements, they will struggle with problems of perspective, and directions of change will help them to know where they stand.

9. The more people are involved in thinking about the strong and weak points of their organization, the better the support given to implementing solutions. Participation is therefore of great importance in all activities.

10. Top management should actively sponsor the change process. This gives a guarantee to the people involved that they can appeal to the top for support when necessary.
BIBLIOGRAPHY

Alderfer, C. P.: Learning from changing: Organizational diagnosis and change (Beverley Hills, Ca., 1975).


Block, P.: Flawless consulting (San Diego, Ca., 1981).


Carlisle, J. A.; Parker, R. D.: Beyond negotiation (Chichester, 1989).


Deal, T. E.; Kennedy, A. A.: Corporate culture: The rites and ritual of corporate life (Reading, 1982).

Dunnet, M. D. (ed.): Handbook of industrial and social psychology (Chicago, 1976).


Kolb, H. D.: *An action research program for organization improvement* (Ann Arbor, 1960).


Learned, E. P. et al.; *Business policy: Texts and cases* (Homewood, Ill.; 1965).


Lievegoed, B. C. J.: *The developing organization* (Millbrae, Ca., 1980).


In order to keep up to date with developments in the field of managing organizational change it is necessary to read as many journals as possible. Below is a short list of recommended articles which have been published on this subject since 1990.


MODULE 9
TOTAL QUALITY MANAGEMENT
MODULE 9: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand and explain the nature of quality and the contribution it makes to economic effectiveness and customer satisfaction.

2. Explain the difference between quality control, quality assurance and total quality management (TQM).

4. Understand the role of customer-supplier relationships in quality improvement.

5. Understand and use the basic quality tools in quality assurance.

6. Use the quality improvement cycle in TQM.

MODULE 9: CONTENTS

UNIT 1: Introduction to the quality concept

UNIT 2: Customer-supplier relationships

UNIT 3: Who is responsible: Variations in quality

UNIT 4: Basic quality tools

UNIT 5: The quality improvement cycle

UNIT 6: Test paper

Bibliography
UNIT 1: INTRODUCTION TO THE QUALITY CONCEPT

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Define the concept of quality and distinguish between different perspectives of quality.
2. Understand how total quality management (TQM) has evolved.
3. Distinguish between inspection, quality assurance, and TQM.
4. Recognize the significance of TQM for reducing costs and increasing productivity.

UNIT 1: CONTENTS

1.1 What is “quality”?
1.2 How TQM has evolved
1.3 What is TQM?
1.4 The evolution of quality in the West
1.5 Quality in the late 80s and beyond
UNIT 1: INTRODUCTION TO THE QUALITY CONCEPT

1.1 What is “quality”?

There are a number of different ways of looking at quality. Before exploring some of these it might be useful for you to talk with colleagues or other participants about your ideas on what makes for a high quality product or service.

You may conclude that there are various perspectives from which quality may be seen. The hardest to define is that which we might call transcendent or innate quality. This is really the area of aesthetics, beauty, art. It is very subjective, extremely difficult to pin down with a neat description, and on the face of it does not have much relevance for the output of most organizations. However, it is important to recognize its existence.

For many years the prevailing view of quality was that which might be called product-based. Here, quality is seen in terms of differences in the quantity or characteristics of some ingredient. According to this view a product is of higher quality if it has more of some desirable ingredient. For example, a company which proudly advertises that it makes “the world’s best cake” bases its claims on the fact that its product contains more different fruits than any other. Again, compared with economy class, a first class seat on an aeroplane not only entitles the passenger to more free food, drink and gifts (such as slippers, eyeshades and so on), but a seat which is wider and has more leg room. Conversely, from this point of view higher quality might mean less of an undesirable ingredient. Drinking water provides a good example here; the fewer the impurities, the higher the quality.

As we have said, the product-based view of quality has been around for a long time. It usually means that a higher level of quality costs more than a lower one - more fruit for the cake; more processing to remove impurities from water. Furthermore, although there may well be a link between this view of quality and marketing/sales, there is no direct connection with productivity as such.

The third major view of quality — the one now at the heart of total quality management (TQM) — is one that is user-based or customer-based. Here, the emphasis is on the requirements of the people who use the product or service, that is to say, the customers. What do they want? What will delight them?

There are important implications here. First, the very word “customer”. The word “customer” comes originally from a Latin word which is the root of expressions such as “be accustomed to”. The customer builds up a long-term relationship with the supplier, and is therefore accustomed to dealing with the firm, to being supplied with that particular product or service.

Next, we have talked about what will delight the customers. This is more than merely satisfying them; it goes a step further. TQM involves a striving to do even better - this is referred to as continuous improvement.

The really radical aspect of taking a customer-based view of quality, however, comes when we apply it not only to the organization’s external customers, but when we use the concept of
internal customers. This involves seeing everything that happens within the organization as a series of flows from an internal supplier to an internal customer, as in figure 9.1(a-c).

The figure shows, in increasing order of complexity, how all activities within an organization can be seen as the process of receiving an input (from the supplier), working on it, and then sending an output to someone else - the customer. A process without a customer is useless and valueless. Use this figure to do the following exercise. The instructions are given for a trainer working with a group, but it is also possible to work through the questions as an individual exercise.

**Exercise 1.1**

Divide the group into pairs or threes. Ask them to think of a product or service familiar to them that they consider to be of particularly high quality. Ask them to discuss amongst themselves the elements in the product or service that make it of high quality. Next, ask them to think of two more products or services - one from anywhere, the other from their own organization or department. This is a good way of sharing information about participants’ organizations and it also makes a link between the module and the real world in which participants work.

After about ten minutes, ask each pair for an example. Write these up on the flipchart, chart,
blackboard, white board or OHP transparency. If you can, try to cluster them, so that examples of the three main perspectives - transcendent/innate; product; customer - are grouped together on the board/screen. Another view may be suggested — value for money. This could be put on its own or it could be included under the customer-based viewpoint. Then continue to discuss figure 9.1.

Looking at figure 9.1 (a-c), define the suppliers and customers in the following cases.

1: Figure 1 (a)
(i) Who is Process A’s customer?
(ii) Who is Process C’s supplier?
(iii) Who is Process C’s customer?

2: Figure 1 (b)
(i) Who is Market research’s customer?
(ii) Who is Design’s supplier?
(iii) What does Manufacturing supply to Sales?
(iv) Who are Design’s customers? What does Design supply to them?

3: Figure 1 (c)
(i) What sort of thing might Market research supply to Research and development?
(ii) What might Research and development supply to Market Research?
(iii) What might Personnel supply to other departments?

The answers to these questions can be found in the Appendix to this unit. If we apply the basic customer-based view of quality to both internal and external customers, we realize another vital aspect of TQM.

Remember, then, that the basic aim is to delight our customers — internal and external. This will mean, amongst other things, cutting down on scrap, waste, errors, rejects and so on, because no customer wants to receive these.

This is where the link between quality and productivity comes in. For one of the major factors behind low productivity is the amount of energy, effort, time and money wasted on getting things wrong. This is particularly obvious in the case of a manufacturing process. When a product is faulty a host of costs arise in sending it back, putting it right (rectification), giving refunds, and making warranty payments. There might also be legal costs and damages. On top of this there is, of course, the cost of making the faulty product in the first place — raw materials, manufacture, overheads.

The same is equally true of a service process. For example, if information is lost between Department A and Department B, then there is the cost of producing it in the first place plus time spent looking for it, asking why it hasn’t arrived, chasing it up, producing it again. On top of all this, there are costs that arise as a result of the chain reaction of delays — perhaps, even, a large contract may be lost because the submission wasn’t delivered on time.

Various experts have estimated that the cost of rework is typically no less than 25 per cent of the organization’s total turnover. This is a startling and sobering thought. Think of the benefits of saving 25 per cent of your organization’s or department’s total turnover. If this sum was not being
wasted because of poor quality, what could be done with it? It could be invested in equipment and staff training for future development. It could be distributed as profit. Or it could be shared with customers by reducing prices which would also increase competitive advantage.

This view of quality is radically different from the view that was widely held in the past. Before, the basic assumption was that increasing quality always led to higher costs. Now, it is recognized that increasing quality actually reduces costs (hence the title of a famous book, “Quality is free” by Philip Crosby).

This is shown in the example of figure 9.2. Here the total “cost of quality” has been divided into three components:

1. **Prevention costs**: these include training, working on quality improvement programmes, and designing quality into the process itself.
2. **Inspection costs**: traditionally, where no great effort was put into building quality into design and processes, considerable effort went into inspection. This was very expensive and, in fact, was also largely ineffective. Not only is inspection very difficult [Exercise 1.2] but it also leads to an attitude of “it doesn’t matter if the product is faulty, because the inspector will find it and stop it going to the customer”. Thus, paradoxically, the greater the level of inspection, the greater the likelihood of scrap products being made.
3. **Failure costs**: these are the costs already described, i.e. scrap, rework, wasted time, warranty claims and so on.

In the example shown in figure 9.2 an increase in prevention costs of £15 million leads to a decrease in total costs of £12.5 million. This represents a return on the investment of 83 per cent. Not bad!

The real returns, however, are much higher. The figure assumes a constant total revenue, but as quality increases so will demand from delighted customers. According to authors Macdonald and Piggot in their book “Global quality”, it is reasonable to expect a total return of anything from 10 to 100 times the investment in quality improvement. That really is worthwhile!

However, a note of caution should be sounded here. TQM is not a quick-fix solution. It requires continuing effort and constancy of purpose, for ever. It is a major change in an organization’s culture. In the short term (months), some significant localized results and benefits may be achieved. But a full-scale TQM programme requires at least two years to implement, and then needs constant, continuous effort, support and further development. The general management and social implications of TQM are shown in figure 9.3.
Figure 9.2: Total cost of quality

INCREASE EXPENDITURE... AND... INCREASE SURPLUS!!
Figure 9.3: Links between TQM and general management

Ensure Quality

- Costs decrease because of less rework, fewer mistakes, fewer delays, snags; better use of machine - time and materials

- Productivity improves

- Capture the market with better Quality and lower price

- Stay in business

- Provide jobs and more jobs

Source: Deming, 1986

Exercise 1.2 The impossibility of inspection

This exercise demonstrates the inefficiency of inspection. Tell the group that they are going to be given an inspection task. This is to count the number of “F”s on the screen, chart or board. Each letter “F” is a fault. Because inspectors are always busy, they will only have a limited time — 10 seconds — to do the task. Then reveal the following statement - written on an OHP slide, flipchart or board. It must only be in view for 10 seconds. Then ask the group to write down how many letter “F”s they saw.

FINISHED FILES ARE THE RESULT OF MANY YEARS OF SCIENTIFIC STUDY COMBINED WITH THE EXPERIENCE OF MANY YEARS OF HARD WORK

When they have written down the number of “F”s they saw, go round the room and ask them to shout out their score. Write these on a chart/board/OHP. The scores usually range between three and seven. Three is a common number — it is the number of “F”s excluding those in the word “of”, which appears four times and is often overlooked. Use this simple exercise to lead into a discussion of the dangers of relying on inspection.
1.2 How TQM has evolved

The history of TQM shows how ideas about quality and management practices have continuously developed and changed. Figure 9.4 summarizes this evolution. It shows quite clearly the differences between the way quality has developed in the West (USA and Europe) and the East (Japan).

Before the end of the nineteenth century, quality was a function of the craftworkers’ skill. Craftworkers controlled the quality of the finished product through their own individual abilities. This was the era in which the only view of quality was from the innate or transcendent perspective.

In the early 1900s mass production really got into its stride with the work of F. W. Taylor. Each worker merely carried out an extremely small part of the process, and lost any sense of identity with the finished product. Hence the need for inspection arose.

However, as we have seen, inspection is ineffective and very costly in that it permits the production of waste, followed by rework. Inspection also leads to adversarial relationships within the organization, with workers trying to outwit inspectors, and everybody seeking to blame somebody else when faults are discovered. In the 1930s an American, Walter Shewhart, invented an approach to controlling quality so that as soon as a fault started to develop in manufacturing processes, it could be rectified before it was too late. This technique, called statistical process control (SPC), was used during the Second World War, but was then dropped in the West.

Why was this? The basic reason was that after the war the USA was the only industrial nation left intact. Germany and Japan were devastated physically and economically; the UK, less damaged physically, was bankrupt, starting to lose the empire which had underpinned its industrial strength, and ill-equipped psychologically and sociologically to learn new ideas about manufacturing. The USA, therefore, had the industrial world to itself, and as a result the prevailing attitude was one of complacency. The lessons and advances made through SPC were forgotten, and the emphasis went back to inspection.

In the East, however, things took a different course. Somewhat ironically, as part of the USA’s aid programme to help rebuild Japan, two leading experts in SPC - W. Edwards Deming and Joseph M. Juran - presented these ideas to senior Japanese managers, who adopted them enthusiastically. From then on, SPC evolved much further in Japan, becoming total quality management.
**Figure 9.4: Evolution of the concept of quality**

<table>
<thead>
<tr>
<th>Year</th>
<th>USA/Europe</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1900</td>
<td>Craftwork</td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td>Inspection</td>
<td></td>
</tr>
<tr>
<td>1930</td>
<td>Statistical process control (SPC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>invented by Shewhart. Little used.</td>
<td></td>
</tr>
<tr>
<td>1940-45</td>
<td>SPC used in USA</td>
<td></td>
</tr>
<tr>
<td>1950s</td>
<td>SPC largely dropped</td>
<td></td>
</tr>
<tr>
<td>work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960s</td>
<td>Quality assurance and zero defects</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>... and then total quality management</td>
</tr>
<tr>
<td>1970-80s</td>
<td>Total quality management taken up</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lean production developed, together with focused creativity. Also other ideas such as Taguchi’s loss function and Hoshin Kanri’s management of policy in a quality way.</td>
</tr>
<tr>
<td>1990s</td>
<td>Lean production - will it be taken up?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The learning company - a Western innovation (Europe and USA). Will it be taken up?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>What next?</td>
<td></td>
</tr>
</tbody>
</table>
1.3 What is TQM?

Before looking at the parallel development of quality in the West, we will now look in more detail at TQM - developed as it was in Japan, out of the ideas of two Americans.

Figure 9.5 shows the main aspects of TQM. To start with, it involves a flow, from a supplier into the process or system (i.e. what is actually done in a department) and then on to the customer. This means that much of the activity in TQM involves working on two key relationships, namely:

- those between ourselves and our customers; and
- those between ourselves and our suppliers.

Next, in order to continue to delight our customers, we are always trying to improve our process(es) or systems. This continuous improvement is carried out through a number of basic quality tools.

Notice the use of the words “we” and “our”. For continuous improvement needs to be carried out by cohesive, discrete, identifiable groups or teams. A department or section owns a process or system, and improvement is always a team effort.

Figure 9.5: TQM

This means that those involved in TQM have to be effective teamworkers - they must be able to empower others. And this in turn means that if you are going to be an effective teamworker you need to be able to manage yourself.

Therefore, in this module we concentrate on

- developing effective relationships with customers and suppliers; and
- using quality tools for the continuous improvement of systems/processes.
1.4 The evolution of quality in the West

TQM, then, primarily evolved between the 1950s and the mid-1980s in Japan, although it built on ideas that originally came from the USA.

What was happening with quality in the West during this period? As already mentioned, Europe was struggling to get back on its feet after the Second World War, and the USA became complacent. This complacency was shattered in the 1960s by the Soviet Union launching the sputnik satellite, which shocked the USA into a dramatic aerospace programme. Here quality became a dominant feature, but the approach taken was very different from that of the Japanese, the emphasis being on getting it “right first time” with “zero defects”. Out of this sprang what is generically termed quality assurance - which involves identifying, analysing and writing down all the procedures within the organization, and then using this documentation to ensure that all procedures are coordinated, and that all employees know what is expected of them and are trained accordingly.

Rather confusingly, this approach to quality assurance is sometimes referred to as total quality management. However, it is very different from TQM.

Quality assurance (QA) can be a useful support activity for TQM. On the other hand, with the emphasis on manuals and procedure writing, it can easily become a giant paperwork exercise and in itself pays little attention to improving customer-supplier relationships. Its emphasis is on ensuring that nothing goes wrong and therefore it attempts to guarantee that the quality of the organization’s output will be as specified. However, in so doing it makes no contribution to continuous improvement and, in the words of W. Edwards Deming, “just because nothing is wrong it doesn’t mean everything is right.”

Nonetheless, quality assurance programmes are to be found in many organizations in the West. Most European countries have established national schemes of assessment and certification for QA.

1.5 Quality in the late 80s and beyond

In the West, the deficiencies of quality assurance have gradually been identified, and somewhat belatedly Deming and Juran are now recognized in their native country. TQM is growing.

Meanwhile, the Japanese have not stood still. They have built on TQM and it has come to be known as “lean production”, which adds other elements to TQM as such. In particular there is a strong emphasis on teamwork and multiskilling, so that it is not only on quality improvement programmes that people work together. There is even more dialogue with customers, and relationships with external suppliers are developed to such an extent that the organization forms a close partnership with a small number of selected suppliers. The intention is that this partnership will be very long term, and that we and our suppliers are committed to each other’s development. There are also other important features of lean production, including just-in-time (JIT) delivery of parts and raw materials; this calls for precise scheduling and very high levels of quality. JIT dramatically reduces the amount of money tied up in stock.

Lean production is matched by lean design, which again involves teamwork and team
leadership, not only in each department or section, but also across functions (known as "simultaneous development"). Through this approach differences of opinion are aired and worked through, rather than being hidden or suppressed. In this way issues are dealt with before they become problems.

In the West, the lessons of lean production are very slowly being learned - usually through Japanese companies opening plants in Europe or the USA. For there is no denying the effectiveness of TQM and lean production in improving productivity. Look at some of the figures below for the motor industry; they are taken from an essential book on this subject, “The machine that changed the world”, by Womack, Jones and Roos, 1990.

<table>
<thead>
<tr>
<th>Car manufacturers</th>
<th>Japanese (excluding Japanese-owned)</th>
<th>N. American</th>
<th>European</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEAN PRODUCTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Productivity - hours/vehicle</td>
<td>16.8</td>
<td>25.1</td>
<td>36.2</td>
</tr>
<tr>
<td>Quality - defects/100 vehicles</td>
<td>60.0</td>
<td>82.3</td>
<td>97.0</td>
</tr>
<tr>
<td>Stockholding - days worth of stock</td>
<td>0.2</td>
<td>2.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Teamwork - % of workforce in teams</td>
<td>69.3</td>
<td>17.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Multiskill level (0 = low, 4 = high)</td>
<td>3.0</td>
<td>0.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Creativity - suggestions per employee</td>
<td>61.6</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Training - hours / new production</td>
<td>380.3</td>
<td>46.4</td>
<td>173.3</td>
</tr>
<tr>
<td>Automation:-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welding (% of direct steps)</td>
<td>86.2</td>
<td>76.2</td>
<td>76.6</td>
</tr>
<tr>
<td>Painting (% of direct steps)</td>
<td>54.6</td>
<td>33.6</td>
<td>38.2</td>
</tr>
<tr>
<td>Assembly (% of direct steps)</td>
<td>1.7</td>
<td>1.2</td>
<td>3.1</td>
</tr>
</tbody>
</table>

| **LEAN DESIGN**                   |                                     |             |          |
| Engineer - hours per new car      | 1,700,000                           | 3,100,000   | 3,000,000|
| Months to develop new car         | 46.2                                | 60.4        | 58.5     |
| Delayed products (%)              | 16.7                                | 50.0        | 33.3     |
| Time from production start to first sale (months) | 1 | 4 | 2 |
| Time to return to normal quality after new model introduced (months) | 1.4 | 11 | 12 |

The figures for automation should be noted. The difference between the Japanese and the others is not all that great — and in assembly work the European plants have more automation than the Japanese. No, contrary to much popular opinion, it is not automation that makes the big difference in productivity, but attitudes to quality, teamwork, organization, and training. Other factors of great importance are creativity and innovation. In the motor industry, Japanese employees make on average 154 times as many suggestions as their American and European counterparts. Japan has completely reversed its old image of being a poor imitator of other people’s designs (see Tatsuno, 1990).
No wonder, then, that in a number of product fields the Japanese are gaining such an advantage. Macdonald and Piggot (1990), list 31 major industries in which the Japanese have more than a 50 per cent share of world trade, including shipbuilding, cameras, photocopiers, video recorders, hi-fi, microwave ovens, motorcycles, artificial leather, pianos, and liquid crystal displays.

This trend is beginning in service industries as well. In 1986 a warning was sounded by Quinn and Gagnon in the Harvard Business Review:

“Daily we encounter the same inattention to quality, emphasis on scale economics, and short-term orientation in the service sector that earlier injured manufacturing... If service industries are misunderstood, disdained or mismanaged, the same forces that led to the decline of US manufacturing stand ready to cut them to pieces.”

The message is clear: to flourish we need to adopt the principles of total quality management, and continue to evolve these principles further — for ever.

**Figure 9.6: Continuous improvement of continuous improvement**

<table>
<thead>
<tr>
<th>Phase 1: Low Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betraying our Customers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 2: Adequate Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfying our Customers</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 3: Competitive Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delighting our Customers</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 4: Creative Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astonishing our Customers</td>
</tr>
</tbody>
</table>

Lose market share or if monopoly, keep it only grudgingly. Lose huge sums of money due to waste, scrap, conflict. Social loss also very high.

In short-term, maintain market share. Keep our customers by talking with them and continuously improving our internal processes. Keep costs down. (In long-term, lose market share)

In short-term, increase market share by attracting more customers through major improvements in quality and value for money. These brought about by increasing dialogue, further improvements of internal processes, particularly through major cross-functional projects and Lean Production methods. In long-term, merely maintain market share.

Become market leader; create new markets by focused creativity (new ideas) and innovations (turning these into new products or services).
Quality management gurus

A number of ‘gurus’ are associated with the development of quality management theory and all of them have useful views. The different perspectives allow us to choose the ideas that are most appropriate to our situation. The best known of these ‘gurus’ are Deming, Juran, Crosby, Taguchi and Ishikawa.

DEMING

Dr. W. Edwards Deming taught statistical process control (SPC) to the Japanese and has always maintained that management must have an appreciation of statistical variation. He successfully applied SPC theory during the Second World War in the USA, and he trained designers, engineers and inspectors for the war effort. His training resulted in large reductions in scrap and rework, plus an improvement in productivity.

Deming insists that it is the responsibility of managers to change systems and processes. They must understand and control variation in systems and processes by using control charts.

He teaches that all systems contain a certain amount of variation. That is, their performance will vary around an average figure — sometimes more than average, sometimes less. Examples of variation in performance include:

- the length of time it takes for a telephone enquiry bureau to answer the telephone;
- the length of time to pay invoices;
- the number of errors in payments;
- the number of complaints from internal customers about being given incorrect information;
- the number of work-hours wasted due to meetings starting late;
- the length of time a customer spends in a queue;
- the percentage of trains that arrive on time;
- the scores on a customer satisfaction survey;
- scores on managers’ performance reviews.

There are in fact two types of variation - those due to common causes and those due to special causes.

Common cause variation is due to the system itself. It is inherent, inevitable, a characteristic of the system as it is at present.

Special cause variation is due to unusual events or happenings which are outside the normal workings of this system.

Deming is widely known because of his theories and in particular his “14-point plan”, the “Deming cycle” and his “deadly diseases”. His 14 points offer a philosophy of management.
DEMING'S 14 POINTS

1. Create constancy of purpose
2. Adopt the new philosophy
3. Eliminate the need for mass inspection
4. Do not award business on cost alone
5. Improve constantly
6. Institute training on the job
7. Institute leadership
8. Drive out fear
9. Break down barriers between departments
10. Eliminate slogans and exhortations
11. Eliminate work standards
12. Remove barriers that rob people of pride in workmanship
13. Institute a vigorous programme of education and self-improvement
14. Put everybody to work on the transformation

These 14 points are Deming's basis for the transformation of American industry anywhere, in small and large companies operating in the manufacturing or service sectors. The "deadly diseases" of quality, as Deming calls them, stand in the way of transformation. These diseases are:

1. Lack of constancy of purpose in planning product and service
2. Emphasis on short-term profits
3. Annual reviews and rating systems which focus on end results. People are rewarded for doing well in the system and not for improving it.
4. Mobility of management known as "job hopping"
5. Management relying only on visible figures. Just as important are figures which are unknown or even unknowable, e.g. effect of an unhappy customer on future sales.

Deming introduced a systematic approach to problem solving and improvement, called the Deming cycle.

**The Deming cycle**

<table>
<thead>
<tr>
<th>ACT</th>
<th>PLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>STUDY</td>
<td>CARRY OUT</td>
</tr>
</tbody>
</table>

When improving a system, it is vital to do so in a rational and conscious manner. Otherwise we have what is known as tampering, which only makes things worse. The Deming cycle, also known as the Shewhart cycle, provides a good basis for systems improvement.
JURAN

Juran is best known for his concepts of “breakthrough”, the “internal customer” and the “quality trilogy”. He is also credited with the introduction of “Pareto analysis” applied to problem solving; for cost of quality as a means of prioritizing and monitoring improvement activity; and the quality council as the means of supporting quality implementation in companies.

His quality trilogy comprises quality planning, quality control and quality improvement. These must be seen as an integral part of quality actions, which have to be planned to achieve control at the level of performance. Further planning for improvement takes place until project-by-project a system achieves “breakthrough” to an improved level of performance.

This systematic organization of quality actions is coordinated by a body called the quality council which sets targets and identifies the means for implementing improvements. This group keeps company directors informed and involved in quality improvement work.

Juran believes there are huge cost savings to be made by measuring and resolving quality problems. Money is the prime language of management and the costs of poor quality can be measured as failure costs, inspection costs and prevention costs. This approach can direct companies towards prioritizing issues for quality improvement action and set them on a systematic project-by-project approach to improved systems and processes.

CROSBY

Crosby has a dynamic personality and his quality ideas have attracted a lot of attention. Crosby’s “four absolutes” of quality and his total quality plan are major contributions to quality philosophy.

His four absolutes are:
1. “The definition of quality is conformance to requirements.” Clearly, managers must specify quality requirements and criteria, or else operators will be deciding what is needed.
2. “The system of quality is prevention.” Preventing problems by understanding processes and improving them before products or services reach the customer.
3. “The performance standard is zero defect.” This means that perfect quality is the aim. It strongly supports the idea of getting the requirements right in the first place. The costs of prevention to reach zero defect seem to be offset by the reduction in failure costs.
4. “The measurement of quality is the price of nonconformance.” Cost of quality measurements appear as a prime motivator to management. Efforts at improving quality will more than pay for themselves through improved productivity, reduced rework and delighted customers.

Crosby’s total quality plan is a specific action plan for implementing total quality. This plan covers:

- management commitment and team development;
- measuring quality;
- quality awareness and planning;
- educating the workforce;
- employee investment;
- review and evaluation of improvement efforts;
- quality as an ongoing process monitored and supported by a quality council.

TAGUCHI

Taguchi is a Japanese engineer who has introduced a number of revolutionary ideas and practices to the field of total quality.

His work on experimental design, which the Japanese have been practising since the early 1950s, introduced powerful methods for the design of new products and processes. These methods set up experiments to identify design parameters that minimize the effect of "noise" — factors such as temperature, pressure or human error — which affect performance.

Taguchi’s method allows this vital information to be collected using far fewer experiments. The result is that products and processes are built to resist “noise”. Taguchi argues that design is the principal determinant of the final product cost.

Taguchi views product development as having three stages:

SYSTEM DESIGN
PARAMETER DESIGN
TOLERANCE DESIGN

- System design involves innovation and requires engineering knowledge.
- Parameter design is the key step which determines the product parameter values and the operating levels of process factors that are least sensitive to noise factors.
- Tolerance design means spending money on better grade materials, components or machinery but only if the reduced variation achieved through parameter design is not sufficient.

Another Taguchi idea, called “loss function” has had a major impact on quality thinking and practice. This idea replaces the conventional view that products are acceptable if they meet specification limits. This means there is a point at which a product becomes unacceptable as it fails to meet specifications.

Taguchi argues that any product variation, even that within the specified limits, will generate a “loss to society” over the product’s lifetime. The further it moves from the target value the greater the decline in product performance. Taguchi maintains that loss is proportional to the square of the deviation from the target value. When a product reaches a customer it imparts a loss if it fails to function. This loss is realized by the customer in costs associated with repair or replacement and by the manufacturer in warranty costs, poor company reputation and loss of market and jobs. In order to minimize this loss, improvement must continue until target perfection is achieved. Specification limits are no longer the target. The improvement effort must never cease.

Quality improvement is the most visible effect of the application of Taguchi’s methods, but the real power of the system is its ability to focus on bottom-line results, both in terms of capital investment and the cost of quality.
ISHIKAWA

Ishikawa advocated use of the “seven tools of quality control”.

- Pareto charts - prioritize action
- Cause and effect diagrams - identify causes (Ishikawa diagram)
- Stratification - subset causes
- Check sheets - collect data
- Histograms - display variation
- Scatter diagrams - investigate dual-factor relationships
- Control charts - monitor process variation

More specifically he said that these tools should be used by quality circle members. Ishikawa pioneered the quality circle movement in Japan. Quality circles are small groups of employees drawn from the same work area in a company. They meet voluntarily and regularly to discuss, investigate, measure and analyse work-based problems. They have a team leader and use the seven tools of quality control. The teams implement changes after consultation with management.

Ishikawa advised that quality circle activity must be part of a company-wide quality effort. Management, he said, must understand total quality and how quality circles function, before circle activities take place. Circle members must also have a wide perspective on quality throughout the organization. Effective coordination and evaluation of all quality efforts must be carried out by management to sustain the problem-solving culture.

Ishikawa’s view was that “total quality” meant participation by everyone in a company working as a member of a team. He emphasized the human element of quality which he believed was based upon “respect for humanity”.

Quality assurance - the ISO 9000 series

ISO 9000 quality assurance is an internationally recognized quality management standard and participation in a world market may well depend on a company adopting ISO 9000 as a model for its quality management system. ISO 9000 standards provide:

- a guide to the development of a quality management system recognized throughout the world as good and efficient practice;
- a level of confidence for potential purchasers who know that the inevitable risk involved can be assessed, measured and controlled;
- an established standard by which any company can be compared in terms of its management processes, providing worldwide communication in commerce to a readily understood criterion.
THE ISO 9000 SERIES

ISO 9000  is a guide to the selection and use of the appropriate part of the series.
ISO 9001  relates to quality specifications for design/development, production, installation and servicing when the requirements of goods or services are specified by the customer in terms of how they must perform and are then provided by the supplier.
ISO 9002  sets out requirements where a firm is manufacturing goods or offering a service to a published specification or to the customer’s specification.
ISO 9003  specifies the quality system to be used in final inspection and test procedures.
ISO 9004  is a guide to overall quality management and the quality system elements within the series.
ISO 9004.2  sets out guidelines for service companies.

More and more companies are taking the standards as a means of developing quality management systems capable of conforming to contractual documents and not as a first practical step to improving the company. However, very few seize the opportunity for improving and gaining a competitive edge since they assume their business base will expand because of their quality ISO 9000 credentials. In the short term this is probably correct, but for longer-term growth and survival it is unlikely to be enough.

Public quality awards

There are a number of quality awards. They include the Deming Prize, BQA Award, the Baldridge Award and the European Quality Award. These awards are often seen as a way of raising staff awareness about quality issues. Company structure and operations have to be totally re-assessed and senior management made fully aware of deficiencies in their company’s total quality management performance to qualify for such an award.

The Baldridge Award, for example, uses criteria and a points system to arrive at a final score. The points indicate the relative importance of each item, as shown below.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Subfactor</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>Senior executive leadership</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Quality values</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Management for quality</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Public responsibility</td>
<td>20</td>
</tr>
<tr>
<td>Information and analysis</td>
<td>Scope and analysis of quality data and information</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Competitive comparisons and benchmarks</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Analysis of quality data</td>
<td>20</td>
</tr>
</tbody>
</table>
Human resource utilization

Many companies are becoming increasingly aware of the benefits to be gained from implementing total quality practices. These awards are becoming the benchmarks for quality and they represent prestigious achievement for successful companies.

Questions for discussion

1. Define the essence of quality.
2. What is the difference between quality control, quality assurance and TQM?
3. Why deal with quality?
4. Discuss the relative importance of the quality of products and the quality of the whole system.
Exercise 1.1  Customers and suppliers (Answers)

Answers are as follows:

1. (i) Process B
   (ii) Process B
   (iii) An external customer

2. (i) Design
   (ii) Market research
   (iii) Finished product (or words to that effect)
   (iv) Purchasing - information on raw materials etc. to be purchased, and Manufacturing —
       designs, plans, specifications and so on to enable manufacturing to produce the item.

3. Answers may vary; you will need to use your own imagination and encourage participants to use theirs. Possibilities include:
   (i) Information about market trends and/or questions about technical implications for
       meeting these.
   (ii) Answers or responses to the questions posed in 3 (i).
   (iii) Staff; training; wage/remuneration policies; welfare services; actual wage payment
       process; industrial relations assistance.

Then make the following comments:

- 3 (i) and (ii) show how processes or departments can be suppliers and customers to each
  other.
- 3 (iii) is an example of a service function supplying its internal customers.
UNIT 2: CUSTOMER-SUPPLIER RELATIONSHIPS

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Relate to the concept of the supply chain.
2. Map your own internal and/or external customers and suppliers.
3. Analyse some of your own customer-supplier relationships.

UNIT 2: CONTENTS

2.1 The view of organizations

2.2 Customers and suppliers
UNIT 2: CUSTOMER-SUPPLIER RELATIONSHIPS

2.1 The view of organizations

This unit is just a reminder of explanations given in Unit 1. Traditionally we have seen the organization as a hierarchy. This is shown in figure 9.7.

**Figure 9.7: The traditional hierarchical concept of organizations**

![Diagram of a traditional hierarchical concept of organizations]

It would be useful to discuss what happens when person A needs something (information or a component) from person B and wants to discuss this.

The new view is to see the contact as a flow from suppliers to customers. We have already seen some of these contacts: in general terms they may be described as a simple generalized supply chain (figure 9.8a) or as a more complex generalized supply chain (figure 9.8b), or else as a generalized supply chain where A supplies B, who adds value, re-supplies A, who adds further value before supplying C. Y takes work from X, adds value, sends to Z. Y also takes work from W, adds value, sends to A (figure 9.9).

**Figure 9.8a: Simple generalized supplier-customer flow (“supply chain”)**

External → suppliers → customers → external

**Figure 9.8b: More complex generalized supply chain**

![Diagram of a more complex generalized supply chain]
Now is the time to apply this idea to your own work situation. We have provided you with a worked example; take a blank sheet for your own use.

2.2 Customers and suppliers

Exercise Mapping your customers

STEP 1: The first thing is to be clear about who "you" are. That is, whose processes are you examining to identify the customers and suppliers? If you are doing this exercise on your own, it will be your own processes. If you are a member of a natural work-based group or team, then it will be that team’s processes. If you are working in a mixed group, that is with people from various organizations or departments, then you will need to select one person (enterprise) to use as an example.

Now write here the name of the person or group whose processes you are going to examine:

STEP 2: List the main things done by the person or group just identified; that is, their main processes at work. There should be a maximum of seven processes and there may be fewer.

The main processes carried out by ______ are:

1. 
2. 
3. 
4. 
5. 
6. 
7. 

STEP 3: Write each of these processes in Column 1 of table 9.1.

STEP 4: Identify the customers of each process. That is, who receives the output from that process? Enter this in Column 2 of the table.

STEP 5: Taking each process in turn, imagine yourself as its customer(s). What will satisfy
you, as the customer? If things were even better, what would delight you? Write these in Column 3.

**STEP 6:** Now go back to looking at things from the point of view of the person/team who carries out the process (the process owner). How well are you satisfying or delighting each customer? What makes you think so? What evidence or data do you have? Put this in Column 4.

**STEP 7:** Although the emphasis in TQM is very much on satisfying or delighting customers, this does not mean, in a simplistic way, that “the customer is always right.” Some customers are their own worst enemy - they really make it hard to please them! By contrast, others help us to help them.

In Column 5, therefore, write down those things that:

(a) customers do that make it easy to satisfy/delight them;
(b) customers do that make it difficult to satisfy/delight them;
(c) customers do not do, but that would make it easier to satisfy/delight them if they started to do.

Now you have a customer map which should provide significant information for further decision making on how to improve your customer-supplier relationships.

<table>
<thead>
<tr>
<th>(1) Main processes</th>
<th>(2) Customers of the process</th>
<th>(3) What will satisfy or delight the customers</th>
<th>(4) How well we are satisfying or delighting these customers</th>
<th>(5) What customers could do/stop doing/start doing to make it easier for us to satisfy or delight them</th>
</tr>
</thead>
</table>

The key to quality improvement, then, is working with our customers to see how we can satisfy or delight them, — with their help — and with our suppliers to see what they can do for us — with our help.

Customers and suppliers are always people. They may be very remote, invisible even, but still they are people. Therefore we need to build good relationships with them. Good customer-supplier relationships lie at the heart of good quality.

In the past, customers and suppliers have all too often looked on each other as opponents, rather than as partners. The relationship has been antagonistic, and combative, rather than
mutually supportive. Those organizations that have taken quality seriously have realized this, and have gone to great efforts to move from win:lose customer-supplier relationships (which always become lose:lose in the long term) to win:win relationships.

Questions for discussion

1. What are the different views of an organization? What are the advantages and disadvantages?
2. Why do we need to map our internal and external customers?
3. What are the major problems in your organization’s customer-supplier relations, and what is their possible effect on quality?
UNIT 3: WHO IS RESPONSIBLE: VARIATIONS IN QUALITY

UNIT 3: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Relate to the concept of variation in a process.
2. Recognize that all processes contain some inherent natural variation.
3. Relate to the aim of increasing quality not only by improving average output, but also by reducing variation.
4. Recognize that control over people’s performance lies mainly in the nature and design of the processes they are required to operate.

UNIT 3: CONTENTS

3.1 Variation in a process
3.2 Natural and special variation
3.3 Exercise: The “red bead game”
UNIT 3: WHO IS RESPONSIBLE: VARIATIONS IN QUALITY

3.1 Variation in a process

Every activity or process has a certain variation inherent in its output. That is, the actual output from a process will vary from time to time. No process is able to deliver exactly the same output every single time.

For example, the time it takes a switchboard operator to answer the telephone will vary, almost from call to call. Sometimes it might be 3 seconds; then 3.5; then 10; and so on. The time taken will depend on many factors, and this difference in time is an example of variation.

Take a machine operator making a particular part; the output might be something like:

<table>
<thead>
<tr>
<th>Hour</th>
<th>Number of parts made</th>
</tr>
</thead>
<tbody>
<tr>
<td>0800 - 0900</td>
<td>40</td>
</tr>
<tr>
<td>0901 - 1000</td>
<td>42</td>
</tr>
<tr>
<td>1001 - 1100</td>
<td>39</td>
</tr>
<tr>
<td>1101 - 1200</td>
<td>40</td>
</tr>
<tr>
<td>1201 - 1300</td>
<td>43</td>
</tr>
</tbody>
</table>

So there is a variation in the number of parts made.

Take the number of errors made by a typist. These might vary like this:

<table>
<thead>
<tr>
<th>Day</th>
<th>Errors per 1000 words typed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>2</td>
<td>0.9</td>
</tr>
<tr>
<td>3</td>
<td>1.1</td>
</tr>
<tr>
<td>4</td>
<td>1.0</td>
</tr>
<tr>
<td>5</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Or again, suppose you travel to work on a particular bus. The time taken for the journey will vary each day, like this:
In every example, the process (answering the telephone, operating the machine, typing, travelling to work) will exhibit a certain amount of variation, or difference, in the size of its output (answering time; number of parts made; error rate; journey time).

One of the aims of TQM is not only to improve the basic level of performance (i.e. the average output), but also to reduce variation in the process. This is because lower variation means that the process is more consistent, more reliable.

3.2 Natural and special variation

In general terms, there are two possible types of cause of variation:

1. Natural or common cause; this is variation due to the nature of the process itself. It is inbuilt, due to random happenings or "luck" on that particular occasion. For the journey to work, this luck factor will depend on traffic lights, the amount of traffic on the road, the time of day and weather conditions.

2. Special causes of variation; these are unusual, abnormal happenings, that are not normally expected. For the journey to work, this might include a major accident, the bus breaking down, a diversion due to a water main bursting or unusual weather conditions.

In an introductory module like this it is not possible to give a detailed explanation of the difference between common and special causes. In the short term, the difference may not matter too much. In the long term, however, as the first round of quality improvements are replaced by further continuous improvement, it may be essential to use control charts to investigate common and special causes. You will then need specialist training. Good introductory books are by Scherkenbach; and Wheeler and Chambers (see the bibliography at the end of this module).

3.3 Exercise: The "red bead game"

This exercise is based on a famous demonstration carried out by one of the world leaders in TQM, Dr. W. Edwards Deming. He uses red and white beads, and a specially constructed instrument called a "paddle".

<table>
<thead>
<tr>
<th>Day</th>
<th>Journey time in minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45.0</td>
</tr>
<tr>
<td>2</td>
<td>59.2</td>
</tr>
<tr>
<td>3</td>
<td>34.6</td>
</tr>
<tr>
<td>4</td>
<td>51.1</td>
</tr>
<tr>
<td>5</td>
<td>44.3</td>
</tr>
<tr>
<td>6</td>
<td>50.0</td>
</tr>
<tr>
<td>7</td>
<td>30.2</td>
</tr>
<tr>
<td>8</td>
<td>52.6</td>
</tr>
<tr>
<td>9</td>
<td>44.8</td>
</tr>
<tr>
<td>10</td>
<td>49.1</td>
</tr>
</tbody>
</table>
Module 9
Unit 3

In this version of the game we use small pieces of paper and containers such as water jugs. The purpose of the exercise is to show that all processes contain natural variation, and that most of this variation is not due to the effectiveness of the operator but to the design of the process itself.

Preparation. You will need four sets of equipment as follows:

1) A dry, empty water jug or similar container.
2) 300 small, screwed up pieces of paper, of colour A. It doesn’t matter what colour this is. Let’s say they are white. To prepare the pieces, take an A4 sheet and tear it in half (two pieces); then in half again (four pieces); then in half again (eight pieces); half again (16 pieces); finally half again (32 pieces). Then screw these 32 pieces into little paper balls. You will therefore need about ten sheets of paper to make the 300 screwed up pieces.
3) 100 screwed up pieces of paper of colour B - i.e. any colour that is different from the first set. Let’s just say they are red. Make them the same way as the 300. Four sheets of A4 paper should be enough.
4) Put the 300 white pieces (colour A) and the 100 red pieces (colour B) into the jug. It is important to have exactly 300 and 100 respectively.
5) Thoroughly mix the pieces in the jug. Shake, then stir them with a ruler or a spoon.
6) Prepare four sets like this. The jugs or containers must all be the same type, size and design.

Briefing the participants Divide the participants into four groups; you should have four to six people per group. Each group works at a table.

If there are more than this (i.e. the total number is greater than 24), have four per group and ask the remainder to watch rather than take an active part. Each of the four groups is the production department in a company making pieces of crushed paper. There are four main roles in each group.

1. The shaker. This person tips and shakes the jug so that pieces of paper fall onto the table. Only 20 pieces should be tipped out.
2. The counter who counts the pieces as they tip out and tells the shaker to stop when 20 are on the table. If up to four more than 20 come out, the last ones are put back in the jug. If more than 24 come out, all are put back, the jug is shaken and stirred, and the process starts again.
3. The selector After 20 pieces are on the table, the selector separates out the red (colour B) ones from the rest.
4. The scorer After each production round, the trainer asks for each group’s score. Here the scorer shouts out the number of red (colour B) pieces.

The trainer explains that the red pieces (colour B) are faults. Therefore the aim is to have as few red pieces as possible. Scores are plotted on a chart (flip-chart, OHP, white board) as follows.
1. Allow each team a practice round before production really commences.
2. After each round, all the pieces are put back in the jug and thoroughly shaken, stirred and mixed.
3. During the tipping, the shaker must not tilt the jug backwards or do anything else to prevent a red (colour B) piece from coming out.
4. During the exercise, the trainer should urge the groups to do better. Praise a group that gets a low score, chastize one with a high score. Threaten dismissal for “poor work”. Give a prize for “good work”. And so on.

A typical output from this exercise is as follows:

<table>
<thead>
<tr>
<th>Turn</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>11</td>
<td>6</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>33</td>
<td>23</td>
<td>28</td>
<td>113</td>
</tr>
</tbody>
</table>

Average number of reds per turn = 113 / 20 = 5.65

This can then be plotted as a run chart, as shown in figure 9.10.
The aim of TQM is to improve the average or mean score (in this case reduce it) and to reduce the spread, or variation, of the scores.

Finally, discuss the exercise. Ask how much control the groups felt they had over their output. In reality, they have very little - the number of "faults" (red/colour B pieces) that come out is virtually random, within certain limits. These limits, which are a measure of the natural spread or variation of the process, are called control limits. We will not go into how they are calculated, here, (although for those with previous statistical knowledge, they are +3 standard deviations from the mean).

As participants had no control over their performance, how did they feel when they were criticized for doing badly and when others were praised for doing well?

How realistic is this example? How many people in organizations have relatively little power over their output, and yet are praised or punished for what they produce?

This game shows that control over people's performance lies in the process or system — i.e. in such factors as the:

- design of the method used;
- nature of the materials provided;
- conditions the work is performed in;
- selection and training of the staff.
These factors are the responsibility of management. All too often management fails to train staff, provides inappropriate equipment and materials, designs poor processes, and expects people to work in bad conditions. Then they blame the workers for poor performance — for poor mean output and high variation.

TQM improves output (mean and variation) by management working together with employees on improving these aspects of the overall process.
UNIT 4: BASIC QUALITY TOOLS

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Identify and describe each of the seven basic quality tools.
2. Use each of the seven tools as appropriate when working on quality improvement projects.

UNIT 4: CONTENTS

4.1 Graphs
4.2 Histograms and bar charts
4.3 Brainstorming
4.4 Nominal group technique
4.5 Pareto analysis
4.6 The flow chart
4.7 The fishbone diagram/cause-and-effect diagram
UNIT 4: BASIC QUALITY TOOLS

The basic quality tools are simple yet very powerful. In this unit we will consider seven such tools, namely

1. Graphs
2. Histograms and bar charts
3. Brainstorming
4. Nominal group technique
5. Pareto analysis
6. Flow chart
7. Fishbone diagram

Most of these can be used in three different ways, each of which will be important in improving quality by helping you to:

- understand what is going on in a process or system;
- decide what to do next, where to place priority;
- make presentations, reports and so on, in order to:
  - make a case for investing resources, time, effort in tackling a quality improvement project;
  - describe plans for tackling quality improvement;
  - illustrate the results of tackling quality improvement.

4.1 Graphs

Graphs give an instant picture of what is happening in a process or system over a period of time. By plotting the output at regular time intervals, we can get a simple picture of whether or not the process is stable, the value of its average or mean output, and the amount of variation we are getting around that mean.

Outputs may be positive or desirable, e.g.

- number of units produced;
- number of telephone calls answered;
- number of customer queries dealt with;
- number of meals served;
- amount of coal extracted;
- area of land ploughed;
- number of hotel bedrooms occupied.

Or else the outputs may be negative, undesirable, e.g.

- number (or percentage) of errors;
- percentage of materials that are scrap;
- number of trains that are delayed;
- percentage absenteeism or sickness;
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- employee lateness — minutes lost.

For positive measures, the aim of TQM is to improve the process so that the average or mean increases. Conversely, with negative measures the aim is to reduce the mean. In both cases the intention is to reduce variation. The lower the variation, the more consistent and predictable the process. For a given level of mean, lowering the variation will be an improvement. In the graphs shown in figure 9.11, process B is more consistent than process A, even though they both have the same mean output.

Although it can be useful to draw a graph after the event, to see what has been happening in the past, the main value of a graph often lies in finding out what is happening now. This involves plotting the graph continuously, in real time, as an ongoing activity. Such a graph is called a run chart. In this way a number of trends can be spotted before their effect becomes too serious. For example:

a) If seven or more consecutive points are rising or falling, then something has changed in the process and should be investigated. This is a trend. [Figures 9.12 and 9.13]
b) If seven or more consecutive points lie either all seven above the mean, or all seven below the mean, then something has changed in the process and should be investigated. This is a run. [Figures 9.14 and 9.15]
c) If a point is far above or below the mean, then something has changed in the process and should be investigated. A strict definition of “far above or below” is three standard deviations either side. If you don’t know how to calculate this, look for what seems an unusually high or low point and then investigate further. This is a special cause [Figure 9.16].
d) Some trends are best spotted visually. For example, a cyclical effect can tell us a lot about the process; it needs investigating to understand the reasons for the regular changes. [Figure 9.17]
e) Sometimes an upward or downward trend can be spotted, even though strictly the sequence of seven points is not true. [Figure 9.18]
f) A run chart can be converted into a “control chart” which is the basis of statistical process control. [See Figure 9.19]

To explore whether a system is under control we calculate the upper and lower control limits. In principle these are placed three standard deviations above and below the average or mean.

The first test of a system’s level of control is whether any points fall outside the control limits: if so, special cause variation is present. Once the special causes have been examined and dealt with, then work can commence on systematically improving the system as a whole.
Figure 9.11: Two processes
Figure 9.12: Upward trend

Output Value

Output Event Number

Upward Trend Starts Here
Figure 9.13: Downward trend

Output Value

Downward Trend Starts Here

Output Event Number

MEAN
Figure 9.14: Upward run
Figure 9.15: Downward run
Figure 9.16: Special cause

Special Cause Happened

Output Event Number

Output

MEAN
Figure 9.17: Cyclical output
Figure 9.18: "Jagged upward trend"
Figure 9.19: Statistical process control
When drawing a graph it is important to choose the right units of measurement. Along the bottom or horizontal axis you put the time scale; this may be minutes, hours, days, weeks or whatever, depending on how often you take measurements.

Sometimes the horizontal measurement is not time as such, but each successive happening or event. For example, you may want to measure how long a customer has to wait in a queue at a bank or government office. Here you would observe someone who has just joined the queue and measure how long it takes until they are served. This is event number 1 on the horizontal axis. When that person has left, you would then choose the next person who joins the queue, and measure how long they have to wait. This is event number 2. And so on.

This example illustrates another essential point about run charts. Any given measured value must not be affected by the preceding values. That is why you must wait for the first person to clear the queue before starting a new measure. Otherwise how long the next person has to stay in line will partly be influenced by what happens to the one in front, who is already going to be on your graph, and this will give a distorted picture of events.

4.2 Histograms and bar charts

Histograms and bar charts look similar and are indeed related, although their uses are slightly different.

Histograms

A histogram shows the frequency distribution of data. For example, it might show:

- how many people there are in various age groups;
- how many people had to wait in a queue for various lengths of time (e.g. less than 3 minutes, 3-6, 6-9, 9-12, more than 12 minutes);
- how many products exhibited various numbers of faults (e.g. 1-5, 5-10, 10-15 and so on);
- how many items were dispatched within various time spans after ordering.

The key words here are “how many” (i.e. the frequency) and the “various numbers ....” The bottom axis gives summarized or clustered numerical widths; the vertical axis shows how many in each of these sections.

We can use an earlier example to illustrate. Figure 9.11 showed two graphs, representing successive measurements of output. These can be converted into a histogram.

The figures for graphs A and B are as follows:
To draw a histogram, you first have to decide how wide the sections or clusters on the bottom axis will be. An appropriate guide is to use these formulae:

1. Calculate the range of the scores; that is, the highest minus the lowest.
   In this case \( \text{range} = 23 - 6 = 17 \)

2. Decide how many sections to have.

   As a rough guide, this depends on how many data points you have, as follows:

<table>
<thead>
<tr>
<th>Number of data points</th>
<th>Number of sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50</td>
<td>5</td>
</tr>
<tr>
<td>50 - 100</td>
<td>6 - 10</td>
</tr>
<tr>
<td>100 - 250</td>
<td>7 - 12</td>
</tr>
<tr>
<td>More than 250</td>
<td>10 - 20</td>
</tr>
</tbody>
</table>

   You choose a convenient number of sections using these figures as a guide. Here we have less than 50 points (in fact 20) so we have five sections.

3. Divide the range by the number of sections, to get the section width. Here,
   \( \text{Range} = 23 - 6 = 17 \)
   \( \text{Number of sections} = 5 \)
   \( \text{Section width} = 17 \div 5 = 3.4 \)

   As all values in our data are whole numbers, let section width = 3
4. The first section starts at minimum value. In this case, this is 6. So we have the following sections:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>-</td>
<td>13</td>
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<tr>
<td>14</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td>18</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>22</td>
<td>-</td>
<td>25</td>
</tr>
</tbody>
</table>

We now mark how many scores fall in each section. We will combine A and B.

<table>
<thead>
<tr>
<th>Section</th>
<th>Number of scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 9</td>
<td>3</td>
</tr>
<tr>
<td>10 - 13</td>
<td>5</td>
</tr>
<tr>
<td>14 - 17</td>
<td>9</td>
</tr>
<tr>
<td>18 - 21</td>
<td>2</td>
</tr>
<tr>
<td>22 - 25</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 9</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>10 - 13</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>14 - 17</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>18 - 21</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>22 - 25</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

We can now produce the histogram as shown in figure 9.20.

These scores are evenly distributed. However, if we plot the two separately, then we get two distributions, as might be expected. Here we have:

<table>
<thead>
<tr>
<th>Section</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 9</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>10 - 13</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>14 - 17</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>18 - 21</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>22 - 25</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Now (figure 9.21) we see that the spread of B is much less than that of A. This is not surprising, as we pointed this out earlier.

Histograms can therefore be used to compare two sets of data, to see if they come from what is called the same "population" - that is, if they have the same average (mean) and spread (variation).

In this case, we started with two sets and wanted to compare them. Often we have one set of data and want to see if there are any different sets. If so, we need to investigate to find the reason for these differences.

Often patterns may indicate something unusual. We have just seen one where there are clearly two sets — two different peaks. Another common one is where most points are at one end of the distribution — that is called skewed (figure 9.22). Again this may need explanation, and examination of the implications.
Bar charts

A bar chart is similar to a histogram except that here the data are divided into qualitative, descriptive, discrete categories along the x-axis.

For example, output per quarter from four different factories was

<table>
<thead>
<tr>
<th>Factory</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory A</td>
<td>20</td>
</tr>
<tr>
<td>Factory B</td>
<td>28</td>
</tr>
<tr>
<td>Factory C</td>
<td>16</td>
</tr>
<tr>
<td>Factory D</td>
<td>30</td>
</tr>
</tbody>
</table>

A bar chart shows these outputs simply, as in figure 9.23.

Again, in a particular process it was found that, over a given time period, the number of various faults was as follows:

<table>
<thead>
<tr>
<th>Fault</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bad rubber</td>
<td>81</td>
</tr>
<tr>
<td>Cuts</td>
<td>15</td>
</tr>
<tr>
<td>Cracks</td>
<td>6</td>
</tr>
<tr>
<td>Holes</td>
<td>42</td>
</tr>
<tr>
<td>Impurities</td>
<td>12</td>
</tr>
<tr>
<td>No adhesion</td>
<td>115</td>
</tr>
<tr>
<td>Others</td>
<td>10</td>
</tr>
</tbody>
</table>
Figure 9.20: Histogram(1)
Figure 9.21: Histogram (2)
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Figure 9.22: Histogram (3)
Figure 9.23: Bar chart (1)

- Factory A
- Factory B
- Factory C
- Factory D

Output per Quarter: 35, 30, 25, 20, 15, 10, 5, 0
Figure 9.24: Bar chart (2)
4.3 Brainstorming

Brainstorming is a technique for helping a group to generate a wealth of ideas. These may be ideas about

- things that need improving
- possible causes of faults or problems
- possible ways of solving problems or bringing about improvements

It is important to realize that the output of brainstorming is no more — and no less — than a list of possibilities. What happens next will depend on the nature of the things being discussed.

The rules of brainstorming are quite simple - although in the heat of the moment it is not always so easy to stick to them!

1. As already stated, brainstorming is a group technique.
2. The question or issue being brainstormed is clearly stated. This is usually best done using a “why”, “how” or “what” question. For example:
   - what needs to be changed to make this office a more enjoyable place to work in?
   - how can we reduce the number of faulty pieces of equipment that are dispatched to customers?
   - why are people not contributing to our suggestion scheme?
   - what do we want senior management to do differently so that we will feel more committed to working for this organization?

