International Labour Organization
Sectoral Activities Programme

TMMEI/2002

Lifelong learning in the mechanical and electrical engineering industries

Report for discussion at the
Tripartite Meeting on Lifelong Learning in the Mechanical
and Electrical Engineering Industries

Geneva, 2002

International Labour Office Geneva

Contents

Page

Introduction

At its 279th Session (November 2000), the Governing Body of the ILO decided to include a Meeting on Lifelong Learning in the Mechanical and Electrical Engineering Industries in its programme of sectoral meetings for 2002-03. Subsequently, at its 280th Session (March 2001), it was decided that the purpose of the Meeting should be an exchange views on the need for lifelong learning and training in the mechanical and electrical engineering (MEE) industries, and the social and labour implications for the parties concerned, using a report prepared by the Office as the basis for its discussions; to adopt conclusions that include proposals for action by governments, by employers' and workers' organizations at the national level and by the ILO; and to adopt a report on its discussion. The Meeting may also adopt resolutions.

Although it had decided at its 280th Session that the composition of the Meeting would be the Governments of 20 countries, 20 Employers' representatives and 20 Workers' representatives, with a reserve list established for the Governments, the Governing Body subsequently decided at its 283rd Session (March 2002) that participation in the Meeting would be open to the government of any ILO member State which indicated its wish to do so.

The Meeting is part of the ILO's Sectoral Activities Programme, the purpose of which is to facilitate the exchange of information between constituents on labour and social developments relevant to particular economic sectors, complemented by practically oriented research on topical sectoral issues. This objective has traditionally been pursued by holding international tripartite sectoral meetings for the exchange of ideas and experience with a view to: fostering a broader understanding of sector-specific issues and problems; developing an international tripartite consensus on sectoral concerns and providing guidance for national and international policies and measures to deal with related issues and problems; promoting the harmonization of all ILO activities of a sectoral character and acting as a focal point between the Office and its constituents; and providing technical advice, practical assistance and support to the latter to facilitate the application of international labour standards.

The final meeting of the Metal Trades Committee [1] in 1994, when referring to the need for strong basic education, still maintained the dichotomy between learning and training while recognizing the need for *long-term training.* [2] In 1998, the Tripartite Meeting on the Impact of Flexible Labour Market Arrangements in the Machinery, Electrical and Electronic Industries adopted conclusions [3] stating that governments should provide sound basic education and regularly adapt curricula and teaching methods so that they remain relevant to the rapidly changing needs of the workplace. The training provided should impart portable skills and be carried out in the context of *lifetime learning* for long-term careers. There should be tripartite involvement in the definition of training needs and,

[1] ILO: *Consequences of structural adjustment for employment, training, further training and retraining in the metal trades*, Report II, Metal Trades Committee, 13th session, Geneva, 1994.

[2] ILO: *Note on the Proceedings: Metal Trades Committee*, 13th session, Geneva, 12-20 Jan. 1994, para. 18, p. 40.

[3] ILO: *Note on the Proceedings: Tripartite Meeting on the Impact of Flexible Labour Market Arrangements in the Machinery, Electrical and Electronic Industries,* Geneva, 26-30 Oct. 1998, Conclusions, especially No. 5, p. 25.

where appropriate, in the administration of training programmes. Within the sectoral activities programme, the topic of *"lifelong learning"* was first addressed as a subject in its own right at a sectoral meeting[4] held in April 2000. The discussions on the need for a new approach to human resources development at the 88th Session of the International Labour Conference (2000) [5] provided a further impetus to examine the subject of lifelong learning in this current Meeting.

The purpose of this report is to provide background information to stimulate discussions at the tripartite meeting of the mechanical and electrical engineering industries on the subject of lifelong learning. As such it does not seek to provide a comprehensive analysis of each national vocational education and training (VET) system, nor to review every individual company or industry scheme. Instead, it focuses on recent economic developments which provide the backdrop against which lifelong learning has become a categorical imperative. The report also provides information on selected trends and issues as illustrations of the need for a paradigm shift from training to learning (at least as far as working life is concerned), together with the factors that facilitate this. The report is organized as follows.

Chapter 1 presents some recent developments in the industry – in the areas of production, exports and employment – using internationally comparable statistics to the extent that they were available. Chapter 2 sets the stage for a paradigm shift from a vocational training approach to one that would include lifelong learning, presenting examples of what is currently taking place in several companies. Chapter 3 traces the development of the colour TV industry, a mainstay of the consumer electronics industry. The industry is one example of how a few developing countries were able to take advantage of some phases in the relocation of industries, and the training and other prerequisites that are conducive to absorbing this technology transfer. Chapter 4 looks at a range of initiatives that have come about mainly as a result of collective bargaining and are directly related to lifelong learning. Chapter 5 examines recent experiences in three of the major countries involved with MEE products – the United States, Japan and China – and the changes that are taking place in order to realign their educational and training systems. Chapter 6 examines "high-performance work" in four companies as one option for implementing lifelong learning at the workplace. Finally, Chapter 7 draws together the major points which have been made and identifies areas where information is still required.

This report is published under the authority of the International Labour Office and was prepared by Paul Bailey of the Sectoral Activities Department, assisted throughout by J.-Pierre Singa Boyenge who was undertaking an internship in the Department at the time and also prepared a background study. [6] Nana Bourtchouladze of the Institut des Hautes Etudes Internationales compiled the statistical data [7] from the ILO's LABORSTA, the OECD's OLISnet, the UNIDO databases and the US Bureau of Labor Statistics. Robert

[4] ILO: *Lifelong learning in the twenty-first century: The changing roles of educational personnel*, Report for discussion, Geneva, 2000, as well as the *Note on the Proceedings*: Joint Meeting on Lifelong Learning in the Twenty-first Century, Geneva, 10-14 Apr. 2000.

[5] ILO: *Training for employment: Social inclusion, productivity and youth employment*, Report V, ILC, 88th Session, Geneva, 2000.

[6] J.-P. Singa Boyenge: *L'apprentissage tout au long de la vie dans l'industrie mécanique et électronique*, (ILO, forthcoming, 2002).

[7] N. Bourtchouladze: *The mechanical and electrical engineering industries in numbers: An update* (ILO, forthcoming, 2002).

Forrant of the University of Massachusetts at Lowell contributed a company case study and a review of innovative apprenticeship programmes [8] in the United States. The Japanese Institute for Labour provided information on recent developments in Japan, and the section on China was compiled by Tian Feng. The preparation of the report benefited from discussions with Trevor Riordan, Torkel Alfthan, Bill Ratteree and Gijsbert van Liemt, as well as from parallel work being undertaken by the InFocus Programme on Skills Development with a view to the development of a new Recommendation on human resource development.

The Governing Body decided at its 283rd Session (March 2002) that this Meeting would be organized around a series of thematic discussions on the following topics:

1. The economic performance of the MEE industries: 2001 recession and outlook.

2. The social impact of restructuring the MEE industries.

3. Lifelong learning in the MEE industries: Concepts and examples.

4. The right curricula for the various aspects of lifelong learning.

5. The roles of the social partners and governments in lifelong learning and beyond in the MEE industries: Implications for the ILO.

[8] R. Forrant: *Case study on the United States* (ILO, forthcoming, 2002).

1. Recent developments in the mechanical and electrical engineering (MEE) industries

Overview

The mechanical and electrical engineering (MEE) industries cover a wide spectrum of activities ranging from the manufacture of heavy special and general-purpose machinery and domestic appliances to lighter, but highly sophisticated, electronic equipment such as office and computing machines, electrical machinery and apparatus, radio, TV and communications equipment, medical, precision and optical instruments, and watches. The processes for manufacturing all these things require a wide variety of skills at varying levels. For the first time, it has been possible to present data in the appendix to this report for most countries according the modified industrial classification of these industries (International Standard Industrial Classification of All Economic Activities (ISIC), Rev. 3 of 1990). This allows for a better breakdown of the subsectors of the industry. Whereas the manufacture of machinery or mechanical engineering has remained one industrial group (ISIC 29), electrical engineering has now been divided into four separate categories to reflect the above division of industries (see box 1.1).

Box 1.1
The mechanical and electrical engineering (MEE) industries*

29	Manufacture of machinery
291	*General-purpose machinery*
	Engines and turbines
	Pumps, compressors, taps and valves
	Bearings, gears, driving elements
	Ovens, furnaces
	Lifting and handling devices (cranes, elevators)
	Other general-purpose machinery (packing, bottling, weighing, canning, air conditioners, refrigerators for commercial purposes, fire extinguishers, etc.)
292	*Special-purpose machinery*
	Agriculture and forestry machinery and equipment
	Machine tools
	Machinery for metallurgy
	Machinery for mining, quarrying and construction
	Machinery for food, beverage and tobacco processing
	Machinery for textile, apparel and leather production
	Weapons and ammunition (tanks, artillery, small arms, bombs, torpedoes, missiles, etc.)
	Other machines for handling rubber, pulp, paper, printing, etc.
293	*Domestic appliances*
	Refrigerators, dishwashers, laundry machines, stoves, etc.
30	Manufacture of office, accounting and computing machinery
	Computers, printers, copying machines, etc.

31	Manufacture of electrical machinery and apparatus
311	*Electricity motors, generators, transformers*
312	*Electricity distribution and control apparatus*
313	*Insulated wire and cable*
314	*Accumulators, primary cells and batteries*
315	*Electric lamps and lighting equipment*
319	*Other*
	Graphite products, ignition and starting equipment, electromagnetic clutches and brakes, traffic control equipment, headlights, windshield wipers
32	Manufacture of radio, television and communication equipment
33	Manufacture of medical appliances, precision instruments for measuring, optical instruments, watches and clocks
72	The development of computer software (outside the scope of this report)

*The categories presented here are according to the International Standard Industrial Classification of All Economic Activities (ISIC), Rev. 3 of 1990.

These industries are particularly significant for most countries. In fact, according to the World Trade Organization (WTO), trade in products of the MEE sector has been growing twice as fast as total world trade throughout the 1990s, and the WTO has described office and telecommunications equipment as "the hardware component that drives the IT revolution". Nevertheless the economic downturn which began in 2001 had already led to the projected loss of some 350,000 jobs in the electronics sector by mid-year, well before the events of 11 September which are likely to exacerbate this trend (and will be discussed later in this chapter). Most countries are suffering from skills shortages to varying degrees and at various levels in many of the segments of this industry that are under pressure from global competition.

As already indicated, this report is also being prepared at a time when the ILO is in the process of revising its Human Resources Development Recommendation, 1975 (No. 150), in light of the resolution adopted by the International Labour Conference on 14 June 2000 on human resources training and development:

> Recommendation No. 150 reflects the planning paradigm of the early 1970s. It leaves little room for demand and labour market considerations and provides little or no guidance on many issues that are central to contemporary training policy and system reforms under way in member States. These issues include the policy, governance and regulatory framework of training; the roles and responsibilities of parties other than the State (e.g. the private sector, the social partners and civil society) in policy formulation and in investing in and providing learning opportunities and training; the move by many countries to provide lifelong learning and training opportunities for all people; devising appropriate policies and mechanisms for targeting learning and training programmes at particular groups with special needs; the shift towards development and recognition of "competencies" that comprise a wide range of work-related knowledge and technical and behavioural skills, and which form elements of many countries' emerging frameworks of national qualifications; and the need to expand skill development activities that prepare workers for self-employment. [1]

Much in line with this thinking, the United States Department of Labor has estimated that 75 per cent of today's current jobs in America will cease to exist in their present form

[1] ILO: *Learning and training for work in the knowledge society*, International Labour Conference, 91st Session, 2003, Report IV(1), (Geneva, 2002), p. 2.

during the next five to ten years (implying a need for massive educational and retraining efforts). Likewise in Europe, employers' and industry associations in the metalworking and electronics sectors – WEM [2] and ORGAMLIME [3] (together representing some 200,000 companies employing 12 million workers) – have also produced a common position paper highlighting the current skills shortage in the industry and its impact on welfare and employability. [4]

According to the *World Employment Report 2001*, [5] the major skills challenge is that by the end of 2010, over 80 per cent of the industries' workers in the European Union will have received their formal education and training at least a decade earlier. Ever younger technologies and an ever older workforce lead to one conclusion: retraining and lifelong learning have become the most significant components of labour market adjustment. The picture is one of global demand for higher and different skills, together with a different mix of skills, across all sectors of the economy. Workers increasingly need higher levels of education, as well as various abilities and behavioural characteristics that help them adapt to rapidly changing work and social environments. The ability of individuals to find and retain a job has much to do with the possession of "foundation skills" that need to be regularly updated and supported with specific skills through training and lifelong learning processes. The first issue is to identify what these skills are; the second, to see whether they are in adequate supply. Much of the evidence suggests that skills shortages exist. [6]

For example, in the United Kingdom, although the number of people studying IT-related subjects (computer science, computer systems engineering, software engineering and artificial intelligence) has grown considerably over the past ten years – from 3,785 in 1987 to 12,383 in 1997 – the number of young people studying electronic engineering has risen only modestly. The problem here lies "upstream" – the limited supply of A-level students in mathematics and physics. The low percentage of women enrolling in electrical engineering and IT-related subjects is particularly to be noted – a pattern not unique to the United Kingdom. [7]

Although much of the original growth and success of the consumer electronics industries were attributable to technological innovations, all of them inevitably fall victim to "disruptive technologies" [8] and a shortened product life cycle which permit less skilled workers eventually to perform tasks previously undertaken only by expensive specialists. For example, the market for minicomputers disappeared after the development of the PC, although it was not until the mid-1980s that the potential of PCs was fully realized (in terms of word processing and spreadsheet analysis) after first coming onto the market in

[2] The Employers' Organization of the Metal Trades in Europe.

[3] The Liaison Group of the European Mechanical, Electrical, Electronic and Metalworking Industries.

[4] *Skills shortages in the engineering industries*, a position paper prepared by WEM and ORGALIME, and the annex "Skills shortages: Selected examples of initiatives undertaken by the European engineering industry".

[5] ILO: Life at work in the information economy, *World Employment Report 2001*, p. 217.

[6] ibid.

[7] ibid.