3. Check that all group members understand the question. Write it up on a chart or board so that it can be seen during the brainstorming session.
4. Give the group some 2 or 3 minutes to think about the question in silence.
5. Then ask for suggestions. As these are shouted out, somebody writes them on a flip chart.
6. Whilst they are being shouted out, there must be no comment, praise, criticism or anything else. This is vitally important. The whole point is to create an atmosphere in which people feel free to make any suggestion they like, no matter how strange, original, unusual, or counter-cultural they might appear to be. This means that non-verbal comments such as laughter, groans, cries of amazement and the like are not permitted either.
7. When writing ideas on the chart, each one must be written, using precisely the wording suggested by the group members. Do not try to shorten or reword ideas at this stage. Even if it appears that an idea being suggested is already on the chart, still write it again.
8. This phase should last about 10 minutes. After this time you may expect to have between 20 and 75 items.
9. Now go through all the items on the chart, checking that everybody understands them. If necessary, the people who suggested ideas explain what they meant.
10. Now go through all the items again to see if any are duplicated. This requires careful discussion. Two items can only be combined into one if both of the people who initially suggested them agree.

This is the basic method of brainstorming. Another way is to give longer at the start for individual thought (say 5-7 minutes), and ask each person to write down their ideas on a scrap of
paper. Then go round the group asking each person in turn to shout out one idea from their list, excluding any that have been suggested by somebody else. Keep going round until everybody has contributed all their items. Then clarify and combine as before.

The output from the brainstorming is thus a list of suggested answers to "what", "how" or "why" questions. These answers will have come from all members of the group, and will have been clarified and, where appropriate, combined.

What happens next will depend on the purpose of the session. For example:

- For things that need improving, the group may prioritize (see nominal group technique in section 4.4) or ask the opinion of other people on possible causes of faults or problems. You may summarize these on a fishbone diagram (section 4.7 below) or collect data about how often each possible cause is in fact responsible. These data may then be analysed with a Pareto chart (see section 4.5 below).
- For possible ways of solving problems, you may:
  - explore and discuss each one in depth, perhaps involving data collection on causes;
  - make a flow chart of each proposed change, paying particular attention to the effects and implications of the change on other parts of the process;
  - carry out pilot experiments;
  - gather together well-informed people then rank each solution using nominal group technique, if there is a large element of subjective judgement involved.

4.4 Nominal group technique

The nominal group technique (NGT) is a simple group method for ranking, prioritizing or voting on a list of issues. The latter may be generated in various ways, such as brainstorming, fishbone diagram, discussions, or customer surveys. NGT can be used with a list of up to about 40 items, by a group of anything from 2-25 members.

The procedure is as follows:

1. Write up all the items to be prioritized on a chart.
2. Ensure that everybody understands what each item means.
3. If any items are duplicated, combine them. Give each remaining item a clear identifying number from 1-N, where N is the total number of items.
4. If you wish, there may be a discussion at this point, in which the pros and cons of each item are examined. This discussion may be illuminated by quantitative data.
5. Decide how many items each group member will rank. Various formulae are given for this in different books, but they usually seem to lead to too many. As a guide we suggest the following:
6. All group members, acting individually, then choose their top “n” items - for example, their top 5, or 7, as decided in the previous step.

7. All members then score their top “n” items as follows:
   - n points to their first choice, their top priority
   - n-1 points to their second priority
   - n-2 points to their third, and so on until 1 point is given to their nth priority.
   For example, if they chose to rank their top 7, then:
   - 7 points to first priority
   - 6 points to second priority
   - 5 points to third priority
   - 4 points to fourth priority
   - 3 points to fifth priority
   - 2 points to sixth priority
   - 1 point to seventh priority

8. The names of group members and the identifying numbers of items are written on a chart.

<table>
<thead>
<tr>
<th>Items</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tbody>
</table>

9. Each member shouts out the scores for their top N items, and these are written in on the chart.

<table>
<thead>
<tr>
<th>Items</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td></td>
<td>2</td>
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<td>2</td>
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<td>3</td>
<td>5</td>
<td>4</td>
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<td>4</td>
<td>7</td>
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<td>N</td>
<td>2</td>
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</table>
10. The total points scored by each item are then added up, row by row.

<table>
<thead>
<tr>
<th>Items</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>Total points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
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<td>5</td>
<td>4</td>
<td>19</td>
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<td>4</td>
<td>7</td>
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<td>6</td>
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<td>6</td>
<td>-</td>
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<td>1</td>
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<td>.</td>
</tr>
<tr>
<td>N</td>
<td>2</td>
<td>-</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>

11. The final ranking is done by using the total points. This cannot be done in the simple example above, as we don’t know the scores given to items 7-N. See below for a complete example.

12. The final ranking shows the group’s overall priorities. In addition, clusters of scores can distinguish subgroups with different priorities. These can be acknowledged and indeed may be worked on by the subgroups.

Example: Seven representatives from a retail outlet were asked the following question:

What stops you doing your job effectively?

A total of 68 items were collected, as follows:

1. Environment - cramped or dingy conditions
2. Lack of information
3. Too few staff
4. Lack of leadership or direction from the manager
5. Unclear information about initiatives in the company
6. Lack of storage space
7. Lack of advertising leaflets
8. Little opportunity for promotion
9. Inadequate training
10. Complicated prices
11. Managers keep changing their minds
12. Lack of fast and relevant feedback in times of crisis
13. Managers don’t listen
14. Bad communication
15. Information on new products/promotions received too late - customer knows first
16. Poor restroom facilities
17. Public don’t know what they want
18. Unable to hear customer because of noise
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19. Too much irrelevant material
20. Too many product changes
21. Poor cash desk design
22. Computer system keeps going down
23. Too many bosses — regions, sectors and local managers
24. Unauthorized staff going behind cash desk
25. No incentive to do better
26. Lack of appreciation from management
27. Utter boredom
28. Working colleague has loud voice
29. Impractical queuing system
30. Not receiving details of special offers early enough
31. Too hot in summer, too cold in winter
32. No standards
33. Dirty office
34. Vague instructions
35. No reason to work any harder than Joe Bloggs
36. Colleagues who smoke
37. Lack of encouragement from supervisors
38. Bad roster arrangement
39. Drunken customers
40. Not enough access for disabled customers
41. No authority to give customers compensation when things go wrong
42. Personal safety
43. I'm just a number in this company
44. Lack of supervision
45. No clear statement of management policy - what am I really here for?
46. Not allowed to think for ourselves
47. Constant cost cutting
48. Wind blowing in through doorway in winter
49. Too many vacancies - I can't take my leave when I want
50. I don't get enough uniform shirts
51. Management closing the office two hours earlier than before
52. No facilities for learning a foreign language
53. Too many systems
54. Too many manuals
55. Management want me to work on the cash desk all the time
56. Business specification for retail outlet
57. Too many promises - nothing happens
58. Management imposing unrealistic systems without consulting the staff
59. No facility for having a cup of tea when we are busy especially now that we can't drink in the shop
60. Managers don't care or understand about our problems
61. Danger of punishment if you are honest
62. Poor recruitment system
63. Getting rid of special foreign items
64. Constantly changing management policy
65. Badly fitting uniform
It was decided to rank 10 items. The rankings were plotted as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Toby</th>
<th>Stuart</th>
<th>Sue</th>
<th>Gill</th>
<th>Ken</th>
<th>June</th>
<th>Nick</th>
<th>Total ranks</th>
<th>Total vote (rs)</th>
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From this ranking the following items were picked as the top 16:

4. Lack of leadership
60. Managers don’t care
7. Lack of leaflets
16. Poor restroom facilities
14. Bad communication
26. Lack of management appreciation
15. Information received
3. Too few staff
12. Lack of feedback
9. Inadequate training
33. Dirty office
25. No incentive to do better
65. Badly fitting uniform
30. Not receiving special offers
47. Cost cutting
58. Unrealistic systems
Note that this is in effect a Pareto chart. From these data then, it is clear that the two main factors are:

- lack of leadership;
- managers don’t care.

This was fed back to management, and formed the starting point for discussions between staff and managers on why staff felt this way, and what they would like in the form of leadership and care from management.

At the same time,

(7) lack of leaflets
was taken up as an improvement project by Sue and Ken.

Similarly,

(16) poor restroom facilities
was an issue tackled by Gill and Nick. Toby and June undertook to improve the situation with respect to

(15) information on new products/promotions received too late.

4.5 Pareto analysis

When preparing to make quality improvements we are nearly always faced with a number of opportunities — i.e., there are a variety of issues that need resolving. The trouble is that we cannot tackle all of these at once. We have to decide which is more important, which should be given priority. Pareto analysis is one tool for helping decide on priority.

This method is named after the Italian economist Vilfredo Pareto, who, in the 1980s, noticed that 80-90 per cent of the country’s wealth lay in the hands of 10-20 per cent of the population. This led to the technique bearing his name which, from his observation, is also known as the 80:20 rule, namely that very often (but not always) 80 per cent of problems arise from 20 per cent of causes.

It must be stressed that this is an empirical rule, not a formally scientific one. In other words, it often happens to be true in practice, although there is no rational explanation why it should be so. The proportion 80:20 is only approximate. It may be 90:10, or 70:30, or 65:35. Each case needs to be examined to obtain its own ratio. In general, though, it may be recognized that very often (not always), the majority of problems can be attributed to just a small number of causes.

We can illustrate this using data from the example of the frequency of various faults in a particular process: these were plotted in figure 9.24.

However, we can present the same data in a more striking way, using the Pareto approach. To do this we list the types of fault in descending order of frequency, as follows:
Module 9
Unit 4

<table>
<thead>
<tr>
<th>Fault type</th>
<th>Number of faults of this type</th>
<th>% of total faults</th>
<th>Cumulative % of faults</th>
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<tr>
<td>No adhesion</td>
<td>115</td>
<td>115/281 = 40.9</td>
<td>40.9</td>
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<tr>
<td>Bad rubber</td>
<td>81</td>
<td>81/281 = 28.8</td>
<td>69.7</td>
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<td>Holes</td>
<td>42</td>
<td>42/281 = 14.9</td>
<td>84.6</td>
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<td>Cuts</td>
<td>15</td>
<td>15/281 = 5.3</td>
<td>89.9</td>
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<td>Impurities</td>
<td>12</td>
<td>12/281 = 4.3</td>
<td>94.2</td>
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<td>Cracks</td>
<td>6</td>
<td>6/281 = 2.1</td>
<td>96.3</td>
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<td>Others</td>
<td>10</td>
<td>10/281 = 3.6</td>
<td>99.9</td>
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We then draw what is in effect a bar chart, but in descending order of the frequency of faults — see figure 9.25.

Figure 9.25: Pareto chart

We also put a second graph on the figure, using the right hand axis. This shows the cumulative frequency as each type of defect is brought into consideration.

This Pareto chart clearly shows, then, that the two most significant faults are “no adhesion” and “bad rubber”. Between them these account for 69.7 per cent of all the faults. We should therefore begin by concentrating on these two in improving quality. If we can count “others” as a category, there are seven categories in this example. The first two — no adhesion and bad rubber — therefore represent 2/7 or 29 per cent of the types of fault. Between them they account for 69.7 per cent of the actual number of faults. We therefore have a 70:30 rule — not quite the purist 80:20 of Pareto himself, but the principle is well illustrated.
4.6 The flow chart

The flow chart is a logical, step-by-step representation of a procedure or process. It is an exceedingly useful tool for a number of purposes, including:

- finding out what is going on;
- comparing this with what we thought or assumed was going on;
- deciding what needs to happen to achieve a desired end;
- identifying bottlenecks or other sources of confusion;
- identifying areas where we are making assumptions which may be unfounded;
- identifying interfaces between parts of a system - which is often where problems arise.

Here we will describe the simple flow chart and the detailed flow chart.

The simple flow chart (also known as the top-down flow chart)

In the simple flow chart, the main steps of the process are identified, and then the substeps written in. The example below in figure 9.26 shows a simple flow chart for producing a report.

**Figure 9.26: A simple flow chart**

```
Step 1:
Plan for the Report

Step 2: Organise the Report

Step 3: Write the Report

Step 4: Produce the Report
```

1.1 Clarify reader(s) requirements and the objectives of the report.
1.2 Identify other characteristics that will "delight the customer" — i.e. will meet the reader(s) needs.

2.1 Identify the main themes or sections.
2.2 Decide the order in which to present items.
2.3 Collect all relevant information.

3.1 Write a draft report.
3.2 Check and edit for flow, completeness, readability.
3.3 Incorporate charts and graphs.
3.4 Check for errors.

4.1 Design layout.
4.2 Typeset/word process.
4.3 Get final versions of charts and diagrams.
4.4 Paste up.
4.5 Proof read and correct.
4.6 Print.

Source: Adapted from Scholtes et al., 1988
The detailed flow chart

As its name suggests, the detailed flow chart is indeed more detailed than the simple one. The reason for extra detail lies in the fact that this chart:

- has more steps;
- allows for activities being carried out in parallel (i.e. at the same time);
- shows what activities must be completed before others can be started;
- provides for alternatives, depending on various questions ("if a, do b, but if x, then do y").

As a simple example, figure 9.27 shows the first step only of the report process, redrawn as a detailed flowchart. It will be seen that as well as actions, shown as

it includes decisions, shown as

Usually, when you draw up a flow chart you begin to realize a number of things about the process. Typically, you see that:

- it is a lot more complex than you originally thought;
- a lot of things are done unconsciously (that is, numerous decisions and substeps exist informally: they are not written down anywhere but are carried in somebody's head. Very often these are the result of trial and error learning);
- people often don't know what happens in other parts of the process. They don't know what happens before their own stage ("upstream") or afterwards ("downstream"). If they did know these things, then it is quite likely that they would feel differently about their own stage - and carry it out differently.

Drawing a flow chart

Suppose you want to organize a public meeting, with a guest speaker. First, write down the various things that need to be done. Do not bother yet about any particular order, just collect them together as they occur to you (in effect, a brainstorming process). Your list might look like this:

- send out invitations;
- book a room;
- ask the guest speaker;
- arrange for refreshments.

Now look at this list. It soon becomes apparent that some things must be done before others. For example, you cannot send out invitations until the speaker and the location are fixed. So the list can be rewritten thus:

1. Arrange guest speaker
2. Book the room
3. Send out invitations
4. Arrange refreshments
Figure 9.27: A detailed flow chart

START

DISCUSS WITH INITIATOR OF REPORT

IDENTIFY ALL READERS OF REPORT

FURTHER DISCUSSIONS

ARE ALL READERS IDENTIFIED?

CHECK TALK WITH READERS IF NECESSARY

STATE WHAT YOU THINK READERS' VARIOUS OBJECTIVES ARE

ARE YOU SURE?

FINALISE STATEMENT OF OBJECTIVES

IDENTIFY WHAT OTHER CHARACTERISTICS (style etc) WILL DELIGHT READERS

ARE YOU SURE?

DO DIFFERENT READERS NEED DIFFERENT REPORTS?

PREPARE SEPARATE REPORTS. GO TO STAGE 2
This can be fleshed out somewhat, to make a simple flow chart as in figure 9.28.

Figure 9.28: Arranging a meeting (simple flow chart)

1.1 Invite guest speaker
1.2 Confirm acceptance
1.3 Change date or speaker if cannot accept

2.1 Estimate number of people likely to attend
2.2 Book the room

3.1 Decide how many to invite
3.2 Print invitations
3.3 Send out invitations

4.1 Decide catering budget
4.2 Obtain quotations
4.3 Arrange refreshments
4.4 Arrange transport

Figure 9.29 shows the same process in the form of a detailed flow chart. This shows that some of the stages can be done in parallel — e.g. making a provisional room booking and inviting the speaker.

The use of flow charts

The main purpose of a flow chart is to analyse a process. This analysis may itself serve a variety of purposes, such as:

1. To highlight critical aspects - e.g. where faults are occurring; where there are opportunities for improvement.
2. To show gaps in understanding - again leading to improvements.
3. To ensure that all steps in a process have been identified correctly.
4. To clarify instructions or for direct working. Often a flow chart, if neatly presented, can be used by an employee as a guide or an aide mémoire.
Figure 9.29: Arranging a meeting (detailed flow chart)
4.7 The fishbone diagram (also known as the cause-and-effect diagram)

The cause-and-effect diagram is one of the basic tools for analysing problems. Its basic shape is shown below, and explains the more common name of fishbone diagram. (It is also sometimes known as an Ishikawa diagram, after its Japanese inventor).

Figure 9.30: A cause-and-effect diagram

As Figure 9.30 shows, the basic structure of the fishbone is a number of lines representing causes, coming together to lead to the effect. In practice, each cause line consists of a number of similar, related causes, clustered together.

Often certain basic clusters of causes are used, in particular

- materials;
- equipment;
- people;
- methods;
- environment;
- information;

leading to a “standard” fishbone skeleton as shown in figure 9.31.

Figure 9.31: A “standard” fishbone diagram
The various subcauses are then written in on each of the six main branches. An example of a partially completed fishbone using these six basic headings is shown in figure 9.32. This was prepared by a group brainstorming session to identify the possible causes of having insufficient leaflets on display in a travel centre.

Figure 9.32: Partially completed fishbone diagram

These basic headings are only suggestions. A number of quality specialists use only four of them - materials, equipment, people and methods. An example is shown in figure 9.33 where the problem is "excessive complaints from residents about food".
Figure 9.33: Completed fishbone diagram for in-house cafeteria

METHODS
- Bar not open long enough
- Conference with dietary technician needed
- New techniques
- Mass food preparation
- Cooking lessons needed

MATERIALS
- Silverware gets stolen
- Handwritten menu is difficult to read
- Poor variety of food
- Some food has funny names; is not explained on menu
- Plastic dishes are stained; do not look good
- Spices used improperly
- Nothing different for special occasions

EQUIPMENT
- Dishwasher is too small; wastes energy
- Equipment which keeps food warm malfunctions frequently
- Air conditioning/heat inappropriate
- Salads are cold; meats do not stay cold
- Toasters are old
- Toaster is old
- Bar not open long enough
- Broiler is too small; wastes energy
- Hot water supply inadequate
- Extra cook needed
- Extra cook needed
- Assistants trained to help
- Assistants trained to help
- Kitchen help appears to be disorganized

PERSONNEL
- Cook is too rushed during peak times
- Cook is too rushed during peak times
- No consultation with dietitian
- Cash register is unmanned at times
- Cash register is unmanned at times
- Silverware gets stolen
- Handwritten menu is difficult to read

Sometimes one of the standard branches/bones can be split into several separate ones, as in the example given in figure 9.34, which shows some of the causes of a customer having to wait on the telephone when asking to be put through to the receiving party in the company.
Figure 9.34: Splitting of standard fishbone

METHOD and EQUIPMENT

Not enough lines

Not enough operators

PEOPLE - RECEIVING PARTY

Away

Not in office

Already on 'phone

CUSTOMER HAS TO WAIT

LENGTHY CONVERSATION

Lack of Knowledge of Co. and staff

Does not understand customer's request

PEOPLE - CUSTOMER

Not giving name of Dept. of receiving person

Starts to leave a message

PEOPLE - OPERATOR

Source: Imai, 1986

Again, it may be desirable to label the "bones" according to the situation - not using the standard ones at all. As an example of this, figure 9.35 shows the reasons for customer complaints in a particular area of a national railway system.
Fishbone diagrams are very often prepared by a group, probably using brainstorming. There are two approaches to this process, depending on how the bones are labelled and used. In the description given here, we are assuming that a group is working on the issue together.

1. Using the basic six bones/clusters. In this case, the six basic factors (i.e. materials, equipment, people, methods, environment, information) are used as a prompt to help generate ideas. The process is as follows:

   (i) Identify the effect/problem/opportunity to be investigated.
   (ii) Draw the basic fishbone with the specific effect written in at the head of the arrow.
   (iii) Write the six headings (materials etc.).
   (iv) The group starts with one of the main causes (say materials). Each member in turn suggests one subcause for that main cluster. This is written on the chart, with the usual brainstorming rules of no comments, or evaluation.
   (v) After each member has suggested one subcause, the group goes round again, each member adding another suggestion. This continues until all points are collected, or until a pre-set time limit is reached.
   (vi) The process is repeated for the other five clusters or “bones.”

The fishbone is thus completed. From then on, various approaches can be adopted. It may be useful to discuss the diagram, clarify subcauses, and either elaborate or condense them. At this stage it often helps to ask the “five whys” — i.e. ask “Why? up to five times, to find out what lies behind the immediate apparent cause. For example:
Cause: PEOPLE
Subcause: Staff unskilled
Why? No training programme (enter under methods or people)
Why? Management does not see the value of training (enter under people - management)

Cause: MATERIALS
Subcause: Impurities in raw material
Why? Dust gets into raw material (materials)
Why? Storage area filthy (environment)

Once a final diagram is agreed, the group decides on the next step. Typically this will be for individual members to take particular subcauses and explore them in depth. Before doing this it may be useful to collect data on each cause — e.g. to determine which is the most frequent. Pareto analysis will then highlight possible priorities.

2. Generating specific bones/clusters appropriate to the situation. In this case, a more open-ended brainstorming is then followed by grouping or clustering.
   (i) Identify the effect/problem/opportunity to be investigated.
   (ii) Draw a fishbone with just the arrow - no side-bones - and write the effect in by the arrowhead.
   (iii) Using brainstorming rules, generate possible causes in an open manner - i.e. not related to any preconceived ideas about groupings.
   (iv) Group the ideas as seems appropriate - i.e. in a way that makes sense, is useful, and is agreed by members. This may mean using the “standard” headings, or quite different ones may be more helpful.
   (v) Draw side-bones on the diagram and mark each with a heading representing one of the groupings.
   (vi) Write up the individual items from each grouping as subcauses.

Other uses of fishbone diagrams

Although originally designed as a means of relating causes to effects, the fishbone diagram is also a useful way of summarizing abstract ideas, factors pertinent to a situation, and so on.

For example, figure 9.36 shows the steps toward quality leadership identified by Scholtes et al.
Figure 9.36: The steps towards quality leadership

Source: Scholtes et al., 1988

Figure 9.37 shows Transform's "seven beacons of organizational success". This is unusual in that the centre spine of the diagram is also labelled in order to illustrate the nature of the model.

Figure 9.37: The seven beacons of organizational success

Source: Transform, 1988
Failure modes and effect analysis (FMEA)

FMEA examines the ways in which a product or service can fail and the impact this has. One identifies the 'vital few' important possible modes of failure and takes action to reduce these risks.

The FMEA process is carried out in the following way:

Step 1 Assemble a group familiar with the product or service system. Include customers, marketing and field support services.
Step 2 Brainstorm all possible causes of failure.
Step 3 Cluster the failures according to their stage in the process or product design.
Step 4 Analyse each mode using the three criteria of severity, occurrence and detection.

For each mode of failure, allocate a score by discussing in the group and agreeing relative scores. Combine the scores of the three failure criteria for each mode. The mode with the highest score is the priority for action.

An example of a failure mode and effect analysis (FMEA) sheet is shown. The subjective rating scale is the same for each criterion and the final score is achieved by addition or multiplication. Severity is related to the consequences of failure, occurrence or likelihood of failure, and detection relates to ease with which a fault or failure is discoverable.

Figure 9.38: FMEA sheet

<table>
<thead>
<tr>
<th>Mode of Failure</th>
<th>Group</th>
<th>Detail</th>
<th>Severity</th>
<th>Occurrence</th>
<th>Detection</th>
<th>Rank Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(1)+ (2)+ (3)+</td>
</tr>
</tbody>
</table>

Note: in addition there may be columns for suggested actions and for implementation responsibility.
UNIT 5: THE QUALITY IMPROVEMENT CYCLE

UNIT 5: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Describe the four basic steps in the quality improvement cycle.
2. Use each of the four steps to tackle a quality improvement project.

UNIT 5: CONTENTS

5.1 Step one: Preparing to tackle the issue
5.2 Step two: Shedding light on the situation
5.3 Step three: Creating movement
5.4 Step four: Grounding the changes
UNIT 5: THE QUALITY IMPROVEMENT CYCLE

There are four basic steps in the quality improvement cycle, as shown in Figure 9.39.

Figure 9.39: The quality improvement cycle

5.1 Step one: Preparing to tackle the issue

The first step is to decide which issue to work on, and name who is going to be involved. This will mean prioritizing - choosing from a number of possible issues, since you can't tackle everything at once. Exactly how you go about doing this will depend on the situation you find yourself in. You may, for example, already have data that suggest a list of possible issues for further exploration. If not, the customer and/or supplier maps (Unit 2) provide an excellent starting point.

For example, using the customer map you can pick out some of the main customers and then go and talk with them. Ask them what would please, or even delight them, and compare this with your previous estimates (table 9.1, column 3).

Again, talk with them to find out how well they feel you are doing - and compare this with your own estimates (column 4 of table 9.1).

Another method of generating a list of possible issues is through brainstorming as explained in Unit 4.

At this point, then, you have obtained a list of possible issues for quality improvement. If this list contains more than four or five points, you may need to cut it down by initial prioritizing,
using the nominal group technique (see Unit 4). Once you have a short list of no more than five issues for priority consideration, you need to look at each one in more detail.

However, it is important to remember that this is still the preparation stage - you are not yet actually working on the improvement.

So for each of the short-listed items (maximum five), you should answer the following questions:

1. What is the “story so far”? That is, what are the background and context of the issue?
2. What are the current consequences of poor performance, of not tackling the issue?
3. What picture of the future do you have that makes this issue important?
4. In the future, what will be the consequence of poor performance, of not tackling the issue?
5. Who is, and who will be affected by the issue?
6. In the future, what sort of improvement is going to be necessary? How big an improvement?
7. What sort of team will work on this project?
8. What resources will be needed to tackle the issue? How long will it take? What “milestones” can we set - that is, what key steps will serve as evidence that progress is being made?
9. What help will the team need?
   - help from managers and others who may be in a position to give permission for the project to go ahead; to “open doors” for the project; to make introductions, contacts and so on; to authorize the use of time and resources;
   - help from experts, who may know about the process we are trying to improve;
   - the use of quality improvement tools.

By answering all these questions, you can finally decide which issue - or issues - to concentrate on, and assign people to work on each project.

4.2 Step two: Shedding light on the situation

Here, you are observing and then analysing the process to be improved. It is nearly always useful to begin by drawing a flow chart of the process (Unit 4). This will start to shed light on the problem straight away.

Then - if you have not already done so - go and watch the process at work. Follow it through, using the flow chart as a “map” or guide. Talk to the people involved at each stage and ask them what they think could be done to improve it. Whenever possible, take measurements of output. These may be of work volume; time taken to perform tasks; number of rejects; number of complaints; types of complaint. Plot these, either on graphs or histograms, using a Pareto diagram (see Unit 4 for all of these).

When watching, talking and measuring, look out for differences or variation between:

- times of day, week, month or year;
- one machine and another;
- one place/location and another;
- one operator or group of operators and another.

These are all ways of observing the process. They will show you what is happening, what needs to be improved.

Before jumping to instant solutions (Ready, Fire, Aim!) you now need to analyse the process. What are the possible reasons why things are not working as well as we want them to?

A good technique here is known as the “five whys”. This simply means asking “why” five times over, each time going more deeply into the issue. Often, however, the issue is more complex, and there are several reasons for a particular problem. Here the cause-and-effect diagram - also known as the fishbone - is very useful (Unit 4). As various causes start to emerge, you need to explore which are the most important. Here you may have to test for the relative importance of each cause, collecting more data, plotting the number of times a specific cause was the culprit, or the magnitude of the effects of that cause. Graphs, histograms and the Pareto diagram can again be used here.

4.3 Step three: Creating movement

Only after the situation has been thoroughly analysed should you attempt to change the process in order to make an improvement.

It is essential to recognize that in carrying out this step you are in fact making planned, systematic experiments. You will try out one or more improvements and measure their effect, so as to decide which improvement(s) are worth incorporating into the normal way of doing things.

To start with, therefore, having analysed the situation you now need to generate some possible solutions or ways of making improvements. When doing this, make sure you really are treating causes, not just fixing symptoms. Be as imaginative as you can in considering possible solutions (use brainstorming). Try to avoid actions which will only cause other problems. Use a flow chart here to draw the new process, showing any changes from the old one. This will often highlight possible snags.

Get those who work in the process to help you generate solutions; they are the ones who really know what’s going on and what is needed. Once you have generated possible solutions and weighed them up, you then begin trying them out. Normally you should only make one change at a time, otherwise it will be almost impossible to distinguish the effects of one change from those of another. (However, there are advanced methods of designing experiments, such as Taguchi design, which enable you to change several variables at a time.)

When a particular change is being tested, you will need to evaluate it by collecting data. Here you will be measuring outputs in the same way as you did in Step 2, when observing the process. So, collect data, follow the process, talk to those involved (including operators and customers); draw graphs, bar charts, Pareto diagram, flow charts. At this stage you may have to review your initial expectations about the nature and magnitude of the improvements that you are hoping to achieve. At the same time, look out for unexpected or unintended outcomes — these may be
either good or bad.

From all this, decide which change(s) are in fact worth incorporating into standard working practices. It may be that certain modifications need to be introduced before this standardization can be made. Finally, don't be disheartened if things don't go quite as well as you were hoping. If you learn from it, there's no such thing as a failed experiment.

5.4 Step four: Grounding the changes

At last, then, you have chosen the issue(s); observed and analysed the situation; generated possible solutions and tested them out. You are now in a position to establish the successful changes as part of the new standard way of doing things.

This will involve telling others about the new way(s) of doing things. Not only telling them but, perhaps, selling the new method to them too.

So think through who is involved, who needs to know? Where are they? When do they need to be informed, trained? Exactly what will they need — information, skills, equipment, tools? How will they best be informed — discussions, briefings, training sessions, courses, memos, letters, manuals? All these need to be considered and prepared.

In the future, too, the changes will have to be incorporated into all the basic induction, briefing, training, education and operations materials, that is the programmes, manuals and documentation.

Once these changes are grounded, the whole cycle starts again. What problems and issues remain? What new ones are arising? You now need to start again, preparing for these. Before doing so, however, take time to reflect on the way you tackled the first issue(s) — on the way you applied the quality improvement cycle itself. Recognize successes and celebrate them. And reflect on all you have learned about quality improvement.

Questions for discussion

1. Why do we describe the quality improvement process as a cycle?
2. Why could the order of these steps not be changed?
3. How could this cycle be applied in a practical situation? Discuss your own (group) case(s).
UNIT 6: TEST PAPER

This paper may be used as a summary of the module and for an examination. Alternatively, most of the items can be used for further practice during work on the module.

1. What is the main view that is now at the heart of total quality management?

2. Under total quality management, the prevailing view is that higher quality leads to lower total costs. List at least five items or areas of cost that can be reduced when quality is improved.

3. List three of the main characteristics of lean production (other than automation) that lead to high productivity and lower unit costs.

4. In Figure T.1, who are:
   (i) Process B’s customers?
   (ii) External supplier Y’s customers?
   (iii) Process F’s suppliers?
5. Figure T2 shows the output from three processes. List them in order of decreasing quality:

(i) The best quality is data set _______
(ii) Next best is data set _______
(iii) Worst is data set _______
6. Explain the difference between special cause variation and common cause variation.

7. Write down the four steps in the quality improvement cycle, and against each give the name of two quality improvement tools that might be particularly useful at that step.

8. The following data are from a quality improvement exercise:

<table>
<thead>
<tr>
<th>Turn or measurement number</th>
<th>Measurement value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.0</td>
</tr>
<tr>
<td>2</td>
<td>8.5</td>
</tr>
<tr>
<td>3</td>
<td>7.9</td>
</tr>
<tr>
<td>4</td>
<td>8.4</td>
</tr>
<tr>
<td>5</td>
<td>8.1</td>
</tr>
<tr>
<td>6</td>
<td>9.5</td>
</tr>
<tr>
<td>7</td>
<td>9.4</td>
</tr>
<tr>
<td>8</td>
<td>9.2</td>
</tr>
<tr>
<td>9</td>
<td>8.7</td>
</tr>
<tr>
<td>10</td>
<td>8.1</td>
</tr>
<tr>
<td>11</td>
<td>7.9</td>
</tr>
<tr>
<td>12</td>
<td>7.2</td>
</tr>
<tr>
<td>13</td>
<td>7.1</td>
</tr>
<tr>
<td>14</td>
<td>9.4</td>
</tr>
<tr>
<td>Turn or measurement number</td>
<td>Measurement value</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>15</td>
<td>10.2</td>
</tr>
<tr>
<td>16</td>
<td>8.6</td>
</tr>
<tr>
<td>17</td>
<td>9.7</td>
</tr>
<tr>
<td>18</td>
<td>10.8</td>
</tr>
<tr>
<td>19</td>
<td>10.2</td>
</tr>
<tr>
<td>20</td>
<td>10.4</td>
</tr>
<tr>
<td>21</td>
<td>10.0</td>
</tr>
<tr>
<td>22</td>
<td>9.7</td>
</tr>
<tr>
<td>23</td>
<td>10.3</td>
</tr>
<tr>
<td>24</td>
<td>9.6</td>
</tr>
<tr>
<td>25</td>
<td>8.5</td>
</tr>
<tr>
<td>26</td>
<td>10.0</td>
</tr>
<tr>
<td>27</td>
<td>9.8</td>
</tr>
<tr>
<td>28</td>
<td>8.2</td>
</tr>
<tr>
<td>29</td>
<td>8.6</td>
</tr>
<tr>
<td>30</td>
<td>10.1</td>
</tr>
<tr>
<td>31</td>
<td>9.2</td>
</tr>
<tr>
<td>32</td>
<td>8.8</td>
</tr>
<tr>
<td>33</td>
<td>8.1</td>
</tr>
<tr>
<td>34</td>
<td>8.5</td>
</tr>
<tr>
<td>35</td>
<td>8.7</td>
</tr>
<tr>
<td>36</td>
<td>9.9</td>
</tr>
<tr>
<td>37</td>
<td>9.3</td>
</tr>
<tr>
<td>38</td>
<td>8.9</td>
</tr>
<tr>
<td>39</td>
<td>7.9</td>
</tr>
<tr>
<td>40</td>
<td>8.3</td>
</tr>
<tr>
<td>41</td>
<td>8.9</td>
</tr>
<tr>
<td>42</td>
<td>9.8</td>
</tr>
<tr>
<td>43</td>
<td>9.4</td>
</tr>
<tr>
<td>44</td>
<td>8.6</td>
</tr>
<tr>
<td>45</td>
<td>8.2</td>
</tr>
<tr>
<td>46</td>
<td>8.3</td>
</tr>
<tr>
<td>47</td>
<td>8.9</td>
</tr>
<tr>
<td>48</td>
<td>9.2</td>
</tr>
<tr>
<td>49</td>
<td>7.9</td>
</tr>
<tr>
<td>50</td>
<td>7.7</td>
</tr>
<tr>
<td>51</td>
<td>8.1</td>
</tr>
<tr>
<td>52</td>
<td>9.1</td>
</tr>
<tr>
<td>53</td>
<td>9.2</td>
</tr>
<tr>
<td>54</td>
<td>7.4</td>
</tr>
<tr>
<td>55</td>
<td>7.6</td>
</tr>
<tr>
<td>56</td>
<td>8.8</td>
</tr>
<tr>
<td>57</td>
<td>9.2</td>
</tr>
<tr>
<td>58</td>
<td>9.7</td>
</tr>
<tr>
<td>59</td>
<td>9.8</td>
</tr>
<tr>
<td>60</td>
<td>9.9</td>
</tr>
</tbody>
</table>
(i) Plot the points as a run chart, with the measurement numbers along the horizontal (X) axis, the measurement values on the vertical (Y) axis.

(ii) Calculate the mean, or average, of the measurement values, and draw this as a graph.

(iii) Mark on the graph the start and end of the following:
   (a) Downward trend
   (b) Cyclical output
   (c) Upward trend
   (d) Upward run

8a Alternative:- The attached Figure (T3) shows the mean and output from a run chart. Mark on it the start and end of the following:
   (a) Downward trend
   (b) Cyclical output
   (c) Upward trend
   (d) Upward run

Figure T.3

9. Draw a histogram showing the following 30 data readings.

   Data Reading
   9.0
   8.5
   8.4
   7.9
   8.1
   9.5
   8.7
   9.2
Ensure that you show the width of each section or cluster.

10. Draw a simple flow chart showing the main steps in a brainstorming exercise.

11. The following data show the main reasons for complaints to a bus company.

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number of complaints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancellations</td>
<td>11</td>
</tr>
<tr>
<td>Dirty buses</td>
<td>3</td>
</tr>
<tr>
<td>Poor punctuality</td>
<td>72</td>
</tr>
<tr>
<td>Crowding</td>
<td>1</td>
</tr>
<tr>
<td>High fares</td>
<td>41</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>2</td>
</tr>
</tbody>
</table>

Draw a Pareto chart of these reasons, showing the number of complaints in each case, and the cumulative percentage of complaints by reason.

Classically, Pareto gives rise to the “80:20” rule. In this case, what “rule” is it?

12. Draw a fishbone diagram with six branches, and label the branches with the six basic clusters of causes.
TEST PAPER SOLUTIONS

1. It is customer or user-based.

2. Lower costs of
   - scrap
   - rejects
   - rework
   - handling customer complaints
   - delays
   - refunds to customers
   - legal fees
   - warranty payments

3. Low stockholding
   High levels of teamwork
   High multiskilling levels
   High creativity
   Extensive training

4. (1) Process C and Process D
    (2) Process C
    (3) Process D; Process E; External supplier Z

5. (i) C
    (ii) B
    (iii) A

6. Special cause - unusual, abnormal events.
    Common cause - inherent, built in to the process or system itself, and is therefore bound to be there

7.1 Preparing to tackle the issue
   - Customer/supplier maps
   - Brainstorming
   - Nominal group technique

7.2. Shedding light on the situation
   - Flow chart
   - Graphs
   - Histograms/bar charts
   - Pareto analysis
   - Five whys
   - Fishbone diagram/cause-and-effect

7.3 Creating movement
   - Systematic experiments
   - Brainstorming
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- Flow charts
- Graphs/histograms
- Bar charts
- Pareto analysis

7.4 Grounding the changes
- Training
- Manuals
- Memos
- Meetings
- Induction
- Briefings
- Documentation

8. (i) Figure S1 at the end of this unit  
(ii) Figure S2 at the end of this unit  
(iii) Figure S3 at the end of this unit

9. Figure S4 at the end of this unit

10. Precise details will vary. However it should be something like this:

<table>
<thead>
<tr>
<th>Step 1: Sort out Question or Issue to Brainstorm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Choose question or issue.</td>
</tr>
<tr>
<td>1.2 Ensure question starts with why? how? or what?</td>
</tr>
<tr>
<td>1.3 Write question on chart or board.</td>
</tr>
<tr>
<td>1.4 Check that everybody understands the question.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 2: Thinking</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Allow each group member two or three minutes to think about the question.</td>
</tr>
<tr>
<td>2.2 Ensure silence during this time</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 3: Collect Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Ask for suggestions to be shouted out.</td>
</tr>
<tr>
<td>3.2 Write suggestions on chart or board.</td>
</tr>
<tr>
<td>3.3 Do not allow any comments about the suggestions.</td>
</tr>
<tr>
<td>3.4 Ensure suggestions are written exactly as shouted out.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 4: Refine Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Go through all answers and check that everybody understands them.</td>
</tr>
<tr>
<td>4.2 Check to see if any are duplicated.</td>
</tr>
<tr>
<td>4.3 Remove duplicated items if everybody agrees.</td>
</tr>
</tbody>
</table>

11. Figure S.5 at the end of this unit. 87:13 rule
12.

(MATERIALS)  (EQUIPMENT)  (PEOPLE)

(METHODS)  (ENVIRONMENT)  (INFORMATION)

(It does not matter which branch has which label.)
Stage 1

Measurement Value

Measurement Number
Figure S.2

Stage 2

Measurement Value

Measurement Number

14 12 10 8 6 4 2 0

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59
Stage 3

Measurement Value

Upward Run

Cyclical Output

Upward Trend

Downward Trend

Measurement Number

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59
Module 9
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Figure S.5

Cumulative % of Total Complaints

Number of Complaints

Reasons for Complaints

Punctuality

Fares
Cancellations
Dirty Buses
Crowding
Miscellaneous
Module 9
Bibliography

BIBLIOGRAPHY

Schoites, P. et al., The team handbook (Maidstone, Wis., Joiner, 1988).
MODULE 10

INDUSTRIAL ENGINEERING TECHNIQUES
MODULE 10: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Describe the tasks of Industrial Engineers in the enterprise.
2. Apply systems thinking and master the main features of the sociotechnical approach to systems design.
3. Identify the right methods and techniques for the right task.
4. Identify and select Industrial Engineering (IE) problems.
5. Develop alternative solutions to problems and select IE tools to implement these solutions.

MODULE 10: CONTENTS

UNIT 1: Introduction to Industrial Engineering (IE)

UNIT 2: From identification to solution: IE tools for solving problems

UNIT 3: Practical exercises

Bibliography
UNIT 1: INTRODUCTION TO INDUSTRIAL ENGINEERING (IE)

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Define IE and describe its main tasks and areas of concern.
2. Be aware of systems thinking and the main principles of the sociotechnical approach in work organization, as well as describe the main elements of the work system.
3. Understand the principles of and the need for choosing the right IE tool for the task.

UNIT 1: CONTENTS

1.1 The tasks of IE
1.2 Systems thinking and the sociotechnical approach
1.3 The right tool for the job
UNIT 1: INTRODUCTION TO INDUSTRIAL ENGINEERING (IE)

1.1 The tasks of IE

Industrial Engineering evolves from the scientific management concept as represented by the names of Taylor, Gantt and Gilbreth in the early twentieth century. Today IE is an advanced methodology for improving systems performance not only in industry but also in the services sector. The American Institute of Industrial Engineers (IAIE) defines the discipline as follows: “Industrial Engineering is concerned with the design, improvement and installation of integrated systems of people, materials, information, equipment and energy. It draws upon specialized knowledge and skill in the mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems.”

In short, the Industrial Engineer deals with the optimization of resources in order to reach a defined output. Figure 10.1 gives a list of typical IE tasks. To achieve the objectives of IE as stated in the above definition, Industrial Engineers are increasingly acting as group facilitators and process consultants rather than behaving like the expert who has the only valid solution to a problem. This role of Industrial Engineers is also reflected in the methodology and approaches they use.

Figure 10.1: The main tasks of an Industrial Engineer

1. Selection of processes and methods.
2. Selection and design of tools and equipment.
3. Design of facilities, including layout of buildings, machines and equipment; material-handling equipment; raw materials and product storage facilities.
4. Design and/or improvement of planning and control systems for distribution of goods and services, production, inventory, quality, plant maintenance and engineering, or any other function.
5. Development of cost control systems such as budgetary controls, cost analysis and standard cost systems.
6. Product development (project management).
7. Design and installation of value engineering and analysis systems.
8. Design and installation of management information systems.
10. Development and performance measures and standards (including work measurement and evaluation systems).
12. Operations research, including such items as mathematical analysis, systems simulation, linear programming and decision theory.
13. Design and installation of data-processing systems.
14. Design and evaluation of office systems, procedures and policies.
15. Organizational planning.
16. Plant location surveys which consider the potential market for plant, raw material sources, labour supply, financing, taxes.
17. Environmental protection, optimal use of water, energy and other natural resources.

Source: Adapted from Maynard, 1971, pp.1-5.
In recent years, Industrial Engineers have also had to pay heed to the environmental concerns of the enterprise. Processes have to be automatically checked for their impact on the environment.

1.2 Systems thinking and the sociotechnical approach

In design processes and organizational structures aiming at improved productivity, a systematic approach has to be taken. This has proved most successful in considering the objectives, functions and elements of a setting. Some advantages of systems thinking have been compiled by Singleton (1974), as shown in table 10.1.

In systems thinking, we describe processes and structures by their inputs, transformation system and the resulting outputs (see figure 10.2). The system is further defined by technology, equipment, organization and human resources.

A type of work system that is of special importance for the Industrial Engineer is that which deals with analyses of the interaction of human operator(s) with equipment and work object(s). Figure 10.3 reproduces a work system and gives examples of its elements. Work system thinking is a useful base for the ergonomic design of workplaces or the allocation of functions between workers and equipment, for example in automation or work structuring.

Table 10.1: Characteristics of systems (design) thinking

<table>
<thead>
<tr>
<th>Cause</th>
<th>Characteristics</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of varieties of ways of carrying out the same activity</td>
<td>Consideration of functions independently of mechanisms</td>
<td>Improved systematic choice between alternative solutions</td>
</tr>
<tr>
<td>Increased complexity of new systems. Feasibility of system performance prediction</td>
<td>Detailed attention to objectives</td>
<td>Fewer expensive design errors. Reduced frequency and magnitude of modifications</td>
</tr>
<tr>
<td>Hardware performance becoming comparable with, and superior to, human performance</td>
<td>Consideration of man as an integral part of the system</td>
<td>Improvement of system performance by improving human performance</td>
</tr>
</tbody>
</table>

Source: Singleton, 1974, p.12.
Module 10
Unit 1

Figure 10.2: The systems approach

<table>
<thead>
<tr>
<th>INPUT</th>
<th>TRANSFORMATION SYSTEM</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Energy</td>
<td>Information</td>
</tr>
<tr>
<td>Capital</td>
<td></td>
<td>Environment</td>
</tr>
</tbody>
</table>

Figure 10.3: The work system

INPUTS

WORKING PERSON → EQUIPMENT → WORK OBJECT

Environment

OUTPUTS

Working person: Examples: Lathe operator, Accountant, Medical doctor

Equipment: Lathe, Personal computer, X-ray machine

Work object: Axis, Bill, Patient

While systems thinking may be seen as the Industrial Engineer's magnifying glass for analysing processes and structures, the sociotechnical approach is his guidebook for developing optimal forms of organization, thus making the best use of technology, human resources and the environment. Traditionally, production or office equipment has been purchased without simultaneously (re)designing work organization, let alone taking account of environmental considerations. Consequently work organization and equipment were adapted by trial and error. Such a traditional approach is displayed in the left-hand column of figure 10.4. At present - and this is due to the high costs of production technology compared with labour costs - Industrial Engineers are increasingly using integrated planning methodologies for technology and work organization.
Such an integrated sociotechnical approach is shown in the right-hand column of figure 10.4.

The sociotechnical approach concentrates not only on how but also on what to analyse, design and evaluate. New forms of work organization, more flexible production units, new reward and performance appraisal schemes, all have their origins in the sociotechnical approach, the main characteristics of which are shown in figure 10.5.

An Industrial Engineer should keep in mind the following three simple guidelines of sociotechnical design:

1. Do not take investment decisions for new or modified equipment (means of production) without having determined the consequences for work flow and work organization.
2. An optimal systems performance will be achieved only if employees are given enough freedom of decision and action and are motivated to make adequate use of this freedom.
3. The less division of work, the better.

**Figure 10.4: Comparison between the traditional and sociotechnical approaches to the design of processes and structures**

<table>
<thead>
<tr>
<th>TRADITIONAL APPROACH</th>
<th>SOCIOTECHNICAL APPROACH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan and purchase office or production equipment (process technology)</td>
<td>Plan and design: Evaluate Technology/ Work consequences equipment organization for environment</td>
</tr>
<tr>
<td>Introduce new technology/equipment</td>
<td>Introduce new systems (technology and organization)</td>
</tr>
<tr>
<td>Analyse consequences for work organization</td>
<td>Operate and adapt new system</td>
</tr>
<tr>
<td>Adapt work organization and technology/equipment by trial and error</td>
<td></td>
</tr>
<tr>
<td>Productivity somewhat higher, but resources are not used optimally</td>
<td>Higher productivity: best use of resources is made</td>
</tr>
</tbody>
</table>

Source: Adapted from REFA, 1987, p.29.
Module 10  
Unit 1

**Figure 10.5: Principles of sociotechnical systems design**

For individual jobs

1. **Task variety**  
   Variety contributes to job satisfaction, but too much can be inefficient.

2. **Task patterns**  
The individual’s job should comprise a “whole”, or a perceptible part of a whole. Ideally, the relation of the tasks to the organization’s end products should be plainly visible.

3. **Cycle time**  
   Very short cycle times can be disorienting. Lengthy cycles may make learning difficult and, if too long, harm productivity.

4. **Performance standards**  
   Employees should have some control over both pace and quality control procedures, with rapid feedback on quality problems particularly desirable.

5. **Auxiliary and preparatory tasks**  
   Boundaries of responsibility should be broad enough that people have some influence over work that affects their own job performance - e.g. machine set-up.

6. **Perceived social value**  
   Jobs should require enough skill, knowledge and effort that employees get satisfaction from their work, as well as the approbation of others both inside and outside the organization.

7. **Perceived economic value**  
   Tasks should be plainly related to the function and value of the end product.

Group interactions

   Jobs should be physically close together, and/or rotate among members of a group when:

   - the tasks are closely interdependent;
   - their contributions to the end product would not otherwise be evident; or
   - job stress is high.

   Under these circumstances, the work group should share influence over performance standards and carry at least some of the responsibility for auxiliary and preparatory tasks.

At the level of the organization

1. **Planning**  
   Individuals and groups should be brought into planning processes for new tasks, new equipment, and/or new work organization practices at an early stage.

2. **Upward mobility**  
   Career paths - i.e. leading to more highly skilled or supervisory positions - should not only exist in theory, but be perceived by the labour force a

1.3 The right tool for the job

The selection of the right tool for the job is extremely important for an Industrial Engineer. In cases where, for example, activity sampling provides enough information on a work situation, it is not necessary to carry out time-consuming studies with a stopwatch. Whereas, in one cultural setting, monetary initiatives would substantially improve performance, in another the introduction of new forms of work organization would have a similar effect.

There are quite a number of differences between industrialized and industrially developing countries relating to IE (see table 10.2). Despite cultural, economic and industrial differences, however, there is some measure of agreement in the international IE community as to which methods are most appropriate for certain productivity improvement tasks.

Despite these differences, the Industrial Engineer has a wide choice of measures to improve the productivity of human resources, equipment, materials and energy, as well as capital.

**Table 10.2: Some differences between industrialized and industrially developing countries related to IE**

<table>
<thead>
<tr>
<th>Industrialized countries</th>
<th>Industrially developing countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of manufacturing industry and services sector</td>
<td>Prevalence of agriculture and primary industry</td>
</tr>
<tr>
<td>Clearly defined work tasks, rationalized work</td>
<td>Definition of work task by the individual</td>
</tr>
<tr>
<td>Mass production: Little contact between consumer and manufacturer</td>
<td>Closer contact between consumer and manufacturer (e.g. household goods, individual tools)</td>
</tr>
<tr>
<td>Homogeneous level of technology, productivity and working conditions</td>
<td>Wide range of technology, productivity and working conditions in different regions and economic sectors</td>
</tr>
<tr>
<td>Workers familiar with technology since childhood</td>
<td>Lack of contact with technology</td>
</tr>
<tr>
<td>Work for social identification</td>
<td>Work for subsistence</td>
</tr>
</tbody>
</table>

Table 10.3 illustrates the main repertoire of productivity improvement measures, grouped in categories according to product, material, processes and technology, organization and methods (O & M), quality and other resources, and controlling. For each measure, we show whether its improvement potential relates to human resources, equipment and/or materials, and energy. The table reveals, however, that most of the measures have an impact on all of these four production factors. A single X indicates that a measure has an influence on the respective improvement potential; two Xs mean that the measure is of prime importance.

The measures of prime importance are cited below:

**Human resources** may be influenced mainly by:

- mechanization and automation;
- new technologies and manufacturing processes, and information technology;
- method and time studies;
- work organization and job design;
- training or job instruction; and
- remuneration and incentive schemes

To improve **equipment productivity**, top priority methods would be:

- production planning and control;
- optimal use of capabilities;
- method and time studies; and
- preventive maintenance.
### Table 10.3: IE methods and their productivity improvement potential

<table>
<thead>
<tr>
<th>Productivity improvement through:</th>
<th>Improvement potential (cost reduction) for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Human resources</td>
</tr>
<tr>
<td><strong>Product</strong></td>
<td></td>
</tr>
<tr>
<td>Value engineering</td>
<td>X</td>
</tr>
<tr>
<td>Standardization/modularization</td>
<td>X</td>
</tr>
<tr>
<td>Parts families</td>
<td></td>
</tr>
<tr>
<td>Make or buy</td>
<td>X</td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td></td>
</tr>
<tr>
<td>Material requirements planning</td>
<td></td>
</tr>
<tr>
<td>Material flow analysis and design</td>
<td></td>
</tr>
<tr>
<td>Rationalization of material transport</td>
<td></td>
</tr>
<tr>
<td><strong>Processes and technology</strong></td>
<td></td>
</tr>
<tr>
<td>Mechanization and automation</td>
<td>XX</td>
</tr>
<tr>
<td>New technologies and manufacturing processes and information techniques</td>
<td>XX</td>
</tr>
<tr>
<td>Production planning and control</td>
<td>X</td>
</tr>
<tr>
<td>Optimal use of capacities</td>
<td>XX</td>
</tr>
<tr>
<td>Economic lot sizes</td>
<td></td>
</tr>
<tr>
<td><strong>O&amp;M</strong></td>
<td></td>
</tr>
<tr>
<td>Project management</td>
<td>X</td>
</tr>
<tr>
<td>Method and time studies</td>
<td>XX</td>
</tr>
<tr>
<td>Work organization and job design</td>
<td>XX</td>
</tr>
<tr>
<td>Occupational safety and health</td>
<td>X</td>
</tr>
<tr>
<td><strong>Worker involvement</strong></td>
<td></td>
</tr>
<tr>
<td>Training or job instruction</td>
<td>XX</td>
</tr>
<tr>
<td>Job evaluation</td>
<td>X</td>
</tr>
<tr>
<td>Remuneration and incentive schemes</td>
<td></td>
</tr>
<tr>
<td>(payment by results)</td>
<td></td>
</tr>
<tr>
<td>Suggestions schemes</td>
<td>X</td>
</tr>
<tr>
<td>Small Group Activities</td>
<td>X</td>
</tr>
<tr>
<td><strong>Quality and resources</strong></td>
<td></td>
</tr>
<tr>
<td>Quality planning and control</td>
<td></td>
</tr>
<tr>
<td>Preventive maintenance</td>
<td></td>
</tr>
<tr>
<td>Energy and resources saving programmes</td>
<td></td>
</tr>
<tr>
<td><strong>Controlling</strong></td>
<td></td>
</tr>
<tr>
<td>Productivity controlling (indicators, capital rotation)</td>
<td>X</td>
</tr>
</tbody>
</table>

X = Measure has influence on respective improvement potential.

XX = Measure is of prime importance for improvement potential.
Materials and energy productivity are improved especially by:

- value engineering;
- standardization/modularization;
- material requirements planning;
- new technologies and information techniques;
- quality planning and control;
- energy and resources saving programmes; and
- capital turnover (rotation) analysis.

The productivity improvement methods shown in table 10.3 may also be classified according to their importance for the different sectors of the economy. In basic industry and mining, the most important measures contributing to the attainment of high levels of productivity are the rationalization of material transport, project management, preventive maintenance, occupational safety and health and job instruction, together with a mechanization and automation strategy.

In process industry, it is energy and resources saving programmes, preventive maintenance, quality planning and control as well as the optimal use of the often costly equipment, that need the special attention of the Industrial Engineer. As for manufacturing companies, it is hardly possible to single out any particular productivity improvement measure with such a wide variety of enterprises. In transport, preventive maintenance of the fleet and fuel saving are of prime importance. Subcontracting certain routes, resource planning and control, as well as work organization (e.g. shift systems), can significantly contribute to productivity increases.

In construction, project management and logistics (material transport), as well as work organization at construction sites, are particularly relevant. For more specific information on productivity in construction, see the ILO publications *Improving site productivity in the construction industry* (Heap, 1987), and *Interactive contractor training* (Hernes, 1987).

Both tables 10.3 and 10.4 are useful instruments for determining priority IE methods and thus selecting “the right tool for the job”.

Questions for discussion

1. What is IE and what are its main tasks and roles in productivity improvement?
2. Why do we need to apply a systems approach in analysing and designing the work system and workplace?
3. What are the main differences between the traditional and sociotechnical approaches in the design of production processes or work structures?
4. Relate the most important IE methods to their potential impact on productivity improvement.
UNIT 2: FROM IDENTIFICATION TO SOLUTION: IE TOOLS FOR SOLVING PROBLEMS

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Describe the main analytical tools of IE, and explain their essence and major areas of application.

2. Understand the tools used for problem identification, analyses, workplace/system design and development, evaluation and implementation.

3. Participate in the practical application of the main IE tools for productivity improvement.

UNIT 2: CONTENTS

2.1 An overview of IE tools

2.2 Problem identification and selection

2.3 Analysis

2.4 Design and development

2.5 Evaluation

2.6 Implementation
UNIT 2: FROM IDENTIFICATION TO SOLUTION: IE TOOLS FOR SOLVING PROBLEMS

2.1 An overview of IE tools

Industrial Engineering techniques can be used for all the steps in solving problems: identification; analysis; design; evaluation of alternatives; and implementation. Most of the IE techniques in use, however, concentrate on the analysis phase.

In this unit, only the most common IE techniques will be discussed. The “classical" IE techniques centre on the optimal human performance in work systems. With the increasing influence of manufacturing equipment and information systems, the Industrial Engineer is still the principal choice for balancing economic working conditions and criteria. That is why ergonomic analysis and design will also be emphasized as an important IE technique.

Table 10.4 provides an overview of the most common techniques or groups of techniques to be used in each stage of the productivity improvement process. These techniques are not necessarily employed only by Industrial Engineers but often also provide a sound database for further IE tasks.

2.2 Problem identification and selection

One of the crucial tasks of Industrial Engineers is continuously to scan operations for potential productivity improvements, anticipate problems, or, in the case of a poorly organized enterprise, sort out the most urgent problems or those to be solved with the least effort. In this case a number of techniques are in use which are briefly described in table 10.5.

2.2.1 Weakness analysis

A large number of checklists, questionnaires, audit procedures and guidelines are in use for screening possible problem areas. A detailed questionnaire on work organization and workplace layout was included in the third edition of the ILO publication Introduction to work study (ILO, 1979). Specific procedures have been elaborated for different sectors of industry, individual enterprises and functions such as product development, production and sales. Other weakness analyses concentrate on possible problem areas such as organization, training, technology, working conditions, etc.

Weakness analysis includes the following steps:

- define the level (enterprise, department, service) at which a weakness analysis should be applied;
- adapt existing procedures to your needs;
- train or advise collaborators in the use of weakness analysis;
- be sure to ask the right people to answer your questions while carrying out the analysis; and
- evaluate the results.
2.2.2 SWOT analysis

A SWOT analysis is mainly used in strategic planning to establish a realistic business plan after the Strengths, Weaknesses, Opportunities and Threats of an enterprise have been evaluated. An Industrial Engineer should make use of such an evaluation in order to remedy detected weaknesses, build on existing strategies, realize new productivity opportunities and anticipate threats to the company by highly productive competitors.

In the SWOT checklist in table 10.6, many questions are directly related to productivity issues. It is also possible to perform a "productivity SWOT analysis" by putting the following questions to group sessions:

- Where do our productivity strengths lie?
- What are our weaknesses in productivity?
- What opportunities do we have to improve productivity?
- What productivity threats do we face?

After the answers to these questions have been given, the participants in the group session define priorities of action as follows:
## Table 10.5: Problem identification

<table>
<thead>
<tr>
<th>Technique</th>
<th>Application</th>
<th>Main features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weakness analysis</td>
<td>To screen possible problem areas</td>
<td>Different checklists/questionnaires available, brainstorming exercises, nominal grouping</td>
</tr>
<tr>
<td>SWOT analysis</td>
<td>To define Strengths, Weaknesses, Opportunities and Threats of an enterprise; to place productivity within strategic plans of an enterprise</td>
<td>SWOT factors are jointly (brainstorming) determined and weighted and alternative business business (productivity) strategies are derived</td>
</tr>
<tr>
<td>Portfolio analysis</td>
<td>To concentrate productivity improvement on the most “promising” products</td>
<td>Groups products according to their life horizon and performance to achieve a balanced product structure</td>
</tr>
<tr>
<td>Pareto analysis</td>
<td>To define priorities of action based on one parameter</td>
<td>Groups objects (e.g. products) according to one parameter (e.g. sales volume); determines the 20% of products which account for 80% of sales, i.e. A-products</td>
</tr>
<tr>
<td>Sensitivity analysis</td>
<td>To determine which action yields the best result (e.g. is energy saving better for overall profitability than cutting labour costs?)</td>
<td>In a set of parameters one is changed at a time, the others are kept constant and the influence on the result is calculated</td>
</tr>
<tr>
<td>Force-field analysis</td>
<td>To identify impelling and impeding forces in an organization</td>
<td>Impelling and impeding forces are determined, usually in a brainstorming exercise, and evaluated in their relative strength. The removal of restraining forces and strengthening of driving forces is analysed</td>
</tr>
</tbody>
</table>

- classify answers for each of the four SWOT factors according to their importance;
- note whether certain strengths and weaknesses, as well as opportunities and threats, are interrelated, and determine the kind of relationship; and
- note that top priority actions will address the highest-ranking weaknesses, threats and opportunities, with more detailed analysis being made for these points.

SWOT analysis is also used in very formalized ways to allot scores to different business alternatives.
### Table 10.6: SWOT checklist

<table>
<thead>
<tr>
<th>Potential internal strengths</th>
<th>Potential internal weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Many product lines?</td>
<td>Obsolete, narrow product lines?</td>
</tr>
<tr>
<td>Broad market coverage?</td>
<td>Rising manufacturing costs?</td>
</tr>
<tr>
<td>Manufacturing competence?</td>
<td>Decline in R&amp;D innovations?</td>
</tr>
<tr>
<td>Good marketing skills?</td>
<td>Poor marketing plan?</td>
</tr>
<tr>
<td>Good materials management systems?</td>
<td>Poor materials management systems?</td>
</tr>
<tr>
<td>R&amp;D skills and leadership?</td>
<td>Loss of customer good will?</td>
</tr>
<tr>
<td>Information system competences?</td>
<td>Inadequate information systems?</td>
</tr>
<tr>
<td>Human resource competences?</td>
<td>Inadequate human resources?</td>
</tr>
<tr>
<td>Brand name reputation?</td>
<td>Loss of brand name capital?</td>
</tr>
<tr>
<td>Portfolio management skills?</td>
<td>Growth without direction?</td>
</tr>
<tr>
<td>Cost or differentiation advantage?</td>
<td>Bad portfolio management?</td>
</tr>
<tr>
<td>New venture management expertise?</td>
<td>Loss of corporate direction?</td>
</tr>
<tr>
<td>Appropriate organizational structure?</td>
<td>Infighting among divisions?</td>
</tr>
<tr>
<td>Appropriate control systems?</td>
<td>Loss of corporate control?</td>
</tr>
<tr>
<td>Ability to manage strategic change?</td>
<td>Inappropriate organizational structure and control systems?</td>
</tr>
<tr>
<td>Well-developed corporate strategy?</td>
<td>High conflict and politics?</td>
</tr>
<tr>
<td>Good financial management?</td>
<td>Poor financial management?</td>
</tr>
<tr>
<td>Others?</td>
<td>Others?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential environmental opportunities</th>
<th>Potential environment threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expand core business(es)?</td>
<td>Attacks on core business(es)?</td>
</tr>
<tr>
<td>Exploit new market segments?</td>
<td>Increases in domestic competition?</td>
</tr>
<tr>
<td>Widen product range?</td>
<td>Increase in foreign competition?</td>
</tr>
<tr>
<td>Extend cost or differentiation advantage?</td>
<td>Change in consumer tastes?</td>
</tr>
<tr>
<td>Diversify into new growth businesses?</td>
<td>Fall in barriers to entry?</td>
</tr>
<tr>
<td>Expand into foreign markets?</td>
<td>Rise in new or substitute products?</td>
</tr>
<tr>
<td>Apply R&amp;D skills in new areas?</td>
<td>Increase in industry rivalry?</td>
</tr>
<tr>
<td>Enter new related businesses?</td>
<td>New forms of industry competition?</td>
</tr>
<tr>
<td>Vertically integrate forward?</td>
<td>Potential for takeover?</td>
</tr>
<tr>
<td>Vertically integrate backward?</td>
<td>Existence of corporate raiders?</td>
</tr>
<tr>
<td>Enlarge corporate portfolio?</td>
<td>Increase in regional competition?</td>
</tr>
<tr>
<td>Overcome barriers to entry?</td>
<td>Changes in demographic factors?</td>
</tr>
<tr>
<td>Reduce rivalry among competitors?</td>
<td>Changes in economic factors?</td>
</tr>
<tr>
<td>Make profitable new acquisitions?</td>
<td>Downturn in economy?</td>
</tr>
<tr>
<td>Apply brand name capital in new areas?</td>
<td>Rising labour costs?</td>
</tr>
<tr>
<td>Seek fast market growth?</td>
<td>Slower market growth?</td>
</tr>
<tr>
<td>Others?</td>
<td>Others?</td>
</tr>
</tbody>
</table>

2.2.3 Portfolio analysis

As with SWOT analysis, a portfolio analysis is an instrument for strategic management. Because the portfolio analysis is product-oriented (while the SWOT analysis is process-oriented), it provides the Industrial Engineer with information on the priority products on which action should be concentrated. Since production organization is increasingly focusing on the products (e.g. by establishing production isles and cells), instead of grouping similar processes together the Industrial Engineer follows this product orientation in setting his priorities for productivity improvement. In a portfolio analysis, business units or products are grouped according to their life expectancy and performance potential.

Again, there are many different ways of carrying out portfolio analysis. One procedure, developed by the Boston Consultancy Group, works as follows (see Hill and Jones, 1989, pp. 188-189):

- divide a company in Strategic Business Units (SBUs);
- compare the SBUs against each other by means of a matrix that indicates the relative prospect in terms of industry growth rate and each relative market share; and
- develop strategic (including productivity) objectives with respect to each SBU.

The Boston Consultancy Group matrix (see Hill and Jones, 1989, p. 189) is divided into four cells representing four distinct categories of strategic business units or products.

1. **Stars** are the leading SBUs in the company’s portfolio. They have a high relative market share and are based in high-growth industries. In the language of SWOT analysis, they have both competitive strengths and opportunities for expansion. Thus they offer excellent long-term profit and growth opportunities. Generally, established stars are likely to be highly profitable and therefore can generate sufficient cash for their own investment needs. Emerging stars, however, may require substantial cash injections to enable them to consolidate their market lead.

2. **Question marks** are SBUs that are relatively weak in competitive terms, having low relative market shares. However, they are based in high-growth industries and thus may offer opportunities for long-term profit and growth. Question marks can become stars if nurtured properly. To become market leaders, question marks require substantial net injections of cash; they are cash-hungry. The corporate head office has to decide whether a particular question mark has the potential to become a star and therefore is worth the capital investment necessary to achieve this.

3. **Cash cows** are in low-growth industries but have a high market share and a strong competitive position in mature industries. Their competitive strength comes from being farthest down the experience curve. They are the cost leaders in their industries.

4. **Dogs** are SBUs in low-growth industries but have a low market share. They have a weak competitive position in unattractive industries and thus are viewed as offering few benefits to the company.

The priority for Industrial Engineers will be to deal with cash cows and question marks. Cash cows need to remain the cost leaders in their industry. Their usually high volume of production gives even small productivity increases a high cost-saving impact. With question marks,
Industrial Engineers have to try every possible way of increasing productivity to make them competitive. Stars need continuous fine-tuning of the production process to remain the stars. Dogs may easily become “cash hogs” which lose money. Industrial Engineers’ efforts should at least avoid such losses.

### 2.2.4 Pareto analysis

Pareto analysis is named after an Italian economist who noted the principle, often called the 80/20 rule, that 80 per cent of the results come from 20 per cent of the effort. It is also called ABC analysis and is a useful tool for productivity analysis since it concentrates attention on the few most important issues or problems and helps to establish priorities. The principle is used in many production and management areas: marketing, quality control, stock analysis, purchasing, sales analysis, waste reduction processes, and so on (see Prokopenko, 1992):

According to Lawlor (1985) the basic steps of Pareto analysis are as follows:

1. **List the items (products or processes)** to be analysed in ascending order of use, cost or occurrence. In our example shown in table 10.7, stock items are listed according to their cost. There the items of category 2 (number of items multiplied by unit cost) cost £60,000, whereas the lowest-ranking items amount only to £250.
2. **Determine the total use, cost or occurrence.** In our example the total cost of items is £150,000 (100 per cent).
3. **Express the individual use, etc., as a percentage of the total.** Items of category 1 represent 40 per cent of the total costs of material in stock.
4. **Produce a cumulative column for step 3.** Adding items 1 and 2 gives 69.4 per cent of the total costs; if the third item is added to items 1 and 2, the result already amounts to 84.1 per cent of total costs.
5. **Divide the cumulative percentage column into three groups, say 70 per cent, 20 per cent and 10 per cent.** Pareto analysis is sometimes called “ABC” analysis - “A” being the expensive 70 per cent, “B” the moderate 20 per cent and “C” the low-cost 10 per cent. The result of this division is shown in the lower part of table 10.7.
6. **Repeat steps 1 to 4 for the items studied.** The previous steps have all related to cost; we now need to relate the ABC aspects to the percentage of items contained in each category.
7. **Compare the cumulative percentage use/cost/occurrence column with the cumulative percentage item column.** This comparison reveals that 20 per cent of the items generate 69.4 per cent of the costs (A products). A further 20 per cent of items are responsible for an additional 24.7 per cent of costs (B products), and the remaining 60 per cent of items make up only 5.9 per cent of costs (C products). A typical graph of such a relationship is shown in figure 10.6.

An Industrial Engineer would certainly try to optimize stocking levels for A products. Even though this seems to be quite obvious after a Pareto analysis has been performed, in reality people very often chase up C problems without being aware of it. This makes the Pareto or ABC analysis an extremely useful tool in setting priorities.
Module 10
Unit 2

Table 10.7: An example of ABC stock analysis

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Stock group</th>
<th>Usage</th>
<th>Cumulative</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cost(£)</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>A</td>
<td>60000</td>
<td>40.0</td>
<td>40.0</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>44000</td>
<td>29.4</td>
<td>69.4</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>22000</td>
<td>14.7</td>
<td>84.1</td>
</tr>
<tr>
<td>4</td>
<td>C</td>
<td>15000</td>
<td>10.0</td>
<td>94.1</td>
</tr>
<tr>
<td>5</td>
<td>C</td>
<td>5000</td>
<td>3.4</td>
<td>97.5</td>
</tr>
<tr>
<td>6</td>
<td>C</td>
<td>2000</td>
<td>1.3</td>
<td>98.8</td>
</tr>
<tr>
<td>7</td>
<td>C</td>
<td>1000</td>
<td>0.7</td>
<td>99.5</td>
</tr>
<tr>
<td>8</td>
<td>C</td>
<td>500</td>
<td>0.3</td>
<td>99.8</td>
</tr>
<tr>
<td>9</td>
<td>C</td>
<td>250</td>
<td>0.1</td>
<td>99.9</td>
</tr>
<tr>
<td>10</td>
<td>C</td>
<td>250</td>
<td>0.1</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>150000</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Summary:

<table>
<thead>
<tr>
<th>Stock group</th>
<th>% of cost</th>
<th>% of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>69.4</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>24.7</td>
<td>20</td>
</tr>
<tr>
<td>C</td>
<td>5.9</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>


Figure 10.6: Typical display of an ABC analysis
2.2.5 Sensitivity analysis

Sensitivity analysis is a tool to determine which efforts yield the best results. If an Industrial Engineer is asked to increase the overall profitability of operations, he may consider reducing energy, labour or material costs or else he may increase the output by using the same resources, just to cite some examples.

In order to decide on the most appropriate measure, he must know which parameter(s) to change to achieve the desired results. For this task a sensitivity analysis is particularly useful. While the Pareto or ABC analysis determines priorities based on one independent parameter, the sensitivity analysis considers several parameters. In such a case, one parameter is changed at a time while the others are kept constant and the influence on the result is calculated.

Sensitivity analysis is carried out as follows:

- Fix a quantitative improvement target - for example, increase the profitability of operations by 20 per cent, or reduce energy costs by 20 per cent.
- Define the influencing parameters and their relationship, for example:

\[
\text{Profitability} = \frac{\text{Sales} - \text{Costs}}{\text{Capital}} = \frac{\text{Profit}}{\text{Capital}}
\]

Sales are a function \(f\) of price, sold units
Costs are a function \(f\) of material, labour and manufacturing costs
Capital is a function \(f\) of buildings, equipment, inventories, etc.

- Change each parameter in turn and calculate the variation of results. Figure 10.7 gives a simplified example. The objective is to reach a profitability level of 20 per cent or more. The present profitability level, as shown, is 17 per cent. Two alternatives are calculated by the Industrial Engineer: to reduce inventories, or to reduce manpower.

**Figure 10.7: Sensitivity calculation on profitability**

<table>
<thead>
<tr>
<th>Present situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales ............... 12.0</td>
</tr>
<tr>
<td>Dir. material ......... -4.8</td>
</tr>
<tr>
<td>Dir. wages ............ -2.0</td>
</tr>
<tr>
<td>Manuf. costs .......... -2.6</td>
</tr>
<tr>
<td>Sales costs ............ -1.1</td>
</tr>
<tr>
<td>Profit ................. 1.5</td>
</tr>
<tr>
<td>Buildings and machinery</td>
</tr>
<tr>
<td>Inventories .......... 4</td>
</tr>
<tr>
<td>Debtors .............. 2</td>
</tr>
<tr>
<td>Working capital ....... 9</td>
</tr>
</tbody>
</table>

Profitability = \( \frac{P_1}{9} = 16.7 = 17\% \)

Alt. 1: Reduce inventories with 50%
\[
P_1 = \frac{1.5}{2} = 21\%; P_2 = \frac{1.5 + 2 \times 0.25}{7} = 29\%
\]

Alt. 2: Reduction in manpower to reach the same result as \( P_1 \) and \( P_2 \) above.
\[
P_1 = 0.21 \times 9 = 1.89
\]
\[
\%P_1 = \frac{1.89}{9} = 21\%
\]
\[
\text{Reduction} = 0.39 \text{ eqv.} = 20\%
\]
\[
P_1 = 0.29 \times 9 = 2.67
\]
\[
\%P_2 = \frac{2.67}{9} = 29.7\%
\]
\[
\text{Reduction} = 1.17 \text{ eqv.} = 59\%
\]

In Alternative 1 an inventory reduction of 50 per cent is calculated (inventory cost of two monetary units (MU) instead of four). Thus the working capital will be reduced from nine to seven MUs and consequently the profitability P1 will rise to 21 per cent. This is a very simplified assumption. In reality the reduction of the inventory by 50 per cent (for example, by introducing a Just-In-Time method) will also lead to the reduction of storing space, handling equipment and manpower.

To calculate a more realistic profitability, P2, a further saving of 25 per cent of the inventory costs (2 multiplied by 0.25) has been added to the profit, thus reaching a P2 of 29 per cent.

By comparing the results of inventory reduction, by how much would manpower costs have to be lowered to reach the same percentages? The calculations shown as Alternative 2 in figure 10.7 show that manpower reductions of 20 per cent or 59 per cent, respectively, would be necessary to obtain the same results as with inventory reduction. Further alternatives could be calculated for increasing prices, reducing material costs, etc. Therefore, an Industrial Engineer would gain a clear picture of the measure or combination of measures that would yield the best results. In figure 10.8 such a comparison of alternatives and their potential for increased profitability, as indicated by percentages, is shown.

### 2.2.6 Force-field analysis

Force-field analysis (FFA) is a tool for analysing a situation that needs to be changed. It facilitates change in an organization by minimizing effort and disruption. FFA can be applied when there is confusion about which improvement step should be taken (next). It opens up new options for action. This technique reduces the problem to a simpler dimension and helps the group to work together. It can be used by an individual, or a small or large group.

<table>
<thead>
<tr>
<th>Key area</th>
<th>Potential improvements (%)</th>
<th>Possible effect on profitability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>5</td>
<td>37.5</td>
</tr>
<tr>
<td>Materials</td>
<td>8</td>
<td>34.4</td>
</tr>
<tr>
<td>Inventories</td>
<td>25</td>
<td>20.0</td>
</tr>
<tr>
<td>Debtors</td>
<td>10</td>
<td>10.0</td>
</tr>
<tr>
<td>Manpower</td>
<td>15</td>
<td>9.0</td>
</tr>
<tr>
<td>Sales volume</td>
<td>3</td>
<td>4.5</td>
</tr>
<tr>
<td>Discounts</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

FFA is based on the concept that any given level of performance is the result of an equilibrium between “driving or impelling forces” (factors which support productive action) and “restraining or impeding forces” (factors which inhibit productive action).

Behaviour resulting in productive action can be caused by one or a combination of the following strategies:

- removing or reducing the restraining forces; and
- adding to or strengthening the driving forces.

Unfortunately, increasing those driving forces that threaten or put pressure on people is likely to increase resistance. It is often better to work on restraining forces, or to increase those driving forces that do not increase resistance. Another possibility is to consider a new driving force that may be brought into play.

An FFA should contain the following steps:

- Define clearly the current “equilibrium condition” - the level of performance which needs to be improved; determine the desired end result.
- Identify the driving and restraining forces that exist in the organization, the environment, the jobs and the workers. (A brainstorming or nominal grouping technique can be used - see figure 10.9.) Present the data graphically.
- Make the length of the arrows in the figure proportionate to the magnitude of the force (strength can also be indicated by numbers: 1 = low, 2 = some, 3 = medium, 4 = high, 5 = very high).
- Analyse which of the restraining forces can be removed or reduced and which driving forces can be added or strengthened.
- Test to see if the analysis is sufficiently complex (e.g. if it includes the motivation of influential people, outside forces, policies, administrative procedures and practices, the nature of individual habits and needs, financial and material input).

Whatever is done must significantly shift the balance in favour of the driving forces. This requires a careful analysis of what is technically, economically, organizationally and politically possible. It is necessary to concentrate on those forces that are easiest to change, have the greatest pay-off and, when altered, are least disruptive.

After completion of the analysis, an implementation plan should be prepared for the proposed change (ensure that, among other points, it contains details of the necessary events that must occur).
2.3 Analysis

After the problems have been identified and priorities of action have been determined, a more detailed analysis of problem areas is required. Here the classical IE techniques of value analysis, method study and work measurement as well as ergonomic analysis and job evaluation are needed. An overview of the techniques used is provided in table 10.8.

2.3.1 Value analysis

Value analysis or, in a broader sense, value engineering is a technique for improving product value by improving the relationship between the function of a product and its costs. As in many cases more than two-thirds of the production costs are determined at the moment of the design of a product, the contribution of value engineering to productivity improvement cannot be underestimated. Productivity improvement programmes often concentrate on the production process rather than on the usefulness of the product, thus neglecting an important productivity improvement potential.

Value engineering not only consists of an analysis of product value but also comprises the whole process of brainstorming and developing improved products. Value engineering has three main features:

- the functions of a system and its elements are analysed;
- teamwork of representatives from different departments with different interests, background and skills is organized; and
- creativity techniques are applied systematically.

### Table 10.8: Analysis

<table>
<thead>
<tr>
<th>Technique (or group of techniques)</th>
<th>Application</th>
<th>Main features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value analysis/engineering</td>
<td>Improvement of product value by “more functions at less cost”; also applied to services or overhead costs (overhead value analysis)</td>
<td>Divide product/service into functions, assess their “value”, and improve design (value analysis is a structured problem-solving process)</td>
</tr>
<tr>
<td>Method study</td>
<td>Improvement of existing and proposed ways of doing work</td>
<td>A variety of techniques such as flow diagrams, process charts, activity charts, film and video recordings are in use to analyze work flow and methods in a workplace, a section or a complete sequence of operations</td>
</tr>
<tr>
<td>Work measurement</td>
<td>Establishment of performance standards for production systems to be used for planning, control and remuneration</td>
<td>Methods such as work sampling/(stopwatch) time study, predetermined time standards and standard data, as well as self-recording and estimations, are most common</td>
</tr>
<tr>
<td>Ergonomic analysis</td>
<td>Making better use of human capacities; protecting working person from overload and health hazards</td>
<td>Questionnaires and measuring techniques are in use to assess physical and mental workloads as well as work strain, environmental influences, risks</td>
</tr>
<tr>
<td>Job evaluation</td>
<td>Clear definition of tasks and responsibility of job-holders, elimination of “doubling” of work, provision of a sound basis for remuneration systems</td>
<td>Jobs are analysed and their features are evaluated by analytical and non-analytical procedures; a job value is determined and related to money</td>
</tr>
</tbody>
</table>
Value engineering was probably the earliest small group activity used in Industrial Engineering, long before quality circles started and small group activities became a fashionable subject. Though value engineering has been developed to improve product value, it is now also applied to processes. The result of a value engineering project is usually a simplified and often more intelligent product. The remaining functions will be a product’s primary function; secondary functions will have been reduced. This is the case with the cutting knife of a mixer shown in figure 10.10. The old design (left-hand side) still required a great number of secondary functions compared with the new design.

How to carry out a value analysis:

- select value analysis aims and set up the team (with representatives from different areas);
- describe the aims and functions of each part. Classify the functions into primary and secondary functions. Primary functions are those which define the purpose of the product (e.g. knife = cutting, lamp = lighting). Secondary functions are those which enable the primary function (fixture for knife or lamp) to give additional value to these (e.g. protect from cutting or burning). A form to classify functions is reproduced in Fallon (1971), p.2-105.
- determine the costs of each function (see Fallon, 1971, p.2-106);
- evaluate the degree of accomplishment and costs of functions;
- brainstorming for possible improvements;
- evaluation of alternatives and selection of an improved system; and
- implementation.

Companies use value engineering not only for their own products but also to evaluate alternative products from suppliers in relation to “make or buy” decisions or to help suppliers to reduce unit costs.
2.3.2 Method study

Method study together with work measurement are the most powerful tools that enable an Industrial Engineer to study work processes. The key to successful working methods is a questioning attitude towards the existing working practices. It is not only the work study practitioner or the Industrial Engineer who must analyse work processes; the workers themselves must actively participate. They are the ones who are fully aware of what is amiss in the work they are performing and how it could be improved. That is why Small Group Activities or a suggestions scheme may be successful when carried out in the right manner.

The questioning technique is an extremely simple and effective method study tool. The basic questions “What?”, “Where?”, “When?”, “How?”, and “Why?”, applied to working processes, often reveal more than sophisticated analysis. Figure 10.11 may guide you in the use of the questioning technique.

Similarly effective, but somewhat more complicated, are process charts which graphically represent the elements, events and actions of a process. There are many ways of charting processes: rough outline charts, flow process charts and multiple activity charts are the most common ones.

While rough outline charts have no format rules, flow process charts are more or less standardized throughout the world. In flow process charts the elements of a process are classified into five categories, each represented by a standardized symbol:

- operation
- transport
- delay
- inspection
- storage

To make use of these symbols a process is categorized as shown in figure 10.12.

**Figure 10.11: The questioning technique**

<table>
<thead>
<tr>
<th>Key questions</th>
<th>Why?</th>
<th>Better ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is achieved?</td>
<td>Is it necessary?</td>
<td>What other achievement would be better?</td>
</tr>
<tr>
<td></td>
<td>Why?</td>
<td></td>
</tr>
<tr>
<td>Where is it done?</td>
<td>Why there?</td>
<td>What other place would be better?</td>
</tr>
<tr>
<td>When is it done?</td>
<td>Why then?</td>
<td>What other time would be better?</td>
</tr>
<tr>
<td>Who does it?</td>
<td>Why that person?</td>
<td>What other person would be better?</td>
</tr>
<tr>
<td>How is it done?</td>
<td>Why in that way?</td>
<td>What other way would be better?</td>
</tr>
</tbody>
</table>
Figure 10.12: Flow process chart, material type: Engine stripping, cleaning and degreasing (original method)

<table>
<thead>
<tr>
<th>FLOW PROCESS CHART</th>
<th>MATERIAL TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHART No. 1</td>
<td>SHEET No. 1</td>
</tr>
<tr>
<td>Subject charted:</td>
<td>Used bus engines</td>
</tr>
</tbody>
</table>

**ACTIVITY:**
- Stripping, cleaning and degreasing

**METHOD:** PRESENT

**LOCATION:** Degreasing Shop

**OPERATIVE(S):** CLOAK NOS. 1234

**COST**

**LABOUR**

**MATERIAL**

**CHARTED BY:**

**APPROVED BY:**

**DATE:**

**DESCRIPTION**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>QTY.</th>
<th>DISTANCE (m)</th>
<th>TIME (min)</th>
<th>SYMBOL</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stored in old-engine store</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine picked up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Electric crane</td>
</tr>
<tr>
<td>Transported to next crane</td>
<td>24</td>
<td></td>
<td></td>
<td>Electric crane</td>
<td></td>
</tr>
<tr>
<td>Unloaded to floor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picked up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Electric crane</td>
</tr>
<tr>
<td>Transported to stripping bay</td>
<td>3</td>
<td></td>
<td></td>
<td>Electric crane</td>
<td></td>
</tr>
<tr>
<td>Unloaded to floor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine stripped</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main components cleaned and laid out</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Components inspected for wear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspection report written</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parts carried to depressing basket</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loaded for depressing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transported to degreaser</td>
<td>1.5</td>
<td></td>
<td></td>
<td>Hand crane</td>
<td></td>
</tr>
<tr>
<td>Unloaded into degreaser</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degrased</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hand crane</td>
</tr>
<tr>
<td>Lifted out of degreaser</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hand crane</td>
</tr>
<tr>
<td>Transported away from degreaser</td>
<td>6</td>
<td></td>
<td></td>
<td>Hand crane</td>
<td></td>
</tr>
<tr>
<td>Unloaded to ground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To cool</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transported to cleaning benches</td>
<td>12</td>
<td></td>
<td></td>
<td>By hand</td>
<td></td>
</tr>
<tr>
<td>All parts cleaned completely</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cleaned parts placed in one box</td>
<td>9</td>
<td></td>
<td></td>
<td>By hand</td>
<td></td>
</tr>
<tr>
<td>Awaiting transport</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All parts except cylinder block and heads loaded on trolley</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transported to engine inspection section</td>
<td>76</td>
<td></td>
<td></td>
<td>Trolley</td>
<td></td>
</tr>
<tr>
<td>Parts unloaded and arranged on inspection table</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder block head loaded on trolley</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transported to engine inspection section</td>
<td>76</td>
<td></td>
<td></td>
<td>Trolley</td>
<td></td>
</tr>
<tr>
<td>Unloaded to ground</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stored temporarily awaiting inspection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL**

| DISTANCE (m) | 237.5 |
| TIME (min)  | 24 |
| DISTANCE (m) | 21 |
| DISTANCE (m) | 3 |
| DISTANCE (m) | 1 |

(Adapted from the original)

There are three types of flow process charts:

- **Worker type:** records what the worker does;
- **Material type:** records how material is handled or transformed; and
- **Equipment type:** records how the equipment is used.

To chart the combined activities of several workers, materials and types of equipment, multiple activity charts are used. A specific type of multiple activity chart is the so-called priority graph, which represents the tasks needed to produce a product and how these tasks are interrelated. The priority graph technique has much in common with the critical path method or similar project management techniques.

Priority graphs are used as a basis to (re)allocate work tasks to new workplaces in work-structuring projects (e.g. job enrichment, job enlargement and job rotation), and also as a planning tool for flexible manufacturing systems. Figure 10.13 shows a priority graph of a product assembly.

After a process has been charted, the questioning technique should be used to examine each operation carefully. The following questions should be asked:

- Can we **eliminate** operations or parts of them?
- Can we **combine** operations?
- Can we **rearrange** the sequence of operations?
- Can we **simplify** operations?

Apart from process charts there are a number of techniques available to record the movements of workers, material and equipment. Table 10.9 contains a survey of the common techniques in relation to their application.

Travel charts and string diagrams trace the movements of workers and material on the shop-floor or in offices. They are used to optimize the layouts, for example of machinery shops, stores, restaurants, canteen kitchens, etc.

To analyse workplaces, micro-analysis based on the evaluations of photographs or films is used. Though many of these techniques are outdated, the analysis of work by using video cameras (camcorders) is increasing. Ergonomic analysis techniques play a more important role in analysing workplaces.
2.3.3 Work measurement

Work measurement serves four basic tasks:

- quantitative evaluation of working methods e.g. bottlenecks, weaknesses, technology and organizational alternatives;
- planning of capacities and investments;
- standard setting for production control and remuneration; and
- cost calculation and control, allocation of overheads.

Available work measurement techniques (see figure 10.14) may be divided into two categories according to the data gathered: actual data and target data. Actual data are the real times or frequencies of activities taken to carry out working tasks. They are to be used for method evaluation, production control (how long was machine A idle last week?) or cost control (how many worker/minutes were needed to complete a client order?).

Actual data are compared with target data (time standards), which define the time allowed or foreseen to carry out operations under standard conditions. One of the standard conditions is the “average qualified worker”, an issue which has been extensively dealt with in work measurement.

Actual data may be recorded by: interviewing; self-recording; sampling; and measurement by timing devices (time study).

Target data are derived by: estimating and comparing in relation to similar operations; and synthesis of time elements using the technique of synthetics (standard data) or Predetermined Time Systems (PTS).
### Table 10.9: Typical industrial problems and appropriate method study techniques

<table>
<thead>
<tr>
<th>Type of job</th>
<th>Examples</th>
<th>Recording technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete sequence of manufacture</td>
<td>Manufacture of an electric motor from raw material to dispatch. Transformation of thread into cloth from preparation to inspection. Receipt, packing and dispatch of fruit.</td>
<td>Outline process chart Flow process chart Flow diagram Priority graphs</td>
</tr>
<tr>
<td>Factory layout: movement of materials</td>
<td>Movements of a diesel engine cylinder head through all machining operations. Movements of grain between milling operations</td>
<td>Outline process chart Flow process chart, material type Flow diagram Travel chart Models</td>
</tr>
<tr>
<td>Factory layout: movement of workers</td>
<td>Labourers servicing spinning machinery with bobbins. Cooks preparing meals in a restaurant kitchen.</td>
<td>Flow process chart, man type String diagram Travel chart</td>
</tr>
<tr>
<td>Handling of materials</td>
<td>Putting materials into and taking them out of stores. Loading lorries with finished products.</td>
<td>Flow process chart, material type Flow diagram String diagram</td>
</tr>
<tr>
<td>Workplace layout</td>
<td>Light assembly work on a bench. Typesetting by hand. Multiple activity chart. Simo chart. Chronocyclegraph.</td>
<td>Flow process chart, man type Two-handed process chart Cyclegraph</td>
</tr>
<tr>
<td>Gang work or automatic machine operation</td>
<td>Assembly line. Operator looking after semi-automatic lathe.</td>
<td>Multiple activity chart Flow process chart, equipment type</td>
</tr>
<tr>
<td>Movements of operatives at work</td>
<td>Females operatives on short-cycle repetition work. Operations demanding great manual dexterity. Micromotion analysis.</td>
<td>Films Film analysis Simo chart Memotion photography</td>
</tr>
</tbody>
</table>

Source: ILO, 1979, p.84.
The main characteristics and application of these work measurement techniques are as follows:

- **Interviewing and self-recording** are used only when the approximate timing of tasks is sought after, for example to allocate the working time of a project manager to different projects and to calculate the approximate working hours required for a project. Self-recording and interviewing are especially appropriate for long cycles and variables and less structured tasks often found in office work.

- **Work sampling**, or activity samples, is mainly applied in obtaining an overview of productive and unproductive operations of machines (whole sections) or workers. Work sampling is a very cost-effective tool as it succeeds in continuously observing a number of machines, for example, and records when and why they are in or out of operation. (See ILO, 1992, for a detailed description.)

- **(Stopwatch) time studies** are normally carried out to calculate target data on the basis of the actual data recorded by time-measuring devices. The most commonly used target data is the standard time. A standard time is the total time in which a task should be completed at standard performance, i.e. basic times plus contingency allowance and relaxation allowance. Standard times are calculated as follows:

\[
\text{Standard time} = \left( \frac{\text{Observed time} \times \frac{\text{Performance rating}}{\text{Standard rating}}}{\text{Basic time}} \right) + \text{Contingency allowance} + \text{Relaxation allowance}
\]
The procedure for carrying out and evaluating time studies is summarized in table 10.10. It must be noted that:

- a time study should be performed only by a well-trained work study practitioner;
- the worker/worker's representative and supervisor must be informed of the time study and have the right to be present during the time recording to certify that the time study has been carried out according to the agreed procedure;
- the layout and ergonomic design and work methods should be optimized before a time study is carried out;
- time study data must be reproducible; and
- the accuracy of recorded data must match the purpose required.

The standard time is based on the concept of "standard performance of an average qualified worker".

When the basic time by time measurement and performance rating has been established, additional components are added to make up the standard time.

Relaxation allowances take account of the fact that work induces fatigue from which the worker must be allowed to recover. Tables of relaxation allowances (a very complicated subject) are contained in Introduction to work study (ILO, 1992). Contingency allowances cater for very small amounts of work or delay essential in a job. They are estimated or measured (e.g. by activity sampling) but not regularly recorded in the time study.

With the increasing use of automatic recording devices and the dominance of technological processes and changing remuneration systems, the importance of the classical time study is decreasing in the industrialized countries.

With the availability of time data banks, the synthesis of time elements using synthetics (standard data) or Predetermined Time Systems (PTS) is becoming increasingly common. It has been noticed that particular types of work with the same or similar elements (e.g. drilling holes) occur regularly throughout a certain range of jobs. Consequently, if times could be established for those elements, it would be possible to build up, or combine, a time for any new job which was made up of elements that had previously been measured.

This is the technique of synthesis. Element times are established by time study, and stored in a databank. These element times are of two basic types. The first are constant elements, which are the same, and therefore take the same time whenever performed. The second is the variable element, in which the time taken for completion varies with some property or attribute of the work being carried out. Such elements will vary with size or weight but there may also be more complex factors involved. For these a number of studies are carried out and the databank will typically contain either a table of values which will cover the expected range of the factor(s) that will occur, or a time formula which will allow the time of any given value of the factor(s) to be calculated. By applying the times of all the constant and variable elements that occur in a new job, the timing for that job can be synthesized without the need for direct measurement.

1 The paragraph on synthetics, PTS and estimating are adapted from an unpublished manuscript produced by a working group operating under the auspices of the European Federation of Productivity Services (EFPS).
<table>
<thead>
<tr>
<th>Modules and Unit</th>
<th>TABLE</th>
<th>10.10: Work Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TECHNIQUE</th>
<th>STOPWATCH TIME STUDY</th>
<th>ESTIMATING, COMPARING</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELECT</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Select the work to be studied</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Inform worker and workers' representative about work measurement</td>
<td></td>
</tr>
<tr>
<td>RECORD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. All relevant data relating to the circumstances and methods through which the work is being done</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Break down activity into elements</td>
<td></td>
</tr>
<tr>
<td>EXAMINE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Determine required number of observations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Make n=50 observations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Eliminate unproductive elements</td>
<td></td>
</tr>
<tr>
<td>MEASURE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Describe time as function of influencing factors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Calculate, estimate, measure times</td>
<td></td>
</tr>
<tr>
<td>COMPILE AND DEFINE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Analyse observed times</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Calculate basic time</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Add allowances</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Determine standard time</td>
<td></td>
</tr>
</tbody>
</table>

| ESTIMATING, COMPARING | 1. Look for comparable elements in other tasks |
|                       | 2. Check for similarities or variations of used methods and work objects |
|                       | 3. Investigate time for additional or deleted elements |
|                       | 4. Calculate and add allowances |
|                       | 5. Determine standard time |
|                       | 6. Plan factory tour |

1. Plan factory tour
2. Determine required number of observations
3. Make n=50 observations
4. Eliminate unproductive elements
5. Analyse observed times
6. Calculate basic time
7. Add allowances
8. Determine standard time
Synthetics, therefore, need considerable effort and expense in creating the databank of element times; but, once established, this databank allows times to be created quickly and cost-effectively. The synthesis procedure is summarized in table 10.10.

**Predetermined Time Systems (PTS)** are a logical extension of the concept of synthesis since they are based on the premise that all work consists of basic human motions and that times can be assigned to these motions if they are defined and classified in a systematic way. For example, if an operator is to use a spanner to turn a nut, the motions he will use are something like:

- *reach* for spanner;
- *pick up* spanner;
- *move* spanner to nut;
- *position* spanner on nut;
- *turn* spanner, etc.

PTS systems are built up from large numbers of studies, which include performance assessment, taken on a large number of jobs which are analysed in detail and categorized. Eventually, this process allows a table of different types and distances of the motion reach to be drawn up and a time to be assigned to each. These data, together with data on the other basic motions, are incorporated into a datacard which is supplied with the system.

An observer measuring a job with a PTS simply observes or simulates the job and breaks it down into its constituent basic motions. The parameters affecting each one (such as distance) are recorded and the appropriate category of the motion is obtained from the datacard together with the associated time value. There is no need for the observer to carry out a performance rating since the times on the datacard are for the “average qualified worker”.

As the “standard performances” underlying PTS systems are not explicitly defined, there may be differences between times derived from time studies and from the application of PTS systems, which have a tendency to result in shorter times and therefore imply that the worker would have to work harder to reach the same level of earnings.

**Estimating** is employed in many areas to arrive at approximate measures. Generally, estimating is used to provide times for work which would be too expensive to measure in other ways, or where the level of detail, and accuracy, required is not high. For estimating techniques to be used as work measurement tools they must follow the stages defined in table 10.10.

A number of techniques have been derived to systematize the process of estimating in order to provide times with known reliability. The most common of these is “comparative estimating”, which is based on the establishment of “benchmark” jobs of known work content (or target time), established by measurement. Other jobs are then compared with these benchmark jobs, put into the appropriate time slot and allotted the appropriate time value.

### 2.3.4 Ergonomic analysis

Productivity improvement efforts will be successful only if working conditions are created and preserved which allow the worker to perform efficiently. The discipline dealing with these
issues is ergonomics, which:
- studies human capacities;
- defines tolerance criteria for work stress and strain;
- sets exposure limits for substances and environmental hazards; and
- defines and provides design methodologies to advise on optimal working conditions.

Ergonomic analysis techniques are important instruments for critically examining working methods and conditions according to criteria of human performance and work strain, taking into account the range of human capacities.

Ergonomic deals with the consequences of workloads (work stress) on the individual according to his or her individual characteristics (sex, age, training level, abilities and skills). This relationship is expressed in the stress - strain concept of ergonomics (see figure 10.15).

**Figure 10.15: Simplified stress - strain concept of ergonomics**

<table>
<thead>
<tr>
<th>Workload</th>
<th>Individual characteristics</th>
<th>Work strain</th>
<th>Consequence of strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work task Exposure to environmental factors</td>
<td>Sex Age Race Physical condition Stamina Dexterity etc.</td>
<td>Individual reaction to workload</td>
<td>Negative Training</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Errors Increased working capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Accidents</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Health effects</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Disability</td>
</tr>
</tbody>
</table>

By appropriate ergonomic analysis procedures, it is possible to check that the work strain is being kept below the tolerance threshold, to prevent people from becoming impaired by their work. Ergonomic analysis also provides a basis for a function (re)allocation between “man and machine”. Anthropometric and biomechanical analysis help to find out if a workplace layout or machine design corresponds to the dimensions and forces of a human operator. Industrial Engineers should carefully evaluate such characteristics, especially if they buy foreign equipment which may have been designed for a completely different population. (See the ILO publication *International data on anthropometry* (Jürgens et al., 1990) for the anthropometric dimensions of different populations.)

Figure 10.16 illustrates the maladaptation of man and machine in the case of a conventional lathe. The controls are arranged in such a way that the operator would need the arms of a giant and at the same time the stature of a dwarf to control the process visually.

A wide range of ergonomic analysis procedures are classified in table 10.11 according to the stress - strain concept. The first part, “workload”, starts with the “impersonal” analysis of systems.
hardware (static evaluation) and software (dynamic evaluation). The second part, “working person”, deals with the assessment and measurement at work of a certain individual. Here the emphasis may be on intra-individual and inter-individual differences as well as on generalizations of data for determining rest allowances, fixing limits of tolerance or developing specifications in work design. The third part, “psychosocial environment”, ascertains that work is taking place under certain socioeconomic and organizational conditions.

**Figure 10.16: Anthropometric analysis of the control configuration of a conventional lathe**
Table 10.11: Taxonomy of ergonomic analysis methods

Analysis methods

1. Workload
   1.1 System’s hardware
       Documentation of system elements
       Equipment analysis
       Work object analysis
       Analysis of dimensions and spatial configuration of workplaces (Somatography)

   1.2 System’s software
       1.2.1 System’s performance
           Analysis of relations between system elements
           Demarcation of subsystems
           Analysis of work sequence
           Analysis of work partition
           Analysis of function allocation
           Analysis of material flow
           Analysis of information flow
           Operations research studies
           Cost/benefit analysis
           Simulation
           Games
           Modelling

       1.2.2 Activity analysis (abstraction from actual worker)
           Time and motion studies
           Time budget studies
           Biomechanical analysis
           Determination of work form
           Determination of environmental influences
           Job/task analysis (analysis of behaviour requirements, analysis of ability requirements, analysis of task characteristics, behaviour description)
           Skills analysis
           Error analysis

       1.2.3 Analysis of individual activity
           Real-time measurements
           Link analysis
           String diagram
           Harmonogram
           Analysis of energetic-effectoric activity
           (energy expenditure, EOG)

2. Working person
   2.1 Individual capacities
       2.1.1 Medical examination
2.1.2 Work physiological studies
   Dynamometry
   Ergonometry (W170, aerobic working capacity, etc.)

2.1.3 Psychological tests

2.2 Work strain
   2.2.1 Objective measurements
       Electrocardiography
       Electromyography
       Respirography
       Electrophonography
       Electroencephalography
       Spare mental capacity
       Primary task measures
       Muscle tension
       Tremor
       Eye and eyelid movements
       Blood pressure
       Electrodermatography
       Chemical analysis of body fluids

   2.2.2 Subjective statements
       Subjective strain
       Monotony, fatigue, saturation
       Aspirations

3. Psychosocial environment
   Analysis of interaction, social behaviour of individuals and groups
   Conflict analysis

Source: North, 1980, p. 784.

2.3.5 Job evaluation

   In work study and ergonomic analysis it is necessary to have an accurate description of the job or tasks to be analysed in detail, so as to clarify the tasks, duties, responsibilities and working conditions of the jobholders as a basis for later improvements.

   Such job analysis has often led to identifying the overlapping of work or unclear responsibilities.

   Though job evaluation procedures have mainly been designed for remuneration, they are quite useful for the above-mentioned purposes. Even the basic step of job analysis provides enough information to (re)structure tasks and responsibilities.

   There is a wide range of job evaluation methods. Some are quite simple in their conception
and means of application. Others involve the use of rather complex techniques, including computer programmes. The choice of an evaluation method depends on the number and kind of jobs to be evaluated, the cost of the operation, available resources and the degree of precision desired. However, certain stages are common to them all.

The first stage is almost always to examine and analyse the tasks and activities entailed by a job. The purpose of “job analysis” is to determine the essential characteristics of each job and the requirements its holder must fulfil to be able to do the job satisfactorily. Job analysis usually begins by establishing a list of all the posts or positions in a given entity in order to group those which are identical or essentially the same into “jobs”. This process is generally known as “job identification”.

This information includes the nature and purpose of the tasks forming the job, the frequency with which they are repeated, the tools and equipment used, the nature and level of the jobholder’s responsibilities, and the surroundings and conditions in which the job has to be done. The personal characteristics that the jobholder must have to do these tasks (such as knowledge, skills and individual abilities) must also be ascertained.

This kind of information can be gathered by questionnaire, interview and direct observation. The information is sifted and recorded concisely in a “job description”. The job descriptions usually follow a standardized format as their purpose is to enable jobs to be evaluated by comparison with each other.

The actual evaluations are carried out essentially by examining job content with a view to comparing jobs directly or indirectly. There are two main ways of doing this. One is to take a whole job, compare it with others and on this basis position it in a job hierarchy; this approach is termed “non-analytical”. The other approach, termed “analytical”, involves reducing the essential characteristics of a job to a number of factors and making a factor-by-factor comparison. The results of these partial comparisons are then added together in order to rank the jobs as a whole. The advantage of the analytical method is the ease with which assessors (or an evaluation committee) can establish a hierarchy of quite diverse jobs by considering them factor by factor.

The result of the evaluation procedure is the ranking of jobs in order of importance. After this stage, it is usual to group into different grades those jobs to which substantially the same values have been ascribed. Translating grades into wage levels is a key operation, as it is the logical culmination of any job evaluation process.

There are four basic methods of job evaluation: ranking, classification, point rating and factor comparison. The first two are usually referred to as “non-analytical methods” and the second two as “analytical methods”.

**Ranking** is a simple method which involves placing jobs in the ranked order of the demands they make on those who perform them. Jobs are considered as a whole and compared with each other by means of comparatively simple job descriptions.

**Classification** is a method where the various grades and their structure are established before the jobs are ranked and then slotted into appropriate grades.
**Point rating** uses clearly defined factors, such as level of skill, effort, responsibility and working conditions. The number of factors may vary from only a few to ten or more, depending on the plan. Each factor is divided into several degree levels to which point values are assigned and weighed by each factor. Jobs are then analysed factor by factor and points awarded accordingly. A total point score is arrived at for each job by adding together the points obtained for each factor. The total point score determines the position of the job in the hierarchy.

**Factor comparison** is derived from point rating. It also involves the analysis and ranking of jobs factor by factor. The main difference is that weighting of the factors is not done beforehand. After detailed analysis of key jobs, the importance of each factor and each level is established.

**New hybrid methods** are based on one of the four methods described above but have developed their own specific characteristics.

The most important job evaluation stage for productivity improvement purposes is information collection on the job. To this end standard job analysis form has to be prepared. The purpose of this exercise is to have a brief description of what the worker does, how and why, under what conditions the work is performed, and what the qualification requirements are for the job.

The questions asked by the analyst cover the following basic elements:

**The job.** Who does the work? What is the job title? What are the essential tasks? How are these tasks performed and with what equipment? Why are these tasks done and what is the relationship between the tasks of the job and the tasks of other jobs? What are the jobholder's responsibilities towards his colleagues and towards the machines? In what working conditions (hours of work, noise, temperature, light, etc.) is the job carried out?

**Qualification requirements for satisfactory performance of the job.** Knowledge; skills, including experience; level of education; physical ability; mental ability; aptitudes.

The analyst would usually elect to use one or a combination of the following three main methods to assemble and verify information needed for each job: (a) a questionnaire to be filled in by the worker and his immediate superior; (b) an interview with the worker and his superiors; and (c) direct observation at the workplace. An example of the result of such a job analysis exercise for a methods engineer is shown in figure 10.17.
Figure 10.17: Job description (in an analytical evaluation scheme) of a methods engineer

Job title: Methods engineer

Job summary
To conduct the necessary investigation in order to recommend the purchase and commissioning of new plant and manufacturing techniques, these recommendations normally being accepted; and to be responsible for the introduction of new processes which increase the efficiency of production units and the economic viability of individual products.

Education
Two to three "O" levels or their equivalent would normally be required, enabling the jobholder to serve an apprenticeship leading to further education at technical college level.

Training and experience
On completion of apprenticeship, four years of job-related experience are normally required.

Accountability for resources
A poor decision based on the recommendation of the jobholder is likely to involve the company in loss. The effect is likely to be major, as the plant involved is frequently specialized and often the only facility of its kind in the company.

Planning requirements
The jobholder works to specified objectives and the achievement is checked by cost savings each quarter. The forward planning on the introduction of new techniques is approximately one year. The jobholder is responsible to the Chief Methods Engineer and is only expected to refer exceptional operating problems to him.

Accountability reports and records
The jobholder is responsible for originating reports which must be for accurate in order to avoid costly mistakes. This requires the ability to be analytical, literate and creative at a high level. The concentration required is normally high and the work is extremely varied. The effect of errors would be serious as the jobholder is responsible for maintaining the company data book and plant list. (The company data book, plant lists and policy statements are all confidential and are handled regularly.)

Contacts and good co-operation
Contacts within the company require the handling of associates in order to secure the coordination of effort between a number of departments. Outside the company, contacts are mainly to discuss requirements with suppliers. These require a high degree of tact and diplomacy.

Supervision of others
The jobholder is responsible for the distribution of work and the discipline of apprentices assigned to him during training. The jobholder is also responsible for supervising the establishment of subcontracts and commissioning engineers. The jobholder is responsible for operator training until the new plant is "handed over".

Working conditions
The jobholder works for 50 per cent of his time in normal office conditions and 50 per cent in various parts of the factory.

2.4 Design and development

By "design" we mean the creation of the form and structure of system elements as well as their interrelationships. The design or development process forms a continuous sequence of analytical and synthetic steps.

Unlike analysis techniques, the task of design algorithms and techniques is to lead creativity and ingenuity in the desired directions. In creating alternative design solutions, skill by far outweighs the restrictions of technique.

Table 10.12 shows three categories of methods and techniques supporting the design and development of systems. While creativity techniques foster the generation of ideas, design algorithms attempt to transform these into solutions to problems. Integral methodologies comprise several steps for developing complex systems with human involvement such as organizational development or nominal grouping (see subsection 2.4.3 below).

2.4.1 Creativity techniques

There are a number of creativity techniques, the commonest and best known being brainstorming.

Brainstorming (see Prokopenko, 1992, pp. 147-148) is an uninhibited discussion in an open atmosphere, in which new ideas (solutions to the problem) are nurtured and new insights developed. All aspects of a subject can be examined without any attempt to limit who says what. This type of discussion generates useful ideas that may not occur to an isolated individual puzzling over a problem.

- A brainstorming session begins with the selection of a specific problem or topic. To ensure that everyone participates, the leader calls on each member in turn for comments.
- No criticism is permitted.
- If members run out of ideas, "who, what, when, where, why and how" questions are used to start the talk flowing again.
- The ideas should be duly noted and written on a flow chart or blackboard kept in full view of everyone.
- The members sort out the various ideas and select the few key ones. These are discussed in detail and listed in order of importance. The whole list is retained for future use.
- Members then select (by majority vote) one or two ideas for in-depth investigation.
- Brainstorming may precede, follow or take place concurrently with the use of other improvement tools and techniques.

Other important creativity techniques include the following (adapted from British Standard 3138):

Lateral thinking is a mode of thought characterized by attempts to find new standpoints from which to view the problem, without being constrained by conventional logic.

Vertical thinking is a mode of thought characterized by strict logic.
Critical examination is the systematic analysis of information about a problem procedure or activity by which it is subjected to exhaustive examination with regard to need, simplifications, combination, sequence and alternatives.

Progressive elimination is a search to eliminate something from consideration, first by challenging it as a whole and then by examining aspects of it in increasingly greater detail.

Heuristic procedures involve some degree of experimentation, e.g. trial and error, at each successive stage towards the solution, taking into account any errors determined in the previous stage.

With successive limited comparisons we arrive at a solution by making successive small changes in the real situation, and testing to see if they have the desired effect.

<table>
<thead>
<tr>
<th>Table 10.12: Design and development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technique</td>
</tr>
<tr>
<td>Creativity techniques</td>
</tr>
<tr>
<td>Design algorithms</td>
</tr>
<tr>
<td>Integral methodologies</td>
</tr>
</tbody>
</table>

2.4.2 Design algorithms

When creativity techniques have led to new ideas, these must be structured so that a complete solution to a problem may be developed. To help in structuring ideas, a number of algorithms and information sources are available, such as databanks of system elements, expert systems, Computer-Aided Design (CAD) systems and information structuring techniques.

A particularly useful tool is the morphological box or matrix which relates the functions of a product or process to ideas (solutions). To find solutions to a problem using the morphological
box, the following process is recommended:

- mark down in the first column of the morphological matrix all the functions you require from a product or process;
- for each function, note in the matrix the possible solutions found in the brainstorming exercise;
- if few or no solutions were found for some functions, consult handbooks, catalogues, databanks of system elements, etc., for possible solutions;
- freely combine partial solutions in order to arrive at possible alternative complete solutions. Check which solutions are feasible and which are to be discarded because they are technically unrealizable; and
- continue to work on the feasible alternatives.

Table 10.13 shows an example of a morphological box for the design of a wrist-watch. Two possible solutions are cited, the first being for the classical mechanical watch with analogue display and the second for an electronic watch with liquid crystal display. In both the respective solutions for individual functions have been marked.

This procedure might be also be applied to the (re)designing of work organization or production processes.