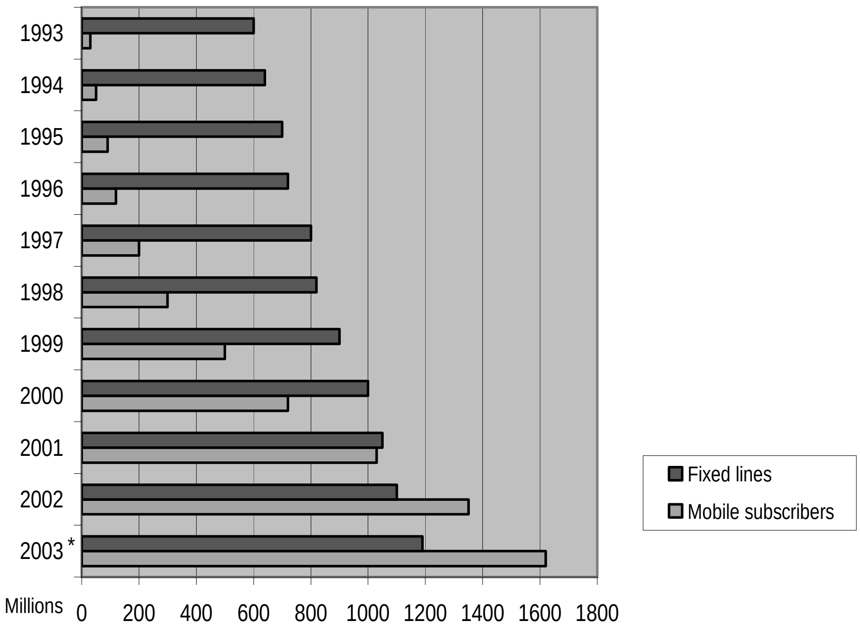
[8] C. Christensen, T. Craig and S. Hart: "The Great Disruption", in *Foreign Affairs* (Council on Foreign Relations), Mar./Apr. 2001, pp. 80-95.

1977. In its day the minicomputer had disrupted the mainframe. Similarly, Ricoh's and Canon's inexpensive tabletop photocopiers soon began to displace Xerox's larger and more expensive machines after their development. Sony's pocket battery-powered transistor radio was another disruptive technology that displaced the vacuum tube, and "transistor" became a synonym for a radio. Portable black and white TVs also disrupted the market for larger television sets. Mobile phones are now replacing fixed phones in much the same way that telephones replaced the telegraph. In fact, mobile phones will outnumber fixed ones (see figure 1.1) within a decade, and third generation mobile phones are no longer simple devices for voice communication. Video cameras are replacing 8 mm ones. CDs are superseding both audio and videotapes. Digital cameras may render film obsolete. And last but not least, the Internet has replaced other means of written communication. What all these innovations in the MEE industries have in common is that a newer, cheaper, mass-produced product replaces an older, more expensive one. Lower profit margins are compensated by lower production costs and increased sales volume for the companies developing the disruptive technologies. Nevertheless, the product innovations displace workers manufacturing the older products, while requiring workers with different skills for the newer products. At the same time continuous product innovation through research and development (R&D) is necessary to replace mature products.

Figure 1.1.

Dialing the right number

The number of mobile subscriptions has increased dramatically over the past decade, from 34 million in 1993 to 1 billion in 2001.



* estimated

Source: *International Herald Tribune*, 19 Feb. 2002, p. 15.

Nevertheless, millions of people are employed today in industries which barely existed in 1950, such as software development, computer manufacturing, microelectronics, VCR and the TV industry. [9] This makes the next 50 years even more difficult to predict.

Moore's Law revisited: The end of the line for the wireless revolution?

Although first promulgated in 1965 by Intel co-founder Gordon Moore, [10] its original axiom – that computing power would double every 18 months to two years as a function of the number of transistors on a chip [11] – has turned out to be remarkably accurate and indeed may be surpassed, as chip speeds are doubling even more frequently. Moreover, it is applicable to just about every product in the industry and epitomizes the need for lifelong learning.

The exponential growth of the cell phone industry and the drive to develop new, smaller and more powerful handsets also has a downside – a mountain of obsolete cellular phones. Luckily, the gold, silver, copper, palladium, platinum and other precious metals they contain make their collection a paying business for recyclers (figure 1.2). Compared with 53 million cell phones sold in Japan, 10 million were handed back. [12] However, for the rest of the electronics industry, "e-waste", as it is coming to be known, is not faring as well. [13] For example, although 723,000 computers were recycled in the United States in 1999 and 100,000 were exported, another 1 million remained unaccounted for. In 1997 alone, some 3.2 million tons of "e-waste" landed in US dump sites, and the amount is expected to quadruple in the not too distant future, as some 315 million computers become obsolete between 1997 and 2004. While many of these old computers are exported to China – providing 100,000 jobs to villagers around the Guiyu region of Guangdong Province, north-east of Hong Kong – lack of training results in exposure of these workers to toxic substances. [14]

[9] L. Soete: "ICTs, knowledge work and employment: The challenges to Europe", in *International Labour Review* (Geneva, ILO), Vol. 140 (2001), No. 2, p. 160.

[10] J. Markoff: "Spotlight on speed: Microprocessors keep surpassing threshold", in *International Herald Tribune*, 5 Feb. 2002, p. 1.

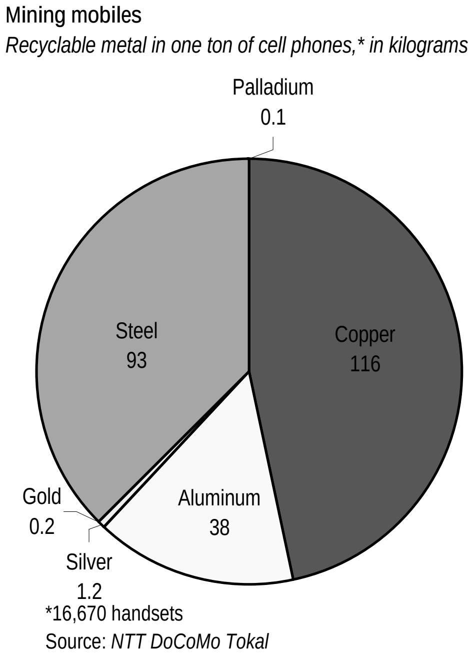
[11] Semiconductors are created on silicon wafers, which are then cut to make chips. As technology advances, it is possible to process larger wafers, thus increasing yield. See C. Brown and B. Campbell: "Technical change, wages and employment in semiconductor manufacturing", in *Industrial and Labor Relations Review* (Cornell University), Vol. 54, No. 2A (2001).

[12] K. Belson: "A cellular second calling: Japan firms recover gold from old phones", in *International Herald Tribune*, 25 Feb. 2002, pp. 13-14.

[13] J. Markoff: "'E-waste' is cited as a threat to poor States", in *International Herald Tribune*, 26 Feb. 2002, p. 1.

[14] *Exporting harm: The techno-trashing of Asia*, report prepared by Basel Action Network (BAN) and Silicon Valley Toxics Coalition (SVT), 25 Feb. 2002.

Figure 1.2.



Reproduced in *International Herald Tribune*, 25 Feb. 2002.

Internet 2

Although predictions quickly go out of date, one estimate has it that the number of PCs with Internet connections will increase from about 50 million today (up from 1 million just a decade ago) to about 350 million sometime within the next ten years [15]. Such a projected overload has in fact spawned speculation about the need to develop an "Internet 2" specifically for universities and specialized research institutes.

Bridging the IT/ICT gap?

Although technically speaking IT, or ICT (information and communications technology) as it is now more frequently called, are outside the scope of this report (which strictly speaking concerns itself only with the physical manufacture of office machines, computers and telecommunications equipment), the *World Employment Report 2001* conveniently offers the definition reproduced in box 1.2, which although all (if not over) embracing, nevertheless underscores the need for lifelong learning. World production of data processing equipment, office equipment, radios, telephones, consumer electronics and electrical components is shown by country in table 1.1.

[15] V. Volchenko: "The Internet as a self-developing synergetic system for distance engineering education", in *Proceedings of the 8th World Conference on Continuing Engineering Education*, Toronto, 12-16 May 2001, p. 174.

Table 1.1. World production of data processing equipment, office machines, radios, telephones, consumer electronics and electrical components, 1997 (US$ millions)

		ICT total	Electronic DP* equipment	Office equipment	Radio communications**	Telecom-munications	Consumer electronics	Components
1	United States	266 798	82 391	5 058	57 551	36 151	6 435	79 212
2	Japan	217 992	67 686	6 215	19 248	21 752	18 711	84 380
3	Korea, Rep. of	48 310	7 915	339	3 903	2 297	5 669	28 187
4	Singapore	42 756	25 000	335	1 284	419	2 357	13 361
5	United Kingdom	37 182	15 246	762	7 595	2 826	2 987	7 766
6	Germany	34 488	8 423	913	4 968	6 624	2 343	11 217
7	Taiwan	31 367	17 885	51	764	1 473	863	10 331
8	France	31 149	7 226	521	9 846	4 743	1 898	6 915
9	Malaysia	29 335	7 544	136	996	1 637	6 355	12 667
10	Brazil	19 384	8 150	268	1 300	1 800	4 734	3 132
11	Italy	16 085	5 637	290	1 950	3 623	645	3 940
12	Thailand	12 060	5 732	264	414	541	1 786	3 323
13	Ireland	10 642	7 879	33	318	686	47	1 679
14	Sweden	9 449	218	16	5 124	2 612	7	1 472
15	Canada	9 285	3 623	118	1 884	2 826	243	591
16	Hong Kong (China)	8 447	1 895	337	297	568	2 655	2 695
17	Netherlands	7 986	3 436	959	731	718	221	1 921
18	Spain	6 760	1 536	73	288	2 606	1 247	1 010
19	Philippines	6 584	800	22	350	320	484	4 608
20	Indonesia	5 833	1 100	77	437	400	2 139	1 680
21	Finland	5 722	925	5	2 259	1 748	161	624
22	Switzerland	5 521	697	83	310	490	2 739	1 202
23	Belgium	5 236	1 927	85	534	969	796	925
24	Israel	4 658	830	8	930	1 650	77	1 163
25	India	4 589	771	70	554	506	1 689	999
26	Australia	3 211	1 045	30	746	784	230	376
27	Austria	3 016	430	47	64	578	658	1 239
28	Portugal	1 991	399	19	137	211	617	608
29	Denmark	1 577	103	8	291	231	186	758
30	Norway	1 072	243	–	322	354	7	146
31	South Africa	1 032	174	6	137	434	229	52
32	Greece	400	106	44	66	92	55	37
	Total							
	Non-OECD	166 045	69 881	1 574	7 463	9 748	23 368	54 011
	OECD 21	723 872	217 091	15 618	118 135	92 921	45 902	234 205

	ICT total	Electronic DP* equipment	Office equipment	Radio communications**	Telecom-munications	Consumer electronics	Components
Listed countries	889 917	286 972	17 192	125 598	102 669	69 270	288 216
Percentage non-OECD	18.7	24.4	9.2	5.9	9.5	33.7	18.7

* DP = data processing. ** includes mobile telephones and radar.
Source: OECD: *An IMF initiative in the information and communications technology (ICT) sector*, policy paper presented to the IMF Executive Committee, Venice, 22-23 May 2001. In following cited as: IMF Policy Paper.

The information technology industry can be divided into four main sectors, each requiring a different type of worker and skills:

- **High technology.** High-end computers, wafer technology for semiconductors, large digital switches, software products, chip components and complex fabrication facilities.
- **Mass production.** PCs, terminal equipment, modems, components, semiconductor assembly, data communications equipment.
- **Skills-intensive human resources.** R&D; software applications and services; repair, maintenance, installation, commissioning.
- **Information technology exports** are predominantly in: electronic data processing goods (37 per cent); semiconductors (20 per cent) and other components (20 per cent); and telecommunications (10.6 per cent). [16]

[16] Information published on 1 Mar. 2000 on the Forum du commerce international web site, www.forumducommerce.org.

Box 1.2
What is "ICT"?

[...] we distinguish the information and communication technologies sectors from the sectors that *use* ICT. The ICT industry is divided into manufacturing (container) industries and service (content) industries: the manufacturing of telecommunications equipment, computers, semi-conductors and other electronic equipment, and the provision of telecommunication services, computer services and software define the core ICT sector. The ICT-using sector is just about everything else.

ILO: *World Employment Report 2001: Life at work in the information economy* (Geneva, 2001), box 2.2, p. 53.

... Thus, ICT does not only cover the provision of services, as is often mistakenly assumed. ICT also comprises the "branch of production" where devices are being manufactured (office equipment, radios, TVs, telephones, computer hardware, etc.) without which ICT services such as telephony or computer software would not be possible at all. …

R. Steiert: "Information and communications technologies", in *Metal World*, No. 3, 2001 (International Metalworkers' Federation, Geneva), p. 22.

Trade in office and telecom equipment

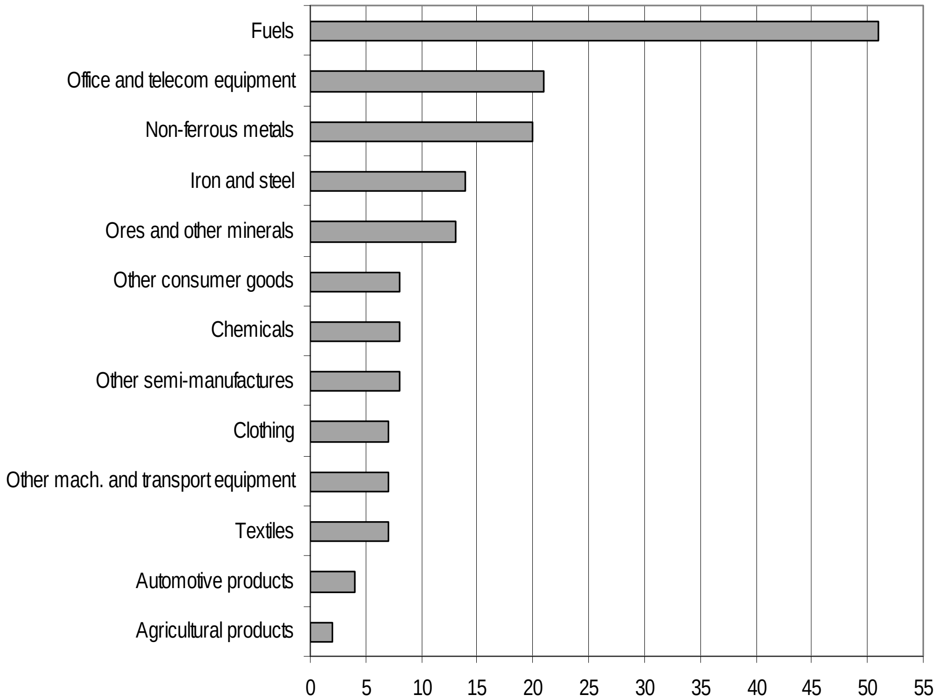
The hardware component that drives today's IT revolution

According to World Trade Organization (WTO) statistics [17] for 2001, trade in office and computer equipment recorded a 20 per cent growth rate in 2000 over the previous year totalling $940 billion (see figure 1.3). This was the highest growth rate for a manufacturing industry, and ranked only behind fuels, which grew at 50 per cent (but were valued at only $630 billion) and had a 10 per cent share in overall world trade that has little changed in the past decade. Strong demand for computers, semiconductors and mobile phones had caused trade in this product category to grow twice as fast as total world trade throughout the previous decade (and in fact doubled its share in the machinery and office and telecom segment). For example, it has been estimated that the dollar value of world exports of mobile phones rose by 25 per cent in 1999, that of semiconductors by 15 per cent, and that of computers (including parts) by just under 10 per cent.