**Table 10.13: Morphological box for the design of a wrist-watch**

<table>
<thead>
<tr>
<th>Functions</th>
<th>Solution principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy provision</td>
<td>Movement (wind up)</td>
</tr>
<tr>
<td></td>
<td>Potential energy</td>
</tr>
<tr>
<td></td>
<td>Electric energy</td>
</tr>
<tr>
<td></td>
<td>Temperature alteration</td>
</tr>
<tr>
<td>Storage of energy</td>
<td>Elevated weight</td>
</tr>
<tr>
<td></td>
<td>Battery</td>
</tr>
<tr>
<td></td>
<td>Watch-spring</td>
</tr>
<tr>
<td>Propulsion</td>
<td>Electro (nic) motor</td>
</tr>
<tr>
<td></td>
<td>Clockwork</td>
</tr>
<tr>
<td></td>
<td>Pneumatic motor</td>
</tr>
<tr>
<td>Velocity control</td>
<td>Vibration or constant frequency</td>
</tr>
<tr>
<td></td>
<td>Electric impulses</td>
</tr>
<tr>
<td></td>
<td>Escapement</td>
</tr>
<tr>
<td></td>
<td>Pendulum</td>
</tr>
<tr>
<td>Transmission power movement</td>
<td>Magnetic transmission</td>
</tr>
<tr>
<td></td>
<td>Gear wheel</td>
</tr>
<tr>
<td></td>
<td>Hydraulic transmission differences</td>
</tr>
<tr>
<td>Display</td>
<td>Liquid crystal display (LCD)</td>
</tr>
<tr>
<td></td>
<td>Movement of pointers</td>
</tr>
<tr>
<td></td>
<td>Movement of dial plate</td>
</tr>
</tbody>
</table>

Possible solutions
2.4.3 Integral methodologies

In addition to creativity techniques and design algorithms, integral methodologies exist for gathering and developing new solutions as a part of structured group participation processes. Such integral methodologies normally contain several steps from analysis to evaluation, and sometimes implementation. As their main objectives are to create new solutions and facilitate change (which are also innovative and creative processes), integral methodologies are dealt with under the heading of design. These integral methodologies, which inter alia comprise such procedures as organizational development, nominal grouping, sociotechnical systems design, Small Group Activities such as Quality Circles, suggestions schemes or other forms of idea gathering, are also often labelled behavioural techniques because they are concerned with human behaviour.

The characteristics of integral methodologies are as follows:

**Organizational development (OD)** is a planned, managed and systematic process (see Prokopenko, 1992, pp. 145 and 150). Its objective is to change the systems, the culture and the behaviour of an organization in order to improve the organization’s effectiveness. OD deals with organizational aspects of the behavioural sciences and has links with human resource development and organizational renewal, with a view to more effective interaction. It helps to integrate the individual’s goals with those of the organization and is considered an ongoing process. OD is based on the assumption that organizations influence human behaviour and that individuals influence the behaviour of organizations, but that both can be modified with proper diagnosis and skillful intervention.

**Nominal grouping** is a participatory approach to fact-finding (gathering data), identifying problems and strengths, generating ideas (action planning) and evaluating progress. It also has an indirect advantage in that the frequent and committed participation of members of the organization enhances the process of change, thus facilitating the implementation phase. In this technique members develop their views (solutions) independently. Then their ideas are shared with other members of the subgroup in a structured format. Suggestions for clarification are discussed and each subgroup reports its findings to the larger group.

Under the nominal grouping technique, the participants are divided into subgroups of six to eight, grouped according to rank (all top managers might be in one group) and/or function. Homogeneous grouping is important because different levels of status and position might inhibit the performance of certain group members if personal relations between managers and subordinates are seen as a problem. Each subgroup then proceeds as follows:

- The members of the subgroup respond individually by writing their own views on cards (one card for each idea, strength or problem).
- Subgroups select one member to serve as the recorder and speaker.
- Each speaker asks members of the subgroup in turn to read out one idea from his or her list, and the speaker writes it down on a flip chart. If anyone else has noted the same idea, a checkmark is placed by the item. The process continues, one item at a time, until all ideas are recorded on the flip chart. Discussion of each item is discouraged until all items are recorded. The same process might be followed for the problems or strengths identified by the subgroup members.
- After all ideas have been noted down, discussion is allowed in order to synthesize, clarify or
add items.

- All subgroup members are again given two cards and asked to vote for the five ideas they think are most significant and, for example, the five problems they feel are most crucial and should receive highest priority.

- Each subgroup reports the top five items on each list to the group as a whole. The moderator then explains that the data will be classified and the results will be presented so that the organization can proceed to develop strategies and improvement plans.

Small Group Activities (SGA) are often mentioned in relation to Quality Circles (QC). In fact, SGAs have much wider-ranging applications such as job design, environment-friendly production practices, energy saving, etc., and are an important part of Total Quality Control (TQC).

According to the Japan Productivity Center (1989, p.204), SGAs may be described as follows:

- The unit of performance is the small group, with each group having up to ten participants.
- Autonomous control: not a "top-down" system based on organizational directives, but rather a "bottom-up" system which emphasizes ascent from the bottom of the organization.
- Essentially real action: referring to an active and vital human activity.

To achieve "quality", each individual must pay the utmost attention to his or her job in order to prevent mistakes; otherwise, any quality problems in a product will not be discovered even at the inspection stage. SGAs supplement shortcomings in job accomplishment procedures based on conventional top-down organization and thus impart a sense of purpose to employees.

SGAs can be a tremendous source of ideas. Employees who are actually doing production jobs are the ones who know most about them. It is most desirable in SGAs that group members should pick up hidden problems in the workplaces, hammer out ideas to rectify the problems and solve the problems by themselves.

Figure 10.18 gives an overview of the types and applications of SGAs. (The operations of small groups are dealt with in more detail in Module 6, "Organizing a company productivity and quality (P&Q) movement").

Besides SGAs, suggestions schemes (see Module 6) are another valuable tool for collecting ideas from the workforce.
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Figure 10.18: Comparison of Small Group Activities

Organizational Small Group Activities

(1) Objectives are directly connected to profit
(2) Several to several dozen of people
(3) Members come from many departments
(4) Managerial level and non-managerial level personnel coexist
(5) Dissolve when the objective is achieved
(6) Controlled by organization

Autonomous Small Group Activities

(1) Objectives are limited to profit-making
(2) Four to ten people
(3) Members are limited to the same workshop
(4) Consists basically of non-managerial personnel
(5) Closely related to the workplace; not dissolved
(6) Autonomous control (free from organizational control)

Small group activities

(1) Activities of small number of people
(2) Includes both organizational and autonomous activities
(3) Supported by different organizations

2.5 Evaluation

2.5.1 How to evaluate

Proposed improvements, the extension of production capacities and alternative procedures all have to be justified in terms of costs and benefits to the enterprise.

Evaluation in IE means the comparison between alternatives or the analysis of one configuration according to monetary or non-monetary criteria. The accuracy of an evaluation depends basically on the evaluation procedure, the criteria applied, the weight of the criteria and the assumptions made for the alternatives to be evaluated.

An evaluation consists of the following steps:

- define the objective of the evaluation;
- describe clearly the alternatives to be evaluated;
- define the assumptions (e.g. production output for reference period, assumed interest rates, etc.) on which the evaluation will be based;
- select evaluation procedures;
- set/adapt evaluation criteria;
- for non-monetary evaluations, establish the rating scale for each criterion;
- for monetary evaluations, decide on the currency base (exchange rates/inflation) in which the evaluation results must be calculated;
- determine the weight of the criteria if necessary;
- evaluate each alternative to the criteria;
- compare results; and
- name the "winner", explaining the feasibility or infeasibility of the proposed investment.

This "recipe" for evaluation is applicable for monetary, non-monetary or combined evaluations (see table 10.15). Monetary evaluations make sense when the main costs and benefits can be translated into money, for example in the case of similar machines with differing prices and capacities. Non-monetary evaluations are becoming more popular for mid- to long-term decisions, which also interrelate with enterprise policy such as installing flexible manufacturing cells or introducing new forms of work organization. As many proposed solutions for productivity improvement will have capital investment implications and non-monetary consequences (e.g. job satisfaction for workers), a combined approach (monetary and non-monetary evaluation) has frequently been used.

Consider the following three cases for the evaluation of proposed solutions:

- The proposed solutions will involve little or no cost but will result in benefits. This is true for example if the number of forms and amount of paperwork in an enterprise are reduced or simplified. Industrial Engineers would calculate the savings in working time, paper and communication facilities, and eventually relate these savings to the analysis costs of the IE service or an external consultant.
- On the other hand, a proposed solution might not have immediate measurable benefits for an enterprise but would perhaps lead to a better competitive position later. This is particularly
true as regards the infrastructure for information processing, and also for training workers in
new technologies which have not yet been applied in the company. Evaluations in such cases
might include a risk assessment.

- The most common case is one where a proposed solution is associated with measurable costs
and benefits.

**Table 10.15: Evaluation**

<table>
<thead>
<tr>
<th>Technique</th>
<th>Application</th>
<th>Main features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation in monetary terms (cost/benefit</td>
<td>Calculate the cost or cost/benefit ratio of alternatives in monetary terms</td>
<td>Costs of alternatives are calculated, benefits are calculated or estimated</td>
</tr>
<tr>
<td>analysis)</td>
<td></td>
<td>(e.g. savings in material costs) cost/benefit ratio is expressed e.g. as</td>
</tr>
<tr>
<td></td>
<td></td>
<td>payback period of investment. There are many (company-specific) procedures</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in use; compare also cost-productivity allocation</td>
</tr>
<tr>
<td>Non-monetary evaluations (integral systems</td>
<td>Comparison of alternatives according to non-monetary criteria</td>
<td>Establish a set of criteria, e.g. flexibility of production, job enrichment,</td>
</tr>
<tr>
<td>evaluations)</td>
<td></td>
<td>high capacity utilization; weigh criteria in relation to each other, establish</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rating scale for each criterion for each alternative and compare results.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Many procedures of this kind are in use. Especially used in the evaluation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of investment alternatives for flexible manufacturing systems, office</td>
</tr>
<tr>
<td></td>
<td></td>
<td>automation, environment impact assessment</td>
</tr>
<tr>
<td>Combined monetary/non-monetary evaluation</td>
<td>Comparison of alternatives in monetary and non-monetary terms</td>
<td>Carry out separate procedures for monetary and non-monetary evaluation; base</td>
</tr>
<tr>
<td></td>
<td></td>
<td>decision on qualitative and quantitative results</td>
</tr>
</tbody>
</table>

**2.5.2 Evaluation in monetary terms**

To evaluate investment alternatives, procedures ranging from the quite simple to the sophisti-
cated are used. The difference is mainly in the way in which they consider the capital costs (inter-
est rates, depreciation, cash flow) involved in an investment and the time lag, for example
between investment and payback (benefits) of the invested capital. Evaluation procedures differ
also in the applied selection criteria such as costs, benefits, payback periods or profitability.

*Cost comparisons* are useful if the alternatives have similar performance characteristics and
differ only in, for instance, their life expectancy (duration of service). A typical case may be as
follows: the IE department is asked to evaluate two offers for the purchase of machines with
almost identical performance characteristics. They differ only in price and life expectancy. One machine costs DM 100,000 and has a life expectancy of eight years; the other costs DM 120,000 and has a life expectancy of ten years. Which would be the better bargain? The calculation procedure, based on calculatory (not real) interest rates and the average tied-up capital, shown in table 10.17 reveals that the Industrial Engineer would recommend the purchase of machine 2, which works out less expensive. The case could become slightly more complicated if the utilized capacities of the two machines differed. In this case the cost comparison would be based on the total costs per produced item (in table 10.16, item 14 divided by item 4).

**Table 10.16: Cost comparison between two alternative machines**

<table>
<thead>
<tr>
<th>Data for cost comparison</th>
<th>Machine 1</th>
<th>Machine 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Cost of acquisition (DM)</td>
<td>100 000</td>
<td>120 000</td>
</tr>
<tr>
<td>(2) Duration of service (years)</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>(3) Reselling price (DM)</td>
<td>10 000</td>
<td>12 000</td>
</tr>
<tr>
<td>(4) Produced units per year</td>
<td>15 000</td>
<td>15 000</td>
</tr>
<tr>
<td>(5) Calculatory interest rate (%)</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>(6) Other fixed costs (DM/year)</td>
<td>1 000</td>
<td>1 100</td>
</tr>
<tr>
<td>(7) Labour costs (DM/year)</td>
<td>6 000</td>
<td>4 800</td>
</tr>
<tr>
<td>(8) Material costs (DM/year)</td>
<td>1 500</td>
<td>1 500</td>
</tr>
<tr>
<td>(9) Variable manufacturing costs</td>
<td>1 850</td>
<td>1 600</td>
</tr>
</tbody>
</table>

**Cost comparison**

(10) Linear depreciation (DM/year) | 100 000-10 000 | 120 000-12 000 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>= 11 250</td>
<td>= 10 800</td>
<td></td>
</tr>
</tbody>
</table>

(11) Interest on tied-up capital (average) (DM/year) | 100 000+10 000 | 120 000+12 000 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>0.07=3.850</td>
<td>0.07=4.620</td>
<td></td>
</tr>
</tbody>
</table>

(12) Sum of fixed costs (DM/year) | 16 100 | 16 520 |

(13) Sum of variable costs (DM/year) | 9 350 | 7 900 |
| (7)+(8)+(9)                          |      |      |

(14) Total costs (DM/year) (12)+(13) | 25 450 | 24 420 |

**Result**

Machine 2 will be purchased due to the lower total cost for the units to be produced (machine utilization).

Source: Blohm et al., 1987, p.140.
If the benefits of the alternatives differ greatly, cost/benefit evaluations are helpful. One such type of evaluation has been already explained under “sensitivity analysis” (see subsection 2.2.5), where the benefit from reducing stock levels was compared to that from reducing labour costs by applying capital productivity as a criterion.

Another procedure is often applied to compare the costs and benefits of alternative processes in relation to the number of units to be produced per period. Consider the following case: as the market demand for your product is increasing, you have been studying the feasibility of mechanizing the process, which up until now has been predominantly manual. You wish to compare the present manual process with the proposed mechanized one. How many units must be produced initially so that the new process will be cheaper than the old one? The comparison to be made is shown in figure 10.19. The fixed and variable costs of both processes are displayed with reference to the number of units produced per period. Process no.1 (manual) has lower fixed costs than process no.2 (mechanized), but the variable costs are rising more quickly as the number of units produced increases. Therefore there must be a critical number of units produced per period at the point when both processes cost the same. In our case this is M2. The Industrial Engineer would consequently recommend the implementation of process no.2 only if the number of units produced per period were significantly higher than M2. The resulting productivity increase is symbolized by the area between the total cost curves of the two processes.

An important evaluation criterion is the payback period of a productivity improvement investment, i.e. how long it takes to pay back the investment through the savings made on the investment. Table 10.17 shows a simplified calculation of three alternatives for the organization of assembly work. The alternative requiring the highest investment also generates the highest savings, but has a slightly longer payback period than alternative A2.

**Figure 10.19: Costs of units produced per period with two alternative processes**
The choice between assembly line and group work, however, has further implications relating to flexibility, quality, motivation of workers, etc., so that a pure monetary evaluation would perhaps not lead to the best decision.

### 2.5.3 Non-monetary evaluations

Even though it is clearly advisable to know how much money is gained or saved through productivity improvement projects, this is sometimes difficult to ascertain, especially if a project has long-term consequences on the performance of a business unit. Product quality and process flexibility are important criteria, the benefits of which are only partly expressed in short-term monetary evaluations. There are several formalized non-monetary evaluation techniques in use. A simple method is to write down the pros and cons of proposed solutions and to base the decision on such a balance sheet of arguments.

*Productivity ratios* comparing present and proposed solutions are extremely useful. How to develop and use these ratios is explained in detail in Module 4, “Productivity measurement and analysis”. A simple “before and after” comparison is shown in figure 10.20 for the redesign of feeding work in a furnace. In the improved design the height of the furnace has been lowered and the pallets for the parts to be dried in the furnace have been raised so as to reduce manipulation distances and the operators’ workload. By this measure the output of the work system was increased by 36 per cent, and in parallel the physical workload (as indicated by the energy consumption) was reduced by 35 per cent.

*Systems value evaluation* provides the possibility of comparing various alternatives according to a number of criteria in a quantitative manner. It has been increasingly used to evaluate alternative proposals - for example, the siting of plants, designing complex manufacturing systems or developing new forms of work organization.

In the following example, the search for the most satisfactory site for a distribution centre of
consumer products explains how systems value evaluation works.

Case study: Evaluation of the siting alternatives for a plant
(adapted from Blohm et al., 1987, p.342)

1. Determinate evaluation criteria (Z1);

<table>
<thead>
<tr>
<th>Criteria Z1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of site (square metres)</td>
</tr>
<tr>
<td>Distance to highway (km)</td>
</tr>
<tr>
<td>Distance to clients (km)</td>
</tr>
</tbody>
</table>

2. Determine the relative importance of evaluation criteria in relation to each other. The weighting may be set on the basis of cross-comparisons of the criteria or by group sessions where participants are asked to give their opinions.

Figure 10.20: Evaluations of a redesigned furnace to improve working conditions (centimetres)
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Old design | New design
---|---
Units dried per minute | 7.4 | 10.1 (+36%)
Operators’ energy consumption (kJ/min) | 16.6 | 9.4 (-5%)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>P *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of site (square metres)</td>
<td>0.3</td>
</tr>
<tr>
<td>Distance to highway (km)</td>
<td>0.2</td>
</tr>
<tr>
<td>Distance to clients (km)</td>
<td>0.5</td>
</tr>
</tbody>
</table>

(*P = weighting factor)

In our example the distance to the clients is considered most important, followed by the area of the site. The distance to a highway is considered least important.

3. Set rating scales for each criterion and define the scores.

<table>
<thead>
<tr>
<th>Criteria Z₁₋₃</th>
<th>P₁₋₃</th>
<th>Definition of score</th>
<th>Value (score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of site (square metres)</td>
<td>0.3</td>
<td>10 000 - 12 000</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 000 - 14 000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 14 000</td>
<td>3</td>
</tr>
<tr>
<td>Distance to highway (km)</td>
<td>0.2</td>
<td>40 - 30</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30 - 20</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 20</td>
<td>3</td>
</tr>
<tr>
<td>Distance to clients (km)</td>
<td>0.5</td>
<td>1 000 - 700</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>700 - 400</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 400</td>
<td>3</td>
</tr>
</tbody>
</table>

4. Determine the relative value of the alternatives.

4.1 Write down the characteristics of the alternatives according to the set of criteria:

| Criteria Z₁ | Location alternatives and their characteristics |
|---|---|---|
| Area of site (square metres) | S₁ | S₂ | S₃ |
|  | 11 700 | 10 200 | 16 000 |
| Distance to highway (km) | 28 | 32 | 37 |
| Distance to clients (km) | 714 | 235 | 956 |
4.2 Score characteristics of siting alternatives according to score definition provided under item 3 above (e.g. alternative S1 has an area of 11,700 square metres which falls into category “10,000 - 12,000” under item 3 and is attributed a score of “1”).

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Area $Z_1$</th>
<th>Highway distance $Z_2$</th>
<th>Client distance $Z_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative S1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Alternative S2</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Alternative S3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

5. Determine the relative value of the alternatives:

Multiply scores of 4.2 with weighting factors $P_1 - P_3$ defined under 2 and sum up each line.

5.2 Set up each line:

<table>
<thead>
<tr>
<th>$Z_1$</th>
<th>$Z_2$</th>
<th>$Z_3$</th>
<th>Sum of line</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>$S_2$</td>
<td>0.3</td>
<td>0.2</td>
<td>1.5</td>
</tr>
<tr>
<td>$S_3$</td>
<td>0.9</td>
<td>0.2</td>
<td>0.5</td>
</tr>
</tbody>
</table>

6. Compare the values of the alternatives. The highest score is the “best” alternative based on the selected criteria and weighting factors. In our example, alternative $S_2$ has the best value, followed by alternative $S_3$. Alternative $S_2$ is by far the nearest to the clients, but has the smallest area on which to build the distribution centre.

2.6 Implementation

2.6.1 Implementation stages

We assume that following the evaluation of alternatives it was decided to implement productivity improvement measures, be it a new incentive scheme or an improved workplace layout.

The implementation phase of such a project will consist of approximately three stages. During the first, the planning stage, time targets and cost targets as well as required resources and responsibilities will have to be determined. The Industrial Engineer establishes a number of
time-activity, cost-time and activity-responsibility charts, graphs and checklists.

After the planning stage the changes are put into practice. This second stage may start with simulations, testing of the new process or layout and training activities, etc. The Industrial Engineer must ensure that the necessary activities are closely interlinked. At this stage, project management techniques such as Critical Path Method (CMP) or Programme Evaluation and Review Technique (PERT), or similar computer-based control instruments, are in use.

The implementation of a project does not stop with the installation of a new procedure. The new procedure must be followed up to ensure that the benefits forecast are attained. For this purpose the evaluation techniques outlined in section 2.5 are used. If the forecast objectives are not yet reached, possible causes may be analysed through weakness analysis (section 2.2).

As the implementation phase is explained in more detail in Module 6, "Implementing a company productivity improvement programme (PIP)", we shall note here only the most important IE techniques, summarized in table 10.18.

**Table 10.18: Implementation**

<table>
<thead>
<tr>
<th>Technique</th>
<th>Application</th>
<th>Main features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project planning</td>
<td>Set time and cost targets, plan required resources, define responsibilities</td>
<td>Charts specifying activities and relating the time, costs, resources, responsibilities, e.g. Gantt chart, linear responsibility charts</td>
</tr>
<tr>
<td>Project execution</td>
<td>Ensure that project objectives are reached at the right time using the allocated resources</td>
<td>Available procedures are inter alia Critical Path Method (CPM) Programme Evaluation and Review Techniques (PERT), simulations, linear programming</td>
</tr>
<tr>
<td>Project controlling</td>
<td>Monitor systems' performance (is foreseen cost/benefit achieved?)</td>
<td>Continuous comparison between &quot;actual and plan&quot;. Extrapolation of system performance to take corrective action</td>
</tr>
</tbody>
</table>

**2.6.2 Activity graphs and charts**

Graphs and charts relating the activities required to implement productivity improvement measures to time, costs, resources and responsibilities are very common. The best-known chart relating activities to the required time is perhaps the bar diagram or Gantt chart. This is not only used for project management but is a common tool for production scheduling. From the Gantt chart, however, it is not clear how activities are interrelated and how, for example, a delay in one activity influences others; these more complex projects should be managed by using CPM, PERT
or similar techniques. A simple Gantt chart is shown in figure 10.21, followed by some other common activity graphs and charts. The activity resources chart (figure 10.22) specifies the quantitative and qualitative resources required for each activity. Here an example of human resource planning is shown. In the linear responsibility chart (figure 10.23), the responsibilities and tasks of those concerned with the project are determined.

Activity cost charts (figure 10.24) focus on the comparison between real and forecast costs of each activity. As it is also important to know when costs occur and the consequence in cost for delays, project cost time charts can be drawn up (figure 10.25). These are just some examples of the many types of chart in use. It is easy to devise the charts needed with spreadsheets and other related personal computer software.

**Figure 10.21: Bar diagram or Gantt chart**

<table>
<thead>
<tr>
<th>Activities</th>
<th>Time</th>
<th>Week</th>
<th>Week</th>
<th>Week</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 10.22: Activities: Human resources chart**

<table>
<thead>
<tr>
<th>Activities</th>
<th>Manpower in weeks</th>
<th>Project engineers</th>
<th>Supervisor</th>
<th>Fitters</th>
<th>Transport personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10 - 56
Figure 10.23: Linear responsibility chart

<table>
<thead>
<tr>
<th>Responsibility task</th>
<th>Board</th>
<th>Steering committee</th>
<th>Project group</th>
<th>Project manager</th>
<th>Systems engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please mark the type of responsibilities/tasks:
1. Decision
2. Overall control
3. Operative management
4. Counselling
5. Information
6. Training

Figure 10.24: Activity cost chart

<table>
<thead>
<tr>
<th>Costs</th>
<th>Labour</th>
<th>Equipment</th>
<th>Energy</th>
<th>Material</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities</td>
<td>Forecast Real</td>
<td>Forecast Real</td>
<td>Forecast Real</td>
<td>Forecast Real</td>
<td>Forecast Real</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 10.25: Project cost time chart

- Foreseen costs
- Real costs

Week

Time
2.6.3 Project control by CPM and PERT

In a project the major complication arises from the fact that activities are interrelated and therefore a delay in one activity may cause delays in others. Consequently a number of networking techniques have been developed that take care of the interdependency of project activities. The Programme Evaluation and Review Technique (PERT) and the Critical Path Method (CPM) are part of a whole family of mostly computer-based networking techniques.

The heart of these networking techniques is the flow diagram, which depicts the sequences and interrelations of activities and events necessary to reach the objective of the project.

The following is a typical networking procedure (cf. Malcolm and Hill, 1971; REFA, 1985):

- Prepare the project: state clearly the project's objectives and purposes, establish its organization and allocate responsibilities.
- Determine the project's structure (work breakdown): identify major milestones. For example, a project to build a new warehouse could be divided into the building itself, and the installation of equipment in the building. Both partial projects may be further divided, depending on the amount of activities to be accomplished.
- List all activities and events: according to Malcolm and Hill (1971, p. 8-59), an event is defined as a distinguishable, unambiguous point in time that coincides with the beginning or end of a specific task or activity. An event does not symbolize the performance of work, but represents the time at which an activity has been started or completed.

To establish a list of activities and events it is helpful to ask the following questions:

What preceded an activity or event?
By which activity or event is it followed?
Which activities or events are independent and can be carried out in parallel?

- Draw the network: networking techniques differ in how they graphically represent the interrelationship between events or activities. Events are normally depicted by circles or boxes, activities leading to these events by arrows. In figure 10.26 two different ways of drawing the five basic relationships of events or activities are shown. After having drawn the network we know the detailed structure of our project, but we still have to determine the required times and resources.
- Calculate the active time elapsed: here again, networking techniques differ in the way in which time calculations are made and how they cater for uncertainties in the completion date of activities. In PERT three estimates are made for the time needed to complete an activity: the shortest time in which the activity is supposed to be completed (optimistic); the most probable time; and the longest time (pessimistic). As PERT assumes that these three assumptions follow a certain probability curve (beta distribution), the expected time is calculated as follows:

\[
\text{Expected time} = \frac{\text{Shortest time} + 4 \times \text{Most likely time} + \text{Longest time}}{6}
\]
### Figure 10.26: Types of events and their display in networking

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of event</th>
<th>Alternative displays of network</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Two events follow each other</td>
<td><img src="image1" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image2" alt="Diagram" /></td>
</tr>
<tr>
<td>2</td>
<td>One event has several successors</td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image4" alt="Diagram" /></td>
</tr>
<tr>
<td>3</td>
<td>Several events have one successor</td>
<td><img src="image5" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image6" alt="Diagram" /></td>
</tr>
<tr>
<td>4</td>
<td>Parallel events</td>
<td><img src="image7" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image8" alt="Diagram" /></td>
</tr>
<tr>
<td>5</td>
<td>Multiple dependency of events</td>
<td><img src="image9" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td><img src="image10" alt="Diagram" /></td>
</tr>
</tbody>
</table>

Source: Adapted from REFA, 1985, p. 27.
Calculate network times of events: how long will the project take? Sum up the expected timing of all activities from the beginning to the end of the “project labyrinth” to get the earliest time for project completion based on the above calculations. After the earliest possible completion date for the last item in a project has been established, the latest permissible occurrence date for each event can be determined by the so-called “backward pass” computation. Therefore each event is noted twice (earliest and latest). Figure 10.27 illustrates these calculations graphically.

Plan required resources: after the allotted times for the events have been determined, it is necessary to plan the required resources carefully so that they are available at the right time.

In this unit we have provided only a rough outline of networking techniques. For those who wish to use one particular technique, in-depth training would be required.

Questions for discussion

1. Name three of the most important analytical tools of IE and discuss possible areas of application, relating them to your company experience: does your company use them?
2. How does your organization approach problems of identification? How do you prioritize your problems by their importance? Who do you need to do so and what are the main instruments used?
3. What major barriers do organizations meet in applying IE techniques?
Figure 10.27: How to calculate network times

$TE =$ earliest possible date that an event can be attained or an activity completed
$TS =$ target completion date for the project
$TL =$ latest possible date that an event can be reached or an activity completed if the project completion date is to be met

\[ \begin{align*}
&TE = 2 \text{ weeks} \\
&TS = 10 \text{ weeks} \\
&TL = 5 \text{ weeks}
\end{align*} \]

Computation of $TE$'s for network events.

\[ \begin{align*}
&TE = 0 \text{ weeks} \\
&TE = 4 \text{ weeks} \\
&TE = 5 \text{ weeks}
\end{align*} \]

Computing $TL$'s for network events.

\[ \begin{align*}
&TL = 6.4 \text{ weeks} \\
&-TE = 2.0 \\
&+4.4
\end{align*} \]

Computing slack where $TL = TE = 0$.

UNIT 3: PRACTICAL EXERCISES

UNIT 3: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Practise your skill in IE techniques and deepen your understanding and confidence in IE as an important productivity improvement approach.

UNIT 3: CONTENTS

3.1 Work organization of client order processing in a toy manufacturing company

3.2 Aluminium Sauce Pans Ltd.
3.1 WORK ORGANIZATION OF CLIENT ORDER PROCESSING IN A TOY MANUFACTURING COMPANY

A toy manufacturer asks an IE consultant to analyse the present work organization of client order processing and to propose improvements.

The manufacturer is particularly unhappy about the relatively long lead time of order processing (four to five days), which he explains is too long in comparison with his competitors. During the order processing nobody in the company seems really to know the stage that has been reached. This is usually when retailers phone to ask when they might expect to receive their orders. As the dispatch department is usually the best informed unit, they are informally running the order processing and have contacts with the clients.

In his analysis the consultant found the following situation.

3.1.1 Analysis of current procedure

Client (toy retailers) orders are received in the sales department; they are checked by the head of the department and subsequently sent to the dispatch department where an order number is allocated and client data are typed into a computer terminal connected to the main computer. Orders received in the morning are sent by internal mail to the computing department where data typists enter the orders into the main computer.

Overnight delivery notes are printed out in batch mode. The following morning client orders and delivery notes are sent to the invoice unit. There, client orders are sorted manually according to client number and are matched and stapled to the respective delivery notes. If there are several orders from one client, they are put together.

Client orders and delivery notes are subsequently sent to the dispatch department, where the head of the unit schedules the orders to be commissioned in the warehouse and to be packed. After the accompanying papers have been prepared, delivery notes are sent to the invoice department where they are sorted according to type of dispatch and other criteria. From the invoice department delivery notes return to the computing department where eventual changes of orders (e.g. owing to unavailability of products) are typed into the system and invoices are processed. Invoices are then sent to the invoice department which forwards them to individual clients or to their purchasing association.

1. Draw a process chart of the existing process.
2. Use the questioning technique to analyse the present system of work organization.
Module 10
Unit 3

Operation carried out by unit:

<table>
<thead>
<tr>
<th>Operation</th>
</tr>
</thead>
</table>
3.1.2 Teaching notes

1. Read the text carefully and discuss any questions you have with the trainer or with your colleagues.
2. Set up small groups and let them chart the existing process.
3. One group has to present the analysis on the blackboard or flipchart. Involve the other groups in the discussion. Complete and/or correct the analysis so that there is agreement on the existing work flow (see attached solution chart).
4. Briefly discuss the questioning technique and apply in small groups or in plenary.
   The following aspects of the existing work flow should be revealed:
   - unclear responsibilities;
   - too many instances involved;
   - unclear information about order processing status;
   - manual work organization remaining practically unchanged after the use of computers was introduced; and
   - costs of order processing too high.
5. Conduct brainstorming sessions in groups to improve work organization. Consult the principles of brainstorming in this module if necessary.
6. Following the brainstorming session, draw a process chart of an improved work flow. Present group solutions and discuss them in plenary. One proposed solution is shown in the attached process charting form (figure 10.28).

3.2 ALUMINIUM SAUCE PANS LTD [1]

In the last year the production and operations management class of Professor Stephen Wamble visited a small-scale factory in the industrial district of a developing country. As he showed them around the factory, the manager of Aluminium Sauce Pans Ltd. explained that he needed to know how many additional stamping presses to buy. Despite his all-out efforts, production of saucepans seemed to fall continually behind demand, and the stamping operation seemed to be the “bottleneck”, preventing an increase in output.

History

Aluminium Sauce Pans Ltd. had been operated for a number of years under private sector management. Last year, after it fell idle for several months, the factory was acquired by new owners who had little experience either in production or in sales. The manager therefore welcomed the visit of the class, saying he hoped the students could help him to decide what steps to take to improve operations.

The product

The company made aluminium saucepans of varying depths and diameters, each with a rim about 2 cm wide. The pans were usually sold in nested sets of three to seven sizes; each pan was designated by its diameter in centimetres. Exhibit 1 in table 10.19 shows the product line of the company with selling prices currently in effect.

Figure 10.28: Work flow of client order processing of a toy manufacturer

Operation carried out by units:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Sales</th>
<th>Dispatch</th>
<th>Computing</th>
<th>Invoice unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Orders received</td>
<td></td>
<td></td>
<td></td>
<td>Proposed: not needed any longer</td>
</tr>
<tr>
<td>2. Check by dept. head</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(proposed: by sales officers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Sent to dispatch</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Allocation of order number</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Entering of client data</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>6. Sent to computing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Entering of client orders</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Processing/printing of delivery notes</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>9. Order forms and delivery notes to invoice unit</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>10. Manual sorting</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>11. Sent to dispatch</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>(proposed: on line)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Scheduling of order commissioning &amp; package 2 (proposed: via computer estimate)</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>13. Commissioning &amp; packaging</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>14. Preparation of accompanying papers</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>15. Delivery notes sent to invoice unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Sorting</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>17. Set to computing</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>18. Entering corrections/changes of orders</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Processing of invoices</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>20. Sent to invoice unit</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>21. Forwarding invoices to clients of retailer associations</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

X Existing work flow
■ Proposed work flow
The production process

Each saucepan was formed in a single stroke of a stamping press. A stamping press is a machine about 3m high, which could move a vertical piston through a stroke of about 70 cm, exerting many hundreds of kg of force per cm$^2$ of area.

In order to determine which product would be made with each stroke, the press was equipped with two halves of a die. The bottom half, which was hollow and formed the outside shape of the pan, was mounted on the platform of the press. The upper half of the die, which was a solid cylinder and formed the inside surface of the pan, was mounted on the end of the piston of the press.

For each saucepan the press operator centred a circular disc of aluminium of the proper diameter over the hollow half of the die. He then threw a switch which caused the solid half of the die, mounted on the piston, to force ("draw") the aluminium into shape. As the piston withdrew and stopped, the operator pulled the formed saucepan from the press and set it aside. The aluminium discs were lightly lubricated before being set in the press, to avoid sticking.

The formed pans were put through various deburring, cleaning and buffing operations before being stored temporarily until they were made into sets and placed in the warehouse. "Not that we have very many pans in storage," the manager said with regret. "In fact, we cannot keep up with demand. We have hardly any complete sets in inventory - just a few hundred 31 cm pans and several dozens of some of the smaller sizes. We always seem to run especially short of 19 cm pans, however." The manager pointed out, however, that in the case of every process except that of stamping, he could increase the throughput at short notice by assigning additional workers; none of the processes other than stamping depended upon scarce machinery.

Equipment

The only output-limiting equipment in the factory consisted of four huge stamping presses. The manager pointed out that presses 01, 02, and 03 were all of about the same size, and smaller than press 04. "The three smaller presses are only able to draw pans up to 23 cm in size," he said. "These pans are all made from thin aluminium discs. Press 04 can handle any size pan we make, but is particularly useful for the three largest sizes, which use thick aluminium, and therefore require more pressure."

Although the manager was unable to give an estimate of the standard operating rate for the machines, he was happy to supply the record of the previous Friday’s production record (exhibit 2 in table 10.19) and to allow the class to observe the machines at work. The records kept by four students, each of whom observed a different press for 30 minutes, are summarized in exhibit 3 (table 10.19).

Labour

The manager pointed out that he had no difficulty in hiring unskilled labourers for Sh.7 per day, the local going rate. Press operators on the smaller presses typically earned Sh.8 per day, and on press 04, Sh.9 per day, since these jobs were considered semi-skilled. Although only one man tended each press, the manager said that several other workers would operate the presses. They were assigned to the presses whenever a regular operator was absent. The company had no
Table 10.19: Aluminium Sauce Pans Ltd.

Exhibit 1: Product line in July 1974

<table>
<thead>
<tr>
<th>Item</th>
<th>Factory selling price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set 01 (5 items)</td>
<td>Sh. 53 per set (one each 15 cm, 17 cm, 19 cm, 21 cm and 23 cm)</td>
</tr>
<tr>
<td>Set 02 (3 items)</td>
<td>Sh. 98 per set (one each 19 cm, 25 cm, and 37 cm)</td>
</tr>
<tr>
<td>Set 03 (7 items)</td>
<td>Sh. 170 per set (one each 15 cm, 17 cm, 19 cm, 23 cm, 25 cm, 31 cm and 37 cm)</td>
</tr>
</tbody>
</table>

Individual pans:

<table>
<thead>
<tr>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 cm</td>
<td>Sh. 7</td>
</tr>
<tr>
<td>17 cm</td>
<td>Sh. 9</td>
</tr>
<tr>
<td>19 cm</td>
<td>Sh. 11</td>
</tr>
<tr>
<td>21 cm</td>
<td>Sh. 13</td>
</tr>
<tr>
<td>23 cm</td>
<td>Sh. 16</td>
</tr>
<tr>
<td>25 cm</td>
<td>Sh. 28</td>
</tr>
<tr>
<td>31 cm</td>
<td>Sh. 43</td>
</tr>
<tr>
<td>37 cm</td>
<td>Sh. 61</td>
</tr>
</tbody>
</table>

Exhibit 2: Production for the previous Friday

<table>
<thead>
<tr>
<th>Hours</th>
<th>Preserves</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-10</td>
<td>01</td>
</tr>
<tr>
<td>10-10.30</td>
<td>02 (15 cm) 360 (17 cm) 320 (19 cm) 160 (25 cm)</td>
</tr>
<tr>
<td>10.30-12.30</td>
<td>03 (set-up change)</td>
</tr>
<tr>
<td>1.30-3</td>
<td>04 (set-up change)</td>
</tr>
<tr>
<td>3.30-5</td>
<td>04 (tea break)</td>
</tr>
<tr>
<td>5.30-5</td>
<td>04 (set-up change)</td>
</tr>
</tbody>
</table>

Total daily production by size:

<table>
<thead>
<tr>
<th>Size</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 cm</td>
<td>400</td>
</tr>
<tr>
<td>17 cm</td>
<td>720</td>
</tr>
<tr>
<td>19 cm</td>
<td>880</td>
</tr>
<tr>
<td>21 cm</td>
<td>400</td>
</tr>
</tbody>
</table>

Total all sizes: 2,860

Exhibit 3: Observations of presuses in operation

<table>
<thead>
<tr>
<th>Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Scrap</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 (21 cm)</td>
<td>13</td>
<td>12</td>
<td>17</td>
<td>2**</td>
<td>18</td>
<td>16</td>
<td>7 units</td>
</tr>
<tr>
<td>02 (25 cm)</td>
<td>10</td>
<td>9</td>
<td>11</td>
<td>12</td>
<td>8</td>
<td>10</td>
<td>5 units</td>
</tr>
<tr>
<td>03 (15 cm)</td>
<td>0**</td>
<td>0**</td>
<td>20</td>
<td>22</td>
<td>18</td>
<td>24</td>
<td>2 units</td>
</tr>
<tr>
<td>04 (37 cm)</td>
<td>3</td>
<td>2</td>
<td>0**</td>
<td>0**</td>
<td>4</td>
<td>4</td>
<td>3 units</td>
</tr>
</tbody>
</table>

Notes:

** Worker paused to smoke a cigarette.
*** Press set-up still being changed.
**** Press stopped for adjustment of die - worker noticed excessive damage rate.

Exhibit 4: Raw material prices, July 1974

<table>
<thead>
<tr>
<th>Dices for</th>
<th>Imported</th>
<th>Local</th>
<th>Value as scrap</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 cm</td>
<td>Sh. 4.40</td>
<td>Sh. 2.50</td>
<td>Sh. 1.50</td>
</tr>
<tr>
<td>17 cm</td>
<td>5.70</td>
<td>3.25</td>
<td>1.95</td>
</tr>
<tr>
<td>19 cm</td>
<td>7.10</td>
<td>4.05</td>
<td>2.40</td>
</tr>
<tr>
<td>21 cm</td>
<td>8.60</td>
<td>4.90</td>
<td>2.95</td>
</tr>
<tr>
<td>23 cm</td>
<td>10.20</td>
<td>5.80</td>
<td>3.50</td>
</tr>
<tr>
<td>25 cm</td>
<td>18.40</td>
<td>10.50</td>
<td>6.30</td>
</tr>
<tr>
<td>31 cm</td>
<td>28.30</td>
<td>16.15</td>
<td>9.70</td>
</tr>
<tr>
<td>37 cm</td>
<td>40.30</td>
<td>23.00</td>
<td>13.80</td>
</tr>
</tbody>
</table>

Module 10
training programme. The major skill required in operating the presses was in properly centring the aluminium disc. This was largely a matter of seating a proper-sized disc within the area of the die bounded by a slight ridge. Discs were usually scrapped. The manager said that he believed the normal scrap rate was 10 per cent.

In addition to the four press operators, the normal workforce of the factory included 12-14 other workers, who performed all other production processes, moved raw materials and work in process from place to place, and manned the storeroom. The manager directed all the workers, treating the operator of press 04, his most experienced man, as a “lead” worker to oversee things when the manager was absent from the factory floor. Each press operator made his own set-up changes, at intervals of a few hours, as the manager tried to keep his stocks in balance in sets.

Marketing

The factory manager could only guess at the total size of the market for saucepans. “We have operated ‘hand-to-mouth’ for three months, since the new owners took over, trying to catch up with demand. We believe that the former owners produced a total of 60,000 sets in the last full year of operation. Sales consisted of about 37,000 of set 01; 17,000 of set 02; and 6,000 of set 03. Our demand still seems to run in about those proportions, but we suspect that sales might reach 72,000 sets annually if we could supply that many.”

Raw materials

Because saucepans were considered a basic necessity of life, the company had been allowed to import as many aluminium discs as they could process. It was these imported discs that were being used at the time of the class visit to the factory. The manager said that locally made aluminium discs were available at substantially lower prices than the imported discs. The local supplier made his discs from reprocessed scrap aluminium (see exhibit 4 in table 10.20 for raw material and scrap prices). The manager said that he did not like to use the local aluminium, which tends to catch and tear in the presses, rather than drawing smoothly into the pan shape 2. The company continued to experiment with local aluminium from time to time, in case imports would suddenly be cut off.

Conclusion

As Professor Wamble and his class thanked the manager for his courtesy in showing them around, he repeated his earlier request. “It is clear to me that the stamping presses are a bottleneck which restricts our output. I have sales literature from manufacturers offering new or used presses for immediate delivery. I could buy additional small presses for about Sh.75,000, or large ones at Sh.150,000, both prices including delivery and set-up. Those are the used machines; new ones are higher. What should I do?”

3.2.1 Teaching notes

The main intention of this exercise is to understand how Industrial Engineers should approach a problem and find appropriate solutions.
1. Read the case carefully and clarify with the trainer and colleagues any queries they may have.
2. Set up working groups to reflect (for about 40 minutes) on how they would proceed in solving the case. Discuss "how to proceed".
3. The case could be solved more easily by pointing out the following questions:
   - What are the capacities of the existing machines (e.g. expressed as time per units for each saucepan type: see table 10.20)?
   - What capacity is needed to produce the desired production programme?
   - How could the capacities of the existing machines be increased?
4. Working groups should take the time to prepare their answers to these questions.
5. Discuss your results, consulting the following solutions:

   Capacities of present machines may be calculated on the basis of the Friday report and the observations (see table 10.21). You may find the presentation of the information confusing, but in real life Industrial Engineers are often confronted with unreliable and confusing information. Part of their skill lies in making the right choices based on the available information.

   Information based on the number of working days per year will be needed:

   Calculation example:

   53 weeks multiplied by 5 working days = 265 working days
   - 35 days holiday
   - 20 days overhaul, maintenance, repair, idle owing to lacking spare parts
   - 10 days operator absentees

   = 200 production days

   Table 10.20: Capacity of present machinery: Production time in minutes/units related to saucepan size (according to production reports and observations\(^1\))

<table>
<thead>
<tr>
<th>Press no.</th>
<th>15</th>
<th>17</th>
<th>19</th>
<th>21</th>
<th>23</th>
<th>25</th>
<th>31</th>
<th>37</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>0.3*</td>
<td>—</td>
<td>—</td>
<td>0.45*</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>02</td>
<td>—</td>
<td>0.33</td>
<td>—</td>
<td>0.35*</td>
<td>—</td>
<td>0.5*</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>03</td>
<td>0.24*</td>
<td>—</td>
<td>0.38</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1.5*</td>
</tr>
<tr>
<td>04</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>0.75</td>
<td>—</td>
<td>1.53*</td>
</tr>
</tbody>
</table>

1) Observed times: intervals with * (pauses, set up, press stopped) have been excluded, scrap has not been considered. Time given is mean value of the included observations.
What capacities would be needed to produce the desired production programme of 72,000 sets a year?

As the factory manager states, the demand continues to run in the old proportions. The new production programme may look as follows:

<table>
<thead>
<tr>
<th>Total number of sets</th>
<th>72 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sets of 1</td>
<td>44 000</td>
</tr>
<tr>
<td>Sets of 2</td>
<td>20 000</td>
</tr>
<tr>
<td>Sets of 3</td>
<td>8 000</td>
</tr>
</tbody>
</table>

In table 10.21 the production programme is established for each pan size. Subsequently the required capacity is calculated. Table 10.22 informs us of the type of capacity utilization of the different presses, given the present machine availability (5 hours per day, 200 days per year are considered; these data must be given to the participants). Make sure that participants calculate using the above number of sets, on which the calculations in the teaching notes are based.

As a result of our calculations we discover that press 04 lacks capacity (210 hours). Discuss possibilities of increasing capacities and their utilization:

- work through breaks (rotating shifts);
- two shifts;
- reduce scrap;
- reduce set-up times (scheduling);
- calculate and control press capacities;
- reorganize supervision;
- training;
- technological processes: dyes, lubrication, pressing velocities, press feeding, etc.;
- choice of materials; and
- incentive schemes for workers.

The case could be further exploited by calculating or estimating the costs and benefits of proposed productivity improvements (e.g. sensitivity analysis or other evaluation techniques could be applied).
### Table 10.22: Production programme and press capacity requirements

<table>
<thead>
<tr>
<th>Saucepan sizes</th>
<th>15</th>
<th>17</th>
<th>19</th>
<th>21</th>
<th>23</th>
<th>25</th>
<th>31</th>
<th>37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set 1</td>
<td>44 000</td>
<td>44 000</td>
<td>44 000</td>
<td>44 000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Set 2</td>
<td>-</td>
<td>-</td>
<td>20 000</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>20 000</td>
<td>-</td>
</tr>
<tr>
<td>Set 3</td>
<td>8 000</td>
<td>8 000</td>
<td>8 000</td>
<td>-</td>
<td>8 000</td>
<td>8 000</td>
<td>8 000</td>
<td>8 000</td>
</tr>
<tr>
<td>Required annual no. of units per size.</td>
<td>52 000</td>
<td>52 000</td>
<td>72 000</td>
<td>44 000</td>
<td>52 000</td>
<td>28 000</td>
<td>8 000</td>
<td>28 000</td>
</tr>
<tr>
<td>Production time per unit (min./unit)</td>
<td>0.3</td>
<td>0.33</td>
<td>0.38</td>
<td>0.45</td>
<td>0.5</td>
<td>0.75</td>
<td>1.2</td>
<td>1.5</td>
</tr>
<tr>
<td>Annual net production hours required</td>
<td>260</td>
<td>286</td>
<td>456</td>
<td>330</td>
<td>433</td>
<td>350</td>
<td>160</td>
<td>700</td>
</tr>
<tr>
<td>Press to be allocated</td>
<td>01 03</td>
<td>02</td>
<td>03</td>
<td>01</td>
<td>02</td>
<td>04</td>
<td>04</td>
<td>04</td>
</tr>
</tbody>
</table>

### Table 10.23: Press capacity availability (annual) and utilization by forecasted production programme

<table>
<thead>
<tr>
<th>Press</th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual net production capacity (5 hours &amp; 200 days) (at present in hours)</td>
<td>1 000</td>
<td>1 000</td>
<td>1 000</td>
<td>1 000</td>
</tr>
<tr>
<td>Used by established production programme</td>
<td>590</td>
<td>719</td>
<td>456</td>
<td>1 210</td>
</tr>
<tr>
<td>Free capacities (hours)</td>
<td>410</td>
<td>221</td>
<td>444</td>
<td>-</td>
</tr>
<tr>
<td>Lacking capacities (hours)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>210</td>
</tr>
</tbody>
</table>
BIBLIOGRAPHY


North, K.: “Ergonomics methodology: An obstacle or promoter for the implementation of ergonomics in industrial practice?” in *Ergonomics* (Basingstoke, United Kingdom, Taylor and Francis), vol. 23, 1980.

58 (Geneva, 1987).


REFA: Methodenlehre des Arbeitstudiums (Munich, Germany, Hanser, 1978-89), Vols. 1-6. Available in German, Spanish, Portuguese, Turkish, Hungarian, French, with a short version in English.

REFA: Methodenlehre der Planung und Steuerung (MLPS), vol. 5 (Munich, Germany, Hanser, 1985).

REFA: Planung und Gestaltung komplexer Produktionssysteme (Munich, Germany, Hanser, 1987).


SRF (Swedish Federation of Productivity Services): Profitability improvement analysis (PIA) (Stockholm, 1988).

MODULE 11
FINANCIAL AND COST ANALYSIS
MODULE 11: LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand the elements of financial statements (income statements and balance sheets) and undertake their analysis and interpretation.

2. Determine cost behaviour patterns and use this information for break-even analysis.

3. Distinguish income and valuation consequences of adopting variable and absorption costing and use variable costing data for short-term decision making.

4. Understand the elements of integrated master budgets and the benefits of the zero-base budgeting approach, and know how to use standard costs for planning, control and identifying production variances.

5. Apply concepts of financial management to the management of working capital, and evaluate capital investments using discounted cash flow techniques.

MODULE 11: CONTENTS

UNIT 1: Introduction to financial and cost analysis

UNIT 2: Financial accounting

UNIT 3: Management accounting

UNIT 4: Financial management

Module overview

Bibliography
UNIT 1: INTRODUCTION TO FINANCIAL AND COST ANALYSIS

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit you will be able to:

1. Appreciate the importance of financial and cost analysis for effective decision making and productivity improvement.

2. Understand and explain the nature of financial accounting and cost analysis, and its three main areas.

UNIT 1: CONTENTS

1.1 The importance of financial and cost analysis

1.2 The nature of financial and cost analysis
UNIT 1: INTRODUCTION TO FINANCIAL AND COST ANALYSIS

1.1 The importance of financial and cost analysis

The concepts of financial and cost analysis have considerable relevance for management and for productivity improvement. It is essential to manage the financial aspects of a business effectively if it is to remain viable. Further, if productivity improvement is to be successful, then financial resources must be soundly managed. This means that the financial consequences of any productivity improvement options must have been clearly analysed and taken into account.

Most productivity-enhancing measures will have financial implications. The following examples highlight productivity improvement measures which may stem initially from factors outside the financial area, but which will have an impact on the firm’s financial situation. Let us consider the following examples:

Replacing an existing manufacturing facility

The industrial engineering department has suggested that the company should renew its manufacturing facilities to bring them into line with recent technological changes. This in turn should enable the company to lower its unit cost of production. Such a decision has multiple consequences, but managers will want to know whether the investment will yield a sufficient return overall to be viable. They will also want to know how the additional investment might be financed and how the new facilities will affect the firm’s future profitability and financial position. A decision like this has major strategic implications for the company and it involves information from a wide range of special areas such as marketing, production, human resources and industrial engineering. Senior management will consider the advice it receives from the various functional specialists. However, it will need some basis for integrating the various inputs in such a way as to clarify the central issues. Typically, senior management will ask the company financial specialists to undertake this integrative analysis.

Setting prices of products

A company is considering its pricing policies for the forthcoming period. It operates in a sector where there are few competitors (i.e. an oligopoly industry). Therefore it is aware that changes in its pricing policy may result in retaliatory action by one (or more) competitors. When considering the situation, it might also look at the financial strength of its competitors. In the event of a price war, does the competitor have the financial strength to outlast the company during a period of heavy discounting? In considering this marketing issue, company management might use some financial expertise to examine the situation of its competitor(s) and assess their relative financial strength.

Ability to finance growth opportunities

The management of the company is reviewing growth plans for the next year, but the financial team warns that there is a shortage of funds to finance growth. Therefore the company has to consider alternative sources of finance. These could come from trading, from greater efficiency in managing the firm’s working capital, from borrowing or from new share issues. Assuming that
the company cannot raise more long-term funds from either debt or share capital, then the remain-
ing sources are trading and also better management of working capital. Senior management can
seek the advice of its financial team on the extent to which growth can be financed by these
sources of finance in the next period.

Accepting or rejecting a special order

The marketing department receives a one-off order from a foreign country, to supply one of
its products. The country is only prepared to pay a sum which is below the normal selling price; in
fact it is below the full absorption cost of the product. The company has production capacity to
produce the extra units without affecting normal sales. Senior management could enlist the help of
the finance team to assess the financial viability of accepting this special order.

Setting up a department to manufacture a new product

Management is considering setting up a new department to produce an entirely different
product. The industrial engineering and marketing departments have estimated the costs of pro-
ducing the new product and the expected sales quantity and selling price. Management now
wishes to undertake some financial analysis to determine whether the venture will be profitable. It
could ask the finance team to undertake a study to determine the break-even production and sales
quantity, and to estimate the production and sales volume necessary to achieve the desired level of
profit from this new facility, given the amount of capital investment involved. This analysis could
then be used to assess whether the venture is worthwhile.

The above list of practical examples illustrates the contribution that financial and cost analy-
sis can make to productivity improvement. It demonstrates that the finance function is an integra-
tive one, providing managers with monetary information which integrates data from the various
functional areas to help with decision making.

1.2 The nature of financial and cost analysis

Accounting and finance

Accounting can be defined as “the process of identifying, measuring and communicating
economic information to permit informed judgements and decisions by users of the information”
(Hoggett and Edwards, 1987, p.5). The information in accounting systems relates mainly to fi-
nancial data about business transactions, which is represented in monetary terms. In addition to
collecting data about past transactions the accounting system may be required to generate fore-
casts and predictions about likely future circumstances as an aid to decision making. Accounting
is sometimes referred to as the language of business. It offers a medium through which the mar-
keting, production, human resources and other impacts of a decision may be reflected in monetary
terms. This indicates the way in which most companies use accounting and finance as an integra-
tive function to show the combined consequences of a proposed course of action on the firm’s fi-
nancial situation.

The materials in this module relate to three broad areas of accounting and financial manage-
ment. These are financial accounting, management accounting and financial management. It is
appropriate here to briefly define and discuss the nature of each of these specialist areas, before
going into further detail.

Financial accounting

The main purpose of financial accounting is to classify and record transaction details in mon-
etary terms, so as to enable the preparation of periodic income statements and balance sheets. The
focus of financial accounting is on preparing the company’s financial statements (income state-
ment and balance sheet) for use by external parties. Generally, accounting principles and com-
pany law require that companies must periodically provide certain essential information to
shareholders. This means providing an income statement and balance sheet at periodic intervals.

Whilst financial accounting information has obvious uses and applications within a firm, the
main focus when studying financial accounting is on the needs of external users of published fi-
nancial statements. The study of financial accounting involves detailed aspects of identifying, re-
cording, measuring and communicating the firm’s financial results.

Management accounting

Management accounting provides the information necessary for managers to make informed
decisions. To that extent management accounting is focused on internal decision making. Conse-
quently, management accounting systems are often far less homogeneous than financial account-
ing systems. To some degree financial accounting systems are dictated by the legal reporting
requirements placed on companies, whereas the nature and extent of management accounting sys-
tems is at the discretion of management. Overall a company will tend to establish management
accounting systems that will assist in planning, controlling, organizing, communicating and moti-
vating. Planning involves such elements as financial plans and budgets for forthcoming periods.
Controlling means providing feedback on actual results so that corrective action can be initiated
when appropriate. Organizing means establishing clear lines of responsibility and authority and a
clear understanding of the links between the various units of a firm. Communicating means pro-
viding individuals and groups with the information and feedback they need to carry out their as-
signed tasks effectively. Motivating means that individuals and groups choose to take decisions
that are congruent with the firm’s overall goals. They need to be committed to organizational
goals and feel that working in the company will enable them to attain their personal goals.