Developing countries accounted for 27 per cent of the world's exports of manufactures in 2000, a remarkable increase from their 17 per cent share in 1990. The largest part of this increased share is accounted for by exports of office and telecom equipment from China, Mexico and the East Asian countries (Singapore, Taiwan (China), Hong Kong (China), Malaysia and the Republic of Korea). But this equipment also accounted for a very large share of all developing countries' exports of manufactures. Taken together, office and telecom equipment plus machinery and transport equipment (other than automobiles) account for one-third of world merchandise trade (see figure 1.4 and table 1.2). The share of manufactures in the merchandise exports of developing countries has risen markedly throughout the 1990s and exceeded two-thirds in 1998-99. Exports of office and telecom equipment alone accounted for a larger share of their exports than either agricultural products or mining products. As regards the latter two product categories, the developing countries' shares in world exports have shown limited gains over the past decade but still exceed – at 30 per cent and 54 per cent respectively – their 27 per cent share of world exports of manufacturers.

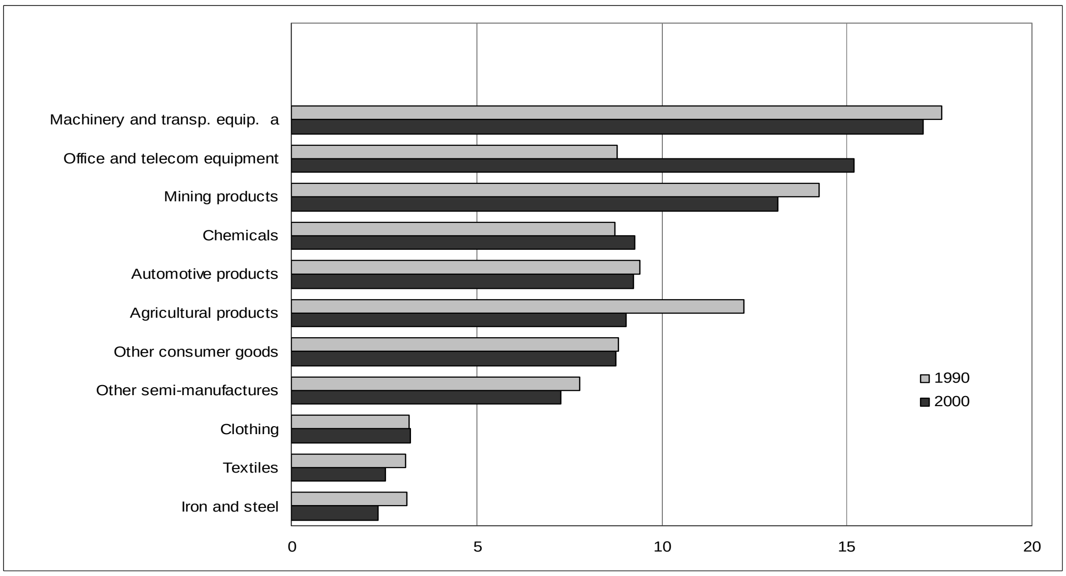
[17] WTO: *International trade statistics 2001* (Geneva, 2001), p. 2.

Figure 1.3. World merchandise trade by product, 2000 (annual percentage change in value terms)



Source: WTO: *International Trade Statistics 2001*, p. 2.

Figure 1.4. World merchandise exports by product, 1990 and 2000



(share based on value)

a = Excluding automotive products and office and telecom equipment (throughout this report they are included with machinery and transport equipment, unless otherwise noted).
Source: WTO: *International Trade Statistics 2001*, p. 95.

Table 1.2. World merchandise exports by product, 2000
(billion dollars and percentage)

	Value	Share		Annual percentage change			
	2000	1990	2000	1990-00	1998	1999	2000
All products [a]	6 186	100.0	100.0	6	-1	4	12
Agricultural products	558	12.2	9.0	3	-5	-3	2
Food	442	9.3	7.2	3	-3	-3	0
Raw materials	116	2.9	1.9	2	-11	-2	10
Mining products	813	14.3	13.1	5	-20	15	42
Ores and other minerals	62	1.6	1.0	2	-8	-5	13
Fuels	631	10.5	10.2	6	-26	22	51
Non-ferrous metals	120	2.1	1.9	5	-5	1	19
Manufactures	4 630	70.5	74.9	7	2	4	10
Iron and steel	144	3.1	2.3	3	-2	-12	14
Chemicals	574	8.7	9.3	7	2	4	8
Other semi-manufactures	449	7.8	7.3	5	0	3	8
Machinery and transport equipment	2 566	35.8	41.5	8	3	6	11
Automotive products	571	9.4	9.2	6	5	5	4
Office and telecom equipment	940	8.8	15.2	12	1	12	20
Other machinery and transport equipment	1 055	17.6	17.1	6	3	1	7
Textiles	157	3.1	2.5	4	-4	-2	7
Clothing	199	3.2	3.2	6	1	0	7
Other consumer goods	541	8.8	8.8	6	1	5	8

[a] Includes unspecified products. They accounted for 3 per cent of world merchandise exports in 2000.

Source: WTO, op. cit., table IV.1.

The product groups among Latin America's merchandise exports showing the strongest rise in 2000 were: fuels (31 per cent), office and telecom equipment (26 per cent), non-ferrous metals (23 per cent), clothing (22 per cent) and automotive products (21 per cent). While the strength of fuels and non-ferrous metal exports can be attributed to price increases, the rise in exports of the other three product groups reflects longer term trends. Each of those three product groups has more than doubled its share in Latin America's exports since 1990, and combined they accounted for more than three-quarters of Latin America's exports in 2000. Unfortunately, the volatility of this segment of the industry is demonstrated by the fact that the outstanding growth of Costa Rican exports [18] in 1999, which had been linked to the sharp rise in shipments from a new microprocessor plant giving office and telecom equipment a 40 per cent share in that country's exports, [19] and which had been noted in the *World Employment Report 2001* for its "potential to

[18] See also *World Employment Report 2001*.

[19] According to WTO data.

leapfrog" [20] was nullified in 2000 by the temporary closure ("mothballing" [21]) of the same chip plant [22] causing its exports to plunge by 10 per cent.

Even in Western Europe, trade in office and telecom equipment rose by more than 10 per cent in both exports and imports, remaining – as in the preceding ten years – the fastest growing product group among the manufactured goods. In 2000, office and telecom equipment accounted for 13 per cent of Western Europe's imports, while automotive products accounted for 10 per cent. Agricultural products, textiles and clothing, in contrast, recorded a contraction on both the export and import side. Office and telecommunications equipment (OTE) exports were primarily responsible for the high growth rates recorded by Ireland, Finland and Malta.

Product groups in Asia that expanded their exports by at least 20 per cent in 2000 included iron and steel, office and telecom equipment and other machinery and transport equipment. Office and telecom equipment again showed the highest expansion in value – apart from fuels – in 2000, bringing their share in Asia's merchandise exports to a record 27 per cent. They have not only become Asia's major merchandise export product but also the product for which Asia has the largest share – nearly one-half – in world exports (see table 1.3). By comparison, Europe's share is a little over one-quarter and North America's less than one-fifth. Developing countries in Asia, in particular, also played a significant role in global trade in office and telecom equipment, not only as exporters (one-third) but also as importers (one-quarter) of these products. In fact, trade in OTE was largely credited with getting Asia back on its feet after the 1997-98 financial crisis.

Table 1.3. Merchandise exports of Asia by product, 2000
(billion dollars and percentage)

	Value	Share in exports of Asia		Share in world exports		Annual percentage change			
	2000	1990	2000	1990	2000	1990-00	1998	1999	2000
Total merchandise exports	1 649.2	100.0	100.0	21.8	26.7	8	-6	7	18
Agricultural products	107.2	9.7	6.5	17.4	19.2	4	-12	-1	11
Food	82.6	6.8	5.0	16.0	18.7	5	-9	-1	9
Raw materials	24.6	2.9	1.5	21.7	21.2	1	-21	-1	17
Mining products	115.9	8.9	7.0	13.6	14.3	6	-16	10	32
Ores and other minerals	14.6	1.5	0.9	20.6	23.4	3	-8	-5	18
Fuels	79.4	6.2	4.8	12.8	12.6	6	-21	15	39
Non-ferrous metals	21.9	1.3	1.3	12.9	18.2	9	-6	7	19
Manufactures	1 389.3	79.1	84.2	24.5	30.0	9	-5	9	18
Iron and steel	35.2	2.8	2.1	19.5	24.5	5	-3	-10	20
Chemicals	98.8	4.6	6.0	11.4	17.2	11	-7	12	17

[20] ILO: *WER 2001*, op. cit., pp. 188-190. In addition to INTEL, ACER (with 600 people in a telecommunications centre) and up to 50 software development firms were providing some 1,500 jobs by mid-2000.

[21] The term "mothballed" is normally used to describe the shutdown or closure of chip factories.

[22] WTO, op. cit., p. 6.

	Value	Share in exports of Asia		Share in world exports		Annual percentage change			
	2000	1990	2000	1990	2000	1990-00	1998	1999	2000
Other semi-manufactures	94.5	6.2	5.7	17.4	21.1	8	-8	8	14
Machinery and transport equipment	832.1	43.2	50.5	26.3	32.4	10	-5	11	20
Automotive products	112.7	9.7	6.8	22.4	19.7	5	-4	9	8
Office and telecom equipment	447.7	18.6	27.1	45.9	47.6	13	-4	14	23
Other machinery and transport equipment	271.7	15.0	16.5	18.6	25.8	9	-6	7	20
Textiles	71.4	5.0	4.3	35.3	45.4	7	-11	3	15
Clothing	89.4	6.4	5.4	43.6	44.9	7	0	1	13
Other consumer goods	167.8	11.0	10.2	27.1	31.0	8	-4	10	15

Source: WTO, op. cit., p. 86.

The major change in Asia's trade by country over the last decade is the increased weight of China. In 1990, China was the fourth largest exporter and fifth largest importer in Asia, and its trade was about one-fifth that of Japan. By 2000, China had become Asia's second largest trader, accounting for 15 per cent of Asia's trade, and its trade was equivalent to roughly one-half of Japan's. Office and telecom equipment accounted for almost one-fifth of China's exports in 2000.

Job cut projections

The following list, first published by the International Metalworkers' Federation (a global union federation) in June 2001 [23] – well before the events of 11 September – had already predicted some 350,000 to half a million staff reductions by mid-2001. It has subsequently been updated (in January and again in March 2002). It now totals some 567,000 projected redundancies (see table 1.4).

Table 1.4. Never-ending job cuts in the IT/ICT sector announced since 2001

Company	Sector	Job cuts
Nortel Networks	Network equipment	49 000
Motorola	Wireless technology	48 400
Lucent Technologies	Network equipment	45 000
Verizon	Telecoms operator	39 000
China Unicom	Telecoms operator	34 000
Alcatel	Network and mobile phone equipment	33 000
Ericsson	Mobile phone equipment	22 000
Hitachi	Electronics/Components/Consumer elec.	20 930
Solectron	Contract network equipment	20 700

[23] R. Steiert: "Information and communications technologies: Bearer of hope or destructor of money?", in *Metal World* (International Metalworkers' Federation, Geneva), No. 3, 2001, p. 27.

Company	Sector	Job cuts
Toshiba	Electronics/computer hardware	20 000
Hewlett Packard / Compaq	Computer/Hardware	20 000
Siemens	Mobile phone and network equipment	17 000
Fujitsu	Semiconductor/computer	16 400
JDS Uniphase	Optical network components	16 000
ABB	Electronics/engineering	12 000
Corning	Fibre-optic components	12 000
Philips	Mobile phone equipment/electronics/consumer electronics	12 000
AT&T	Telecommunication operator	10 400
Kyocera	Electronic Devices/hardware/printers etc.	10 000
ADC	Broadband equipment	9 500
TDK	Electronic parts	8 800
Cisco Systems	Network equipment	8 500
WorldCom Group	Alternative network operator	8 000
Marconi	Network equipment	7 000
Quest	Local telecoms operator	7 000
KPN	Telecoms operator	6 800
Sprint	Telecommunications carrier	6 000
Agere Systems	Network components	6 000
British Telecommunications	Telecoms operator	6 000
3Com	Network components	6 000
Cable and Wireless	Network operator	5 500
NTL	Cable operator	5 000
Matsushita Electric	Electrical/electronics parts	5 000
Infineon	Semiconductors	5 000
Gateway Inc.	Computer	5 000
NEC	Electronic parts/IT hardware	4 000
General Electric – GE	Electrical/electronics/aerospace	4 000
France Telecom	Telecoms operator	3 000
BellSouth	Telecoms carrier	3 000
SBC Communications Inc.	Telecoms provider	3 000
Celestica	Contract network equipment	2 900
Cap Gemini	IT consultant	2 700
Molex	Interconnection equipment	2 500
AMD (Advanced Micro Devices)	Semiconductors/CPUs	2 300
Epcos	Mobile phone components	2 200

Company	Sector	Job cuts
Level 3 Communications	Broadband network operator	2 150
Oki Electric	Telecoms equipment	2 100
Mcleod USA	Alternative telecoms operator	2 075
Conexant Systems	Network components	2 075
Global Crossing	Network services provider	2 000
Mitsubishi Electric	Mobile phones, semiconductors and electronics	2 000
Tellabs	Networking components	2 000
Winstar	Alternative telecoms operator	2 000
Lexmark	Computer printers	1 600
Flextronics	Contract mobile phone equipment	1 500
Elcoteq	Contract mobile phone equipment	1 400
ECI Telecom	Network equipment	1 400
Amazon.com	Online selling	1 300
Nokia	Mobile phone equipment	1 250
Covad Communications	Broadband network operator	1 200
Sonera	Telecoms operator	1 000
Vodafone	Mobile phone operator	960
Northpoint	Alternative telecoms operator	950
Teligent	Alternative telecoms operator	900
Atlantic Telecom	Alternative telecoms operator	895
Japan Telecom	Telecoms operator	850
360networks	Alternative telecoms operator	800
Optus	Telecoms operator	700
Exodus Communications	Internet hosting provider	675
Gemplus	Smartcards and Sim cards	570
Excite@Home	Broadband Internet provider	500
Total of companies listed above		627 380

Sources: *Financial Times*, 19 July 2001; last updated 26 October 2001; “Der Spiegel”, No. 31/2001 and other newspapers.

© Robert Steiert (2001), March 2002.

These listings are useful in that they document the sheer magnitude of the problem and the uniform response, i.e. when companies are confronted with loss of sales and reductions in anticipated earnings, the response has always been the same – job cuts. More recently, however, there have there been suggestions that executive salaries and pensions might also be limited.

Nevertheless, such figures need to be treated with some degree of caution. First of all, they are not always immediate “snapshots”. In most cases, they are announcements of cuts sometime in the future. Second, they are often planned over a long period, up to two or three years in advance. Third, in cases where they are spread over a longer period, early retirements and golden handshakes could ease the burden for those leaving companies. Fourth, large cuts are often the result of a restructuring that involves the sale of a unit. In these instances, a factory which was a member of a larger group is sold and becomes a supplier to its previous parent company. In these cases the announced job cuts are in fact the transfer of employees to another owner; they represent employment reductions for the parent company, but are not overall employment losses. On the other side of the coin, if business picks up many of the workers could be retained, or new ones hired. However, if the downturn is even greater than originally anticipated, the cuts could be even larger than initially announced. For example, Hitachi recently revised its original projections of 16,350 job cuts upwards to 22,930.[24] A case study of Lucent Technologies will be presented in Chapter 6.

Table 1.5 shows employment in the *Financial Times* 500 list of companies. As far as possible, these are compared with the data presented in the report for the previous meeting on the MEE industries. For the most part there was large employment growth over the past five or six years. Growth also continued for most companies between 1999 and 2000 (the last year for which data are available). However, as the FT data (which are taken from company annual reports for 2001) are not yet available for 2002, the IMF projections cannot yet be confirmed and may not be reflected in company reports until 2002.

[24] Figures quoted in *International Herald Tribune*, 4 Mar. 2002.

Table 1.5. Financial Times listings published in 1995, 2000 and 2001

Global 500 Rank 2001	Rank 2000	Company	Country [1]	Market [2] Capital $m	Sector [3]	Employees (ft1995)	Employees (ft2000)	Employees (ft2001)	Percentage change(95-01)	Percentage change(00-01)
1	2	General Electric	US	477 406.3	252	222 000.0	340 000.0	313 000	41.0	-7.9
2	4	Cisco Systems	US	304 699.0	938	8 782.0	21 000.0	34 000	287.2	61.9
9	6	Intel	US	227 048.3	936	41 000.0	64 500.0	86 100	110.0	33.5
12	11	Nokia	Fin	197 497.4	938	31 948.0	51 177.0	58 708	83.8	14.7
18	13	Intl Business Machines	US	164 085.8	932	225 350.0	291 067.0	316 303	40.4	8.7
20	43	Emc	US	155 975.5	932	4 100.0	9 700.0	24 100	487.8	148.5
30	31	Nortel Networks	Can	113 411.0	938		75 052.0	94 500		25.9
35	32	Sun Microsystems	US	101 055.9	932	17 407.0	29 700.0	38 900	123.5	31.0
43	30	Ericsson	Swe	90 981.0	938	80 338.0	101 485.0	105 129	30.9	3.6
44	58	Texas Instruments	US	90 355.6	936	59 570.0	39 597.0	42 481	-28.7	7.3
60	62	Siemens	Ger	75 755.8	252	376 100.0	440 200.0	447 000	18.9	1.5
67	121	Alcatel	Fra	68 311.8	938	191 830.0	118 272.0	99 000	-48.4	-16.3
68	45	Hewlett-Packard	US	67 270.5	932	102 300.0	84 400.0	88 500	-13.5	4.9
69	35	SONY	Jap	67 069.2	345	151 000.0	177 000.0	189 700	25.6	7.2
80	41	Qualcomm	US	59 474.9	938		9 700.0	6 300		-35.1
95	9	Lucent Technologies	US	52 330.5	938		153 000.0	126 000		-17.6
102	49	Motorola	US	50 378.0	938	142 000.0	133 000.0	121 000	-14.8	-9.0
104	36	Dell Computer	US	50 210.5	932	8 400.0	24 400.0	36 500	334.5	49.6
106	87	Matsushita Electric Ind.	Jap	49 842.1	253	265 538.0	282 153.0	290 448	9.4	2.9
114	116	Philips Electronics	Net	46 756.3	253	263 554.0	188 643.0	231 161	-12.3	22.5
118	133	JDS Uniphase	US	46 033.6	936		6 260.0	19 000		203.5
131	326	Juniper Networks	US	40 066.8	932		190.0			
144	131	STMicroelectronics	Fra	36 272.1	936		29 182.0			
146	117	Applied Materials	US	35 943.5	936	10 504.0	12 755.0	19 220	83.0	50.7
161	170	Canon	Jap	32 628.6	253	72 280.0	79 799.0	86 673	19.9	8.6
168	148	NEC	Jap	30 982.7	932	152 719.0	157 773.0	154 787	1.4	-1.9
169	241	Emerson Electric	US	30 958.3	252	78 900.0	116 900.0	123 400	56.4	5.6

Global 500 Rank 2001	Rank 2000	Company	Country [1]	Market [2] Capital $m	Sector [3]	Employees (ft1995)	Employees (ft2000)	Employees (ft2001)	Percentage change(95-01)	Percentage change(00-01)
172	161	ABB	Swi	30 426.9	252	209 637.0	164 154.0	160 818	-23.3	-2.0
175	97	Hitachi	Jap	30 219.8	938	331 673.0	328 351.0	323 827	-2.4	-1.4
176	125	Taiwan Semiconductor	Taiwan	30 052.0	936	3 412.0		7 460	118.6	
177	53	Fujitsu	Jap	29 945.6	932	165 056.0	188 000.0	188 053	13.9	0.0
179	104	Murata Manufacturing	Jap	29 772.0	936	4 095.0	4 692.0	25 427	520.9	441.9
181	110	Compaq Computer	US	28 985.0	932	17 060.0	67 100.0	70 100	310.9	4.5
182	120	Marconi	UK	28 903.2	938		36 838.0	53 000		43.9
195	201	Agilent Technologies	US	26 606.9	253		36 400.0	47 000		29.1
204	229	Tellabs	US	24 841.3	938	2 810.0	8 643.0	10 674	279.9	23.5
207		Ciena	US	24 660.6	938			2 775		
208	123	Rohm	Jap	24 546.6	936	13 739.0	2 657.0	13 659	-0.6	414.1
218	108	Matsushita Communication Ind.	Jap	23 844.3	938		8 065.0	16 762		107.8
225	146	Samsung Electronics	S Korea	23 387.9	252			64 000		
226	298	Micron Technology	US	23 362.8	936		15 700.0	18 800		19.7
233	233	Solectron	US	22 891.7	932		37 936.0	65 273		72.1
236		Infineon Technologies	Ger	22 477.1	936			27 210		
243	235	Toshiba	Jap	21 928.9	932	186 000.0	198 000.0	190 870	2.6	-3.6
244		Applied Micro Circuits	US	21 900.6	936			477		
246		Network Appliance	US	21 607.8	932			1 469		
254	122	Kyocera Corp.	Jap	20 818.6	938	31 000.0	13 759.0	42 309	36.5	207.5
288	371	Analog Devices	US	18 757.0	936		7 400.0	9 100		23.0
306		Comverse Technology	US	17 574.5	938					
307	166	United Mic	Taiwan	17 521.6	932	2 982.0	2 724.0	3 452	15.8	26.7
315	380	Xilinx	US	17 262.8	936		1 491.0	1 939		30.0
329	223	Fanuc	Jap	16 401.3	253	2 121.0	2 112.0	3 707	74.8	75.5
332	494	Linear Technology	US	16 172.7	936		2 337.0	2 815		20.5
335		Sanyo Electric	Jap	15 868.7	253			83 519		
336		Palm	US	15 860.6	932			951		
351	215	Broadcom	US	15 324.4	936			1 147		
352	431	Maxim Integrated Products	US	15 242.9	936		3 045.0	4 181		37.3

Global 500 Rank 2001	Rank 2000	Company	Country [1]	Market [2] Capital $m	Sector [3]	Employees (ft1995)	Employees (ft2000)	Employees (ft2001)	Percentage change(95-01)	Percentage change(00-01)
360		SDL	US	14 938.4	936					
364		ADC Telecommunications	US	14 704.2	938			22 452		
386	388	Mitsubishi Electric	Jap	13 672.6	932		116 479.0	116 588		0.1
391	206	Sharp	Jap	13 455.8	253	44 789.0	48 820.0	49 748	11.1	1.9
412	288	TDK Corp	Jap	12 887.4	345	29 070.0	7 498.0	34 321	18.1	357.7
413		Sanmina	US	12 807.2	253			24 000		
414		Flextronics International	US	12 782.9	253					
415		Sumitomo Electric Ind.	Jap	12 770.6	252			66 992		
424		Furukawa Electric	Jap	12 423.1	252			19 135		
429	412	Ricoh	Jap	12 204.1	253	13 109.0	65 400.0	67 349	413.8	3.0
446		Pmc-Sierr	US	11 702.6	936			660		
455		Altera	US	11 491.3	936			1 947		
470	260	Tokyo Electron	Jap	11 077.9	936	5 616.0	1 218.0	8 946	59.3	634.5
486	243	Sycamore Networks	US	10 661.5	938		148.0			
488	443	Schneider Electric	Fra	10 552.7	252		60 780.0	72 144		18.7
498	395	Keyence	Jap	10 422.4	253		1 276.0	1 606		25.9

The machine tool industry

The machine tool industry is largely concentrated in just ten countries which account for 90 per cent of world production and exports (see tables 1.6 and 1.7). The top ten have remained stable for years, with Spain moving into eighth position in 1999, displacing the Republic of Korea. The most dramatic shift occurred in the United States, which dropped from being a major exporter in the 1950s to becoming a net importer by the 1990s. Also, significant is Japan's rise to the position of the world's number one producer and exporter during the same period (although it was only slightly ahead of Germany in 2000). Japan and Germany together accounted for 44 per cent of world production. Viewed from another perspective, Europe produced 50 per cent and Asia 30 per cent.

Table 1.6. National share of world exports of machine tools (1913-98)

Year	Germany	United States	United Kingdom	Japan	Italy	France	Switzerland	Taiwan	Republic of Korea
1913 [a]	48.0	33.0	12.0	–	–	–	–	–	–
1921	30.0	35.0	14.0	–	–	–	–	–	–
1937	48.0	35.0	7.0	–	–	–	5.0	–	–
1955	24.5	22.7	10.5	0.5	2.6	3.2	10.0	–	–
1965	27.1	16.3	7.3	2.4	5.4 [e]	4.5 [e]	8.1 [e]	–	–
1975 [b]	29.9	7.2	6.2	5.3	7.4	5.5	7.5	0.3 [d]	–
1980	25.8	5.5	5.9	12.6	7.4	4.5	7.6	1.4 [d]	–
1985 [c]	20.0	4.7	3.5	22.1	6.4	2.4	8.8	2.2	0.3
1990	23.6	4.8	3.8	18.3	9.1	2.4	12.6	3.0	0.4
1995	22.8	7.6	3.4	25.3	8.6	1.9	9.1	4.5	0.9
1998	18.2	11.8	–	18.4	11.8	–	6.7	4.6	–

Notes: [a] Data for the years 1913-37 reproduced from UNIDO (1984) do not include the exports from Eastern European countries; 1955 and 1965 data are from Collis (1989). [b] World export data from UNIDO (1984), country data from NMTBA, Economic Handbook, various issues. [c] Data from American Machinist, various issues. [d] Jacobsson (1986). [e] Author's estimates based on data in UNIDO (1984) and Collis (1989).
Source: R. Mazzoleni, "Innovation in the machine tool industry: A historical perspective on the dynamics of comparative advantage", in D.C. Mowery and R.R. Nelson, *Source of industrial leadership* and Chelem-CEPII (1998).

Table 1.7. Production, trade and consumption of machine tools in the top ten countries and worldwide, 1996-2000

Rang	Country	Production ($ million) 2000	%	Production ($ million) 1996	%	Exports ($ million)	Imports ($ million)	Consump-tion [1] ($ million)	Net [2] exports ($ million)
1	Japan	7.70	22.33	9.18	23.76	6.95	718	2.94	6.24
2	Germany	7.40	21.46	7.71	19.95	4.60	1.68	4.79	2.91
3	United States	4.30	12.47	4.52	11.70	1.29	3.69	6.93	-2.40
4	Italy	3.70	10.73	3.77	9.76	2.20	1.29	2.86	910
5	Switzerland	2.00	5.80	2.10	5.43	1.81	409	704	1.40
6	Taiwan, China	1.60	4.63	1.87	4.84	1.43	639	1.08	788
7	China	1.08	3.13	1.79	4.63	254	2.52	4.05	-2.27
8	Spain	0.96	2.78	1.36	3.52	833	1.00	1.53	-171
9	United Kingdom	0.95	2.75	1.21	3.13	478	1.88	2.61	-1.40
10	France	0.80	2.32	1.05	2.72	500	1.18	1.74	-684
	Other	4.00	11.60	4.08	10.56	2.59	6.71	6.71	-2.63
As % of world total									
	Top 10 countries		88.40		89.44				
	Other countries		11.60		10.56				

Notes: [1] Estimate: Apparent consumption = Production - Exports + Imports. [2] Estimate: Net exports = Exports – Imports.
Source: The Economic Handbook of the Machine Tool Industry 1997-1998, www.machine-land.com (April 2000) and P. Unterweger: "Global trends in the machine building industry", in *The machinery industry* (International Metalworkers' Federation, Geneva, 1997), p. 12.

Research and development spending: A proxy indicator of future need for skills?