Financial management

The financial management function is concerned with three major decision areas: the invest-
ment decision; the financing decision; the dividend decision.

The investment decision means selecting those investment projects, from the array of alterna-
tives, that will be most beneficial for the firm and its shareholders. As the benefits, or costs, of
long-term investment decisions will not be realized until some time in the future, these decisions
necessarily involve risk and uncertainty. The investment decision includes new investment, as
well as replacement of existing assets. Essentially, the investment decision involves management
in determining and revising its long-term plan for deployment of the firm’s assets. It involves
careful consideration of how the total pool of assets (resources) available to the firm will be used.
Assessment of capital investments involves determining a firm’s required return on its assets, as
well as techniques for selecting the best projects in terms of the firm’s long-term goals.

The financing decision determines the best mix of finance to be used by the firm. This involves decisions about the mix of owners’ capital (equity) and borrowed capital (debt) that should be used. The critical issue in terms of the financing decision is whether the value of the firm can be affected by the mix of finance used. These issues are part of the capital structure debate and there are many different views on the extent to which capital structure can affect the value of the firm. Capital structure decisions also have implications for managers, in terms of short- and medium-term aspects of financial management.

The dividend decision is also an important decision for financial management. The dividends paid to shareholders diminish the pool of funds available from internal sources that might be used to finance new investment. If shareholders are indifferent to changes between dividend income and capital gains through rising share prices, then it is possible to identify an optimal dividend payment that will maximize the wealth of shareholders.

Financial management is concerned with resolving issues associated with these three areas and typically the objective of the financial manager is assumed to be concerned with maximizing the wealth of the firm’s shareholders. Thus this module incorporates topics from the three areas of financial accounting, management accounting and financial management. The topics included have been selected because of their particular utility from the perspective of managerial decision making and their relevance for productivity improvement. The structure of the module is presented in figure 11.1.

**Figure 11.1: Financial and cost analysis techniques**

<table>
<thead>
<tr>
<th>Financial accounting</th>
<th>Management accounting</th>
<th>Financial management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial statements</td>
<td>Cost behaviour</td>
<td>Working capital management</td>
</tr>
<tr>
<td>Analysis and interpretation</td>
<td>Break-even analyses</td>
<td>Valuation of the cost of capital</td>
</tr>
<tr>
<td></td>
<td>Variable and absorbing costing</td>
<td>Evaluating long-term investments</td>
</tr>
<tr>
<td></td>
<td>Short-term decision making</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard costs and variance analysis</td>
<td></td>
</tr>
</tbody>
</table>

Questions for discussion

1. List the ways in which financial and cost analyses are important for productivity improvement.
2. Name the main three elements of financial and cost analysis and give their main functions.
3. Brainstorm and prepare a list of the most important financial and cost analysis techniques used in your company.
UNIT 2: FINANCIAL ACCOUNTING

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand the relationship between the income statement and the balance sheet.

2. Appreciate the generally accepted accounting principles with respect to entity; realization; going concern; period; monetary unit; consistency; matching; prudence or conservatism; and materiality.

3. Recognize the uses of analysis and interpretation for assessing an organization’s performance.

4. Understand the main measures of financial structure, solvency, profitability ratios and the du Pont formula, and appreciate the usefulness of ratio analysis and its limitations.

UNIT 2: CONTENTS

2.1 Financial statements

2.2 Analysis and interpretation of financial statements
UNIT 2: FINANCIAL ACCOUNTING

This unit will help you understand the concepts used in preparing financial statements, comprehend the content of balance sheets and profit and loss accounts, and appreciate the role of regulatory frameworks in ensuring consistency in published financial statements. Managers should understand the outputs of financial accounting processes and be able to interpret financial statements.

2.1 Financial statements

End-of-period financial reports provide a measure of the firm's performance through the income statement, and the firm's financial position through the balance sheet. It is necessary here to give a brief outline of the purpose of these reports and the five basic groups of accounts that are part of a firm's detailed accounting records (referred to as the general ledger or nominal ledger). Further, it is necessary to outline the generally accepted accounting principles (GAAP), that guide accountants in their treatment of financial events.

It is also necessary to consider the regulatory frameworks that govern the accounting and reporting of corporate activities. Frameworks vary from country to country and there are organizations that endeavour to harmonize these arrangements internationally. The key elements of the systems in the United States of America and the United Kingdom will be outlined, as will the role of international bodies such as the International Accounting Standards Committee (IASC) and the International Federation of Accountants (IFAC).

The terminology in this section is quite extensive and falls into three broad categories:

- end of period reports;
- the five basic groups of accounts;
- generally accepted accounting principles (GAAP).

End-of-period reports

The end-of-period reports that firms produce will always include an income statement (performance report) and a balance sheet (financial position report).

The income statement (or profit and loss account) measures the firm's profit (or loss) in a given accounting period. It does this by matching the firm’s revenue for the period against the expenses involved in earning that revenue. This profit (or loss) represents change in the firm’s wealth during an accounting period, with profit increasing the firm’s wealth and loss decreasing it. This change in wealth affects the claims of the firm’s owners, so that profits are added to owners’ equity in the balance sheet, and losses are deducted. The same report is called the income statement in the USA, and the profit and loss account in the UK. A firm’s periodic income (or profit) is measured by deducting expenses from revenues. This may be represented by the following formula.
Income (or profit) = R - E
Where:
R = revenues for the period
E = expenses for the period

The balance sheet is a report that reflects the firm’s assets, liabilities and owners’ equity (or shareholders’ funds) at the end of an accounting period. A firm’s assets are always equal to the claims of lenders (liabilities) plus owners (owners’ equity). This is referred to as the accounting identity, represented by the following formula:

\[ A = L + OE \]
Where:
A = assets
L = liabilities
OE = owners’ equity

The income statement or profit and loss account measures the firm’s income for a period of time, whereas the balance sheet reflects the financial position, in terms of assets, liabilities and owners’ equity at a specific point in time.

The five basic groups of accounts

In order to maintain detailed records, accountants record transactions in ledger accounts. Although a firm’s ledgers may contain a very large number of accounts, there are only five basic types. These are revenues, expenses, assets, liabilities and owners’ equity (or shareholders’ funds).

Revenues refer to the money that the business earns as a result of providing goods and services to its customers. The sale of goods or the charging of services to a customer produce revenue.

Expenses refer to obligations that the firm incurs as a result of providing goods or services to customers. They include such items as wages, transport, interest on loans, etc.

Assets refer to property which the business owns or over which it has a legally enforceable right. Assets may include buildings, land, inventories (or stocks), accounts receivable (or debts), cash, leasehold property, etc.

Liabilities refer to sums that the business owes. They typically include such items as accounts payable (or trade creditors), bank overdraft, long-term loans, etc.

Owners’ equity (or shareholders’ funds) refers to the excess of assets over liabilities and in this sense equity is a residual amount. It also indicates the interest of the owners in the business. The share of the owners is normally residual in law. When a business is wound up or liquidated the owners have no capital returned until all liability claims are settled.
Generally accepted accounting principles

There are a number of generally accepted accounting principles (GAAP) which guide accountants as they record financial events and prepare the end-of-period reports. GAAP include: entity; realization; going concern; period; monetary unit; consistency; matching; prudence or conservatism; and materiality.

Entity refers to the assumption that the business is separate from the owners. This means that personal transactions are excluded from business records. All transactions between the business and its owner(s) are recorded as if they are separate entities.

Realization indicates that in accounting only those profits that have been realized within an accounting period will be reported. Generally, this means that profits are only recognized when the earning process is almost complete.

Going concern involves the assumption that the business will continue to operate indefinitely.

Period refers to the practice of dividing the life of the business into intervals (say one year) as the basis for determining the profit (or loss) for the year and the firm's financial position at the end of the year.

Monetary unit refers to the fact that all financial events are recorded using money as the common denominator. Only events that can be reflected in monetary terms are entered in the accounting records.

Consistency suggests that the treatment of transactions should be consistent from one period to another; within periods the treatment of like transactions should be consistent.

Matching implies that the expenses incurred should be matched with associated revenues. This GAAP is combined with period, to involve matching the revenues and expenses that relate to a given accounting period (say one year).

Prudence or conservatism indicates that allowance should be made for all potential expenses or losses, but potential revenues or gains should not be counted. This might be summarized as "always anticipate losses, but never anticipate gains". Prudence or conservatism means that a far more conservative approach is adopted with respect to revenues than is the case for expenses.

Materiality suggests that non-standard treatment of financial events can be justified, providing the consequences are immaterial. This may typically apply to small value items. Determining what is material will depend on its size and impact relative to the overall scale of the firm's financial affairs.
THE ILO'S BOOK "HOW TO READ A BALANCE SHEET"

This book provides an excellent programmed introduction to the nature of balance sheets and income statements. Chapters 1 - 4 deal with balance sheets, while Chapter 5 presents some balance sheet ratios which will be considered in this unit. Chapter 6 provides an overview of income statements (or profit and loss accounts) and some ratios, and Chapter 7 provides information on the reliability of balance sheets and outlines some of their limitations.

You should work through this programmed book, taking care to read the preface, the sections on technical data and how the programme works before studying Chapter 1. Note that it is essential to study the chapters in sequence.

Regulatory frameworks for public companies

In addition to producing financial statements for internal use, public companies listed on national and regional stock exchanges are required to provide information to the community at large, notably to shareholders, potential shareholders, creditors and long-term lenders, the public and government. These requirements are generally imposed on publicly listed companies by company law, stock exchange listing requirements and accounting standards.

The company or corporate law prevailing in a country is a significant element in the corporate regulatory framework. Essentially, company law is designed to protect the interests of direct stakeholders such as shareholders and creditors. Generally the law specifies the number, content and frequency of reports. As a minimum, the law generally requires an income statement (or profit and loss account), a balance sheet, a directors’ report and an auditors’ report. In addition it might require other reports, such as a statement of sources and uses of funds.

Public companies seek listing on the stock exchange(s) to facilitate the buying and selling of their issued shares. This makes it possible for the composition of the owners of a company to change over time. In order to maintain its listing, a company must comply with the listing requirements of the stock exchange(s). These often include requirements to: report regularly on the firm’s trading results; explain reasons for significant variations in actual trading performance from the forecast; give reasons for any significant variations from established accounting standards; provide some geographical analysis of turnover and contribution to trading results; give details of countries in which subsidiaries operate; give details of companies in which the group equity interest exceeds 20 per cent; provide details of the directors’ shareholding in the company and of other significant shareholdings.

Accounting standards have been developed in many countries. Their purpose is to ensure consistency and comparability in the financial reports prepared by companies. In the USA and the UK a large range of accounting standards have been established. But each country establishes its own standards, which means that they are not necessarily consistent across countries. The International Accounting Standards Committee (IASC) and the International Federation of Accountants (IFAC) endeavour to harmonize the development of national accounting standards.
International bodies dealing with the harmonization of standards are working to ensure that there is a full range of consistent accounting standards in operation throughout the world. Their task is complicated by the number of national jurisdictions that regulate company reporting, the different models of corporate regulation in use and the perception of unique differences and solutions in certain situations. But the endeavour to produce a more comprehensive set of accounting standards continues.

2.2 Analysis and interpretation of financial statements

Various groups need to analyse and interpret financial information. They include shareholders, potential investors, creditors, long-term lenders, government, investment analysts, competitors and managers. Managers need to understand internally generated reports, and they may also need to make sense of externally generated reports and ratios related to a competitor.

**Analysis and interpretation**

Ratio analysis involves the potential calculation of a large number of ratios. There is no universal agreement on the definition of ratios. Perhaps the most important thing is to choose the basis for calculating a given ratio and then apply that basis consistently throughout the analysis. This is particularly important if the analysis involves a comparative study of two or more firms. Ratios are used for considering financial structure, solvency/liquidity, profitability, and du Pont analysis. Chapter 4 of the ILO’s “How to read a balance sheet” deals with financial structure. It defines solvency and liquidity and outlines the calculation of the gearing ratio. Chapter 5 identifies and illustrates two measures of liquidity, i.e. the current ratio and the quick ratio. Chapter 6 presents two useful measures of profitability, i.e. return on total investment and return on shareholders’ funds. Participants should work through Chapters 4, 5 and 6 of this publication to ensure that they fully understand the computation and use of these ratios.

**The du Pont formula**

The du Pont formula combines the ratios for return on total sales and turnover of total assets. In this sense it identifies the way in which return on total assets depends on the interaction between return on total sales and turnover of total assets.

Return on total sales is measured by the following ratio:

\[
\text{Net income} \over \text{Total sales}
\]

Turnover of total assets is measured by the following ratio:

\[
\text{Total sales} \over \text{Total assets}
\]

The du Pont ratio combines these two ratios and can be expressed as follows:
This ratio demonstrates that for a firm to achieve a satisfactory net income to total assets, there must be a satisfactory interaction between its return on total sales and its turnover of total assets.

**Limitations of analysis and interpretation**

Interpretation of financial statements is widely undertaken, but it does have a number of limitations. Some of these are summarized below.

- Ratios do not provide answers; they assist analysts to identify areas in which additional information might be sought.
- Individual ratios are of little use; they are generally only useful as part of a comprehensive financial analysis of a firm's financial statements.
- It is difficult to ascertain whether a certain ratio is particularly good or bad. For example, increasing sales may only be good if they do not give rise to a disproportionate increase in costs. Also, increasing research and development costs in the current period may give rise to increased sales in future periods.
- Given the monetary assumption used by accountants to prepare financial statements the ratios will normally only be of particular use if they reflect current values. But accounting reports reflect the historic transaction prices associated with report items.
- The degree of permissiveness in accounting practices allows firms to adopt different treatments for essentially the same transactions. This makes interfirm comparisons rather difficult.
- Many firms experience seasonal fluctuations in their level of activity. As a consequence the year-end figures for some report items may provide misleading information for the year as a whole.
- It may be difficult to classify a firm in terms of its industrial category, especially for a diversified or conglomerate firm; this makes it difficult to assess performance relative to industry averages.
- If industry averages are available, then they should be used with caution. They only provide a general indication of acceptable or expected ratios and should not be rigidly used as yardsticks for acceptable ratios.

**The role of analysts**

In countries where capital markets are highly developed, there are firms that specialize in studying companies' published financial statements. These firms are called financial analysts. They undertake financial analyses of companies that are listed on stock exchanges and provide this information to those prepared to pay for the service. In addition to accumulating information on firms, they also aggregate information by industry as well. It is therefore possible to obtain company and industry information from financial analysts.

As there is a considerable degree of permissiveness in the reporting of financial information, a large part of the work of analysts involves adjusting the published financial statements to
remove any “window dressing” that firms might have included. This is done in order to standardize the published financial statements of firms so that valid comparisons can be undertaken.

The services of financial analyst firms are not available outside countries with highly developed capital markets. This means that there are generally no comparative financial data on other firms or data for particular industries. If financial analysis is required it must be compiled by companies themselves, assuming that the basic data are available.

Undertaking analysis and interpretation is a useful way of obtaining an overview of a company, its performance and its current position. However, it will not provide specific answers about the company in question. Instead, it provides a general indication of the areas where further information might be sought.

Questions for discussion and review

1. Discuss and explain the meaning of the following terms:
   (a) Generally accepted accounting principles
   (b) Assets
   (c) Liabilities
   (d) Owners’ equity or shareholders’ funds
   (e) Revenues
   (f) Expenses

2. Australasia Traders Ltd. had the following Sales, Net Income and Total Assets for Years 1, 2 and 3.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>$50,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Net income</td>
<td>$5,000</td>
<td>$6,000</td>
</tr>
<tr>
<td>Total assets</td>
<td>$50,000</td>
<td>$63,000</td>
</tr>
</tbody>
</table>

   Calculate the du Pont ratios using this information for each of the three years. The answer is given below.

   For each year the du Pont ratio is:

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>9.52%</td>
<td>16%</td>
</tr>
</tbody>
</table>
UNIT 3: MANAGEMENT ACCOUNTING

UNIT 3: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Distinguish between different cost behaviour patterns and explain how to separate costs into fixed and variable components.

2. Apply break-even analysis in production and sales planning.

3. Differentiate between variable and absorption costing and appreciate their impact on income assessment and valuation of inventories.


5. Apply the main principles of financial planning (budgeting).

6. Understand the various concepts of standard costs, analyse labour, material and overhead variances, and use them to monitor performance.

UNIT 3: CONTENTS

3.1 Cost behaviour

3.2 Cost volume profit analysis

3.3 Variable and absorption costing

3.4 Short-term decision making

3.5 Budgeting and financial planning

3.6 Standard costs and variance analysis
UNIT 3: MANAGEMENT ACCOUNTING

3.1 Cost behaviour

An understanding of how your organization’s costs vary with changes in the level of output may be extremely useful when confronted with a range of managerial decisions. For example, an understanding of cost behaviour will help management to prepare its budgets, decide whether to make or buy a component, determine what level of output and sales are necessary to break even or to make a certain level of profit, and determine whether a given division or plant is making a positive contribution to the firm’s profitability.

The following terms are used when considering cost behaviour:

- fixed costs;
- variable costs;
- semi-variable costs;
- independent variables;
- dependent variables.

Fixed costs remain constant over a certain time interval and are unaffected by changes in the volume of output.

Variable costs change more or less in direct proportion with changes in the level of output.

Semi-variable costs include partly fixed and partly variable elements. For decision-making purposes, it is normally necessary to split such costs into their fixed and variable elements.

If we are attempting to measure the total labour cost for a department, then the number of hours worked is referred to as the independent variable, whereas the total labour cost is the dependent variable.

The assumption that costs are linear

Accounting and finance people normally assume that cost functions are linear, rather than curvo-linear. As a consequence they assume that cost functions take the form of:

\[ Y = a + bX \]

where:
- \( Y \) = the calculated value of total costs
- \( X \) = the activity level for which costs are being calculated
- \( a \) = the estimation of the real value of fixed costs (A) for the period
- \( b \) = the estimation of the real value of the variable costs (B) per unit

The independent variable is \( Y \) and measures total cost. The dependent variable is \( X \) and might reflect total hours worked or units of production completed in the period.

Given the assumption of linear cost functions it is possible to plot a graph showing the general nature of variable costs, fixed costs and total costs which are just the sum of fixed and...
variable costs. Figure 11.2 illustrates variable and fixed costs. The first vary directly with changes in the volume of output or level of activity. Fixed costs (a) do not change with changes in the volume of output or level of activity. They remain fixed over a given time interval and are often referred to as period costs. Total costs are the sum of the variable and the fixed costs.

The premise used by accountants that cost functions are linear is a simplifying assumption. In fact the actual relationship between the level of output and costs may be curvo-linear (non-linear), and the empirical work undertaken by economists tends to suggest that cost functions are not linear. An example of a typical non-linear cost function is reproduced in figure 11.3.

If cost functions are generally agreed to be non-linear, why do accountants rely on the assumption of linearity? They do this because it is possible to approximate a non-linear cost function with a linear function over a rather limited specified range. So long as the calculated information is used within this limited range then the results will be satisfactory. However, if the results from the linear approximation are used outside the specified range, then this is likely to give rise to significant errors.

Three possible examples of non-linear properties could be considered: an upward sloping supply curve, quantity discounts and step variable costs.

If the supply curve that the firm faces with respect to its purchase of raw materials is upward sloping, as in figure 11.4, then the cost of each additional unit of raw materials is increasing.

In certain circumstances, suppliers will reduce the unit price of their products if we buy in larger quantities. The graph in figure 11.5 illustrates how cost per unit declines as the quantity purchased increases under a quantity discount scheme.

Sometimes costs are fixed over very small ranges of output, but they increase by a discrete amount, or in steps, as the level of output is increased. As a result these costs exhibit a step-like pattern. Step-like cost behaviour will occur in circumstances where the firm buys an input in discrete amounts, but only uses certain fractional quantities. This might occur with certain specialized labour, which must be purchased in a discrete number of hours a week, but which is only required for a small number of hours in a given week. Figure 11.6 illustrates the nature of step variable costs.
Module 11
Unit 3

Figure 11.2: Variable and fixed costs

Total costs: $y = a + bx$

Variable costs (bx)

Fixed costs (a)

Figure 11.3: Non-linear cost functions
Figure 11.4: Upward sloping supply curve

Figure 11.5: Quantity discounts
Figure 11.6: Step variable cost behaviour
### 3.1.1 Techniques for determining fixed and variable costs

Three methods are commonly used to separate costs into their fixed and variable components. These techniques are useful in circumstances when costs have exhibited some discernible pattern in the past and that pattern is expected to continue in the future. The three techniques are: scattergraph; high - low estimation; and simple regression.

Our organization has observed the total costs and direct labour hours shown in table 11.1 over the last 15 months, and believes that future costs will exhibit a similar pattern. Management now wants to identify the pattern in these past costs.

#### Table 11.1: Total costs and direct labour hours

<table>
<thead>
<tr>
<th>Month</th>
<th>Total costs ($)</th>
<th>Direct labour hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2,107</td>
<td>62</td>
</tr>
<tr>
<td>2</td>
<td>2,040</td>
<td>62</td>
</tr>
<tr>
<td>3</td>
<td>2,916</td>
<td>120</td>
</tr>
<tr>
<td>4</td>
<td>2,322</td>
<td>71</td>
</tr>
<tr>
<td>5</td>
<td>1,896</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>2,471</td>
<td>95</td>
</tr>
<tr>
<td>7</td>
<td>3,105</td>
<td>142</td>
</tr>
<tr>
<td>8</td>
<td>2,316</td>
<td>86</td>
</tr>
<tr>
<td>9</td>
<td>2,555</td>
<td>112</td>
</tr>
<tr>
<td>10</td>
<td>2,780</td>
<td>136</td>
</tr>
<tr>
<td>11</td>
<td>2,061</td>
<td>85</td>
</tr>
<tr>
<td>12</td>
<td>2,910</td>
<td>103</td>
</tr>
<tr>
<td>13</td>
<td>2,835</td>
<td>96</td>
</tr>
<tr>
<td>14</td>
<td>2,715</td>
<td>101</td>
</tr>
<tr>
<td>15</td>
<td>1,986</td>
<td>53</td>
</tr>
</tbody>
</table>

#### The scattergraph technique

The scattergraph method involves plotting direct labour hours on the x axis and total costs on the y axis. Examination of the plotted points, reproduced in figure 11.7, indicates a general relationship between the level of direct labour hours and total costs. As direct labour hours increase, total costs also increase.

First, all the points are plotted, then a line of best fit is superimposed over these points. This line is drawn using visual inspection; it represents the overall relationship that the observations indicate. This technique relies on visual judgement and therefore may be subject to considerable error, but a scattergraph and line of best fit can be useful for exploring possible relationships before a more sophisticated analysis is carried out.

#### High - low estimation

If the relationship between output and costs is linear and may be represented by a straight line, then any two points on the scattergraph may be used to determine the cost function. This may be done using the observation at the highest level of output and the observation at the
The slope of the total cost function, which estimates the variable cost per unit, may be estimated using the following formula.

\[
\text{Variable cost/unit} = \frac{\text{(cost at highest level of output} - \text{cost at lowest level of output)}}{\text{(highest level of output} - \text{lowest level of output)}}
\]

Using the data from the illustration:

\[
\text{Variable cost/unit} = \frac{\$(3,105 - 1,896)}{(142 - 50) \text{ direct labour hours (dlh)}} = \$13.141 \text{ per direct labour hour}
\]

**Figure 11.7: Scattergraph with line of best fit superimposed**
The fixed cost for each month may be estimated by taking the total costs at either the highest or the lowest level of output and subtracting the estimated variable costs, to determine the estimated fixed costs. This calculation is shown below:

\[
\text{Fixed cost (a month)} = \text{Total cost at highest activity} - \\
(\text{Variable cost per unit x number of units produced at highest level of activity}) \\
= \$3,105 - (\$13.141 / \text{unit} \times 142 \text{ dlh}) \\
= \$1,239 \text{ (to the nearest dollar)}
\]

Using the high-low technique, the total cost function has been estimated from the historical data provided in table 11.1:

\[
\text{Total costs} = \$1,239 + \$13.141 / \text{direct labour hour (dlh)}
\]

It is important to appreciate the weakness of the high-low method, which uses only two data points from a set of observations. These are the extreme points from the observations and if they are unrepresentative then the estimated cost function will be inaccurate.

**Simple regression analysis**

This method has some similarity with the scattergraph method, but instead of fitting the line by inspection, it uses the statistical technique referred to as least squares to estimate the cost function. A question which arises with simple regression is to know how well this fitted cost function represents the actual costs that have been measured. Two statistical measures that may be used are the coefficient of determination and the correlation coefficient.

### 3.2 Cost volume profit analysis

Cost volume profit analysis may be used to determine the production and sales level necessary for a firm to break even; it might also be used to determine the level of production or sales necessary to achieve a planned level of profit, either before or after taxation.

The cost volume profit analysis assumes linear cost and revenue functions even though these functions may in fact be non-linear. For example, economists generally accept that cost and revenue functions are curvo-linear, as in figure 11.8.

This assumption will not lead to undue errors providing that care is taken in identifying the relevant range to which they apply. Linear functions may be used as reasonable approximations of curvo-linear functions providing that the range of production and sales to which they apply is limited.

Figure 11.9 represents an example of a set of linear cost and revenue functions that an accountant might use. In the graph these linear functions are used to represent curvo-linear functions, over a relatively limited range known as the relevant range. When using cost volume profit analysis, care should always be taken not to extrapolate the results beyond the relevant range.
Figure 11.8: Curvo-linear revenue and cost functions

Figure 11.9: Cost volume profit chart
Cost volume profit terminology

Before considering various aspects of cost volume profit analysis, it is necessary to define some important terms. These are:

- break-even point;
- contribution margin or variable profit;
- contribution margin ratio or variable profit ratio;
- contribution margin or variable profit / unit.

The break-even point is where total sales revenue equals total cost of sales. It is the point where profit is zero because sales revenue equals production expenses. The break-even point may be found by using either a graph or a mathematical formula. Accountants solve break-even questions by assuming linear revenue and cost functions, which may be approximations of the real curvo-linear revenue and cost functions.

The contribution margin or variable profit is the difference between total sales revenue and total variable cost.

\[
\text{Contribution margin} = \text{Sales revenue} - \text{Variable cost}
\]

The contribution margin ratio or the variable profit ratio is equal to the contribution margin or variable profit divided by the sales.

\[
\text{Contribution margin ratio} = \frac{\text{Contribution margin}}{\text{Sales}}
\]

The contribution margin per unit or the variable profit per unit is equal to the selling price per unit less the variable cost per unit.

\[
\text{Contribution margin / unit} = (\text{SP} - \text{VC}) / \text{unit}
\]

3.2.1 Techniques for cost volume profit analysis

Two methods are commonly used to identify a firm’s break-even point using cost volume profit analysis. These are a graphical approach or a mathematical or formula-based approach. They are really variants of the same approach and are generally used in conjunction. The graphical approach provides a visual presentation of the information associated with given cost volume profit data, whilst the mathematical approach uses formulae to identify solutions.

Simple break-even analysis

Assume that the firm Aviators Ltd. has asked us to help identify its break-even level of production and sales. The firm produces a model aeroplane which sells for $8. The accountant has estimated that the fixed costs per month are $15,000 and that the variable cost per unit is $3. First, this information may be used to produce a cost volume profit chart to determine the firm’s
break-even point. A copy of the firm’s cost volume profit chart is presented in figure 11.9.

The total cost function is represented by $y = 15,000 + 3x$ and the revenue function is represented by $y = 8x$, where $x$ is the level of production and sales. The break-even production and sales level from the chart is 3,000 units a month, or where total costs and total revenue are $24,000. Any production and sales quantity above 3,000 units a month will result in a profit (i.e. total revenue will exceed total costs). Any production volume which is less than 3,000 units a month will result in a loss (i.e. total costs will exceed total revenue).

This same basic information may be incorporated in a profit volume chart which indicates the amount of profit/loss that the firm will make at a given level of production and sales. A profit volume chart for Aviators Ltd. is presented in figure 11.10.

**Figure 11.10: Volume profit chart**
Basically, this chart is similar to the cost volume profit chart, but instead of plotting the costs and revenue on the y axis, it plots the profit.

The break-even level of production/sales may be found by using the following formula:

Break even (units) = \frac{\text{Fixed costs}}{\text{Contribution margin / unit}}

Using this formula for the Aviators Ltd. data we get:

Break even (units) = \frac{\$15,000}{($8 - $3) / \text{unit}}

= \frac{\$15,000}{\$5 / \text{unit}}

= 3,000 \text{ units}

The break-even level of sales revenue may be found by the following formula.

Break even (sales) = \frac{\text{Fixed costs}}{\text{Contribution margin ratio}}

In the case of Aviators Ltd. we get:

Break even (sales) = \frac{\$15,000}{($8 - $3) / $8}

= $24,000

Naturally, the sales revenue at break even may also be found by multiplying the break-even sales/production volume by the unit selling price.

Profit planning and break-even analysis

It is possible to use break-even analysis to determine the level of production and sales necessary to achieve a desired level of profit. A company can use this technique to determine the level of business activity necessary to attain a desired level of profit. As with simple break-even analysis, profit planning may be undertaken using a graphical or formula-based approach. Typically, this form of planning will utilize both techniques.

Assume that Motors Ltd. produces a stationary engine which it sells for $500. Its monthly fixed costs are $10,000 and its variable costs per motor are $250. Management wants to achieve
a profit of $7,500 a month. What level of production and sales is required?

A chart can be prepared to indicate the production and sales necessary to attain this target. The chart in figure 11.11 indicates that Motors Ltd. will achieve its required profit if it produces and sells 70 motors a month.

To create this chart, simply plot the revenue and cost functions as in figure 11.11 above. Then draw a new function, which is the sum of the total costs and the desired level of profit. In our example this cost function plus the desired level of profit is \( y = 10,000 + 250x + 7,500 \) which becomes \( y = 17,500 + 250x \). From this chart, production and sales of 70 units will yield total sales revenue of $35,000 and total costs of $27,500 will be incurred, leaving a profit of $7,500. The chart is shown in figure 11.12.

The following formula is used to determine the production and sales quantity necessary to achieve a planned level of profit.

\[
\text{Production/sales quantity} = \frac{\text{Fixed cost} + \text{planned profit}}{\text{Contribution margin/unit}}
\]

In the above example we can use this formula to determine the required level of production and sales.

\[
\text{Production/sales quantity} = \frac{10,000 + 7,500}{(500 - 250)/\text{unit}} = 70 \text{ units}
\]

It is also possible to use a formula to determine the level of sales revenue necessary to attain the desired level of profit.

\[
\text{Required sales level} = \frac{\text{Fixed cost} + \text{planned profit}}{\text{Contribution margin ratio}}
\]

\[
= \frac{10,000 + 7,500}{(500 - 250)/500} = \frac{17,500}{0.50} = 35,000
\]

**Profit planning, taxation and break-even analysis**

The above illustration ignores the impact of company taxes. It only identifies the production and sales necessary to achieve a particular level of pre-tax profits. However, it is possible to amend the formulae to incorporate the impact of corporate profits and to determine the production and sales necessary to attain a planned level of after-tax profits.

Assume that Motors Ltd. is subject to a 40 per cent corporate profits tax and that it plans to
Figure 11.11: Production and sales chart

Figure 11.12: Profit planning chart
achieve an after-tax profit of $6,000. The required level of profits can be found by using the follow-

\[
\text{Required sales level} = \frac{\text{Fixed cost + profit after tax}}{(1-t)} \times \text{Contribution margin / unit}
\]

Where \( t \) is the corporate tax rate. Using the example we can determine the required level of sales.

\[
\begin{align*}
\text{Required sales level} &= \frac{\text{Fixed cost + profit after tax}}{(1-t)} \times \text{Contribution margin / unit} \\
&= \frac{\$10,000 + \$6,000/(1-0.4)}{\$250 / \text{unit}} \\
&= \frac{\$20,000}{\$250 / \text{unit}} = 80 \text{ units}
\end{align*}
\]

Similarly, it is possible to find the dollar level of sales necessary to achieve an after-tax profit of $6,000 by using the following formula.

\[
\begin{align*}
\text{Required sales level} &= \frac{\text{Fixed cost + Planned profit at}}{(1-t)} \times \text{Contribution margin / ratio} \\
&= \frac{\$10,000 + \$6,000/(1-0.4)}{0.5} \\
&= \$40,000
\end{align*}
\]

Thus we have demonstrated the usefulness of cost volume profit analysis to decisions associated with determining the firm's break-even production and sales level and to profit planning.

The models developed assume linear cost and revenue functions and single-product firms. The assumption of linear cost and revenue functions is a simplifying one and means that care should be taken not to extrapolate any results beyond the relevant range. The basic approach to cost volume profit analysis may be extended to multiple product situations, under assumptions of a relatively constant product mix.

Another issue that arises is the reliability of the cost and revenue functions. Often a firm cannot determine the precise functions, but it may be able to identify a range for them. This suggests that firms ought to use sensitivity analysis, to explore the extent to which break-even levels and profitability are sensitive to fluctuations in the cost and revenue functions.

### 3.3 Variable and absorption costing

The costs associated with manufacturing can be classified into three broad groups: materials, labour and overheads. Essentially, materials are the physical items that are used to manufacture a product. Those that are directly in evidence in the finished product are referred to as direct materials. For example, paper and ink used to produce a book are regarded as direct materials.
The other materials are referred to as indirect, because they cannot be attributed to a single product, or it is too costly to try and determine the amount attributed to each product. The glue used to bind books, or lubricant for the printing machines are examples of indirect materials.

As with materials, it is possible to classify labour as either direct or indirect. Direct labour refers to labour which is employed in the manufacture of the firm’s products. Indirect labour refers to that part of the firm’s labour costs that cannot be directly attributed to the production process and might include maintenance staff, cleaners, storekeepers, etc. A firm may decide that some labour costs are indirect because the cost or effort required to determine the direct amount attributable to specific products is too great.

Overhead costs are somewhat difficult to define precisely. Basically, they include all costs associated with the manufacture of products that have not been included as either direct materials or direct labour. In this sense overhead costs are a residual item. They might include such expenses as the depreciation of machinery, insurance of buildings and machinery, heating, electricity, etc. It is also important to distinguish between factory overheads and other overheads. Supplies to the factory manager’s office would be manufacturing overheads, whereas supplies for the sales manager’s office would be classified as a selling expense. In summary, an important characteristic of overhead costs is the difficulty in attributing them directly to specific units of product.

The essential difference between variable and absorption costing relates to the way in which they treat these overhead costs, particularly those costs which are regarded as fixed, at least in the short run.

Variable costing is an inventory valuation method that assigns only direct materials, direct labour and variable manufacturing overhead costs to the units of production produced in a given period. All other manufacturing costs, such as fixed manufacturing overheads, variable and fixed selling and administration costs are treated as period costs. In summary, only variable manufacturing costs are treated as product costs and all others are treated as period costs.

Absorption costing is an inventory valuation system that assigns all manufacturing costs such as direct materials, direct labour, variable manufacturing overheads and fixed manufacturing overheads to the units of output produced in a given period.

The allocation of fixed overhead costs to products is undertaken in the belief that all costs associated with providing manufacturing facilities in a given period should be incorporated in the cost of units manufactured during the period.

The essential difference between these two alternative methods is that under variable costing, the fixed costs are treated as a period cost and are not incorporated in the cost of individual products, whereas under absorption costing fixed costs are clearly regarded as product costs and are included in the determination of each unit’s manufacturing costs.

From a financial accounting perspective, it is argued that absorption costing is consistent with generally accepted accounting principles. These alternative approaches to income measurement and inventory valuation give rise to slightly different income statements.
Under variable costing, the determination of manufacturing costs and the income statement has the following form:

1. Direct materials
2. Direct labour
3. Variable overheads
   - work in process inventory
   - finished goods inventory
   - costs of goods sold inventory

Sales

- cost of goods sold (only variable manufacturing costs)
- fixed manufacturing overhead
- non-production costs (variable and fixed)
- net income

Under absorption costing, the determination of manufacturing costs and the income statement has the following form:

1. Direct materials
2. Direct labour
3. Variable overheads
4. Fixed overheads
   - work in process inventory
   - finished goods inventory
   - cost of goods sold

Sales

- cost of goods sold (variable and fixed manufacturing costs)
- non-production costs (variable and fixed)
- net income

Contrasting variable and absorption costing

The practical implications of the differences between variable and absorption costing will be illustrated by an example showing their impact on a firm in a single period.

A single period example of variable and absorption costing

The following information relates to a company after its first year of operations. As a consequence there are no beginning inventories of finished or partly finished goods and raw materials.

Production 10,000 units
Sales 8,000 units
Direct materials $30,000
Direct labour $20,000
In this example, the absorption costing net income is $8,000 greater than the variable costing net income. What is the reason for this difference?

The reason lies in the different approach to inventory valuation and cost of goods sold determination. Under variable costing there are 2,000 units on hand valued at $6 a unit, giving a closing inventory of $12,000. Under absorption costing there are 2,000 units on hand valued at $10 a unit, giving a closing inventory value of $20,000.

The difference in the valuation of ending inventory, which is $8,000, fully explains the difference in net income in table 11.3.

Let us use this information to determine the value of each unit of output produced and the income that would be earned under variable and absorption costing.

The production costs and the unit cost are calculated under each method in table 3.2

**Table 11.2: Production costs under variable and absorption costing**

<table>
<thead>
<tr>
<th></th>
<th>Absorption costing</th>
<th>Variable costing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct materials</td>
<td>$30,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>20,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Variable overheads</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Fixed overheads</td>
<td>40,000</td>
<td>not applicable</td>
</tr>
<tr>
<td>Total production cost</td>
<td>$100,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Number of units</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Cost per unit</td>
<td>$10</td>
<td>$6</td>
</tr>
</tbody>
</table>

Now assume that the firm had a unit selling price of $20 each. The income statements under variable and absorption costing are presented in table 11.3.

**Table 11.3: Variable and absorption costing income statements**

<table>
<thead>
<tr>
<th></th>
<th>Absorption costing</th>
<th>Variable costing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>8000x$20</td>
<td>8000x$20</td>
</tr>
<tr>
<td>Less:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td>8,000x$10</td>
<td>8,000x$6</td>
</tr>
<tr>
<td></td>
<td>80,000</td>
<td>112,000</td>
</tr>
<tr>
<td>Gross profit (margin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Selling expenses</td>
<td>16,000</td>
<td>16,000</td>
</tr>
<tr>
<td>Fixed overheads</td>
<td>not applicable</td>
<td>40,000</td>
</tr>
<tr>
<td>Net income</td>
<td>$64,000</td>
<td>$56,000</td>
</tr>
</tbody>
</table>

In this example, the absorption costing net income is $8,000 greater than the variable costing net income. What is the reason for this difference?

The reason lies in the different approach to inventory valuation and cost of goods sold determination. Under variable costing there are 2,000 units on hand valued at $6 a unit, giving a closing inventory of $12,000. Under absorption costing there are 2,000 units on hand valued at $10 a unit, giving a closing inventory value of $20,000.

The difference in the valuation of ending inventory, which is $8,000, fully explains the difference in net income in table 11.3.

If in the next period there is no additional production and sales are 2,000 units then the cost
of goods sold would be the current period's closing inventory. The respective amounts for cost of goods sold would be $12,000 under absorption costing and $20,000 under variable costing.

This example highlights the essential differences between variable and absorption costing.

As can be seen from this example, in situations where production and sales are equal and there are no beginning inventories, the net income will be the same under both methods. In situations where production exceeds sales, the net income under absorption costing will exceed that under variable costing. But in situations where sales exceed production, the net income under variable costing will exceed that under absorption costing. However, in the long run, net income under variable and absorption costing will be the same. They are alternative methods of assigning costs to products and periods, but over time these costs all become expenses. The choice of one method in preference to the other only affects the timing of cost allocations and profits, not the long-run costs or profits.

3.4 Short-term decision making

This section will focus on the short-term decisions which firms often have to take, using a range of cost concepts. Taking a decision implies choosing between alternative courses of action when managers must identify the relevant costs and benefits.

Formal accounting records are often not well-suited to direct use in short term and ad hoc decisions. Generally, the accounting costs must be modified in a number of ways which include:

- adjusting them to ensure that they reflect future expected costs, rather than past or historical costs;
- ensuring that they have been computed to aid decision making, which often means that they will not comply with financial accounting rules and cost concepts;
- ensuring that the costs have been computed for the specific decision alternatives, which may also mean that they are inappropriate in other contexts.

The following cost concepts are often used by accountants when addressing short-term and ad hoc decisions:

- relevant/irrelevant costs;
- opportunity costs;
- sunk costs;
- escapable costs;
- differential costs.

Relevant costs are those that will change as a result of choosing a particular course of action; irrelevant costs are those that will not change. For example, a firm may be considering closing a distribution warehouse in another city because it seems unprofitable. The relevant costs are those that will be foregone if the warehouse is closed, such as the wages paid to storekeepers. The irrelevant costs would include prepaid rent on the lease, assuming that it is not refundable. It is vital to identify the costs that are relevant and those that are irrelevant.
Opportunity costs are the earnings that the firm would attain if its available resources and skills were applied in the next best alternative use. A firm's accounting information system only includes details of past transactions. But often, when taking a decision, some costs must be estimated in order to fairly compare alternatives. This is often the case with costs or benefits associated with the next best alternatives.

Sunk costs are prior or historical costs that may or may not be avoided when considering an alternative course of action. They have been incurred as a result of some past decision and cannot be changed or redeemed by any decision that will be made in the future. Whereas opportunity costs are often added to accounting costs when taking a decision, sunk costs are included in the accounting records but must be ignored in a decision context. They must be ignored because they are past (sunk) and therefore will not change with the specific decision being contemplated.

Escapable costs are those that will be avoided if a particular course of action is adopted. Only escapable costs are relevant to a given decision. For example, a firm may be contemplating closing down a particular division or department. Choosing to close down will result in certain (often direct) costs being avoided (escapable). But certain (often indirect) costs will not be avoided (non-escapable).

The differential cost in a decision-making situation is the difference between the costs of two alternatives. In presenting the cost data for a decision, it is often very useful to contrast the alternatives in terms of the differential costs. If a firm is considering two different volumes of activity within the one relevant range, then the differential cost will be the difference between the total variable cost at each particular level of output. However, if the alternative outputs involve different relevant ranges then the differential costs will include the change in fixed costs as well as the change in total variable costs.

3.4.1 The application of cost concepts to short-term decision making

In this section we will provide illustrations involving:

- opportunity costs;
- differential costs;
- decisions involving making or buying components;
- decisions about discontinuing a product or department.

Opportunity costs

Imagine that you are the sole owner of a retail store. You have just received an offer to sell your business for $100,000. Table 11.4 provides details of last year’s net income.
Module 11
Unit 3

Table 11.4: Net income

Profit and loss statement
Sales revenue $120,000
less:
Cost of sales $72,000
Operating expenditure 36,000 108,000
Net income $12,000

If as proprietor, you are going to base your decision solely upon return, relative to market value, then at present it is 12 per cent (i.e. $12,000 income on a market value of $100,000). But to do so would involve ignoring the following opportunity costs:

- the annual salary that you might earn performing a similar role working for an employer;
- the return that you could realize by investing the $100,000 elsewhere at a similar level of risk.

Assume that you could earn a salary of $20,000 a year managing a store and that you could earn 10 per cent by investing in shares which have a similar level of risk. Given this information, the following analysis in table 11.5 would help you decide what to do.

Table 11.5: Store net income and opportunity costs

Comparison between keeping store and selling
Sales revenue $120,000
less:
Cost of sales $72,000
Operating expenditure 36,000 108,000
Net income $12,000
less opportunity costs:
Sacrifice of salary $20,000
Sacrifice of inv. income 10,000 30,000
Loss of potential income from continuing to own store $18,000

This table provides a more informative analysis of your position. From a financial standpoint, you ought to sell the retail store, invest the proceeds and take a salaried position.

Differential costs

Assume that Producers Ltd. has the physical facilities to produce 20,000 units of product. If the company wishes to manufacture more than 20,000 units then it will have to install new equipment which will change the fixed and variable costs. To produce 20,000 units involves fixed costs of $15,000, whereas to produce more than 20,000 units will result in fixed costs of $20,000. The variable costs will remain at $0.40 a unit.

Given this information, it is possible to compile a schedule of manufacturing costs
assuming output levels of 15,000, 20,000 and 25,000 units. The details are presented in table 11.6 below.

**Table 11.6: Costs at different activity levels**

<table>
<thead>
<tr>
<th>Number of units produced</th>
<th>15,000</th>
<th>20,000</th>
<th>25,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable cost ($0.40)</td>
<td>$6,000</td>
<td>$8,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>15,000</td>
<td>15,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Total manufacturing costs</td>
<td>$21,000</td>
<td>$23,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>Average cost / unit</td>
<td>$1.40</td>
<td>$1.15</td>
<td>$1.20</td>
</tr>
<tr>
<td>Differential costs</td>
<td>-</td>
<td>$2,000</td>
<td>$7,000</td>
</tr>
<tr>
<td>Differential cost / unit</td>
<td>-</td>
<td>$0.40</td>
<td>$1.40</td>
</tr>
</tbody>
</table>

The differential cost concept is most useful in managerial decision making. It provides a means of assessing the profitability of changes in output and it provides a much better guide than average costs for decision making.

If Producers Ltd. is currently producing and selling 15,000 units at $1.00 a unit and the order will not increase selling expenses, should it be accepted?

According to the schedule in table 11.6, the average cost of producing 20,000 units (to cover the current sales of 15,000 plus the new order of 5,000 units) is $1.15 a unit, which exceeds the selling price of $1.00 a unit. But differential analysis demonstrates the irrelevance of average cost analysis. Table 11.7 presents the relevant differential cost analysis.

**Table 11.7: Differential profit**

<table>
<thead>
<tr>
<th>Differential analysis</th>
<th>Incremental revenue (5,000 x $1.00)</th>
<th>$5,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental cost</td>
<td>(5,000 x $0.40)</td>
<td>$2,000</td>
</tr>
<tr>
<td>Incremental profit</td>
<td></td>
<td>$3,000</td>
</tr>
</tbody>
</table>

On the basis of this analysis, Producers Ltd. should accept the special order as it increases overall profits, assuming that it does not affect the normal sales of 15,000 units and that it will not increase any other costs.

**Make or buy decisions**

A firm may be buying a part from an outside supplier when it is possible to manufacture the part itself.

For example, Radio Ltd. may purchase 4,000 transistors a month from a supplier for $8.00 each. The production manager has suggested manufacturing the transistors. The department that would make the transistors has capacity for 10,000 direct labour hours a month, but at present it is only using 8,000 hours for other production. The overhead costs at the current operating level and at capacity are presented in table 11.8.
### Table 11.8: Incremental manufacturing overheads

<table>
<thead>
<tr>
<th></th>
<th>Present capacity</th>
<th>Normal capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8,000 hrs</td>
<td>10,000 hrs</td>
</tr>
<tr>
<td>Total cost</td>
<td>$40,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>per hour</td>
<td>5.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Non-variable costs</td>
<td>$40,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td>$16,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>per hour</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>$56,000</td>
<td>$60,000</td>
<td></td>
</tr>
<tr>
<td>Differential cost</td>
<td></td>
<td>$4,000</td>
</tr>
<tr>
<td></td>
<td>$2,000</td>
<td></td>
</tr>
</tbody>
</table>

The production manager also advises that the direct materials and direct labour costs of producing 4,000 transistors would be $8,000 and $16,000 respectively. Also, given that the production department is only working 8,000 hours a month, it has 2,000 hours of unused capacity. The cost of producing the transistors internally is presented in table 11.9.

### Table 11.9: Total and per unit differential costs

<table>
<thead>
<tr>
<th></th>
<th>Total cost</th>
<th>Per unit cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>$8,000</td>
<td>$2.00</td>
</tr>
<tr>
<td>Labour</td>
<td>16,000</td>
<td>4.00</td>
</tr>
<tr>
<td>Overheads</td>
<td>4,000</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>$28,000</td>
<td>$7.00</td>
</tr>
</tbody>
</table>

From table 11.9 it is apparent that the company can produce the transistors for $7.00 each, compared with the supplier’s price of $8.00 each. It would therefore be beneficial to produce them internally, at a saving of $1.00 each, providing that the unused capacity has no other alternative uses that are more beneficial.

### Deciding whether to discontinue a product or a department

A company may be faced with determining whether to eliminate a product or close a department. A conventional accounting report may indicate that a product or department is unprofitable. But as we shall see from the following example this information can be misleading. Table 11.10 provides segmented reporting on a firm’s product lines A, B and C. This indicates that product B appears to be making a loss.
In order to assess whether the company ought to drop the loss-making product B, it is necessary to consider only the revenues and costs that can be directly attributed to this product. In particular, any common production and operational costs that will not be affected by the decision should be ignored in the evaluation. Therefore, it is necessary to undertake further analysis of the information in table 11.10.

Let us assume that further analysis reveals that:

- Direct materials and direct labour are definitely variable costs attributable to the products and that they have been correctly allocated.
- Overhead costs have been allocated to products on the basis of 50 per cent of the direct labour costs. Overhead costs include a fixed component of $11,700 and a variable component of $7,800. Product A incurred $6,000 of variable overheads, product B incurred $800 and product C incurred $1,000.
- The non-variable selling and administration costs were $20,000 and have been arbitrarily allocated to products. The $22,000 variable selling and administration costs amount to $15,000 for product A, $3,000 for product B and $4,000 for product C.
- It is expected that all non-variable costs will remain the same, even if product B is eliminated.

Using the information above and that from table 11.10 it is possible to construct table 11.11, which shows whether all products are making a positive contribution to overall profitability.
Table 11.11: Product contribution and overall profitability

<table>
<thead>
<tr>
<th></th>
<th>Product A</th>
<th>Product B</th>
<th>Product C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales revenue</td>
<td>$100,000</td>
<td>$15,000</td>
<td>$25,000</td>
<td>$140,000</td>
</tr>
<tr>
<td>- Variable costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct materials</td>
<td>15,000</td>
<td>2,000</td>
<td>3,000</td>
<td>20,000</td>
</tr>
<tr>
<td>Direct labour</td>
<td>30,000</td>
<td>4,000</td>
<td>5,000</td>
<td>39,000</td>
</tr>
<tr>
<td>Variable overheads</td>
<td>6,000</td>
<td>800</td>
<td>1,000</td>
<td>7,800</td>
</tr>
<tr>
<td>Variable selling and admin.</td>
<td>15,000</td>
<td>3,000</td>
<td>4,000</td>
<td>22,000</td>
</tr>
<tr>
<td></td>
<td>66,000</td>
<td>9,800</td>
<td>13,000</td>
<td>88,800</td>
</tr>
<tr>
<td>Contribution</td>
<td>34,000</td>
<td>5,200</td>
<td>12,000</td>
<td>51,200</td>
</tr>
<tr>
<td>- Fixed costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overheads</td>
<td></td>
<td></td>
<td>11,700</td>
<td></td>
</tr>
<tr>
<td>Selling/admin.</td>
<td></td>
<td></td>
<td>20,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>31,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$19,500</td>
<td></td>
</tr>
</tbody>
</table>

Table 11.11 indicates that product B is producing revenue which exceeds all the variable costs attributable to it by $5,200. It is contributing to overall profitability and if it were discontinued then overall profitability would decline by $5,200.

It is important to acknowledge that this example assumes that dropping product B will have no impact on the non-variable costs and that sales of products A and C would be unaffected. If the sales of A or C could be expected to increase as a result of dropping B, then the contribution from these additional sales would have to be contrasted with the contribution ($5,200) that B is presently providing.

3.5 Budgeting and financial planning

We will consider here some general concepts related to financial planning and budgeting and two aspects of budgeting. The first relates to developing an integrated set of budgets covering sales, production, manufacturing costs, purchases, selling and administration costs, income statement, cash flow and balance sheet. This integrated set of budgets is often referred to as the master budget. The second relates to the technique known as flexible budgets. This technique is useful when attempting to evaluate performance in situations where the actual level of output or activity is different from what was initially planned.

The following terms need to be discussed prior to considering the various aspects of financial planning:

- planning;
- budgets;
- performance reports;
- flexible budgets;
- zero-base budgeting (ZBB).

Planning can be described as establishing objectives and formulating and evaluating
strategies to attain the objectives. Planning consists of long-term or strategic planning and short-term operational planning.

A budget is a plan that has been quantified in monetary terms; it deals with a defined time period, such as one year. Budgets are prepared and adopted prior to the period to which they relate. They might be prepared with respect to sales, purchases, manufacturing costs, cash flow, income statement, balance sheet, etc. Budgets are a financial representation of a firm’s productivity and quality plans for a given period.

Performance reports involve measuring actual activity and contrasting this information with the planned activity. Any differences between actual activity and planned activity are usually referred to as variances. The level of variation from the plan or target can be monitored by management and corrective or modifying action may be taken.

Flexible budgets incorporate information about the firm’s cost function in predicting costs at various levels of output. If a firm has a linear cost function, then the flexible budget acknowledges that only the variable costs will change within a defined relevant range, whereas outside the relevant range, both fixed and variable costs may change. The use of flexible budget concepts is relevant to performance evaluation when the actual level of production or activity is different from the planned level. The flexible budget function can be used to recast the original budget for the actual level of production or activity, prior to undertaking any variance analysis. Zero-base budgeting (ZBB) involves: (i) elaborating objectives and performance measures; (ii) developing decision packages to meet objectives; and (iii) reviewing and ranking decision packages. ZBB enables functions or activities to be critically reviewed for their contribution to attaining the firm’s objectives. ZBB is discussed in more detail below.

3.5.1 The master budget and different budgeting approaches

The use of formal budgeting forces managers, who may not otherwise allocate time, to plan ahead. Developing a master budget also ensures that planning becomes a structured activity.

When operating responsibilities are divided within firms, coordination of activities is a major issue. Budgets provide a medium for coordinating sales and production activities, etc. An integrated master budgeting system forces managers of various functional areas to communicate their plans and assess their feasibility. Once the master budget has been approved, then the functional area managers know what is expected of them and they can set about achieving targets in their sections. The master budget also provides a basis for assessing actual performance against the yardstick of the budget plan. Variances from the master budget (plan) can be identified and analysed, and corrective action can be taken where appropriate.

Management may use a number of different approaches to involving employees in the budget development process. It may use an authoritative, consultative or participative model. The authoritative model implies a “top-down” approach, which means that senior management develops the budget and imposes it on subordinates. In the consultative model, senior managers consult staff, but the final budget is determined by senior managers and imposed on other staff. With the participative model, all managers take part in budget formulation. Democratic processes are utilized to develop a budget plan that is accepted by all managers.
The choice of a budget formulation model is complex and has considerable implications for individual motivation and satisfaction and organizational effectiveness (see Emmanuel et al., 1990).

For a master budget to be effective a number of conditions must be met. First, the organization must have a clear set of goals which can be quantified and which are based on the firm’s long-run strategic plan. These goals must also identify a range of meaningful sub-goals. In addition, sub-goals should be expressed in relatively concrete terms and should be congruent with the long-term objectives. The organization’s goals and sub-goals must be accepted by the employees. It is important that they view the budgets that flow from this process as realistic and attainable. Once implemented the budget must be tied to some feedback and performance evaluation procedure. Where appropriate, adjusting or corrective action should be initiated in response to this feedback.

The master budget process

The development of a firm’s master budget will typically involve:

- presenting the beginning-of-year balance sheet;
- using the sales forecast to prepare a sales budget;
- developing a production budget to meet the sales forecast;
- developing a manufacturing costs budget for materials, labour and overheads;
- developing a purchases budget to meet production needs;
- developing a selling and administrative costs budget;
- developing a budgeted income statement;
- developing a budgeted balance sheet;
- developing a cash budget.

An important point involves the assumption that this planning approach is driven by marketing. That is, the firm can be described as market driven, which means that it will strive to attain its marketing (sales budget) goals subject to the limits of production constraints and so long as profitability goals are being attained.

The development of all the related sub-budgets will seldom be finalized by a single step or iteration. Instead, most firms will develop their interrelated set of budgets by successive stages of refinement or iterations.

Often, development of the master budget becomes an incremental process, in that it involves starting with the last budget and adjusting it to the next period. This approach can be criticized, as it makes no examination of fundamental assumptions that underpin the master budget. Zero-base budgeting is an attempt to overcome these criticisms.