Although employers, governments and trade unions bemoan the skills shortages and the mismatch between qualifications and what is needed for the labour market, current R&D spending by enterprises can be a good indicator of where breakthroughs will come and what new products will need to be developed and accordingly of the type of skills that will be required in the future. R&D activities themselves employ a significant number of scientific personnel. Although not always decisive, public funding can play a role in industrial development. This is especially true for some of the MEE industries. While the machine tool industry in the United States did not especially benefit, the computer industry certainly did. [25] And just as Silicon Valley is located close to Stanford University and other institutions of higher learning in California, while Route 128/495 is close to the Massachusetts Institute of Technology (MIT) and others, the development of the ICT industry in Bangalore, India, and in Xiam, China, is related to its proximity to long-established science and engineering institutions. [26]

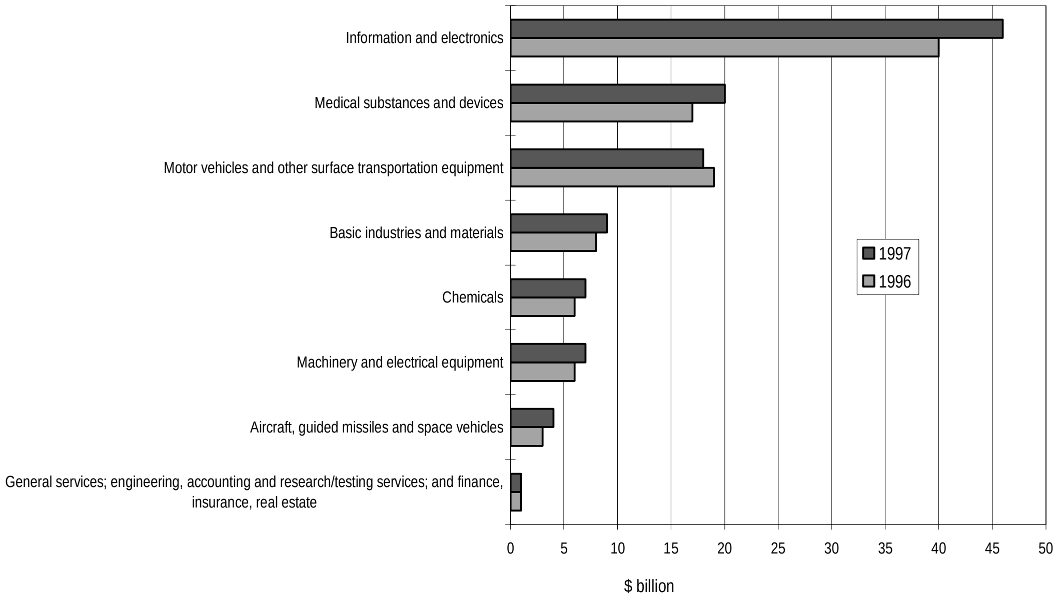
[25] D.C. Mowery and R.R. Nelson (eds.): *Sources of industrial leadership: Studies of seven industries* (Cambridge University Press, New York and Melbourne, 1999).

[26] D. Campbell: "Can the digital divide be contained?", in *International Labour Review* (Geneva, ILO), Vol. 140 (2001), No. 2, p. 133.

R&D spending by industry in the United States

Figures 1.5 and 1.6 display, respectively, the total R&D spending and R&D spending growth rate of the top 500 American corporations of 1996 and 1997, based on a United States Department of Commerce study.[27] These R&D spending levels were grouped among eight major industrial sectors based on their standard industrial classifications and their conceptual similarities with regard to patterns of technological change.

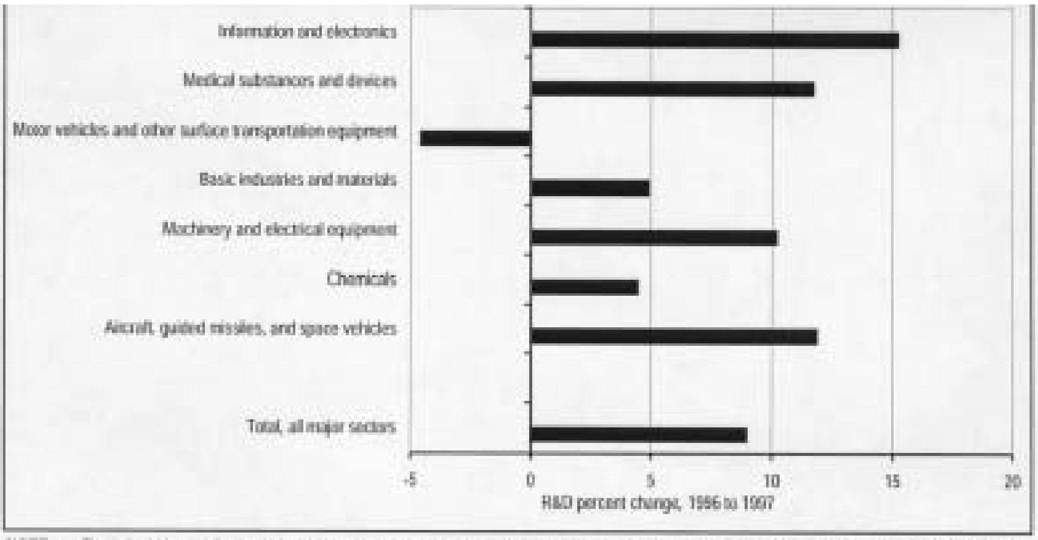
Figure 1.5. R&D spending by major industrial sectors in the United States: Top 500 companies in R&D spending of 1996 and 1997



Source: National Science Foundation and United States Department of Commerce, 1999.

[27] National Science Foundation and United States Department of Commerce: *US Corporate R&D*, Vol. 1. *Top 500 firms in R&D by industry category* (Arlington, VA, 1999), available at www.ta.doc.gov/Reports.htm .

Figure 1.6. R&D annual per cent change by major industrial sectors in the United States: Top 500 R&D corporations of 1996 and 1997



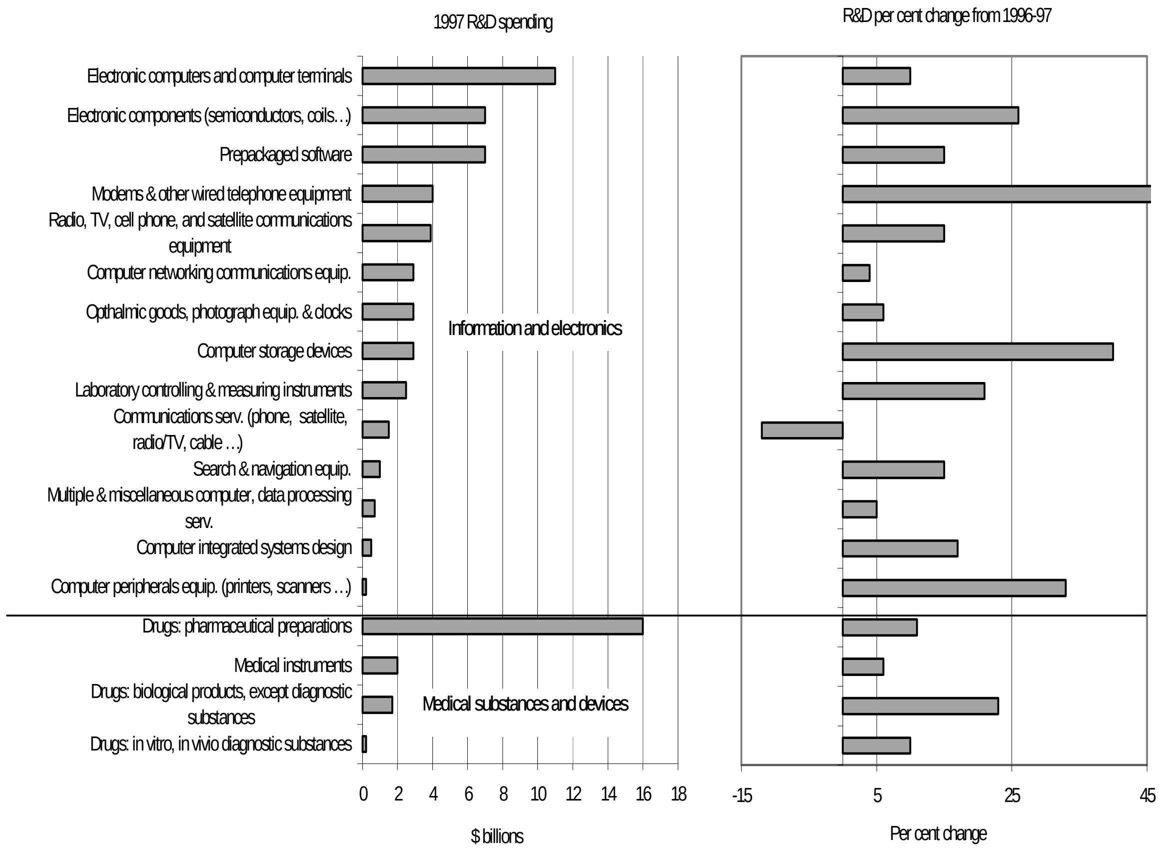
NOTE: Totals include all 8 "major industrial sectors", including the sector "general services; engineering, accounting, and research/testing services; and finance, insurance, real estate. This last sector was not shown separately because of its small relative level of R&D.

SOURCE: Standard & Poor's Compustat, Englewood, CO

Among the seven major sectors that spent more that $4 billion on R&D in 1997, the largest R&D sector, information and electronics, increased its annual R&D spending the most, by 15.2 per cent, to $45.824 billion. The second largest R&D sector, medical substances and devices, raised its R&D spending by 11.7 per cent to $19.849 billion, moving it ahead of the only declining R&D sector (between 1996 and 1997), motor vehicles and surface transportation, which reduced its spending by 4.6 per cent to $18.38 billion. The smaller aircraft, guided missiles and space vehicles R&D sector experienced the second fastest surge in R&D spending, growing by 11.9 per cent to $4.673 billion.

The R&D spending and R&D growth rates of the two largest major sectors (information and electronics and medical substances and devices) are broken down by detailed industry sector in figure 1.7, while figure 1.8 gives a comparative breakdown of “top 500” corporate R&D levels and industry survey R&D. Within information and electronics, firms in the electronic computers and computer terminals industry spent the most on R&D in 1997, totalling $11.094 billion, growing by 10.1 per cent over the previous year. Electronic components, which includes semiconductors, is the second largest R&D spender in the sector at $6.648 billion, growing by 17.3 per cent, and followed closely by the third largest R&D spender, pre-packaged software, which grew by 25.7 per cent. The impressive 39.2 per cent R&D growth rate of the sixth largest R&D spending industry in the sector, computer networking communications equipment, reflects the phenomenal growth of computer network systems, including the Internet.

Figure 1.7. R&D spending and R&D growth of detailed industry sectors within the information and electronics sector and medical substances and devices sector



Note: The figure does not include the two smallest *information and electronics* industry sectors: (1) *household audio and video equipment, and audio recordings*, which spent $230 million on R&D with a 73 per cent R&D decline from the previous year; and (2) *calculating/accounting machines and office machines*, which spent $210 million on R&D with a 2 per cent growth in R&D.
Source: Standard and Poor's Compustat, Englewood, CO.

At 46.8 per cent, the R&D spending growth of the fourth largest information and electronics industry – modems and other wired telephone equipment – is, in part, misleading because of a one-time shift in the reporting year of Lucent Technologies, Inc. Lucent Technologies accounts for 77.3 per cent of that detailed sector's R&D spending. In 1996, Lucent Technologies changed its fiscal year end from 31 December to 30 September, consequently shortening its 1996 reporting year to only nine months. This led to a reduction in the reported amounts of R&D spending in 1996 and other indicators to about three-quarters of what they would have been otherwise, thereby resulting in an artificially inflated reported growth rate between 1996 and 1997.

Within the medical substances and devices sector, pharmaceuticals preparations firms spent by far the largest amount on R&D, totalling $15.733 billion in 1997, which was up 11.5 per cent over 1996. Medical instruments firms spent a total of $2.018 billion, 6.8 per cent more than in 1996.

Figure 1.8. Comparison between top 500 corporate R&D levels and industry-survey R&D levels: 1997

Standard industrial classification	Major and detailed industrial sector [1]	Corporate R&D 1997 (top 500) ($ millions)	Industry survey 1997 R&D ($millions)	Corporate R&D (top 500) as percentage of industry-survey R&D
	Total	111 369	133 611	83.35
372376	Aircraft, guided missiles & space vehicles	4 673	5 677	82.31
	Basic industries & materials			
07-12, 14-17	Agr. services; forestry; fishing; mining; construction	203	1 541	13.19
13, 29	Oil & gas extraction; petroleum refining & related ind.	2 474	1 612	153.48
20, 21	Food & kindred products; tobacco products	1 188	1 787	66.47
22, 23	Textile & apparel products	77	476	16.20
24, 25	Lumber, wood products & furniture	543	348	156.06
26	Paper & allied products	1 516	1 456	104.12
27	Printing, publishing & allied industries	159	2 642	20.13
31, 39	Misc. products (leather, toys, jewellery, musical instr.)	372		
30	Rubber & misc. plastic prod. (tyres, plastic footwear ...)	555	1 372	40.43
32	Stone, clay, glass & concrete products	412	606	68.03
33-332, 3398-99	Ferrous metal products	60	414	14.57
333-336	Non-ferrous metal products	287	353	81.21
34	Fabricated metal products, except machinery & transp. equip.	508	1 669	30.44
	Chemicals	6 822	7 042	96.87
2800, 281-82, 286	Industrial chemicals; plastic & other synthetic materials	4 295	4 970	86.43
284-85, 287-89	Other chem. (soaps, ink, paints, fertilizers, explosives …)	2 526	2 072	121.92
873	Engineering, accounting & research/testing services	138	5 909	2.34
60-65, 67	Finance, insurance, real estate	81	1 500	5.40
	General services	208	10 256	2.03
40-42, 44-47	Transportation; freight & warehousing; & pipeline services	68	670	10.15
49	Electric, gas, sanitary services	0	258	0.00
50-59	Wholesale & retail trade	87	7 961	1.09
731-736, 738	Other (non-computer) bus. serv. (advertising, equip. rental)	53	242	21.73
701, 72, 75-79, 81, 83-84, 89	Lodging, repair, legal, social, consulting, & oth serv; movie prod.	0	446	0.00
801-809	Hospitals & health care-related laboratories & services	0	679	0.00
	Information & electronics	45 824	50 981	89.88
3571, 3575	Electronic computers & computer terminals	11 094	12 787	131.84
3572	Computer storage devices	2 607		
3576 (Compustat code)	Computer networking communications equip.	2 621		
3577	Computer peripheral equip. (printers, scanners)	325		
3578-79	Calculating/accounting mach. & office machines, NEC	210		
365	Household audio & video equipment & audio recordings	230	152	151.15
3661	Modems & other wired telephone equip.	4 011	7 377	103.52
3663, 3669	Radio, TV, cell phone & satellite comm. equip.	3 625		
367	Electronic components (semiconductors, coils)	6 648	10 786	61.64
381	Search & navigation equip.	768	3 719	85.80
382	Lab. controlling & measuring instrument	2 423		
386-387	Opthalmic goods, photograph equip. & clocks [1]	2 616	2 958	88.44
481-484, 489	Communications services (telephone, satellite tracking, radio/TV, cable)	1 054	1 884	55.93
7370, 7371, 7374-5	Multiple & misc. computer & data processing services	540	11 318	67.07
7372	Prepackaged software	6 619		
7373	Computer integrated systems design	431		
	Machinery & electrical equipment	7 039	10 038	70.12
351-56, 358-59	Machinery (industrial farm, service ind., mining & construction)	3 968	5 606	70.78
361-64, 369	Electrical equipment (industrial & household)	3 071	4 432	69.28
	Medical substances & devices	19 849	13 868	143.13
2833	Drugs: medicinal chemicals, botanical products	0	11 586	153.90
2834	Drugs: pharmaceutical preparations	15 733		
2835	Drugs: in vitro, in vivo diagnostic substances	593		
2836	Drugs: biological products, except diagnostic substances	1 505		
3841-5	Medical instruments [1]	2 018	2 282	88.44
	Motor vehicles & other surface transportation equipment	18 380	14 065	130.68
371	Motor vehicles & motor vehicle equipment	18 093	13 758	131.51
373-75, 379	Ships, trains, motorcycles, bicycles, campers, military tanks	287	307	93.42
	Classified differently by industry survey			
384-87	Opthalmic goods, photograph equip. & clocks [2] Medical instruments [2]	N/A	5 240	N/A

[1] In the industry survey, some of these detailed sectors are consolidated into a single data item, as indicated by the horizontal lines in the table, displaying a single entry for more than one group of detailed sectors. [2] Amounts for industry survey are prorated estimates based on the Corporate R&D data, which were done in order to estimate major sector totals.