Zero-base budgeting (ZBB)

The basic idea of zero-base budgeting is to completely reassess the very existence of a service or activity. Master budgeting systems have an inherent weakness in that they imply that most, if not all, activities will continue, with little or no variation over time. ZBB makes it possible to examine the need for an activity by considering its contribution to attaining the
firms objectives and relating this to the cost. In this way ZBB highlights cost/benefit relationships. There are three basic elements in the ZBB approach.

(i) Identify objectives and output measures
The firm must relate its activities to the attainment of objectives. This means that indicators must be established and in many instances these will be non-financial in nature. These performance indicators can be used to assess the impact of a zero base for an activity on the attainment of the firms objectives.

(ii) Develop decision packages
The firm must identify various ways of achieving a particular output level and it must be aware of the cost relationships at various levels of output. This means being aware of its flexible budget. Essentially this task involves searching for the various ways of achieving a desired performance level and identifying the productivity, quality and cost consequences.

(iii) Review and rank decision packages
Having developed sets of quantitative data, the firm can combine these with qualitative data to rank the options, based on perceptions of cost/performance relationships.

ZBB techniques offer the following benefits:

- forcing firms to focus on objectives and plans;
- providing better coordination of overall planning and budgeting;
- increasing the involvement of lower-level management in planning and budgeting;
- encouraging managers to focus on the cost effectiveness of operations;
- identifying alternative ways of attaining objectives;
- specifying trade-offs/interdependence between and within operations;
- providing greater clarity on the relative priorities of various activities.

A flexible budget illustration

The master budget may be appropriate for overall planning purposes for the next year or so, but it has limitations as a control device. First, the master budget has assumed particular levels of activity for sales and production and these may prove to be incorrect. Second, for control purposes the firm wishes to determine how cost effective it has been during the period. To do this it has to relate actual performance to some notion of desirable performance standards. But if the desirable performance standards are based on assumed levels of output that are not attained, then the comparison is unlikely to provide information on the degree of cost effectiveness achieved.

What is a flexible budget? In contrast to a fixed budget, which is prepared assuming a predetermined level of activity, a flexible budget is constructed in such a way that the budgeted figures may be determined for all likely or possible levels of operating activity. In essence the flexible budget takes into account the firms cost function, which generally includes fixed and variable cost components.

Assume that a company has the following production cost function for each month:

\[ y = 10,000 + 1.5x \]
This means that it has fixed costs of $10,000 a month and variable costs of $1.50 a unit. The variable costs for each unit consist of labour ($1) and materials ($0.50). The company also has a plant capacity of 5,000 units a month. Let us assume that it plans to produce 4,500 units in the next month. It will have prepared the production budget shown in table 11.12.

**Table 11.12: A fixed production budget**

<table>
<thead>
<tr>
<th>Production budget (4,500 units)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed costs</td>
<td>$10,000</td>
</tr>
<tr>
<td>Variable costs:</td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>4,500</td>
</tr>
<tr>
<td>Materials</td>
<td>2,250</td>
</tr>
<tr>
<td>Total</td>
<td>$16,750</td>
</tr>
</tbody>
</table>

This budget would be appropriate for evaluating performance if the actual production achieved was 4,500 units or 90 per cent of plant capacity. But if the actual production was different, say 4,000 units or perhaps 5,000 units, then the original budget should be recast before any performance evaluation is attempted. An illustration of a flexible production budget is presented in table 11.13, where expected production costs are calculated at 80 per cent, 90 per cent and 100 per cent of capacity.

**Table 11.13: Flexible production budget for 80%, 90% and 100% of capacity**

<table>
<thead>
<tr>
<th>Production budget: 4,000 units, 4,500 units and 5,000 units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity level</td>
</tr>
<tr>
<td>Fixed costs</td>
</tr>
<tr>
<td>Variable costs:</td>
</tr>
<tr>
<td>Labour</td>
</tr>
<tr>
<td>Materials</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

This example shows that it is not meaningful to compare the actual production costs with the fixed budget in table 11.12 unless the actual production was 4,500 units or 90 per cent of plant capacity. If the actual production was 4,000 units, 5,000 units or some different quantity, then the original budget in table 11.12 should be recast to reflect the actual production level. The flexible budget will reflect the firm’s cost function, which may incorporate fixed, semi-variable and variable costs. Once the fixed budget has been recast as a flexible budget to reflect actual activity, then more meaningful analysis of the variances between the flexible budget and actual costs may be undertaken.

### 3.6 Standard costs and variance analysis

Standard costing is typically used where a firm produces relatively homogeneous output. In these situations it is possible to develop an estimate (standard) for the cost of each unit based upon the materials, labour and overhead costs. The direct materials, direct labour and variable
overhead costs are likely to depend essentially on the quantity produced. The fixed overhead costs attributed to each unit are going to depend on quantity.

When producing a homogeneous product, a firm can develop an estimate (standard) for what the unit cost should be and also the total production costs for the planned level of output. At the end of the accounting period, the actual costs can be contrasted with the standard costs to identify any differences (variances). Analysis of these variances will assist in identifying reasons for any cost overruns or cost savings.

The following terms are used when discussing aspects of standard costing:

- standard costs;
- standard cost systems;
- types of standards.

Standard costs are predetermined or estimated costs of producing a product. Typically, they incorporate the costs of direct materials, direct labour and overheads associated with manufacturing a product.

Standard cost systems utilize the standard cost information to determine the cost of producing the output, to determine the cost of goods sold and to value the ending inventory.

As to the types of standards, firms have a range that they might draw upon to set their standard costs. For example, they might choose ideal, normal or basic standards. Ideal standards reflect the costs that would be incurred when production operations are conducted at optimum efficiency. For example, such standards would assume that waste and spoilage is kept to an absolute minimum. It also assumes that labour will work at optimum levels of efficiency. Normal standards reflect the costs that would be incurred if operations were conducted at the level that might reasonably be expected. Such standards would make allowance for probable waste and spoilage and the fact that workers do not generally work at peak efficiency all the time. Basic standards reflect some base level of performance, perhaps developed at the beginning of the product’s life. They are updated for changes in costs and prices, but generally not for changes in efficiency. It is generally believed that normal standards are the most appropriate to use for standard cost and variance analysis, which will be part of a performance measurement system.

3.6.1 Some standard cost techniques

The initial example that will be used presumes that the firm is using standard absorption costing. Before, variable costing was described as only regarding the variable costs as product costs and treating the fixed costs as period costs. On the other hand, absorption costing was described as regarding both variable and fixed costs as product costs. After dealing with an absorption costing example, the essential differences between standard variable costing and standard absorption costing will be explained.

Setting the standard cost

To develop a product standard cost, the firm has to estimate the standard amount of
materials, labour and overheads required. These may be determined by industrial engineering studies, time and motion studies and cost studies, etc.

Assuming that Homogeneous Ltd. produces a single product, its standard cost is shown in Table 11.14.

**Table 11.14: Standard cost per unit using absorption costing**

<table>
<thead>
<tr>
<th>Product standard cost specification sheet</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct materials:</strong></td>
<td></td>
</tr>
<tr>
<td>15kg at $1 per kg</td>
<td>$15.00</td>
</tr>
<tr>
<td><strong>Direct labour:</strong></td>
<td></td>
</tr>
<tr>
<td>4 hours at $6 per hour</td>
<td>24.00</td>
</tr>
<tr>
<td><strong>Manufacturing overheads:</strong></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>8.00</td>
</tr>
<tr>
<td>Fixed (assume 500 units)</td>
<td>8.00</td>
</tr>
<tr>
<td><strong>Standard cost per unit</strong></td>
<td>$55.00</td>
</tr>
</tbody>
</table>

The overhead costs have been determined by using the firm's flexible budget for overheads which is:

\[
y = 4,000 + 2/\text{direct labour hour}
\]

Based on the production of 500 units, then the total direct labour hours are expected to be 2,000 hours (500 units at 4 hours per unit). Accordingly, the expected costs will be $8,000.

This will be applied at the rate of $2/direct labour hour for fixed overheads (i.e. $4,000/2,000 hours) and also at the rate of $2 per direct labour hour for variable overheads (as indicated in the flexible budget).

The standard cost specification sheet provides a yardstick for actual production costs. It is now possible to measure actual production costs and contrast them with the standard cost, to identify any variances.

**Actual production costs**

Homogeneous Ltd. planned to produce 500 units when it developed its standard cost sheet. However, the actual production for the month was 400 units. It purchased 8,000 kgs of direct materials for $1.05 per kg and a total cost of $8,400. During the month it used 6,240 kgs of direct materials.

The direct labour used for the month was 1,650 hours at $6.40 an hour, at a total cost of $10,560. The actual variable overhead for the month was $3,400. The actual fixed overhead for the month was $4,200. The next step is to contrast these actual costs with the planned costs and identify any variances that have occurred.

### 3.6.2 Variance analysis

It is possible to identify variances with respect to direct materials, direct labour, variable overheads and fixed overheads.
(a) Direct materials variances

There are two variances that can be identified so far as direct materials are concerned. These are:

- materials price variance; and
- materials quantity variance.

The materials price variance is calculated by using the following formula:

\[ mpv = (sp - ap) \times aq \]

Where:

- \( mpv \) = material price variance
- \( sp \) = standard price per unit
- \( ap \) = actual price per unit
- \( aq \) = actual quantity of raw materials purchased

Using the data from the actual production costs and the standard cost sheet, it is possible to calculate the materials price variance.

\[ mpv = (1.00 - 1.05)/kg \times 8,000 \text{ kgs} = $400 \text{ (unfavourable)} \]

The variance is unfavourable because Homogeneous Ltd. paid five cents a kilogram more than the standard cost per kilogram.

The materials quantity (or usage) variance is calculated using the following formula:

\[ mqv = \{(au \times sq) - aq\} \times sp \]

Where:

- \( mqv \) = material quantity (or usage) variance
- \( au \) = actual units produced in the period
- \( sq \) = standard quantity of materials per unit
- \( sp \) = standard price per unit for materials

Using data from the actual production costs and the standard cost sheet, it is possible to calculate the materials quantity variance.

\[ mqv = \{(400 \times 15 \text{ kg}) - 6,240\} \times $1 = $240 \text{ (unfavourable)} \]

The variance is unfavourable because Homogeneous Ltd. used 240 more kilograms than it should have according to the standard.
(b) Direct labour variances

There are two variances that can be identified so far as direct labour is concerned. These are:

- labour price variance; and
- labour price usage.

The labour price variance is calculated by using the following formula:

\[ \text{lpv} = (\text{sr} - \text{ar}) \times \text{ah} \]

Where:

- \( \text{lpv} \) = labour price (or rate) variance
- \( \text{sr} \) = standard labour rate per hour
- \( \text{ar} \) = actual labour rate per hour
- \( \text{ah} \) = actual hours worked by direct labour

Using data from the actual production costs and the standard cost sheet, it is possible to calculate the labour price (or rate) variance.

\[ \text{lpv} = (\$6.40 - \$6.00) / \text{hr} \times 1,650 \text{ hrs} = \$660 \text{ (unfavourable)} \]

The variance is unfavourable because Homogeneous Ltd. paid $0.40 an hour more for direct labour than the standard cost.

The labour quantity (or efficiency) variance is calculated using the following formula:

\[ \text{lqv} = (\text{sh} - \text{ah}) \times \text{sr} \]

Where:

- \( \text{lqv} \) = labour quantity (or efficiency) variance
- \( \text{sh} \) = standard hours (number of units x standard hours)
- \( \text{ah} \) = actual hours worked by direct labour
- \( \text{sr} \) = standard rate per hour for direct labour

Using data from the actual production costs and the standard cost sheet, it is possible to calculate the labour quantity variance.

\[ \text{lqv} = ([400 \text{ units} \times 4 \text{ hrs/unit}] - 1,650 \text{ hrs}) \times \$6/\text{hr} \]
\[ = (1,600 \text{ hrs} - 1,650 \text{ hrs}) \times \$6/\text{hr} = \$300 \text{ (unfavourable)} \]

The variance is unfavourable because Homogeneous Ltd. used 50 hours of direct labour in excess of the standard amount for 400 units.
(c) Overhead variances

There are two categories of overhead variances when using standard absorption costing. These are:

- variable overhead variances; and
- fixed overhead variances.

For variable overheads it is possible to identify two variances. These are

- variable overhead spending variance; and
- variable overhead efficiency variance.

The variable overhead spending variance is calculated by using the following formula:

\[ \text{vohsv} = (svr \times ah) - avo \]

Where:

- \( \text{vohsv} \) = variable overhead spending variance
- \( svr \) = standard variable overhead rate per hour
- \( ah \) = actual hours worked by direct labour
- \( avo \) = actual cost of variable overheads

Using data from the actual production costs and the standard cost sheet, it is possible to calculate the variable overhead spending variance.

\[ \text{vohsv} = (svr \times ah) - avo \]
\[ = (2\$/hr \times 1,650 \text{ hrs}) - 3,400 = 100 \text{ (unfavourable)} \]

The variance is unfavourable because the company paid $100 more than predicted by the standard.

The variable overhead efficiency variance is calculated by using the following formula:

\[ \text{vohev} = \{(au \times sh) - ah\} \times svr \]

Where:

- \( \text{vohev} \) = variable overhead efficiency variance
- \( au \) = actual units produced
- \( sh \) = standard hours per unit
- \( ah \) = actual hours worked by direct labour
- \( svr \) = standard variable overhead rate per hour

Using data from the actual production costs and the standard cost sheet, it is possible to calculate the variable overhead efficiency variance.

\[ \text{vohev} = \{(au \times sh) - ah\} \times svr \]
\[ = \{(400 \text{ units} \times 4 \text{ hrs/unit}) - 1,650 \text{ hrs}\} \times \$2/dlh = 100 \text{ (unfavourable)} \]
The variance is unfavourable because Homogeneous Ltd. took more hours to produce 400 units than predicted by the standard.

For fixed overheads it is possible to identify two variances. These are:

- fixed overhead spending variance; and
- fixed overhead volume variance

The fixed overhead spending variance is calculated by using the following formula:

\[ \text{fohsv} = (\text{fohfb} - \text{afoh}) \]

Where:

- \( \text{fohsv} \) = fixed overhead spending variance
- \( \text{fohfb} \) = fixed overhead from the flexible budget
- \( \text{afoh} \) = actual fixed overhead

Using data from the actual production costs and the standard cost sheet, it is possible to calculate the fixed overhead spending variance.

\[ \text{fohsv} = (\text{fohfb} - \text{afoh}) \]
\[ = $4,000 - $4,200 = $200 \text{ (unfavourable)} \]

The variance is unfavourable because the company spent more on fixed overheads than predicted by the flexible budget.

The fixed overhead volume variance is calculated by using the following formula:

\[ \text{fohvv} = \{(\text{ap} - \text{bp}) \times \text{sh}\} \times \text{fohr} \]

Where:

- \( \text{fohvv} \) = fixed overhead volume variance
- \( \text{ap} \) = actual production in units
- \( \text{bp} \) = budgeted production in units
- \( \text{sh} \) = standard hours per unit of product
- \( \text{fohr} \) = fixed overhead rate per dlh

Using data from the actual production costs and the standard cost sheet it is possible to calculate the fixed overhead spending variance.

\[ \text{fohvv} = \{(\text{ap} - \text{bp}) \times \text{sh}\} \times \text{fohr} \]
\[ =\{(400 - 500) \text{ units} \times 4 \text{ hrs/unit}\} \times $2/\text{dlh} \]
\[ = \{-100 \text{ units} \times 4 \text{ hrs/ unit}\} \times $2/\text{dlh} \]
\[ = $800 \text{ (unfavourable)} \]

The variance is unfavourable because the amount of overhead applied as a result of producing 400 units ($3,200) is less than the amount ($4,000) in the flexible budget.
### 3.6.3 Standard variable costing

The previous illustration involved the use of standard absorption costing and it is appropriate to consider how standard variable costing differs from this. The essential difference relates to the way in which the two systems treat fixed overheads. As outlined before, absorption costing regards fixed overheads as product costs and includes these costs in the cost of goods sold and the value of ending inventories. In contrast, variable costing regards fixed overheads as period costs that are not attached to cost of goods sold or to ending inventories.

Consequently, under standard variable costing all fixed overhead costs will be treated as period costs. This means that under standard variable costing, the standard cost specification sheet will exclude all fixed overhead costs and there will be no analysis of variances related to fixed overheads at the end of each period. This is the only difference between the two systems. Standard variable costing will include two variance calculations at the end of the period with respect to direct materials, direct labour and variable overheads. The formulae are the same as those illustrated in the standard absorption costing example.

**Standard costing systems**

The standard cost systems used by firms accumulate the costs of producing products at standard costs, while at the same time recording the actual costs incurred. At the end of each period the differences between the standard costs and the actual costs are identified and variances calculated. The costs attributed to products, finished goods and inventories are always at standard, with the variances being reported as the period’s discrepancies from the standard.

In the example given for variance analysis, if we assume that there were no beginning inventories and that 250 units were sold for $85.00, then it is possible to determine the gross profit for the month and the value of ending inventory. These details are presented in table 11.15, which illustrates how standard costs and associated variances can be reported in the income statement.

**Table 11.15: Gross profit and inventory valuation using standard absorption costing**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross profit and ending inventory</td>
<td>$21,250</td>
</tr>
<tr>
<td>Sales</td>
<td></td>
</tr>
<tr>
<td>less: standard cost of goods sold</td>
<td>13,750</td>
</tr>
<tr>
<td>Standard gross profit</td>
<td>7,500</td>
</tr>
<tr>
<td>Adjustments for production variances:</td>
<td></td>
</tr>
<tr>
<td>Materials price variance</td>
<td>($400)</td>
</tr>
<tr>
<td>Materials quantity variance</td>
<td>(240)</td>
</tr>
<tr>
<td>Labour price variance</td>
<td>(660)</td>
</tr>
<tr>
<td>Labour quantity variance</td>
<td>(300)</td>
</tr>
<tr>
<td>Variable overhead spending variance</td>
<td>(100)</td>
</tr>
<tr>
<td>Variable overhead efficiency variance</td>
<td>(100)</td>
</tr>
<tr>
<td>Fixed overhead spending variance</td>
<td>(200)</td>
</tr>
<tr>
<td>Fixed overhead volume variance</td>
<td>(800)</td>
</tr>
<tr>
<td>Adjusted gross profit</td>
<td>$4,700</td>
</tr>
<tr>
<td>Ending inventory ($55 each)</td>
<td>150 units</td>
</tr>
<tr>
<td></td>
<td>$8,250</td>
</tr>
</tbody>
</table>
The use of variances for monitoring and controlling performance

The essential benefit of standard costing systems relates to the fact that management has some idea of what costs should be. It then has information on the actual costs and accounting staff can calculate the variances from standard, as detailed above. Management can examine these variances, seek explanations for them and when appropriate, implement corrective action.

The materials price variance is often difficult to control. These variances often arise due to prediction errors. The materials quantity variance may arise from utilization of materials above or below standard. This might be the result of decisions in the factory or could be affected by the quality and type of raw materials purchased.

The labour prices are often clearly established in labour contracts, in which case variances are likely to be modest. However, if the standard has not been revised, or a revision has anticipated a new labour rate which is in operation, then this will result in variances. The setting of labour efficiency is often difficult and variances in this area are often significant. Also, absenteeism can be a major determinant of these variances. They might also be the result of poor estimates of the standard times or poor discipline in the factory to ensure that the standard times are normally attained.

Managers must be careful to investigate significant variances to determine their cause. Having established the factors that have given rise to the variances, it is possible to consider what steps, if any, are appropriate to overcome them in future.

Thus, we have considered standard costs and variance analysis. In particular, we have discussed some terms that are regularly used, the role of standard costs in planning, the basics of variance analysis for materials, labour and overheads, the use of standards within standard cost systems, the difference between standard absorption costing and standard variable costing.

Questions for review

1. Recalculate the standard cost sheet presented in table 11.14, assuming that Homogeneous Ltd. uses standard variance costing.
2. Using the actual cost data and variances calculated, present a report calculating the gross profit and cost of goods sold using standard variable costing.
UNIT 4: FINANCIAL MANAGEMENT

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand the importance of working capital management and the nature of its cycle.

2. Appreciate the importance of cash management and factors associated with inventory and accounts receivable management.

3. Understand the concepts of net present value (NPV) and internal rate of return (IRR) and be able to apply them to capital investment evaluations.

4. Employ techniques for selecting the best combination of investment projects.

UNIT 4: CONTENTS

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Module review

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UNIT 4: FINANCIAL MANAGEMENT

4.1 Working capital management

The effective management of a firm's working capital is vital for its short- to medium-term survival. A firm's ability to continue trading depends on the availability of working capital. It is required to ensure that the firm has sufficient cash, inventories, debtors, accounts receivable and creditors, etc. In addition to having sufficient working capital, it is also necessary to manage the funds devoted to each of the working capital components. This means that the firm must manage both the overall level of working capital and the individual components, such as cash, inventories, accounts receivable, etc. For example, if a firm ties up too much working capital in accounts receivable this could give rise to a cash shortage; in addition it will mean that the firm has unnecessarily invested accounts receivable in resources that might be used elsewhere in the business.

A vital consideration for all firms is the management of cash resources, so that financial commitments can be paid as they fall due. Companies often fail because they have insufficient cash resources to meet their obligations. In the short run, firms can continue to trade if they are making a loss, but they cannot continue in business if they lack the cash to pay debts when they fall due.

This unit will give an outline of working capital management, working capital cycle, risk-return and current asset financing, assessing working capital adequacy, cash management, inventory management and accounts receivable management. The following terminology is essential for studying these topics:

- working capital;
- economic order quantity;
- reorder point.

Working capital refers to short-term financing. It is defined as the firm's excess of current assets over current liabilities (working capital = current assets - current liabilities).

Economic order quantity (EOQ) is the optimal quantity of an item that should be ordered, taking into consideration the costs of holding inventory and the costs of processing an order. There is an optimizing technique from operations research that is useful in identifying the EOQ.

Reorder point indicates the physical inventory level at which an order for replacement stock will be issued. It takes into account the time required to receive shipments from suppliers and the normal rate of usage of the particular item. In addition the firm may set a safety level to guard against running out of supplies if the supplier takes longer than usual to ship the order and/or the rate of actual usage is faster than average.

The working capital cycle

The various items that provide the firm with inflows and outflows of cash can be represented as the working capital cycle shown in figure 11.13. This diagram illustrates the
Figure 11.13: Interaction of working capital components
interrelationship of the various working capital elements, sources for generating cash flows and sources of cash outflows. Note that the diagram includes some non-working capital elements; these are long-term finance and fixed assets. These items affect the firm's cash position in that the raising or retiring of long-term capital changes the cash position as does the acquisition or disposal of fixed assets. The diagram indicates that the firm's cash position and hence its working capital position will be affected by transactions relating to long-term finance and to fixed assets.

4.1.1 Risk return and current asset financing

A firm may choose to adopt a policy where it has a very high level of working capital relative to its overall needs. It may also decide to operate with a very low level of working capital. The first situation might be described as a conservative working capital policy, for it means there is little risk of experiencing a shortage of working capital. But the firm is losing the opportunity to utilize the excess of working capital elsewhere to earn an additional return. Such an approach to working capital management can be described as a low risk-low return working capital policy.

The second situation might be described as an aggressive working capital policy, for it means there is a high risk of experiencing a shortage of working capital. However, the firm is minimizing the amount of resources invested in working capital. Such an approach can be described as a high risk-high return working capital policy.

The concept of a trade-off between risk and return in deciding on the level of working capital has been presented diagrammatically by Weston and Copeland (1989) as shown in figure 11.14 below. This diagram indicates that the firm can, at different points in time, choose the level of current assets that it wishes to have relative to its output. The various options present the firm with different risk return alternatives and management can select the particular alternative that matches its overall preference.

**Figure 11.14: Risk return and working capital**

Conservative: low risk - low return
(high current assets: sales)

Theoretical optimum: ideal risk-return
(best mix current assets: sales)

Aggressive: high risk: high return
(low current assets: sales)

Source: Weston and Copeland, 1989, p.277
In financing its working capital requirements a firm has a range of options. Considering these options requires a brief discussion of long- and short-term sources of financing. A firm can raise funds from long-term sources (debt and equity capital) and from short-term credit (bank overdrafts and creditors). A firm can examine its current assets and determine its permanent requirements and its fluctuating requirements (those that vary with seasonal influences).

A conservative working capital policy would involve financing fixed asset requirements, permanent requirements and only some fluctuating current asset requirements from long-term sources of finance. The remaining fluctuating current asset requirements would be financed from short-term sources.

An aggressive working capital policy would involve financing fixed asset requirements and only some permanent current asset requirements from long-term sources. The balance of its permanent current assets, together with its fluctuating current assets would be financed out of short-term sources.

An average working capital policy would involve financing fixed asset requirements and permanent current asset requirements from long-term sources. Fluctuating current asset requirements would be financed from short-term sources.

Assessing working capital adequacy/inadequacy

It is possible to assess the extent to which a firm has adequately provided for its working capital needs. Overtrading refers to situations where the firm is trying to undertake too much business using its capital (including working capital). Overinvestment refers to situations where a firm has excessively high levels of working capital relative to its overall needs.

Overtrading refers to situations where companies attempt too much business activity using the resources (short- and long-term) available to them. This means that a firm is attempting to attain a higher level of turnover than is reasonable with its current capital base. The problem will often show up in terms of a cash shortage, insufficient inventory levels, etc. to support the level of activity. Overtrading situations can get out of control and lead to business failure due to an adverse liquidity position. Typically, overtrading situations arise steadily over a considerable period of time, when a firm is growing. As attempts are made to increase turnover, insufficient planning is undertaken to ensure sufficient resources to finance increases in cash, inventories and debts. A lack of working capital can lead to overdraft borrowing. Often in these situations, firms find that gross profit margins decline in the attempt to obtain additional sales, and net profit margins decline as selling expenses and short-term financing costs increase. The following are often evident when overtrading occurs:

- a rapid increase in turnover;
- a rapid increase in current assets and possibly fixed assets;
- most or all of the increase in assets is financed by short-term credit;
- debt and liquidity ratios increase sharply, including debt, equity, current, quick asset ratios;
- operating costs may increase substantially due to rising costs and interest charges;
- gross profit margins decline due to increased purchasing costs and lower selling prices on the additional volumes.
To overcome this situation or to avoid it firms need to match their growth plans (including working capital) with their ability to raise long-term finance to meet long-term financing needs.

On the other hand overinvestment in working capital means that the firm has more short-term assets than it needs. This means that it is using more finance (short- and long-term) than it needs to, in generating its turnover and net profit. It could reduce its current assets and therefore its need for overall finance and achieve the same turnover. This means that the overall return on investment and owners’ funds could be increased. Further, the reductions made in current assets can be invested to increase the overall return.

**Cash management**

To manage cash effectively, a firm must have established procedures for predicting and monitoring the actual cash position; when necessary the firm must borrow to cover any shortfall and invest any surplus. This prediction takes the form of the cash budget. The relationship between the cash budget and other aspects of the financial planning process were covered in Unit 3.

**Inventory management**

For manufacturing or merchandising firms inventories represent a significant component of working capital. They may consist of raw materials, partly processed materials and finished goods. As with all working capital items, the firm wants a level of inventory that is neither too high nor too low. If it is too high excessive amounts of capital are required, more warehouse space is needed and the risk of obsolescence and deterioration is increased. If the level is too low this can cause production delays, placement of frequent, rushed orders, foregone sales due to running out of stock and possibly the loss of discounts available for large orders.

Management must ensure that the firm has a clearly defined set of inventory policies that address physical security; separation of responsibilities for manufacturing usage and storekeeping; accurate recording of inventory levels and movements. Firms can use a technique from operations research, known as the economic order quantity (EOQ) to determine the optimum order quantity. This technique attempts to minimize total variable inventory costs. The model assumes that the variable cost of holding inventories and the variable cost of ordering inventories comprise the total variable inventory costs. The formula is reproduced below:

\[
EOQ = \sqrt{\frac{2V \times U}{CP}}
\]

Where:
- \(EOQ\) = economic order quantity
- \(V\) = variable cost per order (dollars)
- \(U\) = annual usage in a year (units)
- \(CP\) = cost of holding a unit of stock for a year (dollars)

Assume that Producers Ltd. purchase 2 million components a year, the variable holding cost
per unit has been calculated to be $0.50 a year and the variable cost of each order is $75. The following EOQ is calculated using the above formula.

$$EOQ = \sqrt{\frac{1 \times $75 \times 2,000,000}{$0.50}} = 24,494.90$$

The firm is likely to round the order up to 24,500 or 25,000 units an order.

Having calculated the EOQ, the firm should also estimate the reorder point, taking account of the lead time for a delivery from the supplier. The reorder point may be found by using the following formula.

$$R = \frac{L \times U}{W}$$

Where:

L = lead time for supplier to deliver after order is received
U = annual usage in a year (units)
W = number of working days in a year

Assuming that there are 300 working days a year and the supplier takes three working days to deliver, then the reorder point may be calculated:

$$R = \frac{3 \times 2,000,000}{300} = 20,000$$

When the stock is down to 20,000 units the firm should place an order for a new shipment of the EOQ.

To avoid the risk of running out of stock, the firm may also add a safety margin to the reorder stock level. Often the safety stock will correspond to a number of days’ average usage.

The concepts of EOQ, reorder point and safety stock are simple and elegant. The difficulty arises in making accurate estimates of the calculation components. Many firms have difficulty doing this and may have to contemplate time-consuming and costly research to get reliable figures.

*Accounts receivable management*

The effective management of accounts receivable and the firm’s credit policies have a critical bearing on the effectiveness of overall working capital management. The actual level of outstanding accounts receivable will depend on the level of credit sales and the average time it takes to collect from customers.

When developing its credit policy, or contemplating a change in policy, a firm will need to
consider:

- the normal credit period to be allowed;
- the level of discount to be offered to credit customers who pay early;
- the means of establishing the creditworthiness of customers;
- techniques for monitoring the management of accounts receivable (including age analysis, turnover, level of bad debts, effectiveness of recovery action, etc.).

Within a given industry, there may be norms relating to the credit period and discount terms for early payment. The firm must set its own policies within the context of any overall norms. It should be borne in mind that overgenerous discounts may reduce profitability, whilst relatively tough credit conditions may have an adverse impact on overall sales. A firm should carefully assess the impact that its accounts receivable policy may have on its overall working capital requirements.

4.2 Valuation and the cost of capital

This topic addresses some essential issues in the valuation of shares and debt instruments, and then deals with determining the firm’s cost of capital. Valuation of a firm’s shares and/or debt instruments may have a number of uses including:

- assessment of the “fair value” of the share capital or the overall company in a takeover situation;
- determining an appropriate share price for a private or government company planning to become a public corporation;
- determining the “value” of each firm in a merger between two companies;
- determining the value of shares as security for a long-term loan.

The most important approach involves discounting the future cash flows to be generated by the instrument, to determine its present value.

The cost of capital is a related and important concept which is used in financial management. In order to evaluate its current and future investments, a firm needs to assess whether its present and proposed projects are worthwhile. The cost of capital attempts to determine the cost of the firm’s funds that are available for investment. There are a number of techniques for determining a firm’s cost of capital, but their overriding purpose is to provide a measure of the cost of the firm’s funds. If the firm is aware of the cost of the funds being used, then it can adopt evaluation techniques that ensure that current and future investment projects yield a return that is at least as great as its cost of capital. The following terms are used in determining the instruments of evaluation:

- cost of capital;
- the capital asset pricing model;
- debentures and/or bonds;
- ordinary shares;
- preference shares.
Cost of capital refers to the overall cost to the firm of its total capital, reflecting the rate of return that the firm must attain if it wishes to attract funds in the form of debt and share capital. Typically, it will vary from firm to firm, reflecting the different risk-return situations of individual firms. It might be measured using the weighted average cost of capital (WACC), the marginal cost of capital (MCC) or the capital asset pricing model (CAPM). The use of each of these approaches is outlined later in this unit.

The capital asset pricing model is a market-based model for analysing the risk-return trade-offs associated with all share capital investment decisions. It suggests that there are two aspects of risk. First, there is diversifiable risk, which is also known as non-systematic risk. This relates to the underlying or unique risk of a particular investment, which can be eliminated by investing in a diversified portfolio. Second, there is non-diversifiable risk, which is also known as systematic risk. This is associated with overall market risk and cannot be eliminated by diversification.

Debentures and/or bonds are particular long-term debt instruments. In countries whose legal/accounting systems have developed from the UK model, they are generally referred to as debentures, whereas in countries that have developed their legal/accounting systems from the US model, they are generally referred to as bonds. They typically have a specified issue price, a date on which they must be redeemed (repaid) and a fixed rate of interest that must be paid periodically. They may be secured or unsecured, which refers to the priority of their claim over assets in the event of liquidation or winding up. If they are secured, then they will have some security over a particular class of assets or over all the firm’s assets.

Ordinary shares belong to the shareholders who bear the ultimate risk for the company. They have the residual claims on the company’s profits and its assets (in winding up or liquidation). If the company is highly successful they will be the ultimate beneficiaries, but if it is unsuccessful they must bear the primary loss. In liquidation or winding up, they generally rank after the debt holders and any preference shareholders.

Preference shares usually entitle the owner to a fixed rate of dividend and generally they have a prior claim to dividends over that of ordinary shareholders. Also in the event of liquidation or winding up, they normally have priority over ordinary shareholders for the return of share capital. It is also possible for preference shares to be issued as participating preference shares. Participating preference shares generally entitle the owner to a fixed level of dividend and then a share of surplus profits, after dividends have been paid to ordinary shareholders.

4.2.1 Valuation of share capital

In finance it is generally accepted that the value of a particular share will fluctuate over time in accordance with supply and demand. One approach to valuing shares is to examine the cash flows that a share investment will generate as the basis for a valuation model. This general approach is referred to as the dividend valuation model. If we assume that a share is purchased in time zero \((t = 0)\) for \(P\) and we expect it to produce an after-tax dividend for \(D\) a year, which is expected to grow by a constant rate of \(g\) per year, then it is possible to express the current price mathematically, where the cost of capital is \(Ke\):
When the dividend rate and growth rate are constant, the value of a share may be simplified to:

\[
P_0 = \frac{D_1}{1 + K_e} + \frac{D_2(1+g)}{(1 + K_e)^2} + \frac{D_3(1+g)^2}{(1 + K_e)^3} + \ldots
\]

Assume that you are contemplating buying a share which has a current market price of $10. The current dividend per share is $0.50 and the future dividends are expected to grow at a constant 8 per cent a year. If your required rate of return is 12 per cent, calculate whether the shares represent a good investment. Using the above formula, it is possible to calculate the underlying value of the share and compare that with the current market price.

\[
P_0 = \frac{D_1}{K_e - g} = \frac{0.50}{(0.12 - 0.08)} = 12.50
\]

Each share has an underlying value of $12.50, compared with a current market price of $10, which makes the shares an attractive investment.

In the case of preference capital, the value \(P_0\) is related to the expected cash flow (i.e. the preference dividend \(D\)) and the cost of capital \(K_p\). The preference capital valuation model is as follows:

\[
P_0 = \frac{D_1}{1 + K_p} + \frac{D_2}{(1 + K_p)^2} + \frac{D_3}{(1 + K_p)^3} + \ldots
\]

If we assume that this cash flow is available in perpetuity, then the expression can be simplified to become:

\[
P_0 = \frac{D}{K_p}
\]

Assume that a preference share is presently selling for $10. It is currently paying $0.75 cents a year dividend and your required rate of return on preference shares is 10 per cent. On the basis of this information, would you regard the preference share as a worthwhile investment?

Using the above formula and the information given, it is possible to calculate the underlying value of the share and compare that with the current market price.
Given the required rate of return on preference shares, it has an underlying value of $7.50, which is less than the current market price; therefore you would not purchase the preference share at its current price of $10.

### 4.2.2 Valuation of debt capital

The above approach for share capital may also be applied to debt capital. If the amount of periodic interest I payable on a debt instrument is known, together with the debtholders required rate of return $k_d$, then it is possible to determine the underlying value of the debt instrument by using the following expression:

$$P_0 = \frac{I_1}{1 + K_d} + \frac{I_2}{(1 + K_d)^2} + \frac{I_3}{(1 + K_d)^3} + \ldots$$

If we assume that the interest payments are going to be received in perpetuity, then it is possible to further simplify this expression:

$$P_0 = \frac{I}{K_d}$$

Let us assume that a bond or a debenture has a current market price of $125, it is paying annual interest of $12 and your required rate of return on debt is 9.5 per cent. Would you buy the debenture/bond at the current market price? Using the above formula, the value of the bond may be calculated:

$$P_0 = \frac{12}{0.095} = \frac{12}{0.095} = $126.32$$

On the basis of these calculations the underlying value of the share is $126.32. This exceeds the current market price of the debenture/bond of $125.00, which suggests that it is worth purchasing.

These valuation methods may also be used to determine overall firm values in merger, takeover, privatization and floatation situations. However, there are other methods, not dealt with in this module, including: the capital asset pricing model; accounting book values; and price earnings ratios.
4.2.3 The concept of cost of capital as a required return

A firm should determine its cost of capital as a means of identifying its overall cost of funds. It is possible to visualize the firm as consisting of two aspects. The first involves accumulating a pool of investment resources and the second involves identifying a range of worthwhile investment projects. In accumulating a pool of investment resources, the firm must consider the cost of those funds. It would be counterproductive to raise funds if the firm cannot invest them in projects that yield a higher return than the overall cost of the funds.

This implies that the raising of funds must take into account:
- the potential projects and the returns they offer; and
- the cost of the funds that it has raised or is contemplating raising.

How is it possible to use the valuation models outlined above to determine a firm’s cost of capital? First, a calculation is made for each capital component and then the results are combined to determine the weighted average cost of capital (WACC). Using the dividend growth valuation model described above, it is possible to re-express it in terms of the cost of ordinary share capital Ke:

\[ K_e = \frac{D}{P_0} + g \]

For preference share capital the constant dividend valuation model can be re-expressed in terms of the cost of preference capital.

\[ K_p = \frac{D}{P_0} \]

For bonds/debentures it is possible to re-express the debt capital valuation model presented above so as to calculate the cost of debt capital Kd:

\[ K_d = \frac{I(1-t)}{P_0} \]

Where t represents the corporate tax rate. The firm’s cash outflows are reduced if interest payments can be deducted from taxes. Below are a few approaches to calculating the costs of capital.

Calculating the weighted average cost of capital

A firm which is using capital from equity and debt components needs some means of determining its overall cost of capital. One method of calculating the cost of capital is to first, calculate the cost of each capital component as outlined above and then to combine the results by weighting the cost of each component according to its proportion of overall capital. This
approach is referred to as the weighted average cost of capital (WACC) method.

Let us illustrate the technique with an example. The Capital Company has the following capital structure:

- Ordinary shares: $2,500,000
- Preference shares: $1,000,000
- Debentures: $1,500,000

The ordinary shares are presently selling for $20, the dividend stream is expected to be $2 a year and the growth rate per year is expected to be 5 per cent. The preference shares are paying 10 per cent on their issue price of $10 and are currently being traded at $8 each. The debentures are paying 24 per cent on their issue price of $100 and are presently selling for $120. The current corporate tax rate is 50 per cent.

The first step involves calculating the cost of capital for each capital component. The cost of the ordinary share capital is as follows:

\[ K_e = \frac{D}{P_o} + g = \frac{\$2}{\$20} + 0.05 = 0.15 \text{ or } 15 \text{ per cent} \]

The cost of the preference capital is:

\[ K_p = \frac{D}{P_o} = \frac{\$1}{\$8} = 0.125 \text{ or } 12.5 \text{ per cent} \]

The cost of the debenture capital is:

\[ K_d = \frac{I(1-t)}{P_o} = \frac{\$24(1-0.5)}{\$120} = 0.10 \text{ or } 10 \text{ per cent} \]

Having calculated the cost of the individual components of the firm’s capital, the second step is to combine them in calculating the WACC. The calculation of Capital Company’s weighted average cost of capital is presented in table 11.16. The calculation shows that the company has a weighted average cost of capital of 13.00 per cent.

<table>
<thead>
<tr>
<th>Capital item</th>
<th>Dollar amount</th>
<th>Weight</th>
<th>Percentage cost (k)</th>
<th>Weighted cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ord. shares</td>
<td>$2,500,000</td>
<td>.50</td>
<td>.15</td>
<td>0.0750</td>
</tr>
<tr>
<td>Pref. shares</td>
<td>1,000,000</td>
<td>.20</td>
<td>.125</td>
<td>0.0250</td>
</tr>
<tr>
<td>Debentures</td>
<td>1,500,000</td>
<td>.30</td>
<td>.10</td>
<td>0.0300</td>
</tr>
<tr>
<td>WACC</td>
<td></td>
<td></td>
<td></td>
<td>0.1300</td>
</tr>
</tbody>
</table>
The marginal cost of capital

Another approach to calculating the cost of capital is to consider this cost at the margin. Advocates of this approach suggest that the firm is often looking at investment projects at the margin and the associated cost of financing them. In such situations, some specialists suggest that firms should calculate the marginal cost of raising the additional capital.

This approach is only slightly different from the WACC method. The first step involves estimating the cost of the various sources of incremental finance. The same valuation models are used to determine the cost of each capital component. But in this case the cost being estimated relates only to the additional (marginal) capital required. The second step involves calculating the overall marginal cost of capital by weighting the additional (marginal) capital items, using a similar approach to that used in the WACC approach in table 11.16.

Let us assume that the Capital Company wishes to raise new funds for an investment project. It plans to raise $600,000 in new ordinary share capital and $400,000 in debentures. The shares will be sold for $20 each and the debentures for $125 each. It expects to pay the same dividends on the new share capital and 25 per cent interest on the new debenture issue. The cost of making these issues of equity and debt capital will be 1 per cent of the funds raised. The 1 per cent is required to cover legal and other costs associated with raising new capital. To calculate the marginal cost of capital, Capital Company must:

(i) calculate the cost of the marginal share capital and the cost of the marginal debt capital; and
(ii) calculate the marginal weighted average cost capital.

The marginal cost of the new share capital raising may be calculated as follows:

$$K_e = \frac{D}{(P_0 - C) + g}$$

Where $C$ = the issue costs associated with each new share.

$$K_e = \frac{\$2}{($20 - $0.20)} + 0.05 = 0.1510 \text{ or } 15.1 \text{ per cent}$$

The marginal cost of raising the new debenture capital may be calculated as follows:

$$K_d = \frac{I (1-t)}{(P_0 - C)}$$

Where $C$ = the issue costs associated with each new debenture.

$$K_d = \frac{\$25 \times (1-0.5)}{($125 - $1.250)} = 0.1010 \text{ or } 10.1 \text{ per cent}$$
The Capital Company’s marginal cost of capital using the WACC concept is 13.10 per cent, as shown in table 11.17.

Table 11.17: The Capital Company’s marginal cost of capital based on the weighted average cost of capital concept

<table>
<thead>
<tr>
<th>Capital item</th>
<th>Dollar amount</th>
<th>Weight</th>
<th>Percentage cost (k)</th>
<th>Weighted cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ord. shares</td>
<td>600,000</td>
<td>.60</td>
<td>.1510</td>
<td>0.0906</td>
</tr>
<tr>
<td>Debentures</td>
<td>400,000</td>
<td>.40</td>
<td>.1010</td>
<td>0.0404</td>
</tr>
<tr>
<td>MCC</td>
<td></td>
<td></td>
<td></td>
<td>0.1310</td>
</tr>
</tbody>
</table>

The capital asset pricing model (CAPM) approach

The capital asset pricing model may be used to determine the cost of capital for a firm, by using the following formula:

\[ K_e = r_e = r_f + \beta (r_m - r_f) \]

Where:
- \( r_e \) = the required rate of return on equity capital
- \( r_f \) = the risk-free rate of return
- \( \beta \) = the firm’s systematic or non-diversifiable risk
- \( r_m \) = the expected return on the market in general

The long-term government bond rate is typically used to approximate the risk-free rate of return. It is the rate of return available where the risk of default is approximately zero.

Beta measures the variability of the returns to a share (measured by its covariance) relative to those returns on the market as a whole (measured by its variance).

Assume that Capital Company has a Beta of 1.25, the risk-free rate of return is 9 per cent and the overall market return is 14 per cent. Using this information it is possible to calculate the required rate of return on ordinary share capital using CAPM.

\[ K_e = r_e = r_f + \beta (r_m - r_f) = 0.09 + 1.25(0.14 - 0.09) = 0.1525 \text{ or } 15.25 \text{ per cent} \]

The required rate of return on ordinary share capital may be used as one of the calculation elements in determining a firm’s weighted average cost of capital. In the case of Capital Company, the CAPM calculation for ordinary share capital could replace the dividend valuation model calculation in table 11.16 with the calculation of the cost of preference shares and debentures remaining unchanged.

A difficulty in applying the CAPM approach is that it requires a well-established securities market with research infrastructure to determine Beta, risk-free rates of return, market rates of return, etc. This approach cannot be applied directly in situations where these market data are not available.
Public sector organizations

Public enterprises should also be interested in the concept of cost of capital. Often they find it difficult to identify their cost of capital because they do not have ready access to market data. But as they are constantly making capital investment decisions, the concept of a required rate of return is relevant. Often public enterprises have the required rate of return prescribed by a regulatory agency or a supervisory ministry, although there is well-documented literature dealing with the difficulties that can arise from setting required rates of return, notably with regard to pricing and investment policy. However, many regulatory agencies and supervisory ministries do set required rates of return for public enterprises.

4.4 Evaluating long-term investments

In this section we will consider the techniques for evaluating a firm’s potential investment projects using the cost of capital for evaluating the viability of such projects. We will also consider some other evaluation techniques.

When a firm is considering its long-term investment alternatives it should limit its projects to those that are consistent with its overall objectives and business strategy. In addition, potential projects should only be considered viable if they can cover the cost of funds to the firm. If more viable projects are identified than can be funded, then some method of selecting the most desirable projects must be found.

The evaluation of projects, whilst involving financial and quantitative data, will also involve non-financial and descriptive data. In the end managers will have to use their judgement on the weight to be attributed to the various factors.

Identification of the financial factors involves the periodic, after-tax (if applicable) cash flows that the project will generate throughout its expected life. For all taxable entities, the cash flows will have some tax consequences and these must be adjusted for. In the case of non-taxable entities, before- and after-tax cash flows are the same, since tax is zero. Perhaps the most prudent approach is always to calculate the project’s after-tax cash flows.

Calculating a project’s after-tax cash flows will involve many factors. Some of the more common items are: the initial cost of the investment and the timing of the outlay(s); the expected life of the project; estimates of the end-of-project value of the assets; the after-tax cash flows that will be generated by the project during each year; taxation assumptions regarding investment allowance, corporate taxes, capital gains tax, etc.; the cost of capital or required rate of return and the sensitivity of the outcome to changes in any of the assumptions regarding the above factors.

To discuss these issues we will use the following terms:

- discounted cash flow (DCF);
- net present value (NPV);
- internal rate of return (IRR);
- accounting rate of return;
Discounted cash flow (DCF) refers to the technique for converting a future estimated stream of cash flows into their present value. There are two broad approaches, which are known as net present value (NPV) and internal rate of return (IRR).

Net present value (NPV) is used when the discount rate or required rate of return is known, which facilitates calculation of the project’s NPV.

Internal rate of return (IRR) is used when the project’s cash flows are known and the implied discount rate or internal rate of return (IRR) is calculated.

The accounting rate of return is the average annual profit that a project is expected to yield, divided by the amount of capital investment. This technique uses accounting profit rather than cash flows. It also ignores the time value of money which is embodied in DCF techniques.

The payback period refers to the number of years that it will take the cash inflows from a project to offset the cash outflows. It provides an indication of the speed with which a project can recover the cash flows required for it to be undertaken.

All these techniques could be used to assess long-term investments.

**Accounting rate of return**

As mentioned above, the accounting rate of return is the average annual profit that a project is expected to yield, divided by the amount of capital investment. This calculation is usually expressed as a percentage and can be written as a formula:

\[
\text{Accounting rate of return} = \frac{\text{Average annual profit}}{\text{Capital investment}} \times 100
\]

Projects Ltd. is considering an investment project involving an outlay of $36,000. The project has an estimated life of six years with annual after-tax cash inflows of $13,000. The total accumulated accounting profits over the project’s life are estimated to be $42,000. It is possible to use this information to calculate the accounting rate of return on this project:

\[
\frac{\text{Average annual profit}}{\text{Capital investment}} \times 100 \times \frac{\$42,000/6}{\$36,000} \times 100 = 19.44 \text{ per cent}
\]

This project provides an accounting rate of return of 19.44 per cent. If the company ranks its investment projects on the basis of accounting rate of return, then it will select projects with the highest accounting rate of return, up to the limit of its available investment funds.

It is also quite common with this evaluation technique to use the average capital invested as the denominator. This causes the accounting rate of return to be higher than when it is calculated using the capital invested as the denominator. This approach is criticized because it takes
no account of the time value of money, which results in end-of-project profits being given equal weight with beginning-of-project profits. It is also criticized because it uses accounting profits rather than after-tax cash flows. Despite these criticisms it is still used as a long-term investment evaluation technique.

Payback period

The payback period uses after-tax cash flow data to determine the number of years that it will take the cash inflows from a project to offset the outflows. It is usually expressed in terms of the number of years or part years that are needed to recover the funds invested. If we take the example involving Projects Ltd. above, then it is possible to calculate the payback period using the following formula:

Payback period:

\[
\frac{\text{Capital investment}}{\text{Net cash inflow (after tax)}} = \frac{\$36,000}{\$13,000} = 2.77 \text{ years}
\]

The above formula can only be used in those rare circumstances when the after-tax cash flows are equal.

Assume that Projects Ltd. expects cash flows for years 1 to 6 of $8,000, $12,000, $12,000, $15,000, $16,000 and $15,000 respectively. What is the payback period? It is clear that Projects Ltd. will recover the capital investment sometime in the fourth year of the project (i.e. after year 3 the cash inflow will be $32,000 and after year 4 it will be $57,000). In other words the first $4,000 of cash flow generated in year 4 will see the initial investment recovered. Assuming that the cash flow will be earned uniformly in year 4, then it will take 0.27 of year 4 to achieve this (i.e. $4,000/$15,000 for the year). The payback period for this project is 3.27 years. The payback period would rank projects according to the speed with which they recover the initial investment, but it ignores the overall return that a project will generate over its expected life. Again, this technique for evaluating long-term investments is criticized because it does not take into account the time value of money. It treats cash flows as being of equal value up to and until the initial investment is recovered. Despite these criticisms this technique is still among the evaluation techniques used for long-term investment decisions.

Net present value (NPV)

The net present value (NPV) approach and the internal rate of return (IRR) approach use the discounted cash flow (DCF) technique to evaluate projects. The DCF technique attempts to restate future cash flows in terms of their value at the start of the project (i.e. in terms of present value), assuming that more immediate cash flows are more attractive than those that are more distant. This idea is known as the time value of money.

To calculate the present values for a project we need to know the initial investment, the after-tax cash flows that the project will yield during its estimated life and the firm’s cost of capital, which is its required rate of return.
Assume that Projects Ltd. is considering undertaking two mutually exclusive projects. They each involve an investment of $36,000 at the beginning of year 1. Project 1 and Project 2 are expected to yield the following cash flows over their estimated lives of 6 years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Project 1</th>
<th>Project 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$13,000</td>
<td>$0</td>
</tr>
<tr>
<td>2</td>
<td>$13,000</td>
<td>$0</td>
</tr>
<tr>
<td>3</td>
<td>$13,000</td>
<td>$0</td>
</tr>
<tr>
<td>4</td>
<td>$13,000</td>
<td>$0</td>
</tr>
<tr>
<td>5</td>
<td>$13,000</td>
<td>$0</td>
</tr>
<tr>
<td>6</td>
<td>$13,000</td>
<td>$150,000</td>
</tr>
</tbody>
</table>

How can we calculate the net present value for these projects, determine if they meet the company’s cost of capital requirement (which is 20 per cent) and then select the best project on an NPV basis?

To calculate the NPV, we need to use a present value table, as shown in table 11.18.

For each year of the projects’ estimated life, it is necessary to determine the appropriate discount factor. For example, to find the discount factor for year 1, it is necessary to look up the value that coincides with year 1 and a 20 per cent required rate of return, which is 0.833. The discount factors for years 2 to 6 are found in the same way. The discount factor for the initial investment at the beginning of the projects is 1.

The calculations in table 11.19 indicate that both projects are viable as they have a positive NPV. But in a situation where the firm can only undertake one project, it will select Project 2 because it has the largest NPV and therefore offers the highest return.
## Table 11.18: Present value table

<table>
<thead>
<tr>
<th>Years to Be Discounted</th>
<th>2%</th>
<th>4%</th>
<th>6%</th>
<th>8%</th>
<th>10%</th>
<th>12%</th>
<th>15%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.9800</td>
<td>0.9609</td>
<td>0.9417</td>
<td>0.9235</td>
<td>0.9060</td>
<td>0.8900</td>
<td>0.8753</td>
<td>0.8573</td>
<td>0.7629</td>
<td>0.6805</td>
<td>0.6045</td>
</tr>
<tr>
<td>2</td>
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<td>0.9246</td>
<td>0.8890</td>
<td>0.8553</td>
<td>0.8235</td>
<td>0.7938</td>
<td>0.7664</td>
<td>0.7313</td>
<td>0.6380</td>
<td>0.5542</td>
<td>0.4823</td>
</tr>
<tr>
<td>3</td>
<td>0.9417</td>
<td>0.8930</td>
<td>0.8453</td>
<td>0.8062</td>
<td>0.7692</td>
<td>0.7312</td>
<td>0.6938</td>
<td>0.6505</td>
<td>0.5574</td>
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<td>0.8730</td>
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<td>0.7710</td>
<td>0.7246</td>
<td>0.6790</td>
<td>0.6365</td>
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<td>0.3475</td>
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<td>0.8052</td>
<td>0.7513</td>
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<td>0.8900</td>
<td>0.8219</td>
<td>0.7637</td>
<td>0.7083</td>
<td>0.6567</td>
<td>0.6042</td>
<td>0.5557</td>
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<td>0.3351</td>
<td>0.2670</td>
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<td>7</td>
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<td>0.7891</td>
<td>0.7283</td>
<td>0.6680</td>
<td>0.6174</td>
<td>0.5644</td>
<td>0.5152</td>
<td>0.4657</td>
<td>0.3763</td>
<td>0.2980</td>
<td>0.2295</td>
</tr>
<tr>
<td>8</td>
<td>0.8617</td>
<td>0.7710</td>
<td>0.7058</td>
<td>0.6445</td>
<td>0.5934</td>
<td>0.5385</td>
<td>0.4875</td>
<td>0.4372</td>
<td>0.3481</td>
<td>0.2704</td>
<td>0.2025</td>
</tr>
<tr>
<td>9</td>
<td>0.8475</td>
<td>0.7552</td>
<td>0.6887</td>
<td>0.6253</td>
<td>0.5727</td>
<td>0.5161</td>
<td>0.4635</td>
<td>0.4131</td>
<td>0.3250</td>
<td>0.2480</td>
<td>0.1811</td>
</tr>
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<td>10</td>
<td>0.8339</td>
<td>0.7394</td>
<td>0.6715</td>
<td>0.6066</td>
<td>0.5529</td>
<td>0.4949</td>
<td>0.4413</td>
<td>0.3907</td>
<td>0.3039</td>
<td>0.2280</td>
<td>0.1619</td>
</tr>
<tr>
<td>11</td>
<td>0.8209</td>
<td>0.7235</td>
<td>0.6546</td>
<td>0.5896</td>
<td>0.5350</td>
<td>0.4749</td>
<td>0.4213</td>
<td>0.3706</td>
<td>0.2852</td>
<td>0.2093</td>
<td>0.1432</td>
</tr>
<tr>
<td>12</td>
<td>0.8085</td>
<td>0.7076</td>
<td>0.6376</td>
<td>0.5726</td>
<td>0.5171</td>
<td>0.4559</td>
<td>0.4020</td>
<td>0.3512</td>
<td>0.2658</td>
<td>0.1900</td>
<td>0.1239</td>
</tr>
<tr>
<td>13</td>
<td>0.7967</td>
<td>0.6915</td>
<td>0.6106</td>
<td>0.5456</td>
<td>0.4891</td>
<td>0.4267</td>
<td>0.3726</td>
<td>0.3217</td>
<td>0.2363</td>
<td>0.1605</td>
<td>0.0943</td>
</tr>
<tr>
<td>14</td>
<td>0.7855</td>
<td>0.6753</td>
<td>0.5896</td>
<td>0.5285</td>
<td>0.4712</td>
<td>0.4076</td>
<td>0.3532</td>
<td>0.3023</td>
<td>0.2169</td>
<td>0.1409</td>
<td>0.0748</td>
</tr>
<tr>
<td>15</td>
<td>0.7748</td>
<td>0.6590</td>
<td>0.5686</td>
<td>0.5115</td>
<td>0.4531</td>
<td>0.3885</td>
<td>0.3340</td>
<td>0.2831</td>
<td>0.2076</td>
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<td>0.0658</td>
</tr>
<tr>
<td>16</td>
<td>0.7647</td>
<td>0.6427</td>
<td>0.5476</td>
<td>0.4945</td>
<td>0.4350</td>
<td>0.3689</td>
<td>0.3144</td>
<td>0.2635</td>
<td>0.1880</td>
<td>0.1119</td>
<td>0.0458</td>
</tr>
<tr>
<td>17</td>
<td>0.7552</td>
<td>0.6263</td>
<td>0.5266</td>
<td>0.4775</td>
<td>0.4168</td>
<td>0.3496</td>
<td>0.2950</td>
<td>0.2441</td>
<td>0.1684</td>
<td>0.0918</td>
<td>0.0258</td>
</tr>
<tr>
<td>18</td>
<td>0.7463</td>
<td>0.6100</td>
<td>0.5056</td>
<td>0.4605</td>
<td>0.3986</td>
<td>0.3292</td>
<td>0.2745</td>
<td>0.2236</td>
<td>0.1498</td>
<td>0.0728</td>
<td>0.0157</td>
</tr>
<tr>
<td>19</td>
<td>0.7380</td>
<td>0.5936</td>
<td>0.4846</td>
<td>0.4435</td>
<td>0.3804</td>
<td>0.3178</td>
<td>0.2630</td>
<td>0.2120</td>
<td>0.1352</td>
<td>0.0538</td>
<td>0.0057</td>
</tr>
<tr>
<td>20</td>
<td>0.7302</td>
<td>0.5771</td>
<td>0.4636</td>
<td>0.4265</td>
<td>0.3622</td>
<td>0.2954</td>
<td>0.2424</td>
<td>0.1915</td>
<td>0.1127</td>
<td>0.0348</td>
<td>0.0056</td>
</tr>
</tbody>
</table>

Note: The table entries represent the present value factor for a single payment discounted at the indicated interest rate over the specified number of years.
Table 11.19: NPV of Project 1 and Project 2

<table>
<thead>
<tr>
<th>Year</th>
<th>Project 1</th>
<th>Project 2</th>
<th>Discount factor</th>
<th>Present value Project 1</th>
<th>Present value Project 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>($36,000)</td>
<td>($36,000)</td>
<td>1.000</td>
<td>($36,000)</td>
<td>($36,000)</td>
</tr>
<tr>
<td>1</td>
<td>13,000</td>
<td>0</td>
<td>0.833</td>
<td>10,829</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>13,000</td>
<td>0</td>
<td>0.694</td>
<td>9,022</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>13,000</td>
<td>0</td>
<td>0.579</td>
<td>7,527</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>13,000</td>
<td>0</td>
<td>0.482</td>
<td>6,266</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>13,000</td>
<td>0</td>
<td>0.402</td>
<td>5,226</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>13,000</td>
<td>150,000</td>
<td>0.335</td>
<td>$7,225</td>
<td>$14,250</td>
</tr>
<tr>
<td>NPV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Internal rate of return (IRR)

The internal rate of return (IRR) is also a DCF technique, but it attempts to solve for the underlying interest rate (IRR). Basically, it involves solving for the implicit interest rate, where the initial investment is just equal to the present value of the projects after-tax cash flows.

In the case of Project 1 for Projects Ltd, we would solve for the interest rate i where:

\[
$36,000 = \frac{13,000}{(1+i)} + \frac{13,000}{(1+i)^2} + \frac{13,000}{(1+i)^3} + \frac{13,000}{(1+i)^4} + \frac{13,000}{(1+i)^5} + \frac{13,000}{(1+i)^6}
\]

Conceptually, it is a simple matter to think of the underlying return that this expression implies. The complex part involves solving for this interest rate. The expression cannot be rearranged in terms of i. Consequently, i must be found by trial and error.

We can begin trying to solve for the IRR by trying a specific value of i. Let us begin by trying 26 per cent. Using 26 per cent we can prepare table 11.20. It is apparent that 26 per cent is below the IRR as Project 1 has a positive NPV at this interest rate.

Table 11.20: Finding IRR of Project 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Project 1</th>
<th>Discount factor</th>
<th>Present value Project 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>($36,000)</td>
<td>1.000</td>
<td>($36,000)</td>
</tr>
<tr>
<td>1</td>
<td>13,000</td>
<td>0.794</td>
<td>10,322</td>
</tr>
<tr>
<td>2</td>
<td>13,000</td>
<td>0.630</td>
<td>8,190</td>
</tr>
<tr>
<td>3</td>
<td>13,000</td>
<td>0.500</td>
<td>6,500</td>
</tr>
<tr>
<td>4</td>
<td>13,000</td>
<td>0.397</td>
<td>5,161</td>
</tr>
<tr>
<td>5</td>
<td>13,000</td>
<td>0.315</td>
<td>4,095</td>
</tr>
<tr>
<td>6</td>
<td>13,000</td>
<td>0.250</td>
<td>3,250</td>
</tr>
<tr>
<td>NPV</td>
<td></td>
<td></td>
<td>$1,518</td>
</tr>
</tbody>
</table>
To continue our search for the IRR we must try another interest rate, which is greater than 26 per cent, thus reducing the present value of the cash inflows. We can prepare another table, trying an interest rate of 28 per cent. The results of these calculations are shown in table 11.21.

Table 11.21: Finding IRR of Project 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Project 1</th>
<th>Discount factor</th>
<th>Present value $</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>($36,000)</td>
<td>1.000</td>
<td>($36,000)</td>
</tr>
<tr>
<td>1</td>
<td>13,000</td>
<td>0.781</td>
<td>10,153</td>
</tr>
<tr>
<td>2</td>
<td>13,000</td>
<td>0.610</td>
<td>7,930</td>
</tr>
<tr>
<td>3</td>
<td>13,000</td>
<td>0.477</td>
<td>6,201</td>
</tr>
<tr>
<td>4</td>
<td>13,000</td>
<td>0.373</td>
<td>4,849</td>
</tr>
<tr>
<td>5</td>
<td>13,000</td>
<td>0.291</td>
<td>3,783</td>
</tr>
<tr>
<td>6</td>
<td>13,000</td>
<td>0.227</td>
<td>2,951</td>
</tr>
<tr>
<td></td>
<td>NPV</td>
<td></td>
<td>$(33)</td>
</tr>
</tbody>
</table>

It is clear from table 11.21 that the IRR is very close to 28 per cent, as the project NPV using this interest rate is very close to zero. In fact it is possible to approximate the real IRR, which is between 26 and 28 per cent by using linear interpolation. This is a technique for approximating the IRR assuming a linear relationship between the NPV and interest rate. Whilst the relationship is in fact curvo-linear, any error will be small if the distance between the two observations (in our example 26 and 28 per cent) is not too great. The IRR can be estimated using the following formula:

\[
\text{IRR} = \text{LBR} + \frac{\text{LBNPV}}{\text{LBNPV} - \text{UBNPV}} \times \text{change in interest rates}
\]

Where:
- IRR = internal rate of return
- LBR = lower bound interest rate (26 per cent)
- LBNPV = lower bound NPV (NPV associated with lower interest rate of 26 per cent)
- UBNPV = upper bound NPV (NPV associated with higher interest rate of 28 per cent)

Using this formula, it is possible to estimate the IRR for Project 1.

\[
\text{IRR} = \text{LBR} + \frac{\text{LBNPV}}{\text{LBNPV} - \text{UBNPV}} \times \text{change in interest rates}
\]

\[
= 0.26 + \frac{\$1,518}{($1,518 - $33)} \times 0.02 = 0.2796 \text{ or 27.96 per cent}
\]

Using the same methodology, it is possible to find the IRR for Project 2, which is 26.85 per cent.
The NPV analysis and the IRR analysis yield conflicting results. The NPV analysis suggests that Project 2 is the best project, whereas the IRR analysis indicates that Project 1 is preferred. How is it that two DCF techniques can present us with conflicting advice? The difference in ranking arises because of differences in the implied re-investment rates. The IRR method presumes that cash inflows received during the project's life (Project 1 in our example) can be re-invested at a rate equal to the IRR on that project, whereas the NPV method assumes that any intermediate cash inflows (in Project 1) can be re-invested at the cost of capital (20 per cent in our NPV evaluation). Under the NPV method, intermediate cash flows are assumed to be re-invested at 20 per cent, but IRR assumes that they are re-invested at 27.95 per cent.

**NPV versus IRR**

The NPV approach is regarded as conceptually superior to the IRR approach. The NPV assumption that cash flows generated during a project’s life may be re-invested at the cost of capital is realistic to the extent that this opportunity cost rate is found by reference to the firm’s cost of capital. On the other hand the IRR assumption that these intermediate cash flows can be re-invested at the IRR is quite artificial and there is no market justification for the assumption.

A further reason advanced in support of NPV is that it provides a measure of the firm’s increase in value (NPV) as a result of taking on the project. With IRR, the firm only has a measure of the annual compound rate of return on the project, which does not signal the extent that the firm’s wealth will be increased.

For these reasons, the NPV approach is regarded as the best DCF capital investment evaluation technique.

**Mutually exclusive projects with unequal lives**

A practical problem for many firms engaging in evaluation of long-term investments is that they often have alternative projects that are mutually exclusive and which have different lives. For example Projects Ltd. may be faced with a choice between Project 1 and Project 2 to enhance its manufacturing capacity. They may each provide the same production capacity, but Project 1 may have an estimated life of 3 years and Project 2 may have an estimated life of 2 years. How might Projects Ltd. evaluate these alternatives?

There are several approaches that might be used which include:

- evaluating the alternative projects over a period which represents the lowest common multiple of their lives;
- using the equivalent annual cost method;
- incorporating estimated terminal values into the investment evaluation process.

In the case of the lowest common multiple technique, the firm may wish to choose between a 2-year project and a 3-year project. The lowest common multiple of these project lives is 6 years. The firm can then compare the NPV of three combined projects with a 2-year life with the NPV of two combined projects with a 3-year life. It should select the project which will
yield the highest NPV over the 6 years.

The equivalent annual cost method involves converting the NPV for each project to its annual equivalent. This can be done using the following formula:

\[
\text{Projects NPV} = \text{Equivalent annual amount} \times \text{An}_i
\]

Where \( \text{An}_i \) = Present value of an annuity of $1 received during the project’s life (for \( n \) years) at \( i \) per cent (the cost of capital)

The above expression can be re-written in terms of the equivalent annual amount:

\[
\text{Equivalent annual amount} = \frac{\text{Projects NPV}}{\text{An}_i}
\]

For each alternative project the equivalent annual amount can be calculated and the project which generates the highest equivalent annual amount will be selected.

Another approach in these situations is to use terminal values as an integral part of the NPV analysis. For example Projects Ltd. may wish to choose between an investment with a 3-year life and another with 4-year life. To use either of the above techniques assumes an investment period of 12 years, given that the lowest common multiple of 3 and 4 is 12.

The terminal value approach assumes that each project has a life of 3 years, the lowest project life of the alternative investments. For the 4-year investment alternative, the life would be adjusted to 3 years and the NPV analysis would incorporate the terminal values of any assets at the end of the third year as cash inflows. This method suffers the obvious disadvantages of arbitrarily cutting short a project’s life for evaluation purposes and estimating the residual values of the assets is likely to be difficult.

**Single period capital rationing**

So far we have simply suggested that the firm should regard projects as viable if they are expected to produce a positive NPV. What might the firm do if it has insufficient funds to undertake all the projects that produce a positive NPV?

It can start out by ranking projects on the size of the NPV. But this ignores the investment required to generate the NPV. It is appropriate to calculate the NPV index for the projects and rank them on this basis. The NPV index is found by using the following formula:

\[
\text{NPV index} = \frac{\text{Project's NPV}}{\text{Initial investment}}
\]

However, ranking projects on this basis can also give rise to problems in capital rationing situations, due to the lumpiness of investment projects and the limited investment funds available.
Assume that Projects Ltd. has evaluated four projects. It has a limit of $1 million to invest and wishes to select the most profitable combination. The loss of profitability that would result from slavishly applying the NPV index can be illustrated by the example in table 11.22.

**Table 11.22: Problem of relying solely on the NPV index to rank projects**

<table>
<thead>
<tr>
<th>Project</th>
<th>Initial investment</th>
<th>Net present value</th>
<th>NPV index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$600,000</td>
<td>$720,000</td>
<td>1.20</td>
</tr>
<tr>
<td>2</td>
<td>550,000</td>
<td>649,000</td>
<td>1.18</td>
</tr>
<tr>
<td>3</td>
<td>450,000</td>
<td>517,500</td>
<td>1.15</td>
</tr>
<tr>
<td>4</td>
<td>300,000</td>
<td>330,000</td>
<td>1.10</td>
</tr>
</tbody>
</table>

If the firm selects Project 1, then it can only combine it with Project 4, given the limit of $1 million to invest. These two projects yield a combined NPV of $1,050,000. But undertaking Projects 3 and 4 will yield an NPV of $1,166,500. The company needs to select the combination of projects that will generate the highest total NPV and in the above example, it would select Projects 3 and 4.

**Inflation adjustments**

Inflation can affect long-term investment evaluation. For example, it generally means that providers of capital will expect nominal interest rates to be higher as the level of inflation rises. Inflation can also pose problems in estimating the cash flows associated with projects; it will give rise to an increase in the nominal dollar cash flows over time.

To address the impact of inflation on cash flows, firms have two basic choices. They can either predict the cash flows in nominal dollars, therefore including the inflation boost to cash flows. Alternatively, they can predict the cash flows in real terms, excluding any future inflation impacts.

If the cash flows are in nominal dollars (inflation included), then the cost of capital needs to reflect the expected level of inflation throughout the project's life. This means that a nominal interest rate should be used. However, if the cash flows exclude the impact of inflation and are in real dollars, then the cost of capital should reflect the real cost of capital.

**Questions for exercises and discussion**

1. Computer Ltd. manufactures personal computers. It purchases printed circuit boards from suppliers at a cost of $10 each. It uses 600,000 boards a year and the variable cost of processing an order is $200. The variable cost of holding a unit of this inventory for a year is estimated $0.60.
   Determine the economic order quantity.

2. Computer Ltd. operates a 300-day working year. The lead time from placement of an order until the items are received is 6 days.
   Determine the reorder point.
3. Capital Investments is presently evaluating two alternatives for investing its whole capital expenditure budget for the year, which is $60,000. Each of the two projects requires an outlay of $60,000 at commencement. They will generate the following after-tax cash flows over their useful lives of 5 years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Project 1</th>
<th>Project 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$12,000</td>
<td>$0</td>
</tr>
<tr>
<td>2</td>
<td>$24,000</td>
<td>$0</td>
</tr>
<tr>
<td>3</td>
<td>$24,000</td>
<td>$0</td>
</tr>
<tr>
<td>4</td>
<td>$20,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>5</td>
<td>$20,000</td>
<td>$100,000</td>
</tr>
</tbody>
</table>

The 5-year accounting profits from Project 1 are $40,000, whereas for Project 2 they are $70,000. The company has a cost of capital of 15 per cent and seeks your assistance to rank the projects using:

(a) the accounting rate of return;
(b) the payback period;
(c) NPV;
(d) IRR.

Are the NPV and IRR rankings different? If so, what is the reason and which method would you rely on?

4. Investment Potential Ltd. has five viable investment projects in NPV terms and a limit of $2 million to invest in the period. It has prepared the table below indicating each project’s initial investment, NPV and NPV index.

<table>
<thead>
<tr>
<th>Project</th>
<th>Initial investment</th>
<th>Net present value</th>
<th>NPV index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$1,300,000</td>
<td>$1,690,000</td>
<td>1.30</td>
</tr>
<tr>
<td>2</td>
<td>800,000</td>
<td>1,000,000</td>
<td>1.25</td>
</tr>
<tr>
<td>3</td>
<td>800,000</td>
<td>960,000</td>
<td>1.20</td>
</tr>
<tr>
<td>4</td>
<td>400,000</td>
<td>476,000</td>
<td>1.19</td>
</tr>
<tr>
<td>5</td>
<td>400,000</td>
<td>440,000</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Advise Investment Potential regarding the best combination of investment projects to undertake, given its limited funds of $2 million.
Answers to Questions

Question 1

\[ EOQ = \sqrt{\frac{2V \times U}{CP}} \]

Where:
- \( EOQ \) = economic order quantity
- \( V \) = variable cost per order (dollars)
- \( U \) = annual usage in a year (units)
- \( CP \) = cost of holding a unit stock for a year (dollars)

In the case of Computers Ltd. its EOQ can be found by using the above formula.

\[ EOQ = \sqrt{\frac{2 \times 200 \times 600,000}{0.60}} = 20,000 \text{ (printed circuit boards)} \]

Question 2

The reorder point is found by using the following formula

\[ R = \frac{LU}{W} \]

Where:
- \( L \) = lead time for supplier to deliver after order is received
- \( U \) = annual usage in a year (units)
- \( W \) = number of working days in a year.

\[ R = \frac{6 \times 600,000}{300} = 12,000 \text{ (reorder when inventory reaches this level)} \]

Question 3

(a) The accounting rate of return is given by the following formula:

\[ \text{Accounting rate of return} = \frac{\text{Average annual profit} \times 100}{\text{Capital investment}} \]

For Project 1:

\[ \frac{\$40,000/5 \times 100}{\$60,000} = 13.33 \text{ per cent} \]
Module 11
Unit 4

For Project 2 = $70,000/5 \times \frac{x 100}{60,000}

= 23.33$ per cent

Project 2 is the preferred project.

(b) The payback period for Project 1 is 3 years. The payback period for Project 2 is 4.3 years. Project 1 is the preferred project.

(c) The NPV for Projects 1 and 2 are calculated in the table below.

NPV of Project 1 and Project 2

Calculation of net present value

<table>
<thead>
<tr>
<th>Year</th>
<th>Project 1</th>
<th>Project 2</th>
<th>Discount factor</th>
<th>Present value Project 1</th>
<th>Present value Project 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>($60,000)</td>
<td>($20,000)</td>
<td>1.000</td>
<td>($60,000)</td>
<td>(60,000)</td>
</tr>
<tr>
<td>1</td>
<td>12,000</td>
<td>0</td>
<td>0.870</td>
<td>10,440</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>24,000</td>
<td>0</td>
<td>0.756</td>
<td>18,144</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>24,000</td>
<td>0</td>
<td>0.658</td>
<td>15,792</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>20,000</td>
<td>30,000</td>
<td>0.572</td>
<td>11,440</td>
<td>17,160</td>
</tr>
<tr>
<td>5</td>
<td>20,000</td>
<td>100,000</td>
<td>0.497</td>
<td>9,940</td>
<td>49,700</td>
</tr>
</tbody>
</table>

On the basis of NPV, Project 2 is preferred.

(d) To find the IRR for Project 1, let’s try an i of 18 per cent. The following tables show the calculations.

Finding IRR of Project 1

Calculation of internal rate of return

<table>
<thead>
<tr>
<th>Year</th>
<th>Project 1</th>
<th>Discount factor</th>
<th>Present value Project 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>($60,000)</td>
<td>1.000</td>
<td>($60,000)</td>
</tr>
<tr>
<td>1</td>
<td>12,000</td>
<td>0.847</td>
<td>10,164</td>
</tr>
<tr>
<td>2</td>
<td>24,000</td>
<td>0.718</td>
<td>17,232</td>
</tr>
<tr>
<td>3</td>
<td>24,000</td>
<td>0.609</td>
<td>14,616</td>
</tr>
<tr>
<td>4</td>
<td>20,000</td>
<td>0.516</td>
<td>10,320</td>
</tr>
<tr>
<td>5</td>
<td>20,000</td>
<td>0.437</td>
<td>8,740</td>
</tr>
</tbody>
</table>

NPV

It is evident that 18 per cent is below the actual IRR as the NPV is still positive. The result of trying 19 per cent is shown in the table below.
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Unit 4

Finding IRR of Project 1

Calculation of internal rate of return

<table>
<thead>
<tr>
<th>Year</th>
<th>Project 1</th>
<th>Discount factor</th>
<th>Present value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>($60,000)</td>
<td>1.000</td>
<td>($60,000)</td>
</tr>
<tr>
<td>1</td>
<td>12,000</td>
<td>0.840</td>
<td>10,080</td>
</tr>
<tr>
<td>2</td>
<td>24,000</td>
<td>0.706</td>
<td>16,944</td>
</tr>
<tr>
<td>3</td>
<td>24,000</td>
<td>0.593</td>
<td>14,232</td>
</tr>
<tr>
<td>4</td>
<td>20,000</td>
<td>0.499</td>
<td>9,980</td>
</tr>
<tr>
<td>5</td>
<td>20,000</td>
<td>0.419</td>
<td>8,380</td>
</tr>
</tbody>
</table>

The NPV at 19 per cent is slightly negative, indicating that the IRR is below 19 per cent. It is possible to approximate the IRR by using linear interpolation.

\[
\text{IRR} = \text{LBR} + \frac{\text{LBNPV}}{\text{LBNPV} - \text{UBNPV}} \times \text{change in interest rate}
\]

\[
= 0.18 + \frac{1,072}{(1,072 - 384)} \times 0.02 = 0.1874 \text{ or } 18.74 \text{ per cent}
\]

Using the same technique, it is possible to find the IRR for Project 2, which is 17.66 per cent.

The NPV and IRR rankings are contradictory and for the reasons outlined in this unit, the NPV approach is considered the superior.

Question 4

The most beneficial combination of projects is 2, 3 and 4 which offer a combined NPV of $2,436,000. No other combination of projects involving a combined investment of $2 million or less will yield a higher combined NPV.
MODULE REVIEW

This module suggested that accounting and finance consists of three areas, namely:

- financial accounting;
- management accounting;
- financial management.

Financial accounting is principally concerned with gathering information about transactions, to enable the firm to report its income and financial position via the income statement and balance sheet, to its shareholders. The major focus of management accounting is the provision of information to managers as a means of assisting them to carry out the tasks of planning, controlling, organizing, communicating and motivating. Financial management, on the other hand, is concerned with decisions in terms of selecting investments, achieving an appropriate capital structure and developing a dividend policy.

An overview of the financial reporting process has been given. The ILO’s programmed guide: “How to read a balance sheet” was used to explain the role of income statements in measuring financial performance and to develop an understanding of balance sheets as statements of financial position. The assumptions underlying accounting or accounting principles were also outlined, together with the five basic groups of accounts. Some basic ratios were presented and the nature and use of the du Pont formula was discussed.

A number of topics in management accounting have been covered, including cost behaviour patterns, and ways to determine cost behaviour information for break-even analysis, which can encompass production/sales planning and profit planning. The differences between variable and absorption costing have also been addressed in terms of their different timing effects, so far as the income statement and the balance sheet are concerned. The benefits of variable costing concepts for managerial planning and decision making, especially in the short run, have been discussed. The management accounting section concluded with a study of financial planning and budgeting (encompassing incremental master budgets and zero-base budgets) and standard cost systems.

The financial management section addressed working capital management and long-term investment decision making. The section stressed the need for firms to effectively manage their overall working capital and the individual components of working capital. A comprehensive approach to effective management of cash, inventories and accounts receivable was identified. The financial management unit concluded with a consideration of long-term investment evaluation to demonstrate the use of discounting techniques for evaluating the firm’s capital investment alternatives. Various techniques for capital investment evaluation were considered, including the internal rate of return (IRR) and the net present value (NPV) methods.

This range of topics should assist you to better contribute to management and to be active in productivity improvement within your organization when financial issues arise. The central purpose of this module is to encourage you to focus on the financial consequences of decisions that you take, or participate in, as a manager.
Action guidelines

The materials in this module are highly relevant to productivity improvement. The examples below are illustrations and do not represent an exhaustive list of the ways that the materials might be used by participants for productivity improvement.

Financial accounting

The unit dealing with financial accounting will be of use in the following ways:

(a) to understand financial accounting processes and the financial statement consequences of alternative courses of action;
(b) to analyse the company’s financial statements and assess the major factors that have contributed to a changed financial situation since the last period;
(c) to analyse a competitor(s) financial statements and assess the major factors that have contributed to a changed financial situation since the last period;
(d) to use the analysis in (b) and (c) to assess the firm's financial strengths and weaknesses vis-à-vis its competitor(s).

Management accounting

The unit dealing with management accounting will be of use in the following ways:

(a) to utilize statistical and other techniques to determine cost behaviour patterns from raw cost data;
(b) to determine production and sales volumes necessary to break even or to achieve predetermined profit levels;
(c) to use variable costing information for management decision making and to understand that income and valuation outcomes may be different in single periods under variable and absorption costing;
(d) to use relevant cost, unavoidable cost, opportunity cost and sunk cost concepts, and to distinguish between variable and fixed costs in taking short-term decisions;
(e) to calculate and present the differential costs as a means of highlighting the difference between two alternatives in short-term decision making;
(f) to use integrated budgeting, with a master budget, sales, production and wages sub-budgets, as an important element of medium- to short-term financial planning and control;
(g) to use standard costs as an important adjunct in medium- to short-term planning and control, in situations where firms are manufacturing relatively homogeneous products;
(h) to take a zero-base budgeting approach to consider objectives and output measures, develop and rank decision packages when planning for future periods.

Financial management

The unit dealing with financial management will be of use in the following ways:

(a) to manage working capital (current assets less current liabilities) as an important element of managing the firm's resources. This is because underinvestment will give rise to liquidity problems and overinvestment will result in lower returns to shareholders;
(b) to select appropriate techniques in the management of individual working capital items, such as cash, debtors, accounts receivable and inventories;
(c) to use arithmetical and mathematical techniques for evaluating long-term investments. The mathematical approach is referred to as the discounted cash flow (DCF) technique, which is considered conceptually superior to the alternatives. With the DCF technique there are two basic methods, net present value (NPV) and internal rate of return (IRR). The NPV method is considered to be conceptually superior. When undertaking long-term investment evaluation, there are additional techniques for mutually exclusive projects with unequal lives, single period capital rationing and adjusting for the impact of inflation.
BIBLIOGRAPHY


MODULE 12
CAPITAL PRODUCTIVITY MANAGEMENT
MODULE 12:  LEARNING OBJECTIVES

Once you have learnt this module, you will be able to:

1. Understand the role of capital productivity in profitability improvement.
2. Explain the structure of capital assets and identify the tied-up capital among its elements.
3. Be aware of the most important approaches and methods of improving capital productivity.
4. Participate in capital productivity projects and assess their results.

MODULE 12:  CONTENTS

UNIT 1:  From cost control to profitability analysis
UNIT 2:  The structure of capital assets
UNIT 3:  Analysing tied-up capital
UNIT 4:  Improvement areas and ways of improvement
UNIT 5:  Using capital productivity projects
UNIT 6:  Measures and following up of results

Bibliography
UNIT 1: FROM COST CONTROL TO PROFITABILITY ANALYSIS

UNIT 1: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and explain the relationship between productivity and profitability and the main economic categories involved (profit, working capital, sales, profit margin, return on net assets, etc.).

2. Define fixed capital and distinguish it from variable (working) capital and understand its importance in capital productivity improvement.

3. Understand the Du-Pont model integrating the most important profitability factors and analyse the effect on productivity of changes in factors.

UNIT 1: CONTENTS

1.1 Capital productivity

1.2 Profit and profitability

1.3 The Du-Pont model for profitability analysis
UNIT 1: FROM COST CONTROL TO PROFITABILITY ANALYSIS

This module is based on the experiences of the Swedish Federation of Productivity Services (SRF) over the past ten years.

The module is designed for managers at all levels. But it is important to begin by obtaining top management’s commitment to the concept of capital rationalization. It is also very important to involve the workers on the shop-floor in the process and see that they understand how important capital productivity is for the profitability of the company. It is, however, the middle managers who must have the operational responsibility of running projects to improve capital productivity.

1.1 Capital productivity

Methods of increasing productivity nowadays focus very much on total productivity. The latter, among other factors, includes capital productivity, which deals mostly with tied-up capital but also covers costs and quality. The ultimate goal is to attain the highest possible level of profitability. This means that capital productivity has to enhance a company’s profitability. In this module we shall therefore consider profitability as the main objective of capital productivity.

1.2 Profit and profitability

In order to be able to discuss profit and profitability, let us first look at some important economic terms.

An industry’s manufacturing costs consist mainly of wages, purchased goods and depreciation of buildings and machinery. What remains after these costs have been covered can be called the company’s profit. The relation of profit to invested capital is profitability. It is also defined as Return on Net Assets (RNA).

Since profitability is among the important company targets, it is essential to have employees’ cooperation in achieving it. This requires an explanation of how profitability is calculated and how it is affected by various factors which can change daily.

Profitability = \( \frac{\text{profit}}{\text{working capital}} \) or \( \frac{\text{profit}}{\text{sales}} \times \frac{\text{sales}}{\text{working capital}} \)

Profitability is thus a function of: Profit margin = \( \frac{\text{profit}}{\text{sales}} \)

and Capital turnover rate = \( \frac{\text{sales}}{\text{working capital}} \)

or Profit margin x turnover rate = profitability.
1.3 The Du-Pont model for profitability analysis

The Du-Pont model (see figure 12.1) is a good model that shows the connection between the factors from which profitability is built. It is an educational tool to explain how various factors affect the final result and it can be used as an instrument to analyse profitability. The model can also be used to carry out a sensitivity analysis of the factors that affect profitability; and it is a tool for determining the RNA.

This model highlights the most important connection between the operational and the capital sides of the business. The basic concept underlined here is that profitability can be improved by increasing either the profit margin or the capital turnover rate or both.

1.3.1 Operational side of the model

Sales revenue. When profitability is calculated at the company cost centre level, revenue is defined as equal to sales revenue. This is also true when you want to measure profitability per product or product group. On the other hand, the revenue concept is not so well defined at a lower level because, in this case, revenue is normally not based on a market price.

Costs. One part of the costs is in principle directly proportional to the size of production. These are called variable costs (e.g. material and direct wages). Other costs are, in the short term, independent of the size of production. They could be called fixed costs (e.g. depreciation, rent, cost of administration, etc).

This classification by variable and fixed costs is useful provided that the variations in the production or sales volume are fairly small. It also points towards the use of the contribution concept.

Contribution. The contribution is that part of the sales value which remains after covering the variable costs. The contribution is intended to cover the fixed costs and give a profit. With unchanged fixed costs a greater contribution will give a greater profit.

Profit. Profit is what remains of the contribution after covering the fixed costs. Profit = contribution - fixed costs or sales value - variable and fixed costs; or Profit = revenue - variable costs - fixed costs.

Profit margin. The profit margin is the profit divided by sales expressed as a percentage.

1.3.2 Capital side of the model

The capital concept can be described from two points of view: use of capital, and acquisition of capital. These can be found in the balance sheet as assets and debts and stockholders' equity.

Total assets consist of current (variable) and fixed assets. Current (variable) assets are assets with a maximum duration of one year. They consist mainly of materials in store, work in progress, finished stock, receivables and cash. Fixed assets are assets with a duration of more than one year. They consist mainly of buildings and machinery. Fixed assets and current (variable) assets
Figure 12.1: How is RNA generated? (Du-Pont model)
make up the working capital in a company.

The Du-Pont model shows how all the above-mentioned factors make up profit margins and capital turnover rate, both of which determine profitability (expressed as RNA).

Figure 12.2 shows the effect on profitability of raising, in various situations, the turnover rate and increasing the profit margin.

Suppose that in one situation the company has a profitability of 5 per cent built up from a capital turnover rate of 1.2 and a profit margin of 4.2 per cent. In order to increase profitability to 7 per cent, the profit margin must be increased to 5.8 per cent by cost rationalization (i.e. reducing the manufacturing costs) or the turnover rate increased to 1.7 by reducing the capital tied up in inventories (i.e. reducing the working capital).

In another case, profitability remains at 5 per cent but with a profit margin of 14 per cent and a turnover rate of 0.36. In this situation an increase of the turnover rate to 0.48 in combination with an increase of the profit margin to 14.5 per cent might be a good solution to achieve the desired profitability of 7 per cent.

In most cases a combination of increasing the turnover rate and the profit margin is the best way to achieve higher profitability.
Figure 12.2: Profitability diagram

RNA = Return on Net Assets

Capital turnover rate

Profit margin (%)
Example
A company has the following (simplified) profit and loss account and balance sheet:

PROFIT AND LOSS ACCOUNT

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>10.0</td>
</tr>
<tr>
<td>Material costs</td>
<td>-3.0</td>
</tr>
<tr>
<td>Direct wages incl. supplementary wage costs</td>
<td>-2.0</td>
</tr>
<tr>
<td>Expenses</td>
<td>-3.6</td>
</tr>
<tr>
<td>Depreciation</td>
<td>-0.4</td>
</tr>
<tr>
<td><strong>Profit</strong></td>
<td><strong>1.0</strong></td>
</tr>
</tbody>
</table>

BALANCE SHEET

**Assets**

*Current (variable) assets*

<table>
<thead>
<tr>
<th>Asset</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash</td>
<td>1.0</td>
</tr>
<tr>
<td>Debtors</td>
<td>2.5</td>
</tr>
<tr>
<td>Raw material</td>
<td>0.5</td>
</tr>
<tr>
<td>Work in progress (WIP)</td>
<td>0.7</td>
</tr>
<tr>
<td>Finished goods</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5.5</strong></td>
</tr>
</tbody>
</table>

*Fixed assets*

<table>
<thead>
<tr>
<th>Asset</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery</td>
<td>1.5</td>
</tr>
<tr>
<td>Buildings</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4.0</strong></td>
</tr>
</tbody>
</table>

Working capital

<table>
<thead>
<tr>
<th>Debits and stockholders' equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-term debts</td>
</tr>
<tr>
<td>Creditors</td>
</tr>
<tr>
<td>Long-term debts</td>
</tr>
<tr>
<td>Bank loans</td>
</tr>
<tr>
<td>Stockholders' equity</td>
</tr>
<tr>
<td>Share capital</td>
</tr>
</tbody>
</table>
If you enter profit and working capital in the Du-Pont model, you will find the RNA (see figure 12.3).

**Figure 12.3: Company profitability (initial)**

Suppose that successful rationalization will reduce costs for materials and wages from 5 million to 4.5 million currency units. The profitability will be affected as indicated in figure 12.4. The increase in the profit margin from 10 per cent to 15 per cent increases profitability from 11.8 per cent to 17.7 per cent.
Figure 12.4: Company profitability after reducing cost of materials and wages

Suppose also that the company has been working on its capital profitability and has been successful in reducing work in progress to half and also in reducing the costs for materials and wages from 5 million to 4.5 million currency units. The results are illustrated in figure 12.5. The increase in the capital turnover rate from 1.18 to 1.29 has increased profitability from 17.7 per cent to 19.4 per cent.
This is, however, not the whole truth as a lower demand for capital also has a long-term influence on the costs. Smaller quantities of material and components in stock will probably mean that you need fewer people to handle the goods, lower costs for insurance, etc. The same effect occurs when you can eliminate a building or machine - the costs are reduced. That means that in reality the profitability gains will be even higher than calculated here.

Questions for discussion

1. What is the relationship between total productivity and capital productivity?
2. What is the relationship between capital productivity and profitability? Discuss the most important factors/elements of both and compare them.
3. What is the advantage of the Du-Pont model for profitability analysis and how important is factor assessment in improving RNA?
UNIT 2: THE STRUCTURE OF CAPITAL ASSETS

UNIT 2: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Explain how capital is distributed among different resources and judge the efficiency of this distribution.

2. Identify and explain the nature of different kinds of capital stock, their role in the production process and their main components.

3. Understand the nature of capital trading in customer receivables.

4. Appreciate the role of non-financial assets in capital management and productivity.

UNIT 2: CONTENTS

2.1 Distribution of capital among different resources

2.2 How do we analyse the stock?

2.3 Customer receivables

2.4 Non-financial assets

Appendix
UNIT 2: THE STRUCTURE OF CAPITAL ASSETS

Capital is an important production resource and productivity factor. Capital resources are realized in buildings, machinery, goods and money, etc. There is a distinction between physical capital and financial capital. Physical capital consists of buildings, machinery and work in progress, for example, whereas financial capital means cash, receivables, advance payments, etc. Physical capital could cost approximately 20-25 per cent per year of its value, plus interest of perhaps 10-15 per cent, making a total of about 30-40 per cent per year.

2.1 Distribution of capital among different resources

A company’s investment in goods is often 30 per cent or more of total assets. Sometimes it is even 60-70 per cent. The fact that a company’s investment in goods is often the same as its investments in machinery and buildings indicates the significance of both in productivity improvement. Much money is tied up in machinery, buildings and goods. International comparison shows that American and Japanese companies work with much less capital tied up in goods at a fixed turnover. A study made by Chalmers Technical University in Gothenburg shows that the capital turnover rate per year of inventories in industry was approximately 3.5 times in Sweden, 5.5 times in Germany, 7 times in the United States and 8.5 times in Japan. We must therefore ask the following questions: How can we use our capital in a better way? Shall we pay more attention to current assets or fixed assets? How do they affect each other? How shall we analyse the tied-up capital?

Buildings and machinery. This category includes all kinds of machinery, transport equipment, handling equipment, tools, buildings, etc. At the same time as automation increases the fixed assets, the relative share of the working capital grows also and demands for high utilization will increase.

Goods. This is capital tied up in materials flow and it must be looked upon in the same way as other investments. What does it cost and what will you gain from the investment? What motives are there for investing in materials flow? Let us first clarify why we invest in materials flow or goods. Investments in stock and work in progress are made for two reasons:

1. It takes time to deliver goods in both the production and the distribution chain. We are interested in ensuring the best possible coordination in the chain so that the work of the purchasing department is coordinated with the production work, and the production work with that of distribution. But as the flow of goods takes a certain time, the purchasing department’s planning must be based on an estimate of future needs. Such an estimate or prognosis will be a suitable starting-point for guiding and coordinating the activities within the chain. The prognosis will (if it is not based on fixed order quantities) always contain a few errors. This also creates the need for keeping some stocks within the chain.

2. Orders are placed at certain times, in quantities that ensure that the size and reordering quantity reach a replenishment level. This way of ordering is usual when you have a regular inventory of the stocks as a basis for the replenishment.

The most important types and purposes of stock are the following:
### Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Replenishment stock</td>
<td>Eliminate unnecessary costs</td>
</tr>
<tr>
<td>B. Base stock</td>
<td>Service ability</td>
</tr>
<tr>
<td>C. Buffer stock</td>
<td>Shop load balancing</td>
</tr>
<tr>
<td>D. Synchronization stock</td>
<td>Synchronization</td>
</tr>
<tr>
<td>E. Process stock</td>
<td>Production process</td>
</tr>
</tbody>
</table>

The relationships between these stocks are illustrated in figure 12.6.

**Figure 12.6: Relationship of different types of stock to production**

![Diagram of stock relationship]

#### 2.2 How do we analyse the stock?

First of all we can study the different types of stock we have. If the stocks consist of different products, the analysis can be facilitated by grouping them in categories such as: replenishment stock; base stock; buffer stock; synchronization stock; and process stock.

*Replenishment stock*. This is the stock that is necessary to keep the costs for ordering a single article at a reasonable level (see figure 12.7).

To reach reasonable overall cost levels, orders should be placed in so-called optimal batch sizes. When you receive an order, start to manufacture an order or deliver goods, you incur costs for:

- writing order sheets;
- deliveries from/to your stocks;
- adjustment of the machines;
- checking stock recordings, etc.
These costs which, generally speaking, are independent of the batch size are called change-over costs. To keep these as low as possible per unit, you order several items at the same time, which will then be used gradually. Few orders per year involve big batch sizes and a consequently larger replenishment stock. Stocks also imply interest on tied-up capital, costs for premises, workforce and insurance, etc.

**Base stock.** The time from the initiation of the order to the actual delivery is called the lead time. Consumption during this time can be covered only by using existing items (including those ordered earlier, but not yet delivered). To avoid shortages in your stock during the lead time, the stock level must be larger than or equal to the consumption per time unit multiplied by the lead time.

If you want to avoid shortages resulting from variations in stock level, estimated consumption and the time required to meet the need, you must have a base stock. The base stock is intended to compensate for errors in stock files, variations in the consumption rate and variations in the local time as compared with Greenwich Mean Time.

Thus, a base stock is essential if a reasonable service level is to be provided for a single article. For materials in store and finished stock, the shortage level is a measure of delivery readiness. The shortage level is defined as the time when an item is entered as shortage compared with the total time. In practice the shortage level can be checked by investigating how many items or number of items are out of stock (shortage) at the same time, or where the quantity in stock is fully used for needs that are registered during the lead time. The difficulty when optimizing the base stock is to calculate a reasonable shortage level.

In theory, costs for shortages plus costs for base stock should be minimized. In practice policy decisions should be made to the effect that certain items should have a certain service level or
should counter certain deviations in the lead time, e.g. two weeks. If one deviation is much greater than the others, you can ignore the small ones. When you set a reasonable service level you must realize that the base stock needed increases sharply when the service level comes close to 100 per cent. From figure 12.8 you can see that a doubling of the base stock gives an increase of the service level from 95 per cent to 98.5 per cent, or from 98.5 per cent to 99.5 per cent. In theory an infinite base stock is needed if you want to reach a service level of 100 per cent.

The level of the base stock is usually expressed as a proportion of the consumption during the lead time. For instance, if the base stock is 40 per cent of the consumption during the lead time you multiply the consumption during the lead time by 0.4 to calculate the base stock. Thus the formula is:

\[
\text{Base stock} = \text{safety factor} \times \text{consumption during the lead time.}
\]

**Figure 12.8: Base stock as a function of service level**

![Graph showing base stock as a function of service level](image)

**Example:**

Calculate the base stock in the following case:

- safety factor: 0.3
- annual consumption: 1,600 pieces (one year = 48 weeks)
- lead time: 4 weeks.

Solution: Base stock = \( \frac{0.3 \times 1,600 \times 4}{4} = 40 \) pieces.

An alternative, simpler way which is often used in manual systems is:
Base stock = safety time x consumption per time unit.

Example:

Calculate the base stock in the following case:

- safety time: 2 weeks
- annual consumption: 1,600 pieces (one year = 48 weeks).

Solution: Base stock = \( \frac{2 \times 1,600}{48} \) = 67 pieces.

Buffer stock. This is the stock needed to maintain the utilization of machines and manpower at a uniform and high level. A high level of utilization at one work station theoretically implies a buffer stock in case deliveries arrive by chance. In figure 12.9 you can see how the average queue is dependent upon the utilization. The figure also illustrates the work in progress needed to maintain a uniform and high level of utilization of machines and manpower.

**Figure 12.9: Dependence of average queue upon the order of utilization**

In the production line buffers are needed between the work stations. If they are not provided, all the work stations are always obliged to produce at the same speed. Without buffers the line would not be able to produce faster than the speed of the slowest work station.

Synchronization stock. This is the stock needed to ensure that several items are available in specified quantities at the same time. These stocks occur prior to assembly, transportation and delivery and are affected by the complexity of the product/production and the difficulty of predicting lead times. An example is shown in figure 12.10.
Figure 12.10: The purpose of synchronization stock

Process stock. This stock is work in progress required to perform an operation. It is made up of a number of parts simultaneously at the assembly, testing or transportation stage.

2.3 Customer receivables

Customer receivables and cash assets are a good base for big improvements in profitability. They often amount to approximately 50 per cent of financial capital assets. It is therefore important to reduce the time between delivery and the receipt of payment. For example:

Average credit time 45 days, annual turnover US$10 million: average customer receivables = \( \frac{45 \times 10}{360} \) = US$1.25 million.

In addition, capital is also tied up in the payment process, either as not yet invoiced sales or money on the way to, for example, suppliers or the bank. The following exercise will illustrate this.

A company has the following average time periods for handling its invoices:

<table>
<thead>
<tr>
<th>Order to delivery</th>
<th>1 day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invoicing</td>
<td>6 days</td>
</tr>
<tr>
<td>Conditions for payment</td>
<td>30 days</td>
</tr>
<tr>
<td>Late payments</td>
<td>15 days</td>
</tr>
<tr>
<td>Handling of payments at banks</td>
<td>4 days</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>56 days</td>
</tr>
</tbody>
</table>
Discuss with colleagues which parts of the above time periods can be reduced and what effect these reductions would have.

You will find a proposed solution in the appendix at the end of this unit.

2.4 Non-financial assets

Non-financial assets are assets that you cannot find in the balance sheet, but which are nevertheless important. Investment in manpower, for instance, is not a conventional financial asset. Certain costs for manpower may be regarded as capital assets: thus employment and training are assets in knowledge as they represent payments before an employee can produce. Thus a job may imply the commitment of a very large amount of capital if you calculate the annual salary and fringe benefits multiplied by the employment time. Capital assets in administration are tied up in systems development, programming, etc., and the purchase of office equipment such as computers.

In this unit we have discussed different kinds of stock and other capital assets, but the most usual kind of stock is what we may call “comfort stock”, i.e. large stocks without any reason behind them. If you have large stocks, you may feel very comfortable as these large stocks hide problems which you need to solve. Thus a gradual reduction of “comfort stocks” facilitates the progressive elimination of the causes for the hidden problems as they appear.

In the example below you can see the inventories taken from the balance sheet of a big international company.

<table>
<thead>
<tr>
<th>Stores</th>
<th>US$ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Purchased goods</td>
<td>18</td>
</tr>
<tr>
<td>- Purchased semi-finished goods</td>
<td>27</td>
</tr>
<tr>
<td>- Tools, etc.</td>
<td>11</td>
</tr>
<tr>
<td>Work in progress</td>
<td>106</td>
</tr>
<tr>
<td>Finished stock</td>
<td>22</td>
</tr>
<tr>
<td>Product in external assembly and delivery</td>
<td>74</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>278</strong></td>
</tr>
</tbody>
</table>

Annual cost of inventories (40%) | 111

Annual profit | 25

As can be seen, this company had US$278 million tied up in capital assets: its annual cost of 40 per cent for inventories equals US$111 million, as compared with the annual profit that year of only US$25 million. Thus a reduction of only 10 per cent in the inventories would give an annual profit almost 50 per cent higher.
Module 12
Unit 2

Questions for discussion

1. What are the main elements in the structure of capital assets?
2. What is the definition of process stock and where do you find it in a company?
3. Why do enterprises need stocks, and what are their main types and purposes? How does stock value influence productivity?
4. How can you analyse stocks and make decisions on improvements?
Proposed solution for exercise in section 2.3

The following time reductions are possible:

1. Reduce time between delivery and invoicing   = 5 days
2. Specify date of payment and follow up late payments  = 10 days (on average)
3. Improve banking routines  = 1 day

16 days
= -29%

On a turnover of US$10 million with 90 per cent of the sales at 30 days credit, customer receivables can be reduced by:

\[
\frac{16 \times 9,000,000}{360} = \text{US$400,000.}
\]

If the reduced customer receivables can reduce our loans or give an interest of 18 per cent, this will result in an annual saving of:

\[
0.18 \times 400,000 = \text{US$72,000.}
\]

If the profit margin is 5 per cent, the sales must increase by 15 per cent.
UNIT 3: ANALYSING TIED-UP CAPITAL

UNIT 3: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand and explain the nature of tied-up capital and its major forms.

2. Take part in analysis exercises and explain the implications of using overview analysis and detailed analysis.

3. Use the analysis results for management decision-making in optimizing inventories.

UNIT 3: CONTENTS

3.1 Overview analysis

3.2 Detailed analysis

Appendix 1

Appendix 2

Appendix 3
UNIT 3: ANALYSING TIED-UP CAPITAL

In unit 2 we discussed the structure and distribution of capital assets. When you know where your capital is tied up, you must also have a way of analyzing how much is tied up. In this unit we look at two different kinds of tied-up capital analysis. The most commonly used is an overview analysis, which can be used to calculate the average capital assets in a production line.

3.1 Overview analysis

Capital assets as inventories in a production flow of different types of product are best analysed through an overview analysis method. The method consists of three major steps:

Step 1. Draw the flow chart for the production line to be analysed. An example is given in figure 12.11.

Figure 12.11: An example of a production flow chart

Step 2. Collect data about ATO, RTO or t for each step in the production flow. If ATO is the annual turnover (volume) and RT0 is the turnover rate, and t is the average time in store, throughput, etc., then the inventories (capital assets) will be:

\[ C = A_{T0} \times \frac{t}{48}, \text{ where } \frac{t}{48} \text{ is the inversion of } R_{T0} \]

or \[ C = \frac{A_{T0}}{R_{T0}} \]

The figure “48” expresses the number of working weeks per year. For calculation purposes you use an average of ingoing and outgoing values.
Follow these directions strictly. There is a risk of mixing $A_{T0}$ and $C$ if this format is not followed. Then use the process illustrated in figure 12.12 to allocate the data diskette obtained.

**Figure 12.12: Scheme for the allocation of capital value along the process flow**

Step 3. Calculate the capital assets ($C$) for each step in the flow chart. The following data have been gathered concerning inventories ($A_{T0}$ in millions of US$ and $t$ in weeks).

| Stored purchased components | 2 | 12 |
| Stored raw material          | 30| 20 |
| Order-specific raw material  | 1 | 6  |
| Order-specific components    | 4 | 4  |

After component manufacturing, which takes 3 weeks, the flow has an annual value of US$50 million. The assembly starts 2 weeks after completion of component manufacturing.

The assembly takes 1 week. The annual value of the production is now US$70 million, of which 20 per cent is delivered direct to customers and the rest is sold to a warehouse for finished stock. The turnover rate of the finished stock is six times per year.

Figure 12.13 provides the solution for this exercise in the identification of tied-up capital, reordering points and time.

When you are familiar with the technique of overview analysis, you may use your knowledge in the following exercise.
Case 1

Gislaved Cupboard Ltd manufactures cupboards for home and industrial use. The company has two manufacturing units. In both units the complete product range of cupboards is manufactured. The annual turnover last year was US$180 million.

During recent years the company’s share of the market and its profitability both fell.

Capital assets in inventories amount to approximately US$100 million, which is considered extremely high. A competitor has the same product range but only US$45 million worth of inventory with an annual turnover of US$120 million. The competitor has a different type of production layout and also well modularized products.

The products are composed of side units, back units, bottom units and roof units (all manufactured from chipboard). The assembled units make a cupboard frame. The raw material is stored prior to component manufacturing and has an annual turnover of US$25 million. Customer-tailored cupboards are built by assembling different doors, handles, shelves and footings, etc., on the frames. The number of stored components is approximately 7,000 items, of which 6,500, accounting for US$35 million a year, are purchased (special doors, handles, hinges, screws, etc). Component manufacturing has an annual turnover of US$131 million. The components are stored prior to the frame assembly.

The premises are extended to keep the necessary stocks close to the location of the various stages of the production process. The machines for component manufacturing are
functionally organized. The manufacturing flows, owing to these conditions, are long and complicated to follow. The floors are covered with material waiting for processing. Component manufacturing (side units, back units, bottom units, roof units and doors) is controlled by a reordering point system. Component manufacturing consists basically of four sequential operations, namely size cutting, edge preparation, drilling and painting.

Manufactured components and purchased components are stored in intermediate stores prior to the assembly of frames. These stores are also controlled by a reordering point system. The frames are stored prior to final assembly. The policy of the company is to maintain an average stock of frames which corresponds to 6 weeks of normal consumption. This stock was originally intended as a seasonal stock.

The throughput time for component manufacturing is 7 weeks, for frame assembly 2 days and for final assembly 1 day. The average storage time for manufactured components prior to frame assembly is 18 weeks. The company's policy is to deliver the cupboards directly after final assembly when the order is complete.

The value added in frame assembly is US$4 million a year and in final assembly US$10 million a year.

The turnover rate in the store for purchased components is 2.4 and for raw material 5.6. US$5 million of the purchased components go to frame assembly and US$30 million to final assembly.

The normal delivery time of 2 weeks for final assembly has been difficult to obtain recently. The actual delivery time has often been up to around 4 weeks.

The planning department complains that they have poor control over where in the production flow components and semi-assembled products are to be found. The service level from the different stores is also very poor.

The sales show clear seasonal variations, with a peak in spring which leads to large and difficult fluctuations in the demands on the production facilities, causing overload and production shortfall at different times.

The company realized the need for drastic improvements if it was to survive. Profitability must be increased within the coming 2 years. Improvements are needed mainly in production and control.

***

Exercise: Analyse the capital assets in inventories.

Calculate in weeks (1 day = 0.2 week).
Use figure 12.14 to calculate time and capital assets. A solution for this exercise can be found in Appendix 1 at the end of this unit.

### 3.2 Detailed analysis

The second way to analyse tied-up capital is through a detailed analysis. This is used when you calculate capital assets in inventories for one single product.

The following procedure is recommended for a detailed analysis:

1. Calculate the production rate
2. Collect data on average times for the different stages
3. Collect data on costs
4. Draw a time and cost diagram
5. Calculate capital assets according to vertical and horizontal cuts

#### Exercise

Calculate capital assets in inventories and receivables for the following production example:

Production: 12,000 units per year (calculate on the basis of 250 working days per year).

Sales price = US$175.

Time:
- The average storage time for raw material is 60 days.
- Production time is 10 days.
- Average storage time in warehouse is 20 days.
- Customer credit is 10 days.

Payments for administration and sales begin when production starts and continue until payments from customer have been received.

<table>
<thead>
<tr>
<th>Costs</th>
<th>US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Material (DM)</td>
<td>60</td>
</tr>
<tr>
<td>Direct Labour (DL)</td>
<td>40</td>
</tr>
<tr>
<td>Manufacturing Overheads (MO)</td>
<td>25</td>
</tr>
<tr>
<td>Administration Overheads (AO)</td>
<td>10</td>
</tr>
<tr>
<td>Sales Overheads (SO)</td>
<td></td>
</tr>
</tbody>
</table>

Payments of AO and SO are made successively from the time when production starts.

#### Solution

**Step 1:** Calculate the production rate (in units per time unit)

Production rate per day = \(\frac{12,000\text{ units}}{250\text{ days}} = 40\) units per days
Figure 12.14: Calculation of time and capital assets

Diagram showing the process flow involving purchased components, raw material, component manufacturing, frame assembly, frames, and final assembly.
Step 2: Collect data on average times

Raw material store 60 days
Production time 10 days
Time in warehouse 20 days
Customer credit 10 days

Payments for administration and sales begin when production starts.

Calculation of average storage time in store or warehouse

Average stock level = \( B + \frac{Q}{2} \)

Average consumption rate = \( N \) units per day

Average storage time = \( \frac{B + \frac{Q}{2}}{N} \) (days)

Example:

Average stock level = \( 200 + \frac{800}{2} = 600 \)

Assume that the average consumption rate is 20 units per day:

Average storage time = \( \frac{600}{20} = 30 \) days

Turnover rate = \( \frac{360}{30} = 12 \) times per year
Step 3: Collect data on costs

US$

DM 60
DL 40
MO 25
AO + SO 10

In principle, depreciations should be excluded as they do not generate any payments in this particular production flow and are not related to operating capital. However, in practical applications depreciations are normally not subtracted from the overhead costs.