Key: N/A - Not applicable.

NEC - Not elsewhere classified.

Source: Standard and Poor's Compustat, Englewood, CO; and National Science Foundation/Division of Science Resources Studies, *Research and Development in Industry 1997* , Detailed statistical tables, by Raymond M. Wolfe (Arlington, VA, forthcoming).

2. From training to lifelong learning: A paradigm shift

Main types of training systems: The pre-2000 scenario

The *World Employment Report 1998-99* [1] devotes a chapter to an analysis of training systems and differentiates between three broad categories (table 2.1).

1. *The cooperative system:* Here training is left neither to employer or employee decisions nor to government planning, but emerges from interaction between the three parties. This generally involves strong workforce representation on works councils. Germany is the best known example of this system. Employers offer apprenticeships in all sectors, taking in over half the relevant age group. Chambers of industry and commerce are heavily involved in registering apprentices and setting qualification standards. Training is provided by public vocational schools, with half the cost borne by employers; apprentices also make a contribution by taking low wages. The qualifications are nationally recognized, and poaching is discouraged by strong unions. This is the basis of the "high skill equilibrium" in Germany. A number of Latin American countries have a similar system based on vocational training institutions.

Table 2.1. Main types of training systems

System	Examples	Main features
1. Cooperative	Austria, Germany, Switzerland, many Latin American countries	Pressures to train from cooperation between employers' organizations, government and trade unions
2. Enterprise-based		
A. Low labour turnover	Japan	Low labour mobility, lifetime employment, absence of stock market pressures
B. Voluntarist	United Kingdom, United States	Few institutional pressures to train
3. State driven		
A. Demand led	Hong Kong (China), Republic of Korea, Singapore, Taiwan (China) (Four Tigers)	State plays leading role in coordinating demand for a supply of skills, in an open competitive environment
B. Supply led	Economies in transition; many developing countries in Asia and Africa	Government takes prime responsibility for training in institutions. Little pressure for employers to train

Source: ILO, *World Employment Report 1998-99,* table 3.2.

2. *Enterprise-based systems:* These rely primarily on training provided by enterprises, with Japan on the one hand (providing massive amounts of training to long-staying employees) and the United States and the United Kingdom on the other (with voluntary training). This system is often blamed in the United Kingdom for its "low

[1] *World Employment Report 1998-99: Employability in the global economy – How training matters* (Geneva, ILO, 1998), table 3.2, p. 70.

skill equilibrium", while in the United States the deficiencies of enterprise training are apparently offset by a large supply of high-level engineering skills.

3. *The state-driven system:* This also has two variants. In the mature newly industrialized economies (NIEs), government has had a strong role in meeting fast-changing skill needs. In the Republic of Korea, in particular, the Government created skills in advance of setting up new industries. The other variant is state-led education found in the former socialist economies and in many developing countries.

The challenge for lifelong learning: The post-2000 scenario [2]

The concept of lifelong learning poses a challenge to existing vocational education and training (VET) systems to meet rapidly and continuously changing labour market demands. Education and training systems face a multiple challenge.

Firstly, schools must prepare students in the educational system with basic education, core foundation skills and entry-level qualifications to take up work, together with a solid basis for continuing training and learning throughout their working lives.

Secondly, a system of continuous in-service training needs to be developed for workers who are already employed and who stay with the same employer, in order to equip them with new skills and competencies.

Thirdly, training schemes need to be devised that can respond flexibly and rapidly to labour market requirements and permit workers to change employers or professions when necessary.

Fourthly, the unemployed, the disadvantaged and those at risk must be assured of access to training opportunities.

What is the role of social dialogue in adapting existing VET to the changing requirements of the labour market? And what is the role of social dialogue in the governance and delivery of VET?

VET within the education system

Using schools and public institutions within the education system to impart workplace skills took hold only during the twentieth century. Many countries now include the delivery of skills in the regular school curriculum. In most of the former centrally planned economies and in many developing countries, technical and vocational schools combine academic education with technical and hands-on training.

Vocational training institutions (VTIs) outside the education system

VTIs have been established outside the formal education system throughout the world and may be publicly owned or privately owned by voluntary non-profit organizations, or

[2] This section has been adapted from "The changing role of government and other stakeholders in vocational education and training", Training Policies and Systems Branch, Employment and Training Department, International Labour Office (ILO) (http//www.unesco.org/education/educprog/tve/nseoul/docse/rcrolgve.html).

owned by proprietary agencies operated for profit or by enterprises. Many large enterprises, recognizing the importance of a well-qualified labour force and dissatisfied with the quality of workers provided by the VET system, have set up their own training centres.

Private sector training

Enterprises have continued to play a critical role both in the pre-employment training of young people through informal and organized apprenticeships and on-the-job training, while voluntary non-profit agencies have focused their efforts on reaching the most disadvantaged. And yet, despite its economic importance, the role of the private sector in the provision of skills has been largely overlooked in official policy-making, as has the contribution of VTIs operated by enterprises. In the case of proprietary training, in particular, the profit motive has sometimes been seen as overriding broader educational and training objectives and hence lowering the quality of delivery. Private sector institutions can, however, respond quickly to changing requirements and adapt their curricula to their clientele, thus maintaining placement rates, while public VTIs tend to suffer from a rigid regulatory framework and a lack of accountability, entrepreneurial know-how and capital, all of which limit their capacity to respond to demand quickly and adequately.

Public/private collaboration

As apprenticeships have evolved in line with production practices, there has been a shift in many countries towards in-service, hands-on training by the enterprises themselves. The latter part of this second stage and the early part of the third are accordingly marked by the establishment of structured and regulated apprenticeship systems, such as Germany’s dual system and the alternance training practised in France and other European countries. This combination of on-the-job training by enterprises with vocational education and training in schools and institutions has been an important step in public/private collaboration. That said, however, the extent of the private sector’s actual involvement in the design, development and governance of VET has varied widely among countries.

No country falls neatly into any one of the categories described above. In the face of the challenges posed by globalization and technological change, there is a clear need today for VET to be demand-driven, rather than supply-oriented, and for the private sector and trade unions to play a prominent and formal role in its governance and delivery. However, there are many intermediate stages in the transition from state-controlled, centralized and supply-driven VET to a decentralized and market-driven system responding to the private sector. There may also be differences between sectors, industries and regions within a given country. In practice, the respective roles of government and private sector in providing VET will depend, inter alia, on a country’s level of economic development, on the strength of its private sector and on the perception of the government’s core function.

New skill requirements and the need for private sector involvement

The world is in the process of transition from an industrial era to one of information and communications – often referred to as the “knowledge society”. The new society requires a different kind of learning, one that enhances “trainability” leading to employability. For the individual, learning for employability (rather than just for the job) means developing the capacity to find, keep and change employment, or even to generate self-employment. Employable skills facilitate the vertical and horizontal mobility of workers in the labour market and their continuous adaptation to changing technology and new forms of work organization. For the worker, learning for employability means lifelong learning and the acquisition of competency in flexible skills that enhance mobility and job security. For the enterprise, employable skills mean that its workers are able to respond to changing workplace requirements and enhance enterprise competitiveness and growth (see the chapter on high-performance work). For the State, the concept means creating a workforce through education with adaptable competencies that are in line with the changing demands of the labour market, as a critical factor in contributing towards the goal of full employment.

Learning, however, does not automatically lead to employability. Employability is determined more by the ability to transfer core competencies from one job to another and from one enterprise to another, rather than by job-specific skills. It requires a sound educational foundation and a broad initial training upon which continuing learning can build throughout a person's working life. Certain approaches in industrialized and rapidly industrializing countries indicate a shift from the old paradigm of VET and an active search for new responses. Some of these approaches are listed in table 2.2.

Table 2.2. Old and new approaches to training

Old paradigm	New paradigm
Supply-driven approach	Search for demand-driven approaches
Training for employment	Learning for employability
In-service training	Concept of continuing lifelong learning
Training and focus on the teacher/trainer	Self-learning and focus on the learner
One-time learning	Continuing recurrent lifelong learning
Education and training separated	Education and training integrated (a sound general education and broad-based initial training are essential bases for lifelong continuing learning)
Specialization in one skill	A search for multiskilling
Skill recognition based on training period and examination	Recognition based on competency and prior learning
Rigid and fixed entry and exit	Flexible and multiple entry and exit
Focus on formal sector	Recognition of the need to focus both on formal and informal sectors
Training for wage employment	Training for wage and self-employment
Centralized system	Decentralized system requiring both strong national and decentralized institutions
Policy and delivery dominated by the State	Policy and delivery separate, market-driven
Governance dominated by the State	Participatory governance, recognition of multiple actors, social dialogue

Source: "The changing role of government and other stakeholders in vocational education and training", Training Policies and Systems Branch, Employment and Training Department, ILO (http//www.unesco.org/education/educprog/tve/nseoul/docse/rcrolgve.html).

It may be said that training for employability rests at the core of the new paradigm. It calls on the capacity of the individual to adapt to changes in work and its organization, to combine different types of knowledge and to build on them through a lifelong process of self-learning. The development of an employable skills profile has been proposed, for example, by the Canadian Task Force on Transition into Employment, as a basis for developing curricula in secondary schools. The concept could be expanded into initial training programmes for youth as well as retraining programmes.

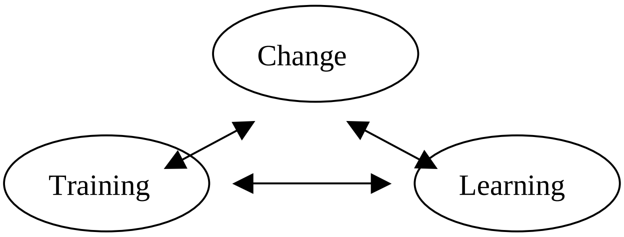
The core knowledge, skills and attitudes that enhance employability may be grouped as follows:

- intellectual skills for diagnosis and analysis, innovation and learning to learn;
- social and interpersonal skills involved in communication, decision-making, teamwork and adaptability, positive attitudes and behaviour, and the ability to assume and discharge responsibilities;
- business and entrepreneurial skills, including the development of an entrepreneurial attitude at work, creativity and innovation, the ability to identify and create opportunities, calculated risk-taking and an understanding of basic business concepts such as productivity and cost and skills for self-employment;
- multiple technical skills in generic areas which are central to a number of occupations that facilitate occupational mobility.

Continuing professional development

Learning v. *training: A dichotomy?*

It can be assumed that "training" is something that takes place in an organized context, provided by the employer or by an institution through an instructor (or a manual), whether on-the-job or outside the workplace, whereas "learning" is more individual and dependent on how the worker absorbs and applies the training he or she receives. Learning is more knowledge-oriented. It may also be autodidactic.



Source: E.P. Antonacopoulou: "The paradoxical nature of the relationship between training and learning", in *Journal of Management Studies*, 38:3, May 2001, p. 328.

Training is based on control and conditioning of an individual's understanding, whereas education is about broadening and liberating understanding.

Training and learning are not always closely linked. Training is a learning event whereas learning is ongoing. The effectiveness of training as a learning method depends on what individuals bring to it and with what attitude and mindset they approach it. Training is often seen as an overhead, rather than a core part of the business, [3] whereas it should be seen as an investment, if workers apply what they have learnt and turn it into human capital.

[3] R. Morris, an e-learning specialist at KPGM, quoted in an article by S. Murray in *Financial Times*, 3 Dec. 2001.

In this connection an interesting question might be: which types of training pay off more – general or specific? In an attempt to answer the question, researchers at the Economics and Social Research Institute in Dublin undertook a study of "continuing vocational training" which excluded trainees and apprentices. [4] Although the study was not limited to the MEE industries, it did include the manufacturing industry (just under half of which is foreign-owned, and of these firms just over half were American-owned) in which electronics companies are prominent in Ireland. Surprisingly – or perhaps not so surprisingly – it turned out that general training produced better results than specific training. This is not to say that specific training did not have an impact, but that "general training has a statistically significant positive effect – one that remains when we control for other workplace policies and corporate restructuring, for firm size and existing levels of human capital, and for interactions between training and investment and employment growth". [5] Why is this? The answer lies in employees' perception of general training as something valuable to them outside their present employment, which explains their different reaction to the provision of this more valuable type of training (especially if they should lose their current jobs). Classroom lectures and demonstrations remain meaningless until translated into human capital through learning and application of the newly acquired skills, something which is more likely to happen with general than specific training. In addition, there is also the question of motivation. Workers know that general training will be useful to them in the event of lay-offs, whereas specific training will not. Therefore they will devote greater effort to general training, which will also pay off in terms of higher productivity in their present jobs. Finally, workers feel gratified that, even though they will be more mobile as a result of more general training, the employer nonetheless provides such training, confident that workers will remain; this strengthens workers' commitment to the firm, leading to greater effort and higher productivity. With regard to the funding of training programmes, although not specific to the MEE industries, a theoretical model was used in the United Kingdom to assess the success of imposing a training levy on firms – either on profits or payroll – and concluded that a rationale for such a course of action existed, [6] even though it only partially solved the problem.