Step 4: Draw a time and cost diagram

Draw the time axis (X-axis) and mark on it the various times for the respective steps:

<table>
<thead>
<tr>
<th>Raw material store</th>
<th>Production</th>
<th>Warehouse</th>
<th>Customer credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>10</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

Mark the costs on the Y-axis for the steps concerned:

\[
\begin{align*}
\text{AO + SO US$ 10} \\
\text{DL + MO US$ 65} \\
\text{DM US$ 60}
\end{align*}
\]

\[
\frac{A}{10} = \frac{10}{40} \rightarrow A = 25 \quad \frac{B}{10} = \frac{30}{40} \rightarrow B = 7.5
\]
Step 5 A: Calculations according to vertical cut

Capital assets in:

**Raw material store (C\textsubscript{RS})**

\[ C_{RS} = 48 \text{ units/day} \times \text{US$60 per unit} \times 60 \text{ days} = \text{US$172,800} \]

**Work in progress**

\[ C_{WIP} = 48 \text{ units/day} \times \text{US$60 per unit} \times 10 \text{ days} + \\
48 \text{ units/day} \times \text{US$65 per unit} \times \frac{10}{2} \text{ days} + \\
48 \text{ units/day} \times 2.5 \text{ US$/unit} \times \frac{20}{2} \text{ days} = \text{US$45,000} \]

**Warehouse**

\[ C_{W} = 48 \text{ units/day} \times \text{US$60 per unit} \times 20 \text{ days} + \\
48 \text{ units/day} \times \text{US$65 per unit} \times 20 \text{ days} + \\
48 \text{ units/day} \times 2.5 + 7.5 \times \frac{20}{2} \text{ days} = \text{US$124,800} \]

*Total capital assets in inventories = US$342,600.*

Step 5 B: Calculations according to horizontal cut

**Direct material**

\[ C_{DM} = 48 \text{ units/day} \times \text{US$60 per unit} \times (60 + 10 + 20) \text{ days} = \text{US$259,200} \]

**Direct labour and manufacturing overheads**

\[ C_{DW+LO} = 48 \text{ units/day} \times \text{US$65 per unit} \times \frac{10 + 20 \text{ days}}{2} = \text{US$78,000} \]

**Administrative overheads and sales overheads**

\[ C_{AO+SO} = 48 \text{ units/day} \times \text{US$7.5 per unit} \times \frac{10 + 20 \text{ days}}{2} = \text{US$5,400} \]

*Total capital assets in inventories = US$342,600*
Step 5 C: Customer receivables

Customer receivables: 48 units per day x US$175 per unit x 10 days = US$84,000

Comments on the exercise

The cost of the capital assets may differ according to the type of capital we use. For example:

Annual cost for physical capital in inventories is approximately 40 per cent.
Annual cost for financial capital in customer receivables is approximately 17 per cent.

Using these examples of detailed analyses, you should be able to solve the following two cases:

Case 2

Calculate the average capital assets in inventories for the following raw material store:

| Consumption  | 6,000 units per year |
| Supplies     | In batches of 2,000 units, 10 days from order |
| Reordering point | 400 units |
| Price        | US$9.60 per unit |
| Materials overheads | US$0.40 per unit |

Assume 360 days per year to be the base in this calculation.

The solution to this case can be found in Appendix 2 of this unit.
Case 3

Alfa, a household equipment manufacturer, is estimated to produce 15,000 units per year.

The following cost calculations have been made:

<table>
<thead>
<tr>
<th>Cost Item</th>
<th>US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct material</td>
<td>400</td>
</tr>
<tr>
<td>Direct wages</td>
<td>200</td>
</tr>
<tr>
<td>Overheads</td>
<td></td>
</tr>
<tr>
<td>- Supply material</td>
<td>15</td>
</tr>
<tr>
<td>- Indirect wages</td>
<td>25</td>
</tr>
<tr>
<td>- Depreciation</td>
<td>20</td>
</tr>
<tr>
<td>- Sales costs</td>
<td>50</td>
</tr>
</tbody>
</table>

| Total Overheads    | 110 |
| Profit             | 100 |
| Price per unit     | 810 |

Direct wages and overheads for manufacturing are spread equally over the production time, which is estimated to be 1 month. The sales costs are derived from information on finished stocks in the warehouse. The average storage time in the warehouse is 3 months.

The household machines are sold to supermarkets and to stores specializing in this area. Conditions for payment are one-third on order, which is normally 2 months prior to delivery; one-third on delivery, and one-third when the products have been sold to customers (which is normally 8 months after delivery).

Raw materials, components from suppliers, etc., are delivered in batches for the manufacture of 3,600 household machines. The base stock is 300 units.

Calculate the tied-up capital assets by using the “detailed analysis” method. Use the vertical cut approach (see Step 5A above) and determine the tied-up capital for storage, work in progress, finished stock and customer receivables. One month is a suitable time unit.

Do not take account of depreciation when determining costs.
Module 12
Unit 3

Questions for discussion

1. What is tied-up capital? Why do we need to analyse it?
2. What is the cost of capital tied up in inventories, and what should be included in these costs?
3. What is the relationship between these analyses and the improvement of capital productivity?
4. What are the main differences between overview analysis and detailed analysis, and what are their major applications?
APPENDIX 1

Solution to Case 1

Steps 1 and 2

Purchased components

US$35 million

\[ R_{TO} = 2.4 \]

US$25 million

\[ R_{TO} = 5.6 \]

Raw material

Component manufacturing

7 weeks

US$25 million

US$10 million

Final assembly

1 day

US$31 million

Frame assembly

2 days

US$140 million

US$4 million

Components

t = 6w

US$131 million

US$5 million

US$30 million
Step 3

\[ R_{TO} = \frac{35}{2.4} = \text{US$14.6 million} \]

\[ C = \frac{18}{47} \times 131 = \text{US$50.2 million} \]

\[ C = \frac{6}{47} \times 140 = \text{US$17.9 million} \]

Purchased components

\[ \text{US$35 million} \]

\[ R_{TO} = 5.6 \]

\[ C = \frac{25}{5.6} = \text{US$4.5 million} \]

\[ C = \frac{7}{47} \times \frac{25 + 131}{2} = \text{US$11.6 million} \]

\[ C = \frac{0.4}{47} \times \frac{30 + 140 + 180}{2} = \text{US$0.7 million} \]

\[ C = \frac{0.4}{47} \times \frac{5 + 131 + 140}{2} = \text{US$1.2 million} \]

Raw material → Component manufacturing → Components → Final assembly → Frames → Frame assembly

- 7 weeks
- 2 days
- 1 day

APPENDIX 2

Solution to Case 2

The fluctuation of the stock level is shown in the diagram below:

![Diagram showing stock level fluctuations](image)

**Total consumption**

6,000 units per year or

\[
\frac{6,000}{360} = 17 \text{ units per day}
\]

Minimum stock level = Base stock = Reordering point - consumption during lead time = 400 - 10 \times 17 = 230 units

(Maximum stock = Base stock + purchased quantity = 230 + 2,000 = 2,230 units)

Average stock = \( \frac{\text{Batch size}}{2} + \text{Base stock} = \frac{2,000}{2} + 230 = 1,230 \text{ units} \)

Average storage time = \( \frac{\text{Average stock}}{\text{Consumption rate}} = \frac{1,230}{17} = 72 \text{ days} \)

Capital assets in stock = 72 \times 17 \times (9.60 + 0.40) = US$12,240
APPENDIX 3

Solution to Case 3

Consumption: 15 + units per year = 1.25 units per month

Store

Average stock: $\frac{3,600}{2} + 300 = 2,100$ units

Average storage time: $\frac{2,100}{1.250} = 1.7$ months

Capital assets in store: $1.7 \times 1,250 \times 400 = \text{US$0.85 million}$

Work in progress (wip)

Average production time: 1 month

Added value in production: $200 + 15 + 25 = \text{US$240}$

Capital assets (wip) $1 \times 1,250 \times (400 + \frac{240}{2}) = \text{US$0.650 million}$

Finished stock

Average storage time: 3 months

Added value in warehouse: US$50
(sales costs)

Capital assets in warehouse: $3 \times 1,250 \times (400 + \frac{50}{2}) = \text{US$0.2494}$
Customer receivables

Credit time for customer receivables: 8 months

Capital assets as customer receivables: \( 8 \times 1,250 \times \frac{810}{3} = \text{US$0.27 million} \)

The company has the following curve for capital assets:

![Capital Assets Curve](image)

Total assets in inventories = 850 + 650 + 2,490 = US$0.399 million

Total assets in customer receivables = US$0.27 million.
UNIT 4: IMPROVEMENT AREAS AND WAYS OF IMPROVEMENT

UNIT 4: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand the interdependence between the improvement areas offering the greatest possibilities and their impact on the different components of capital assets.
2. Explain the main elements of the production system.
3. Understand and explain the structure and types of production flow and their relation to capital productivity.
4. Appreciate the role of flexibility in production management and its main impact on the most important capital-intensive areas.
5. Appreciate the role and method of production planning and control in improving capital productivity.

UNIT 4: CONTENTS

4.1 Overview
4.2 The production system
4.3 Production flow
4.4 Flexibility and tied-up capital
4.5 Materials planning and production control
UNIT 4: IMPROVEMENT AREAS AND WAYS OF IMPROVEMENT

4.1 Overview

In units 2 and 3 we saw where capital was tied up and looked at two different ways of analysing the size of the tied-up capital. Here we shall discuss how to utilize this potential.

The potential areas for action are as follows:

- the production system;
- materials and production planning;
- personnel;
- the product range;
- product design;
- the administration of on-site assembly;
- transport and distribution; and
- the administration of receivables.

Figure 12.15: Potential areas for improvement capital productivity

The matrix in figure 12.15 provides an excellent illustration of the potential areas for improvement and the areas where capital is usually tied up. The black dots in the matrix represent the most important relationships between tied-up capital and the areas where we can take practical measures. Thus, if we have to work with materials in store, this matrix shows that action can be taken in the production system, materials and production control, product range and product design areas. The matrix can also be read in the other direction. For instance, changes in the production system affect a number of places where capital is tied up, i.e. machines and equipment, plant, stores, work in progress, finished stock, manpower and administration. The matrix also shows that you cannot evaluate the improvement potential for only a single factor or for one single area. Every measure will influence several areas.

There are two ways of improving capital productivity. The first way is based on providing
better guidance about targets and policies, and on changing behaviour with the aim of modifying
the use of tied-up capital. This way will give fast but uncertain results. In this case it is essential
that people should quickly gain an understanding of the new orientation and that all managers
should motivate their personnel.

The other way is to create new conditions by developing new products, new production sys-
tems, new administration systems, etc., and thereby affect the tied-up capital and its utilization.
This way provides long-term and stable results because it influences peoples’ ability to succeed
with the new systems. Regardless of which way you choose, you can either use extremely so-
plicated methods or try simple ways of finding new solutions. Experience from Japan shows
that it is often the simple solutions that give the best results (Kanban system, sequence number-
ing, etc.). The measures to be taken can be introduced either by changing the existing system or
by developing a new one.

4.2 The production system

To plan manufacturing capacity you begin by determining which products are to be manu-
factured and in what quantities. The precision of these forecasts is therefore of significant im-
portance in reaching a correct decision about the production volume and manufacturing
capacities. The choice of the correct side of manufacturing capacity is not only connected with
the product range or the demand; other judgements must also be made. One of these is the con-
nection between building up stocks and capacity.

To manufacture the product volume needed, you can use two alternative strategies. One
strategy (I) is to extend your capacity so that the maximal demand can be met. Another strategy
(II) involves choosing a lower capacity and managing the peaks in demand by building up
stocks when the demand is lower than the manufacturing capacity. When you choose your strat-
egy you must compare the cost of holding stocks with the cost of capacity.

Besides these two strategies you can also use combinations. For example, you can plan for a
certain under-capacity and compensate for this through overtime production. Another alterna-
tive is to choose capacity according to strategy I above and to increase the utilization of the pro-
duction system by stimulating the market with, for instance, low price offers and more
aggressive advertising which will increase the demand. Which alternative you choose depends
to a large extent on the sales potential of other products and on the possibilities you have to use
your capacity. The choice of strategy has a great importance on tied-up capital. Finally, a deci-
sion on capacity is dependent upon the number of shifts. To introduce more than one shift gives
a lower capital cost per manufactured unit because the machines can be used during more hours
per planning period. The cost for wages will, however, increase when you run more than one
shift.

If we use our available production components under ideal conditions, we obtain the theo-
retical maximum capacity for our production system. We call this nominal capacity or gross ca-
pacity. As ideal manufacturing circumstances occur very seldom, in practice you must therefore
calculate for reduced capacity or for available capacity.
4.2.1 Organization and management

By planning, organizing, managing and controlling the work done we aim at having the right products produced at the right time with the most effective use of resources. This means that the costs for machinery and equipment, production personnel, work in progress and finished stock should be as low as possible. The contribution of efficient management in achieving this goal cannot be overemphasized, as the following case illustrates.

Case 4

A company had 40 blue-collar workers in the production unit. The production team was led by an engineer and two working supervisors who themselves worked in production for 50-70 per cent of their time. The administration personnel in production numbered just 1.5-2 men. Skilled personnel who had worked for a long time within the company made the production unit run well. The quantity of materials in store, work in progress and finished goods was relatively large and because of this it was possible to deliver goods to the salesmen rapidly. At the same time as the production line was running smoothly the company appointed a new manager who quickly succeeded in increasing the sales. To increase production correspondingly, more blue-collar workers were employed and the company bought more automated machines. During this expansion period the following problems occurred:

- Delivery times to the retailers increased by between 100 and 600 per cent.
- Wrong products were found in the stores of finished goods. The capital turnover rate decreased by 40 per cent and the remaining orders increased considerably.
- In the workshop efficiency was low and there was a high turnover rate of personnel (no one had time to instruct the new people).

This problem forced the company to hire a workshop manager and a planner to allow the supervisors to have more time for managing. The company also introduced routines for long- and short-term planning. These measures enabled the company to solve its problem. This example shows how you can bring better management into an existing production plant.

Some hints to facilitate managing and organization are given below:

- overview of the entire area of responsibility;
- clear-cut limits of responsibility, avoidance of breakdown of flow, continuous manufacturing;
- high degree of self-sufficiency;
- only one planning department, purchasing department, design department, etc., for given areas of responsibility in the main flow;
- support functions organized as close as possible to the main flow;
- responsibility for physical capital delegated to the main flow;
- rewards for short throughput times; and
- teamwork introduced wherever possible.
4.3 Production flow

The flow in a production system is to a great extent determined by the way you group your production equipment and lay out the production flow (grouping of workplaces, machinery, transport equipment, stores, service resources, etc.). When you design a production flow you should keep in mind three characteristics for the material flow - speed, reliability and frequency - which determine the amount of capital tied up. These are:

**Speed**
- Time between operations: Flow-oriented production
- Time in the operation: Parallel stations
  - Buffer
  - Similarity in processing time

**Reliability**
- Good preparation of products and production
- Trouble-resistant flow

**Frequency**
(*=small batches*)
- Reduce changeover cost
- Sub-batching

It is important to keep in mind that the capital tied up in work in progress is approximately in direct proportion to the lead time. The size of the base stock is dependent upon replenishment time. The amount of stock is dependent upon how many continuous flows you have been able to create.

Some principles for the grouping of production equipment are given below.

4.3.1 Functional layout of a workshop.

The functional workshop is the oldest of the production systems and the least flow-oriented. The basic idea was that by adding small functional units to one large unit you could gain large-scale advantages (see figure 12.16).
This figure illustrates the advantages and drawbacks of the functional workshop, which can be summarized as follows:

**Advantages:**

- adjustable to various production circumstances;
- low sensitivity to disturbances;
- personnel with specialist knowledge; and
- high utilization of machinery.

**Disadvantages:**

- much work in progress;
- large intermediate stocks;
- long and uncertain lead times;
- considerable planning, managing and administration problems; and
- the worker is “locked” to his machine.

The functional workshop often gives long and uncertain lead times. The problems arise when the manufacturing chain for a product is long, which results in:

- Manufacturing in batches. The whole batch is usually manufactured in one operation before it is transported to the next.
- Queues to even out variations in utilization. The organization of “one man - one machine” demands a high utilization of all machines.
- Big differences in the lead times for different batches, and thus long queueing times.
- Many components for one product. If every component has an uncertain lead time, the product lead time will be long because you have to plan with time and other resource allowances.
- Lack of space in the workshop. Bottlenecks can be difficult to foresee before they appear.
- Disturbances. Illness or lack of tools or material could make it difficult to see the effect of different disturbances and thus to take measures at the right time and place.
- Overestimation of capacity and release of orders. Capacity may be available in the first operation, but it is not clear whether it will be in the fifth operation in about one month’s time when the batch is not yet halfway through the workshop.

4.3.2 Flow-oriented layout

With this layout the production equipment is grouped in such a way that we can manufacture a detail from start to finish within one machine group (see figure 12.17).

![Flow-oriented layout](image)

The experience of some Swedish companies with flow groups shows that the lead times can be drastically reduced to a third or less compared with the lead time in a functional organization. However, a flow group needs greater investments in machinery and equipment because of lower utilization. Experience shows, however, that the gains from a reduction in work in progress are often much larger than the extra investment in machinery and equipment. The introduction of flow groups, however, calls for new ways of thinking about work organization, machine layout, planning, etc. One drawback with flow groups has been found to be inflexibility as regards changes in product volume and the product mix.

4.3.3 Product workshop

A product workshop is a production unit which is built and equipped to manufacture a finished product or a family of products independently. The target of the product workshop is physically and administratively to bring together the whole manufacturing chain for a specific product or group of products. Changing the production line into product workshops means that a larger network of linked functional departments is divided into many smaller and product-based units which can work independently. Product workshops have a number of advantages, for example:
- simple supervision and coordination from product order and design via planning, production and testing to delivery and invoicing;
- shorter lead times for the products and thus less capital tied up in work in progress; and
- shorter distances for transportation.

It is evident that the planning is simplified when you work with a product workshop. The production in different workshops need not to be coordinated but can be planned independently. By keeping the product flow within a workshop together, the need for intermediate stock decreases and it will be easier to survey and decide on the stock levels. As the product range within a product workshop is relatively unified, the flow can be straightforward and it will be easier to follow the production through. Moreover, the lead times will be similar for the different operations in the office as well as in the workshop, and this will give shorter queue times. The result will therefore be a far simpler administration of production and a simpler flowpattern as compared with work in functional workshops. Consequently lead times and the capital tied up in work in progress can be reduced.

4.3.4 Use of parallel stations

Work flows with parallel stations rather than consecutive stations have much shorter lead times and therefore tie up less capital in work in progress (see figure 12.18).

**Figure 12.18: Parallel stations = short queues**

Example:
- Identical processing time
- 30% utilization

<table>
<thead>
<tr>
<th>4 series stations</th>
<th>4 parallel stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 units/hour</td>
<td>4 units/hour</td>
</tr>
<tr>
<td>$T_p/4$</td>
<td>$T_p/4$</td>
</tr>
<tr>
<td>$T_p/4$</td>
<td>$T_p/4$</td>
</tr>
<tr>
<td>$T_p/4$</td>
<td>$T_p/4$</td>
</tr>
</tbody>
</table>

$T_T = (1 \times 4) \times 4 \times T_p/4 = 5.0 T_p$

$T_T = (1 + 1) \times T_p = 2.0 T_p$

$T_T = \text{throughput time}$

$T_p = \text{processing time}$

Experience has shown that under normal circumstances the lead time will be twice as long if the flow consists of two operations in line rather than two parallel stations. The conclusion is therefore that doubling the number of parallel stations for one operation gives a 50 per cent reduction in lead time and work in progress.
Note the following important remarks regarding production flows:

1. A short lead time is often more important for capital productivity than an intensive utilization of the production equipment.
2. Strive to achieve clean production flows (straight or U-shaped) with all the material moving in the direction of the flow.
3. The reduction of lead times in the critical path (the sequence of stages determining the minimum time needed for an operation) has a much greater effect than more general measures.
4. Disturbances affecting one product in the main flow must not affect the other products. Introduce special procedures alongside the main flow where the cause of breakdowns can be handled.
5. Avoid dividing a flow into several supervisory areas.
6. Strive to achieve complete flows that cover starting operations as well as closing operations.
7. Product similarity makes it possible for workers to identify with the work, and this will increase their motivation.
8. Similarities in the sequence of operations and in lead time in a production flow will make it possible to reduce lead times by 50 per cent.
9. In order to decrease disturbances in the flow, it is preferable that each part of the production system has to work for only one design department, sales department, etc.

4.4 Flexibility and tied-up capital

The need for flexibility in the production system is determined by:

- variable demand for the company’s products, which results in variable volumes;
- dynamic product development and thus shorter product life. These developments necessitate a different capacity for different operations in the manufacturing chain, as new products often have a different work content from the old ones; and
- increased customer orientation.

Flexibility in the daily work means that:

- the system should provide opportunities for manufacturing several variations of a product in a production group;
- the system should provide for taking a product or a transportation facility out of the system. A faulty product or an idle transportation facility should not be allowed to cause hold-ups and queues in the production line; and
- a system should be able to handle changes in capacity - for example, a working group should be able to vary the workload over time.

Some rules for flexibility:

- numerically controlled (NC) machines can be adjusted to run on new computer programs and are therefore much more flexible than conveyor lines;
- in parallel systems it is easier for the assembly line to handle a number of product variants as well as changes in the volume of production; and
the possibility of jumping towards or backwards in the flow creates flexibility.

Several studies have shown that flexibility, as expressed in alternative parallel production methods, flexible machines, flow groups or jumps in the operation flow, considerably decreases queue times and contributes to improved time schedules. Even if the opportunities are limited, a relatively sizeable improvement is usually reached when flexibility is introduced. In the following subsections we consider a number of approaches for reducing the amount of tied-up capital.

4.4.1 Set-up times

Figure 12.19 illustrates some ways in which the reduction of set-up and/or resetting time can reduce the lead time.

Reduced set-up times make smaller batch sizes possible, and this decreases the lead time and the capital cost for materials in stock (for finished goods as well as for work in progress). The Japanese Kanban system is one way of stressing the importance of operations aiming at reducing set-up times. One of the main principles of this system is to arrive at an even production flow. The ideal target is the manufacturing of one part or product at the required time. This calls for an active and continuous search for shorter set-up times. In the motor vehicle industry, changing dies in a press line takes 3 hours in an American car factory, 2 hours in a Swedish factory and 12 minutes in Japan. Good flows may be achieved by adopting the following methods:

- using NC machines and equipment (several operations on the same machine);
- using preset tools (simple and fast resetting);
- preparing flow groups for a given product range; and
- ensuring that workplace layout and methods for set-up work are efficient and effective.

4.4.2 Machines and equipment

One way of introducing higher productivity is to replace manpower by machines. In this case capital productivity may be expressed as the capital coefficient, which is total capital divided by value added. Investments which do not reduce the capital coefficient are of doubtful
value. Higher productivity can also be achieved by increasing the volume or reducing the work in progress in order to compensate for the investment. Work in progress may be reduced by introducing NC machines, semi-automatic production and flow groups. When investing in machines and equipment, you should bear the following points in mind:

- avoid investments in special machines with low utilization;
- buy externally the small quantities of parts which require these special machines;
- assign responsibility for capital assets in machines to the line-managers and supervisors and give them the possibility of doing without excess machine assets; and
- greater investments in machines and equipment lead to demands for higher utilization through shift work or a reduction in operatives' time.

Figure 12.20 shows capital assets per workplace when working in one or two shifts. The change from one shift to two shifts increases the optimal capital assets per workplace. The minimum point of the total cost curve moves from A to B. When optimizing capital assets as in position B, both cost of capital per unit and wage costs per unit will be reduced. In summary, even if you have to pay higher wages for working more than one shift, the reduction of capital cost per unit is higher than the increase in wages and the total cost per unit will be reduced.

**Figure 12.20: Capital assets per workplace**

4.4.3 Buildings

A factor that contributes to reducing tied-up capital is the optimal utilization of buildings, adjustment to the production process and flexibility so that the work can be rearranged without large investments. This is a measure of how well you use the floor space, i.e. how well you have designed the layout of the production facilities and how successful you are in keeping work in progress low. More work in progress will always need more space. The handling and storage of goods should be avoided as much as possible. The way buildings are utilized has a great impact on totally tied-up capital. In capital-intensive work you always have some form of shift work while in other work, for example light assembly, you only run one shift. In automated machines we have yet another tool to increase the utilization of equipment and buildings.

The quality of the building be chosen so that it harmonizes with the work that is done in it. For instance, you can use tents to store goods, which is a cheap way if the temperature in the
premises is without importance. This cheap alternative gives possibilities of saving on investments so as to use them more productively elsewhere. Besides, a tent is also a flexible solution. If you decide to build a certain type of building, you should investigate if, by increasing the investment a little, you can raise the roof of the building or make other changes which increases its use and flexibility. When you decide to build a new plant you should design for flexibility, and should also build in small steps instead of going for a big plant which will not be utilized from the start. As buildings always cost money, you should also look at your old buildings and demolish unnecessary ones.

4.5 Materials planning and production control

Systems for materials planning and production control have a great significance for capital productivity. The main task of the materials planning function is to determine the optimal balance between tied-up capital, service and utilization of resources within existing production systems, at the lowest possible administrative cost. Our intention in this unit is not to describe the materials planning area in detail but to concentrate on seeing how, by using the tied-up capital, you can influence materials planning and production control (MPPC).

Since Module 19, "Material management", covers this subject, we shall limit ourselves here to looking at its contribution to flexibility and the improvement of capital utilization (see figure 12.21).

**Figure 12.21: An overview of MPPC**

The main strategies affecting managerial MPPC decisions aimed at reducing the amount of capital tied up in production are:

1. **Customer orders instead of stock orders**
   - requires fast, reliable and frequent production flows;
   - reduces needs for forecasts on variants, only trends; and
   - reduces inventories to a minimum.
2. **Advanced preparations = simplified production**  
- results in understanding and cooperation; and  
- immediate feedback for corrective actions.

3. **Cooperation with subsuppliers based on confidence/respect**  
- creates responsibility in customer-supplier relations; and  
- responsibility for inventories at the source where it can be improved.

4. **“Just in time” instead of “Just in case”**  
- provides precision and reliability in production flows; and  
- reduces administration for inventories.

### 4.5.1 Release of new orders

You can never take more from a production system than its capacity allows. As long as there is enough work in progress to avoid long waiting times, and after allowing a certain time for starting up, the following formula is valid:

\[ D = 2C - R \]

where:  
\( D \) = deliveries per time unit from the production process  
\( C \) = manufacturing capacity per time unit  
\( R \) = release of new orders to production

This connection gives a positive result when \( R > C \), \( D < C \). If, however, \( R < C \), \( D > C \) it reveals a lack of capacity; the delays will be longer than necessary, if you do not decrease the release of new jobs to not more than the production capacity can handle.

### 4.5.2 Sequence numbering

A simple but effective way of handling priority problems in planning mixed manufacturing is through the sequence numbering of released orders. You often work with short series, e.g. up to four positions. This system makes it easy for all supervisors and planners to adopt the same priorities. The technique of sequence numbering can be used both in functional workshops and in product workshops. The most common principles of sequence numbering are:

- sequence numbering of released orders;  
- usually short series;  
- same priority of orders for all personnel involved;  
- fits in both functional workshops and product workshops;  
- easy to understand by everyone; and  
- unifies the resources so they pull in the same direction.
4.5.3 Kanban system (JIT)

The Kanban system, or just-in-time manufacturing (JIT), may be defined as a production system where the lead time is short and where the right part is manufactured at the right time and in the right quantity with the minimum of material needed to maintain the manufacturing flow.

This target is attained by combining the philosophy of balanced production with a system of production control where every operation, when a need occurs, orders parts from the previous operation in advance. This method of ordering can be used right back to the store of raw material or even to the subsupplier. Orders in the traditional sense are given only to the assembly line.

To order parts you use a special card, the Kanban card. Each card represents a fixed ordering quantity, and by exchanging the appropriate number of cards for the number of articles you require, you can control the volume of materials in the buffer stock. To decrease the operation’s sensitivity to disturbances and the number of buffers and increase the lead time, you also try to build up linked flows where machines are linked together in groups. People in the group have no fixed workplace but operate together all the machines in the group, which lessens problems of absentees.

Furthermore, the amount of material allowed between the machines is very limited. The target is the smooth movement of one part through the machines in the group. To avoid rejects, the principle of total control after every step in the manufacturing process is introduced. The function of “automatic stop” is to reduce the need for supervision of automatic processes and to make it possible to run more than one machine at a time. One variant is to stop the production in the whole production flow as soon as an error occurs at any of the stations. By revealing all disturbances instead of absorbing them in buffers you can, according to this philosophy, gradually reach very good production results. The Kanban technique is mainly used where the main part of the product assortment is stable and the manufacturing often repeated.

The positive results of the Kanban system are, among others:

- less work in progress (small batches in manufacturing);
- reduced lead times (through small batches, short set-up time and simple administration);
- better quality; and
- easier to prioritize (work in progress is small and the lead time short).

4.5.4 Stores

The importance of speed, safety and frequency in the material flow is highlighted in the following extract from a Swedish news item: “The capital productivity in an economic enterprise is a measure of how well it has succeeded. Profitability benefits from high income as well as low costs and reduced capital assets in the enterprise. All these items depend on the material flow in the enterprise.”
4.5.5 The Wilson formula.

In a mechanical workshop it is usual for material to be ordered when the storage level has fallen to a predetermined level. The order quantity usually corresponds to what is called optimal order size, which can be determined by the so-called Wilson formula. Under normal circumstances you then arrive at the curve for material in store, as shown in figure 12.22.

**Figure 12.22: The normal curve for materials in store**

The lower part of the figure represents the base stock, while half the optimal order size corresponds to what is called the consumption store. The base stock is needed to protect the company in the event of disturbances, which can be either a sudden increase in consumption or interruptions in deliveries. A typical Wilson formula for the calculation of optimal batch size is:

\[
Q_{\text{opt}} = \sqrt{\frac{200 \times N \times P}{U \times B}}
\]

where
- \(Q_{\text{opt}}\) = optimal batch size (units)
- \(N\) = estimated annual requirement (units)
- \(P\) = changeover cost
- \(U\) = stockholding cost (% of \(B\))
- \(B\) = manufacturing cost or procurement price per unit

The formula can be applied if:

- the price per unit is unchanged, regardless of volume;
- demand is continuous and constant;
- the replenishment of stocks is instantaneous in relation to consumption;
- the reordering cost is independent of order size; and
- the stock-keeping cost is proportional to the amount of stock.

When using the Wilson formula for specific conditions, put a constant before the formula to adjust for the cost of work in progress. This constant varies between 0.4 and 0.7. Here is an example of how to use the Wilson formula:
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Annual requirement (N) = US$1,200 per year
Prime cost (P) = US$200
Stock-keeping cost (U) = 40 per cent
Price (B) = US$20 each
Constant (example) = 0.6

\[ Q_{opt} = 0.6 \sqrt{\frac{200 \times N \times P}{U \times B}} = 0.6 \sqrt{\frac{200 \times 1,200 \times 200}{40 \times 20}} = 244 \times 0.6 \approx 150 \]

4.5.6 Lead time and productivity

We have pointed out several times that work in progress is directly dependent on the lead time, i.e.:

\[ \text{lead-time} = \text{queue factor} \times \text{average handling time}. \]

The total lead time is the sum of all individual lead times. It is clear that the average handling time depends on the productivity in the workshop, and measures aiming at increasing productivity will have a direct effect on tied-up capital. The size of the queue factor is to a great extent dependent on the plant utilization. Studies of the queue factor have shown that a decrease in utilization from 95 to 90 per cent or from 90 to 80 per cent will reduce the queue factor by 50 per cent and thus reduce the lead time too. If we succeed in increasing productivity and thereby reducing the lead time in a place where we have a bottleneck, the effect of our measures will be considerably bigger. If, on the other hand, we increase the productivity where, because of unbalance, we already have low utilization, the effect on the lead time will be minimal. Higher productivity can, of course, also mean that you use the spare time as additional capacity. If so, the lead time is not affected but instead we shall arrive at a better utilization of equipment and machinery which gives a lower capital cost per product unit. Measures to increase productivity such as the elimination of causes of disturbance also give favourable effects in other areas.

4.5.7 Personnel turnover and capital productivity

Recently hired personnel need time to reach the same level of productivity as experienced workers. It is therefore useful for capital rationalization to minimize the training time for newly hired personnel. Excessive personnel turnover rate therefore results in reduced capital utilization. If you have to hire new personnel some machines and equipment must be set aside for training. The utilization of the machines will therefore be higher and the lead times will increase.

4.5.8 Motivation and training for better capital utilization

To involve employees in improving capital productivity, the staff should be taught about the different cost factors and their impact on productivity. They should be taught the consequences of different productivity improvement measures on profitability, the working environment and their own salary as well as on their job security. Otherwise there could be opposition.
to productivity measures.

For example, queues are often created to maintain the high utilization of machines and manpower. Underutilization is often seen as a symptom of bad management. But queues will entail high costs for work in progress; therefore, the consequences of different ways of manning a production section must be clarified. Especially when working with large-scale capital productivity projects it is of the utmost importance that you provide the necessary information and training to convey an understanding of the measures taken.

A special form of training in which the staff is trained for a number of different tasks in a work flow, provides more flexibility. One of the motives behind this is to increase a company's ability to manage changes in demand through replacing the absent persons and/or working on different equipment if required. Figure 12.23 illustrates this graphically.

![Figure 12.23: Flexibility in training](image)

- Analyse common needs for flexibility (transfer employees or jobs)
- Train a limited number of employees for this flexibility
- Negotiate how these transfers are compensated in principle to avoid an individual negotiation for each transfer
- Reward flexibility generously when it is used (rather than merely rewarding knowledge and skill)

Ten workers who work 10 per cent overtime when required achieve a 25 per cent shorter throughput time than 11 workers with the same average capacity. This result is also achieved with short-term transfers between different operations.

A change of demand from one product to another can mean that certain production sections will be underutilized and others will be overloaded. If some of the personnel in the underutilized section can be moved to the overloaded one, you will be in a good position to handle changes of demand. By doing this you can reduce possible queues in production and in work in progress. Figure 12.24 gives an example showing how the flexibility of your staff can be analysed by means of a flexibility table giving the work tasks that each employee can do.
Figure 12.24: Training and skills flexibility analyses

<table>
<thead>
<tr>
<th>No.</th>
<th>Person's Name</th>
<th>Job</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Turning</td>
</tr>
<tr>
<td>0193</td>
<td>Gaunt</td>
<td>1</td>
</tr>
<tr>
<td>4487</td>
<td>Ronconi</td>
<td>-</td>
</tr>
<tr>
<td>4625</td>
<td>Smith</td>
<td>3</td>
</tr>
<tr>
<td>7301</td>
<td>Wadenoyen</td>
<td>2</td>
</tr>
</tbody>
</table>

1. New in job, requires continuous supervision
2. Can adequately handle task but requires training
3. Fully trained in job

Every worker should manage at least two jobs. If not, additional training is needed.

4.5.9 Changing the product range

In many manufacturing companies there is a risk of the product range comprising an uneconomic number of variants. This affects the capital tied up in stock proportionally to the square root of the number of variants at a given total turnover for the product models. This means that if, instead of keeping in store and selling product A with an annual sales volume of 100 units, you choose to keep in store and sell two variants A1 and A2 with an annual sales volume of 50 units each, the tied-up capital increases by 40 per cent ($\sqrt{2} - \sqrt{1}$).

The range of products also influences the size of inventories:

$$\text{Inventories} = \text{constant} \times \sqrt{\text{number of variants}}$$

as in the following example:

<table>
<thead>
<tr>
<th>Alternative 1</th>
<th>Alternative 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of variants</td>
<td>2</td>
</tr>
<tr>
<td>Volume of variants</td>
<td>50</td>
</tr>
<tr>
<td>Inventories</td>
<td>Constant $\times \sqrt{2}$</td>
</tr>
</tbody>
</table>

Alternative 2 compared with Alternative 1 = \frac{\text{Constant} \times \sqrt{1}}{\text{Constant} \times \sqrt{2}} = 0.7

Thus the inventory has been reduced by 30 per cent.
To avoid producing an unprofitable number of variants it is better to have a company policy which takes into consideration the need for standardization and simplification of the development work for

- finished products;
- components; and
- materials.

**Finished products.** To get a view of the profitability of reducing the product range and a hint about where the reductions should be made, a study of the profitability and sales volume of various products and models is usually needed. Normally a small part of the products represents the greater part of the sales volume. In principle the 80-20 rule can be applied, i.e. 20 per cent of the products account for 80 per cent of sales. Therefore, products with a high sales volume subsidize products with a low volume. If these products are to be manufactured, the price must be set so that you have full cost coverage. A standardization of the product range gives economic advantages which can be of benefit to a customer in the form of lower sales prices. It can be summarized in the following points;

- increased automation is possible when you have longer series;
- direct work can be reduced by introducing capital-intensive production;
- standardization leads to higher utilization of machines because there are fewer changeovers;
- less storage space is needed for material, components and finished goods with a consequent reduction in tied-up capital; and
- a simplified production control system is possible.

On the other hand, too much standardization or too great a reduction in a product range can affect efficiency, market share and product development. The company may surrender exclusive markets which support high prices in favour of markets with standardized manufacturing which are characterized by price competition.

**Components.** A large number of variants within a limited product range can often be reached in spite of a high level of standardization of ingoing components. In this connection we talk about modularization or building blocks. To a great extent the standardization of components gives the same economic advantages as the standardization of the finished products, but the drawbacks can be partially eliminated. To many companies, modularization implies successful trade-off efforts between demands for long series and product differentiation.

**Materials.** Standardization can cover direct as well as indirect materials. In both cases there is often an unnecessarily diversified lot of material in both size and types. A certain degree of standardization is therefore often economic since it can lead to smaller stores, simplified purchasing and storage systems, quantity discounts and better maintenance. The drawbacks are mainly that you may have to use more expensive material where it is not necessary and that the utilization of material may decrease. There are also certain risks that material which does not meet quality or maintenance standards may be used.
4.5.10 Product design

The possibility of working simultaneously on the different components of a product has a great impact on the lead time, which in turn determines how much capital must be tied up in work in progress. We should therefore attempt to create a product design where the structure of the products makes it possible to manufacture the different parts in the product simultaneously. One way to do this is to build up products from modules. The advantages are that modules:

- combine different customer demands;
- facilitate design;
- facilitate manufacturing;
- facilitate control;
- facilitate stock-keeping; and
- facilitate service.

One of the most important arguments is, however, that the batch size can be larger for single modules than for complete products.

An example of component modularization is given in figure 12.25, illustrating how a Swedish manufacturer has designed his sinking pumps. Different tailor-made pumps can be assembled by combining one base module and seven other modules.

**Figure 12.25: Modularized design**

![Modularized design diagram]

The modularization method is not effective, however, when:

- it is important to optimize product performance;
- it is uncertain whether more than one single product will be manufactured; and
- the volume of the total number of variants is very small.

Modularization enhances capital productivity through:
the simultaneous manufacturing of different modules, which leads to less capital being tied up in work in progress;
- decreasing storage costs; and
- greater preparedness for production, with fewer disturbances as a result.

If a product incorporates extremely expensive components, it can be cheaper to have the expensive part as a module which is manufactured when you receive an order.

4.5.11 On-site assembly

Owing to the high capital intensity of the product, it is important that:
- as much work as possible is done in-plant prior to on-site assembly;
- the production of components and/or subsystems is well synchronized;
- the planning of on-site assembly is based on a substantial buffer time;
- the product design permits easy and fast on-site assembly;
- heavy and large transport operations are planned in detail; and
- cooperation with subcontractors and contractors is good.

Efficient on-site assembly requires careful organization which permeates the entire company.

4.5.12 Transportation and distribution

The capital assets at the distribution level must be controlled by the producer. Thus, producing companies often invest more capital in distribution than in production. When you consider transportation, you should bear in mind that:

- efficient transportation implies not only large volumes but also efficient and frequent goods handling; and
- transportation damage causes complaints and delays in payment.

To improve the efficiency of transportation, it is important to:

- reduce the number of market variants;
- use standard packaging (containers);
- reduce large overseas transportation; and
- share transportation with other companies.

Fast, safe and frequent transportation, although more costly, is generally better than cheap transportation. Direct distribution orders can be handled in one day. Lead time is then 1 day plus the average waiting time between despatches plus transportation time. The lead time can often be reduced to one-tenth of what is normal for conventional distribution from the warehouse (down to 1-3 days). Inventories in the central warehouse and distribution units can be reduced to one-third as a consequence of a shorter lead time.

Experience has shown that costs for handling and packing do not increase proportionally with the number of despatched items. In one factory a fourfold increase in the number of order
items following the introduction of direct distribution doubled the need for staff in the central warehouse, but this increase was less than the reduction in the distribution unit. Finally, EDP and telephone charges will only show minor increases. These costs rise by only 10 per cent when the number of order items is four times greater.

4.5.13 Administration of receivables

Customer receivables often account for approximately 50 per cent of financial capital assets. It is therefore important to reduce the time between delivery and the receipt of payment. Routines for reporting completed production, despatch and invoicing are important if production is to improve. The following hints may be useful:

- aim at a short despatch time;
- ensure that documents such as delivery slips, invoices, etc., are produced on time (documents should be ready when the product is ready for delivery);
- request advance payments for capital-intensive equipment;
- state the latest day of payment, not a time period;
- follow up late payments and charge penalty interest; and
- sell customer receivables to an invoicing company.

Questions for discussion

1. What are production systems and production flows? Explain their relationship.
2. What is the benefit of using parallel stations instead of one single station in a manufacturing process?
3. What are the advantages and drawbacks of an MPPC planning system?
4. Briefly explain the Kanban system and the conditions for its use.
UNIT 5: USING CAPITAL PRODUCTIVITY PROJECTS

UNIT 5: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Understand the importance of coordinating capital rationalization activities with other activities and the essential role of project organization.

2. Understand the main reasons for capital rationalization projects.

3. Understand the most important areas of conflict between project targets and departmental targets and optimize them through project activities.

UNIT 5: CONTENTS

5.1 Coordination with other rationalization activities

5.2 Capital rationalization in projects

5.3 Project activities
UNIT 5: USING CAPITAL PRODUCTIVITY PROJECTS

5.1 Coordination with other rationalization activities

The need for capital in a company results from the time gap between the outgoing payments by the company and the customers’ payments to the company. The less capital you disburse for the same output, the higher is your capital productivity. The aim of capital rationalization is therefore to minimize your need for capital. That means:

- decreasing the money going out;
- increasing the money coming in; and
- decreasing the time that elapses between paying money out and receiving incoming money.

With such a broad definition, almost any form of rationalization in a company could be called capital rationalization. It is the overall aim of the project that characterizes capital rationalization rather than the rationalization techniques that will be used. For example, industrial engineering techniques may be used to reduce production and materials handling costs by:

- developing better working methods;
- developing more stimulating wage systems;
- decreasing the use of material;
- decreasing damages in transport and handling; and
- decreasing disturbances, etc.

With these measures the industrial engineer can influence the sums the company has to pay out and thus the capital tied up - even if the effects of his work are measured in the form of lower labour and material costs. A better utilization of investments, e.g. through shorter operation times and fewer disturbances, may result in more money coming in owing to a greater production volume. The aim of decreasing labour and material costs often leads to the same results as capital rationalization, but not always. The conventional manufacturing calculations which the industrial engineer often uses are rather insensitive to variations in tied-up capital, turnover rate, lead time, etc. Therefore these could easily be overloaded. That is why it is important that the industrial engineer should systematically look at any possibilities of decreasing tied-up capital.

5.2 Capital rationalization in projects

In situations where a company experiences lower profitability, high interest costs, difficulties in obtaining capital and a low capital turnover rate, it is necessary to look into capital rationalization and see what it could mean in the form of released capital. This often leads to a pre-analysis regarding the rationalization potential within different areas of the company. The pre-analysis can be made by a neutral department in the company or by external consultants. The pre-analysis in turn often results in a project proposal with suggestions for targets, preliminary work plans, time schedules and views on the project organization and its manning. Usually the project is also broken down into subprojects, dealing with certain types of problems, or with certain departments or functions. Before a project is begun, support for the idea of capital rationalization must be obtained from the key persons in the company. It is also important that the
managers of the departments concerned accept the targets of the project. The motivation level of the work of capital rationalization should be very high during the whole project time. In a large project the project management is usually assigned to the top management of the company. It is also common to engage internal or external consultants for the steering committee and the project work. It should also be borne in mind that in a certain specific department or function the problem with tied-up capital can be of such a size and complexity that capital rationalization can be successfully implemented only in the form of a project.

5.3 Project activities

Here we shall not look closely into the forms of a project but limit ourselves to giving some useful hints. The project organization consists of personnel from:

- departments affected by the project;
- other departments that can supply specialists to the project; and
- external specialists when this is necessary.

Good cooperation between the project organization and the departments concerned is important from the very start of the project. The following points are usually valid as regards the cooperation between the project organization and the base organization:

- every project is led by a steering group, which is the highest decision-making unit within the project. The members of this group are responsible for decisions taken in the base organization;
- decisions regarding the implementation of changes in systems, routines, etc., are taken by managers in the base organization; and
- every member in the project groups is subordinate to the project leader. Administratively the member of a project group is subordinate to his normal line manager in the base organization. There must be continuous communication between the project organization and the base organization in order to coordinate the project with the normal business in the company.

5.3.1 Target setting

It is essential that target setting for a capital rationalization project be clear and quantified. Already at the pre-analysis stage it is often useful to use a technique such as the matrix reproduced earlier in figure 12.15, showing where capital is tied up and what measures can be taken.

5.3.2 Capital rationalization in the base organization

In the base organization the main aim is to integrate capital rationalization aspects into the ordinary work. Some special questions can nevertheless be solved by giving them as a special task to certain personnel, without setting up a project. However, the most serious problems of capital rationalization should be solved within the project framework.
5.3.3 Subtargets and subtarget conflicts

The target of capital rationalization is to release (minimize) tied-up capital and/or increase its utilization. This may come into conflict with other subtargets set by the company. When you establish priorities for these subtargets, the aspects of capital rationalization can often be forgotten. Let us illustrate this with a very simplified example.

Company X manufactures door-closing equipment (approximately 100,000 pieces per year). In the manufacturing process a cutting and bending operation is included. This operation is carried out in a press with special tools. The set-up time is relatively long. The operation is carried out in batches of 10,000 units, giving the following price per unit (in US$):

- set-up cost 0.01
- cutting and bending 0.125
- total 0.135.

An analysis has shown that cutting the batch size by half would result in a material store of US$2,000 less. In this case the price per unit is:

- set-up cost 0.02
- cutting and bending 0.125
- total 0.145.

The manager of the press department is not very attracted by this alternative, because he is under orders to show a cost rationalization for the press department of 5 per cent per year. If this proposal were accepted, he would have a negative rationalization. The conclusion is that good capital rationalization can mean excess costs in the manufacturing process itself. In this case there is no benefit for the press department and its staff. The demand for an annual reduction in labour costs ought to be coordinated with instructions that less capital should be tied up so that an optimal solution is reached. It is important to understand that you should not work with either tied-up capital or product prices but with both. More work on the basic problems behind the tied-up capital in the above example, namely the set-up time, could perhaps reduce both product price and tied-up capital. To run certain machines at full capacity must never be a goal in itself. This may be because you have an expensive NC machine which you think you cannot afford to leave idle. To have large numbers of semi-products stored in front of the NC machine with longer lead times and a consequent increase in tied-up capital is often a poor use of resources - especially if at the same time there is free capacity in other machines. One hour saved on the NC machine can in this case mean an increased lead time of many weeks. The fact that more capital is tied up can be much more important than the value of increased machine time.

5.3.4 Need for information and knowledge

One of the factors that determines the attitude of the individual in different circumstances is knowledge. This is especially true regarding questions of capital rationalization. It is important that the staff should be informed about targets, strategy, etc., regarding the use of capital in the company. Unsafe and improper handling of capital is often connected with a lack of information. Everyone within the company must therefore understand the advantages of
releasing capital tied up in stores so that instead it can be used actively for investments in machines, for instance. From the example above you will understand that capital rationalization cannot as a rule be performed as an isolated action in a corner of the company. If capital rationalization is to be attained by a change in behaviour, the change must be done on a company-wide basis. If capital rationalization is to be attained through practical changes, a new attitude from managers and other people directly concerned is called for. Capital rationalization must also have the backing of top management. Otherwise the activity will not be given sufficient support and priority. The setting of targets for capital rationalization must be followed up in the same ways as with other targets in the company. Information about results should be able to stimulate further measures. One cause of the frequent unwillingness to carry out capital rationalization by lowering stock levels is that problems and disturbances appear more often when this is done. In such cases you must attack the causes behind the disturbances - for instance, poor surveillance of deliveries from subsuppliers, bad accounting systems. The staff in question must be aware of the necessity to follow established rules and routines.

5.3.5 Responsibility and authority

It is very important that responsibility and authority should correspond. A person who can handle storage should also have the responsibility of keeping stocks at a reasonable level. The supervisor of a production group should see the benefit of keeping down the number of cutters in his workshop. The workers on the shop-floor who influence the lead times should also see it as their responsibility to ensure that semi-products do not lie idle in the workshop and that defined lead times are met. It is also important to clarify the responsibility for intermediate stores between the workshops. Many companies find that capital tied up in various kinds of stores has a tendency to grow in an uncontrolled way. This kind of tied-up capital is looked upon as being very difficult to handle. One cause for this is often that responsibility and authority in this area are unclear. There may even be company stores for which no one at all feels responsible. These stores have just been established without any decision at all. In a successful capital rationalization process it is therefore very important to clarify questions about responsibility and authority. The successful improvement of the capital turnover rate requires that great attention be paid to setting up the common goals and to handling conflicts of target between different departments. The following case highlights these conflicts.
Case 5

Improved capital utilization is an optimization problem. Often, different departments in the company are directly responsible for individual factors in this optimization. Improving the capital turnover rate requires paying the highest attention to eliminating sub-optimization and to the handling of target conflicts between different departments in the company.

This case is intended to highlight these target conflicts.

Conditions

Company X is striving for:

- an efficient delivery service;
- high capacity utilization;
- small inventories;
- low administration costs (planners, purchasers, foremen, etc.);
- low manufacturing costs;
- short throughput times; and
- controlled quality.

Within the company the following departments are found, each of which is focusing on one or several of the above-mentioned objectives:

- production P
- production planning PP
- accounting A
- sales S

Target 1

Designate the department which is most likely to highlight the above objectives (one or a maximum of two departments per objective).

Target 2

Evaluate the different objectives against each other in the matrix in figure 12.26 by assigning (C) for concurrent objectives, (O) for counteractive objectives and (−) for independent objectives.

Questions for discussion

1. What are the main reasons for capital rationalization projects?
2. What could be the main, typical capital rationalization project strategies?
3. Relate project activities and the needs for optimization of different departmental and functional targets. Describe the project’s role.
Figure 12.26: Objectives matrix

![Objectives matrix diagram]

See figure 12.27 for proposed solutions.

Figure 12.27: Proposed solution to Case 5

![Proposed solution diagram]

1. Small inventories, small batches
2. Big batches
3. Small batches, flexibility
4. Small staff, simple routines
5. Big batches
6. Small batches, flexibility
7. Controlled quality
UNIT 6: MEASURES AND FOLLOWING UP OF RESULTS

UNIT 6: LEARNING OBJECTIVES

Once you have learnt this unit, you will be able to:

1. Appreciate the role of benchmarking in assessing the results of capital rationalization.

2. Choose the key measures and data for assessing the results and identify the standards or norms for comparison.

3. Explain the main reasons for using key measures and their analysis in capital rationalization.

UNIT 6: CONTENTS

6.1 General views on benchmarking

6.2 Practical example

6.3 Key measures in capital rationalization
UNIT 6:  MEASURES AND FOLLOWING UP OF RESULTS

In unit 4 we saw that many different measures can be taken to improve the use of capital. They may be measures in supporting functions (materials planning systems, etc.), improved management and/or coordination, new physical conditions, new behaviour, and so on. When you have introduced the measures that have been decided upon, the result should be reflected in production changes. It is important not to look only for direct effects when changes have been consciously made. You often have indirect effects also, positive as well as negative. The normal budget system is very seldom suitable for this, because it deals mainly with costs and income and not with tied-up capital and the use of capital - possibly with the exception of a cash budget. Besides, it functions almost entirely in the monetary dimension. When the books are closed each year, changes in current and fixed assets are registered in the balance sheet and you can follow up an expected decrease in goods in store, for example. Other effects of this decrease, such as a lower level of service, more disturbances in the production, etc., cannot be followed up in the balance sheet. Perhaps you can trace indirect effects in the profit and loss account in the form of a lower result.

The follow-up of the direct effects of measures aiming at the higher utilization of fixed assets must usually be done in other dimensions than monetary - for example, machine utilization in hours, etc. Such figures must be collected from other sources than the economic accounts.

The technique of benchmarking has been found very useful when you want to measure and follow up the effects of rationalization. Producing key figures for suitable time periods which can be compared to precalculated standard values is an effective methodology. The necessary data for the key numbers are collected from the economic accounts and other special reports.

6.1  General views on benchmarking

We need to compare key measures because an isolated number in itself has little importance. It will be of value only when you compare it with another number. A key measure expresses in one single number a comparison between two numbers. A key measure can therefore be improved by improving one part of it or, of course, both parts. Suppose that a company thinks that the ratio between sales value and manufacturing cost is an interesting key measure which they will try to improve. The company either aims at increasing sales at unchanged costs or at reducing costs at unchanged sales. One of the advantages with key measures is that the same importance is put on the nominator as on the denominator. This makes it easier to avoid the trap that arises when you use absolute figures. If, for example, you look only at the costs you will easily end up thinking that all costs are bad and therefore should be lower. It is very important for there to be coordination between the nominator and the denominator in a key measure and between the calculation method for the key measure and the standard measure with which the key measure is compared.

6.1.1  Choice of key measure and data

Before an organization can choose its key measures, it must determine its targets. Only then can it measure in what degree it has reached the targets. The choice of key measures cannot
be separated from the possibilities you have of obtaining data. If you need special data just for
the calculation of key measures, the risk is great that the quality and access to these will be lim-
ited in the future. To exemplify the difficulties in obtaining data we have chosen the following
key measure. The key measure indicates how many days of production value is tied up in work
in progress. The formula is:

\[ \text{Work in progress} \]
\[ \text{Average daily value of started and finished production.} \]

The work in progress is, as you see, divided by the average of the material flow to the pro-
duction unit and the flow of finished goods from the production unit. We shall not look into this
formula in more detail but just state that it should be possible to get the figures included in the
formula from a traditional accounting system.

6.2 Practical example

In the following example we show how a company follows up two different key-measures. In
the first the company follows up the number of manufactured units of a component per em-
ployee and per day. The result is shown in figure 12.28.

**Figure 12.28: Practical example: Produced units**

The second key measure in this company is the follow-up of the capital turnover rate for
work in progress. This key measure is calculated every month according to the following for-
mula:

\[ \frac{\text{Deliveries from work in progress}}{\text{Work in progress}} = \text{Turnover rate for work in progress per month.} \]

The result is shown in figure 12.29.
6.2.1 Comparison between key measures and standard measures

An isolated figure has little importance and this is also because of key measures. First, when a key measure is compared with a standard measure you can judge if it is satisfactory or not. There are both internal and external standard measures with which you can compare the achievements of a company (figure 12.30).

Figure 12.30: Comparison of key measures with standards (norms)

1. Historical data in the company (trend)
   - result (volume)
   - variations in business cycles
   - changes in technical levels
   - US$ per ton → inflation
2. Comparison with budget → target
3. Comparison with other companies

Key measures are not standards. They must be compared with something to form a basis for evaluation.

6.3 Key measures in capital rationalization

There are two main ways of using key measures and key measure analyses in capital rationalization:

- as a tool for judging the rationalization potential within different areas; and
- as an instrument for following up the results of capital rationalization measures.
Figure 12.15 reproduced a matrix illustrating where capital is tied up in the company and what action areas are interesting in the capital rationalization of production. The key measures for current assets are usually in the form of turnover rate or lead time. These key measures can then be broken down into other measures which could be affected by capital rationalization: for example, the lead time affected by capacity, steering system, number of work operations, transport times, etc.

For fixed assets the key measures usually refer to utilization. If you work with capital rationalization of the raw material store, the action areas in question are usually the production system, the material planning system, the product range and product design. As a rule the rationalization leads to a number of measures within these areas. The total results should be higher turnover rate.

The turnover rate is usually defined as the relationship between the value of deliveries per time unit from the store, and value of the store in the same time period.

The turnover rate of the store is a good indication of how you manage your store. You should, however, also ensure that the service level of the store is satisfactory. This can be done, for example, by a key measure that shows the relationship between the number of shortages and the total number of deliveries. Sometimes you may find it necessary to follow up in more detail the development within the different action areas. Suppose, for example, that the materials planning section has planned to decrease the base stock by increasing the safety of deliveries from the subsuppliers. In this case it may be helpful to introduce a key measure for this. In the same way it may be useful to use key measures to follow up other changes regarding, for example, variant limitations, product design, production systems and materials planning systems.

It is not practical to make a complete list of key measures. In certain cases you are recommended to think for yourself how a key measure for following up a special situation should look. As mentioned earlier, in such a case you should investigate the accessibility of the information you need. The follow up of key measures should be delegated to the managers responsible for a certain area. You should try to limit the number of key measures per manager to those which describe what is essential for the work that he or she is in charge of.

Questions for discussion

1. What is benchmarking? How can you use it in assessing the results of capital rationalization?
2. What are direct and indirect measures? Why do we often need indirect measures to assess the results of the project?
3. What are the key measures for assessing the results of a capital rationalization project?
BIBLIOGRAPHY