Company-based in-house teaching

This report will mention a few examples of "company universities", ranging from Motorola in the United States and Mondragón (a cooperative) in Spain to Haier in China. In the United States alone there are reportedly already over 2,000 corporate universities or learning centres. Companies often link up with one other to provide group training. On the other hand, business schools are more adept at marketing learning products that companies need, although the subjects offered are more closely linked to finance and marketing.

[4] A. Barret and P.J. O'Connell: "Does training generally work? The returns to in-company training", in *Industrial and Labor Relations Review*, Cornell University, Vol. 54, No. 3 (Apr. 2001), p. 659. Initially a representative sample of 1,000 enterprises employing more than ten people in manufacturing, construction and private services was randomly selected. A total of 654 usable returns were obtained in 1993. A follow-up survey conducted of these same enterprises in 1997 had a response rate of 33.5 per cent (or 215 enterprises).

[5] ibid., p. 659.

[6] M. Stevens: "Should firms be required to pay for vocational training?", in *The Economic Journal*, Blackwell Publishers, Oxford, III (July), pp. 485-505.

Box 2.1
Companies look inwards

Dell, the computer company, uses Dell Learning to instruct employees while on the job. In the Miami Valley area, eight leading organizations including the computer company NCR have joined forces to found the Center for Leadership and Executive Development. The advantage of the center is that it allows the organizations involved access to far greater training resources than they could afford individually. Babson College in Boston last year launched Babson Interactive, a for-profit company, when a new MBA programme for Intel, the chip maker, became the first of several corporate online programmes initiated by the company. Ms. Rosenblum, CEO of Duke Universities, Fuqua client-based executive education department, believes a new, more focused attitude to continuing education is emerging. According to Jean Meister, president of Corporate University Xchange, a New York-based corporate education and consulting firm: “As the corporate universities get bigger budgets and become stronger customers of education, they’re able to craft partnerships to address their specific needs and they no longer have to send masses of employees to open enrolment programmes.”

Source: S. Murray: “Business Schools and Corporate Universities”, in *Financial Times*, 3 Dec. 2001.

According to the *World Employment Report 2001*, approximately 15 out of a total of 200 working days per year are typically spent learning new skills at IBM and Nokia, using a combination of distance learning on the Web and traditional classroom training. The web-based element is increasing at both companies, as it is more accessible to staff spread across countries and can be accessed “just-in-time” (i.e. when needed). Mentoring is becoming an important element in the learning process; the individual staff member is now responsible for her or his learning, while the company provides the “enabling environment” conducive to learning.

The search for ready-made “talent” is also on the rise, as this allows economies of time to be made. When an enterprise is faced with a product life cycle as short as six months, a training period of even six weeks represents one-quarter of the time to market.

In the United Kingdom, one survey cited in the *World Employment Report 2001* revealed that the number of employees receiving on-the-job training increased by more than 90 per cent between 1994 and 1999, and the United Kingdom tops the OECD’s training league table. The time pressure of rapid response to product markets is becoming exacting, however. Newly recruited graduates still take six months or more to become fully productive. In the highly skilled ICT job market, where job growth is fastest and labour markets tightest, training time may be longer still. Employer preferences thus tend to centre on employees who have not only the requisite technical skills, but also work experience. Employers are also willing to pay a premium to hire people who have the exact education and skill profile being sought. [7] Again, looking at the United States, only 41 per cent of those employed as computer scientists, computer engineers, systems analysts or programmers in 1995 had received a bachelor’s or higher degree in computer science or computer engineering. A further source of confusion is that approximately 25 per cent of systems analysts and nearly 35 per cent of those in the other computer and information science occupations do not have a degree in either science or engineering. The Scientists and Engineers Statistical Data System (SESTAT) surveys [8] show the diverse background of many people working in the ICT field. Many are likely to be self-taught.

[7] *WER 2001*, p. 231.

[8] Reproduced in *World Employment Report 2001*, p. 230.

Related to the provision of training is the ability of firms to tap what their employees already know or could learn by themselves. As noted earlier, there are various categories of knowledge, and those gained from direct experience ("knowing how" and "knowing who") are more socially embedded, acquired in our social relations and our place of work. Often described as "tacit knowledge", the latter is gained from experience and interaction, rather than developed through formal education or training.

The *WER* has observed that tacit knowledge is becoming as important as formal knowledge in the workplace. The job of management in the most innovative companies is to create an environment in which the trust and cooperation of employees are fully nurtured, so that they are in turn inclined to share their tacit knowledge rather than to keep it to themselves. However, for this to occur, a high degree of workforce stability is required, at least among the core workforce.

In one Danish study, for example, informal ways of learning were not confined to learning by the individual, but extended to learning by the team. Firms were seeking ways in which to capture and exploit the vast amount of underutilized tacit knowledge. In these firms, it is the more fluid job context and participation in shared projects that allow employees to learn and thus to contribute. Similarly, a growing number of technology-intensive firms have become interested in ways in which to assess competencies of employees and harness them more fully than in the past. In part, this is in response to labour shortages in critical skills, but it also reflects how the older, more formal classifications by job description or educational degree are less relevant than what one knows or could learn. This gives way to different assessments of ability or "talent".

Training as a policy to retain staff

Many firms, such as Motorola, view training not merely in relation to the product development needs of the firm, but as a policy for attracting and retaining the best people. Employees at the cutting edge of the ICT field are highly motivated to keep up to date with the latest technologies, have very marketable skills, and use their employment as a means of further developing these skills. IBM seeks to create a learning environment conducive to retaining its employees, but the firm acknowledges that there will always be qualified people who leave. IBM nevertheless tries to keep contact with these "alumni" since the greater mobility of some skills means that employees could always return, and teamwork may in any case cut across company boundaries. While some of the largest firms thus provide training as a means, inter alia, of meeting employee expectations, for these firms and many others a traditional concern remains that employees in whom the firm has made an investment may be lured away by another employer who would benefit from the investment in training without having had to pay for it.

Nevertheless, employers' attitudes to training and poaching are hard to interpret. A finding that employers are deterred from providing training because they may lose workers to other firms would be consistent with a competitive labour market; however, it does not necessarily constitute evidence. On the other hand, a survey by the Confederation of British Industry (CBI) (1997) found that although employers provided training which they believed to be highly transferable, this training nevertheless increased the likelihood of retaining employees by instilling "greater organizational commitment". The CBI interpreted this as evidence against a poaching problem, but it does suggest that training increases the labour market power of employers, although it does not fully explain why there may still be under-investment in training. [9]

The *World Employment Report* found that ICT firms surveyed in the United States show a high level of confidence in their own structured training programmes. Companies train, cross-train and retrain their employees for careers in ICT, and programmes with a high component of on-the-job training were the most widespread form of training. However, these findings apply to the largest firms, and information on the extent of training provided by all enterprises is scarce. In the United Kingdom, a national survey found that sizeable proportions of new entrants may not receive sufficient in-company training, and that the level of training for some employees is below the average for the broad occupational categories to which they belong. For example, only 30 per cent of software engineers in IT services had received training recently, compared to 45 per cent for all those in professional occupations.

Box 2.2
Corporate online learning time and cost savings

Siemens Information Networks Inc. (United States) needed to train at short notice 600 high-level engineers on data/voice convergence technology. Traditional classroom training would have taken three years to reach all 600 engineers and would have cost some US$4 million in lost travel and production time, in addition to the direct training costs. At a cost of only US$75,000 for hardware and learning software – and an additional charge of US$1,500 for 100 classroom seats – the company was able to create interactive online classes via the company's Intranet. Over time the course evolved from being merely cost-effective to improving productivity, raising the company's market share and generating high rates of return. At present, Siemens' voice data course is one of 64 online classes offered to 7,500 employees.

Source: K. Friewick: "The online option", in *CFO Magazine*, Dec. 1999. Cited in *WER 2001*, p. 239.

Skill provision through the private sector: Vendors as trainers

One form of training that is increasing in popularity is that provided by software vendors such as Microsoft, Novell, Oracle and others. In the United Kingdom, for example, the industry-standard software qualifications are very popular. Many higher education students see the advantages of having experience of applications in widespread use in industry in searching for jobs when they graduate, and businesses see individuals as employable only if they have these specific skills. Microsoft, for example, has experienced an explosion in the number of people being trained around its products. The company has moved from training 30,000 technical professionals a year five years ago to the current level of 1.2 million. The courses are conducted in commercial classrooms through 1,900 independent companies around the world. Online learning is the fastest growing method used to obtain Microsoft training. An estimated 10 million people will participate in a free online seminar. Box 2.3 shows the international profile of people undertaking Microsoft-certified training courses. Enrolment appears to confirm the industry stereotype in that it is dominated by young men; only 11 per cent of the students are women.

[9] Quoted in M. Stevens: "Should firms be required to pay for vocational training?", op. cit.

Box 2.3
Profile of Microsoft-certified professionals

Sex:	89 per cent male; 11 per cent female
Education:	31 per cent have some community college education
	43 per cent are college graduates
	24 per cent have some graduate education
Location:	50 per cent are outside the United States
Age:	7 per cent are 18-24 years old
	50 per cent are 25-34
	32 per cent are 35-44

Source: The North Dakota Information Technology Summit, 27-28 October 1998, citing a survey of 360,000 Microsoft-certified professionals, cited in US Department of Commerce: *The digital workforce: Building Infotech skills at the speed of innovation* (1999), *WER 2001*, p. 238.

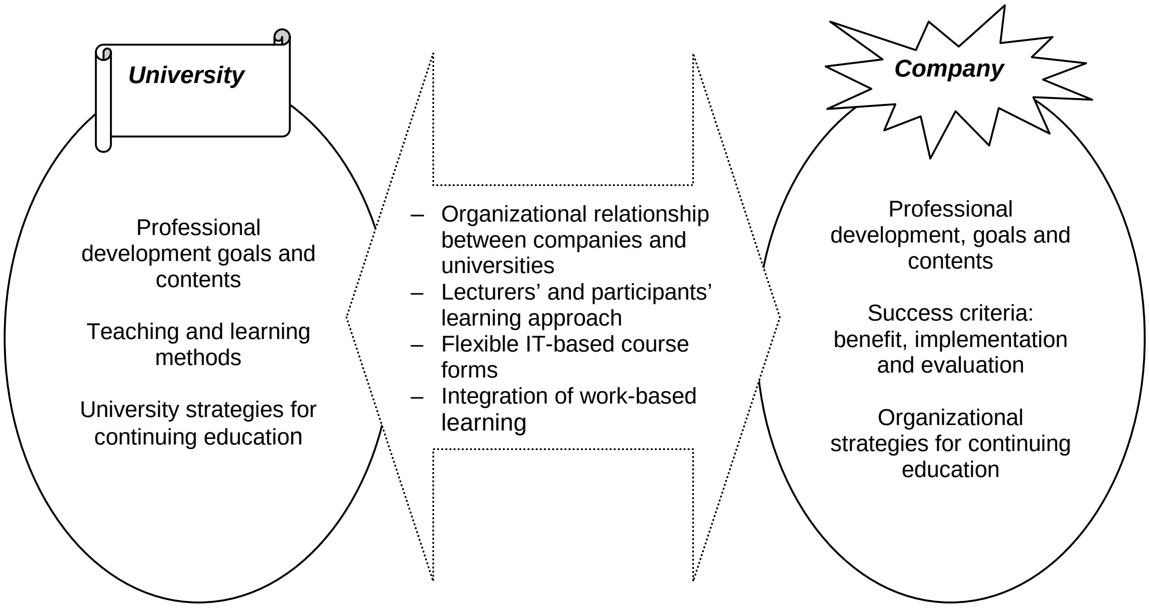
There are clear advantages to these certificate programmes. At the same time, there is doubt as to whether short-term courses such as these can provide an adequate foundation for moving into higher-level ICT jobs and for making the transition into the new technical areas emerging as a result of the rapid advance of information technologies. Businesses stress the need for the types of skills produced in short-term intensive skills training programmes, but they may not place enough emphasis on underlying knowledge and problem-solving skills. If workers do not possess the foundation knowledge and skills, their specific technical skills will become outdated very quickly. Rapid technological change could eventually devalue certifications based on narrow, technology-specific skills sets. The belief is growing in business in the United States that certificate holders need a broader technical education so that learning can occur when their current skills and knowledge are made obsolete.

A new role for universities?

Translating the theory of lifelong learning into reality may require revamping the way we think about universities and other institutions of higher learning. In addition, the traditional trajectory of primary, secondary and tertiary education (and of first and higher degrees at university level) may have to be rethought.

Notwithstanding the above, universities remain uniquely placed to play a role, as most technical staff being placed for retraining will have attended or graduated from an institute of higher learning at some earlier stage. However, universities as “ivory towers” steeped in tradition may themselves be the major obstacle to change. It may be that universities will be required to change from merely being involved in the supply side of the equation to offering courses on demand and according to specifications. While not impossible such an endeavour may involve a considerable amount of rethinking (see figure 2.1).

Figure 2.1. Model for continuing professional development



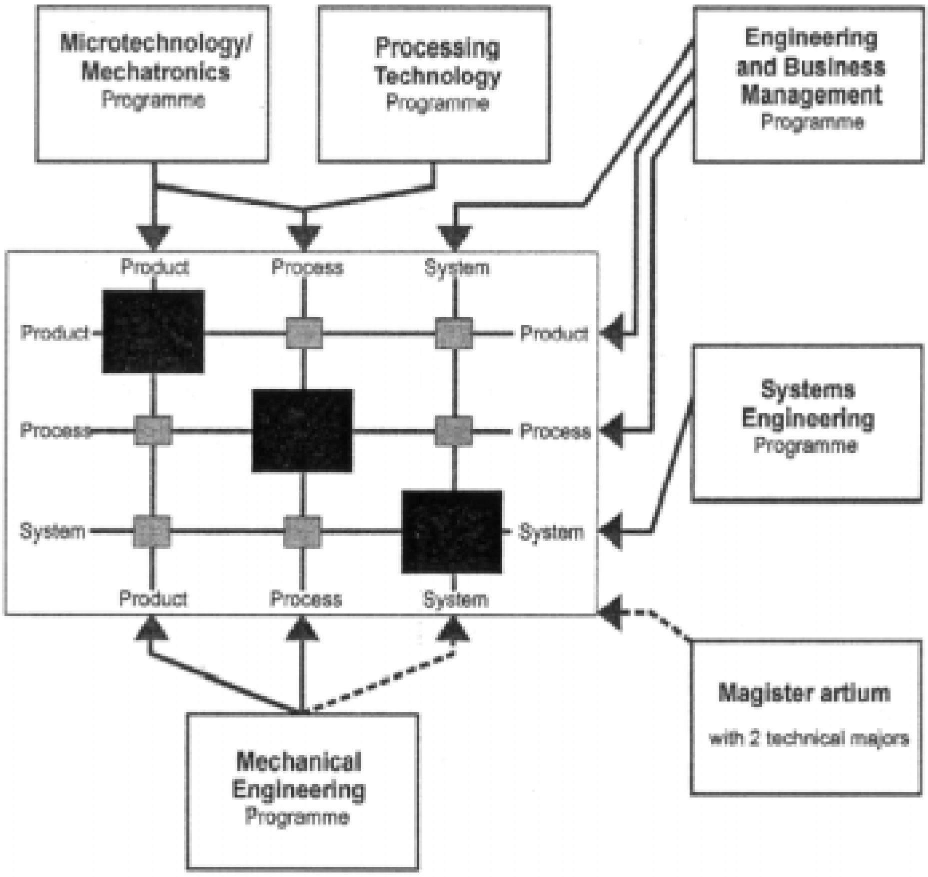
Source: F. Fink: "Understanding the dynamics of continuing professional development", *Proceedings of the 8th World Conference on Continuing Engineering Education*, Toronto, 12-16 May 2001, p. 19.

One technique would be to design a modular curriculum which would permit certain modules to be learned over time, with ample periods for extended traineeships or apprenticeships in industry. Different degrees and levels of specialization could also be permitted. Finally, networks to all schools offering studies in engineering could also be established (as in the case of Canada). From a wide range of possibilities, two examples are presented below, one from the Faculty of Mechanical Engineering and Process Technology (MEPT – figures 2.2, 2.3 and 2.4) at the Chemnitz University of Technology (CUT) [10] and the other from the Canadian Design Engineering Network (CDEN) [11] covering all universities in Canada offering design engineering courses (figure 2.5). CEDN is merely used as one example to show how all schools could be linked on single subject to permit an exchange of information and the development of modules of best practice.

[10] S. Wirth and H. Dürr: "Systems engineering – A new international programme of study", in *Proceedings of the 8th World Conference on Continuing Engineering Education*, Toronto, 12-16 May 2001, p. 57.

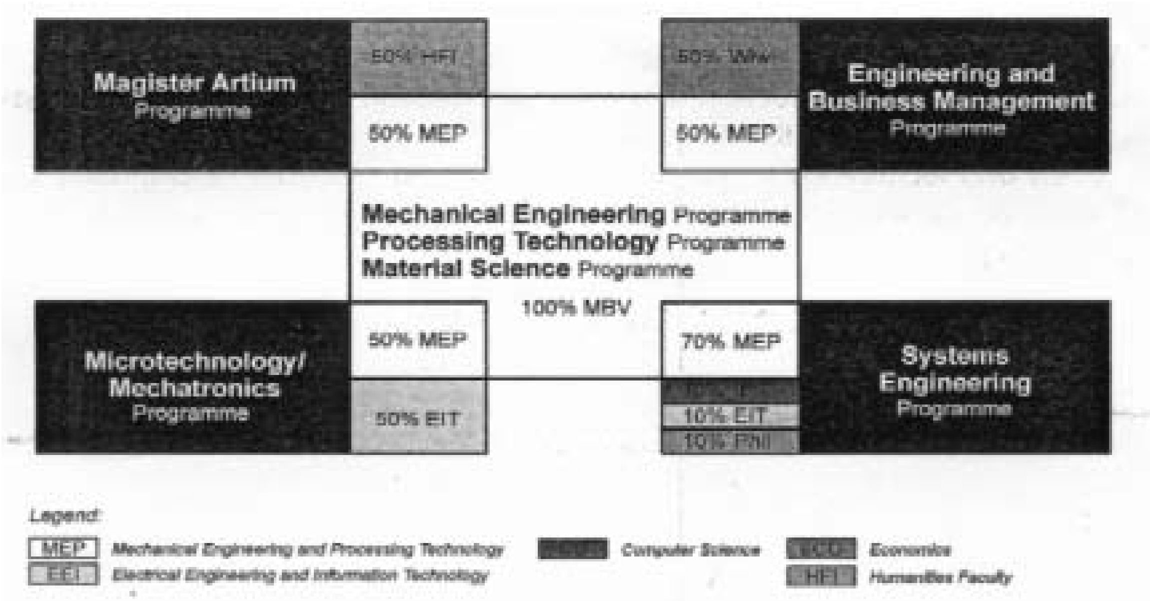
[11] I. Yellowley, R.D. Ventner and F.A. Sulustri: "The Canadian design engineering network (CDEN/RCCI): Sharing engineering design educational tools within thirty-three schools of engineering in Canada", in *Proceedings of the 8th World Conference*, op. cit., pp. 232 ff.

Figure 2.2. The main emphases of the programmes offered at the Faculty of MEPT with the product – process – system target



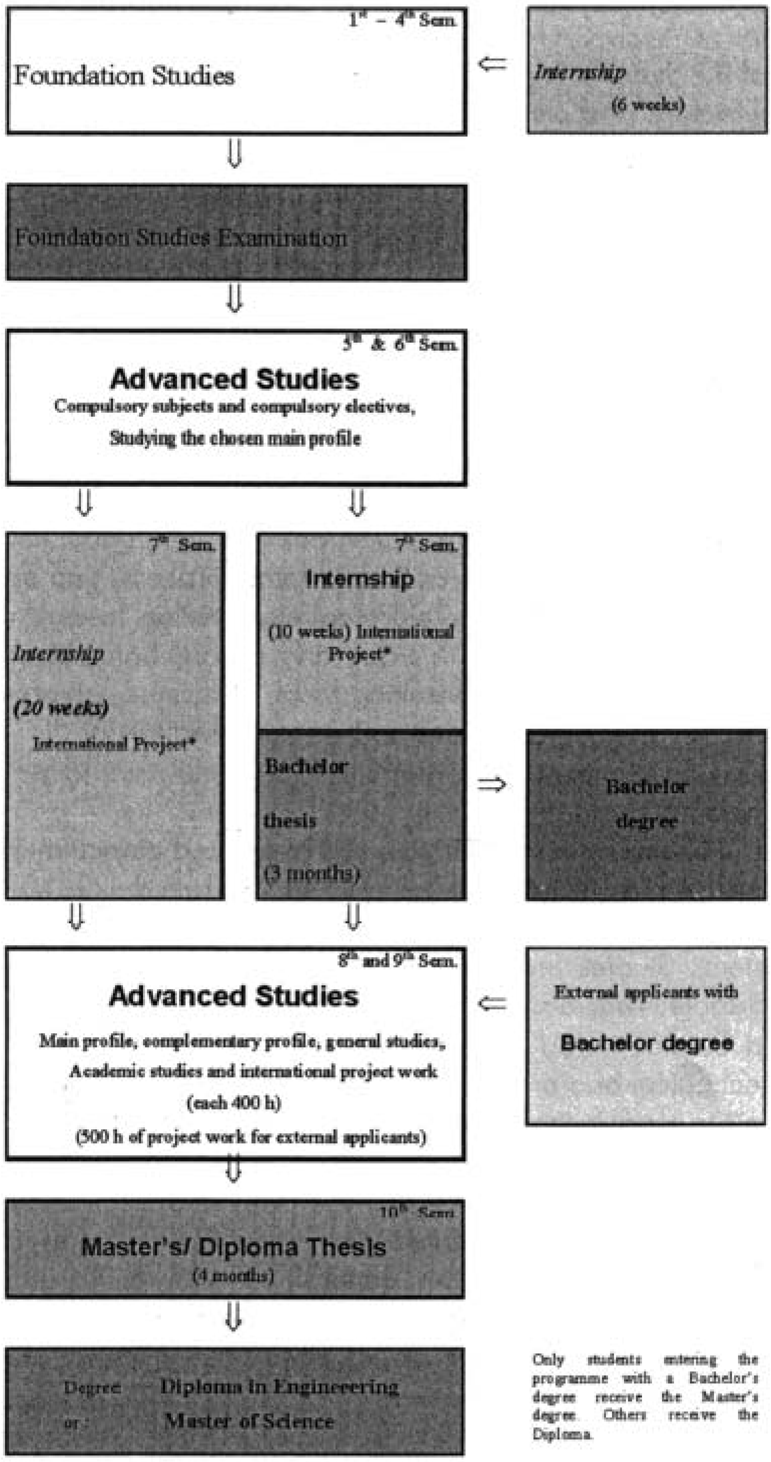
Source: *Proceedings of the 8th World Conference on Continuing Engineering Education*, Toronto, 12-16 May 2001, p. 58.

Figure 2.3. Faculty-oriented and interdisciplinary programmes offered at the Faculty of MEPT



Source: *Proceedings of the 8th World Conference on Continuing Engineering Education*, Toronto, 12-16 May 2001, p. 58.

Figure 2.4. The structure of the systems engineering programme

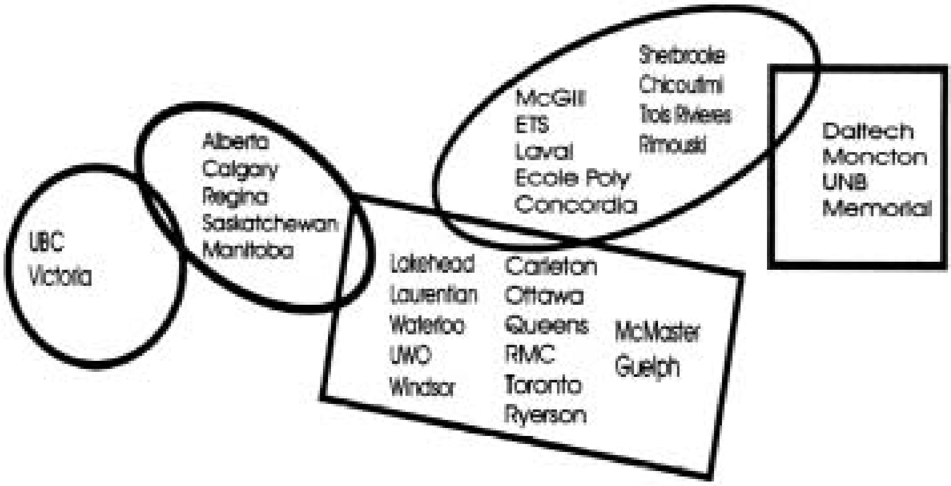


Source: *Proceedings of the 8th World Conference on Continuing Engineering Education*, Toronto, 12-16 May 2001, p. 62.

Faculty-oriented and interfaculty programmes

Both faculty-oriented and interfaculty programmes are offered at CUT. The faculty-oriented programmes, with 100 per cent mechanical engineering-related classes, are mechanical engineering and process engineering. Interfaculty programmes include systems engineering, microtechnology/mechantronics, engineering and business management, and the master's programme (magister artium). All programmes allow for the free choice of additional classes. It is therefore possible for students to select a minor. The programmes are detailed in figure 2.4.

Figure 2.5. The CDEN/RCCI network. NSERC Engineering Design Chairs at Serbrooke, Calgary, Manitoba, Ecole Polytechnique and Datech. Eleven additional Chairs to be awarded.



Source: *Proceedings of the 8th World Conference on Continuing Engineering Education*, Toronto, 12-16 May 2001, p. 234.

3. Developing countries

Competing with labour: Skills and competitiveness

Economists have long debated the question of whether development is education- or technology-induced, i.e. whether the supply of a highly educated workforce is sufficient to attract investment, or whether foreign investment in high-tech industries is the catalyst creating a demand for a skilled workforce which triggers government spending on education leading to growth. [1] This chapter will begin with an examination of learning and training from the perspective of export performance and level of educational achievement as recently addressed in a working paper prepared for the ILO by Sanjaya Lall in 1999. [2] It will also take a closer look at training provided in the consumer electronics industry and especially in the manufacture of colour television sets.

WTO data in Chapter 1 showed the importance of exports of office machines and telecommunications equipment (OMTE) as a share of total exports for various developing economies: China (17 per cent), Hong Kong, China (25 per cent), Indonesia (12 per cent), Malaysia (52 per cent), Mexico (20 per cent), Philippines (61 per cent), Singapore (54 per cent), Taiwan, China (39 per cent), Thailand (28 per cent). This performance correlates well with foreign direct investment (FDI) by multinationals. Table 3.1 depicts the ten largest developing country recipients of FDI between 1986 and 2000.

Table 3.1. Top ten recipients of foreign direct investment (FDI) going to developing countries 1986-2000

FDI recipients 1986-91	FDI recipients 1997	FDI recipients 2000	Average % 1998-2000
Singapore	China	China	19. 2
China	Brazil	Hong Kong, China	16. 0
Mexico	Mexico	Brazil	14. 4
Hong Kong, China	Singapore	Argentina	6. 5
Malaysia	Argentina	Mexico	4. 6
Thailand	Chile	Korea, Rep. of	4. 0
Brazil	Indonesia	Singapore	3. 1
Argentina	Venezuela	Bermuda	2. 8
Taiwan, China	Malaysia	Chile	2. 7
Korea, Rep. of	Thailand	Cayman Islands	2. 4
64.4%	75.9%		76.7

Source: UNCTAD: *World Investment Report 1998* and *2001*, p. 52.

[1] R.B. Freeman and R.H. Oostendorp: "Wages around the world: Pay across occupations and countries", National Bureau of Economic Research (NBER), Washington, Dec. 2000, available online at www.nber.org. The answer also depends very much on whether one is a trade, development or labour economist.

[2] S. Lall: *Competing with labour: Skills and competitiveness in developing countries*, Issues in Development Discussion Paper No. 31 (Geneva, ILO, 1999).

Table 3.2 shows the major R&D efforts in developing countries which also match the exporters of electronics equipment.

Table 3.2. Technological effort in major developing countries
(ranked by enterprise-financed R&D as a percentage of GNP)

	Country	Year	Total R&D (% GNP)	Enterprise-financed R&D (% GNP) [a]	R&D per capita 1995 (US$) [b]
1	Korea, Rep. of	1995	2.7	2.27	261.9
2	Taiwan, China	1994	1.8	1.00	198.0
3	Singapore	1994	1.1	0.69	294.0
4	South Africa	1991	1.0	0.50	31.6
5	Malaysia	1992	0.4	0.17	15.6
6	Chile	1994	0.8	0.16	38.6
7	India	1995	1.1	0.14	3.7
8	Turkey	1995	0.4	0.12	11.1
9	China	1993	0.6	0.11	3.7
10	Mexico	1995	0.4	0.09	13.3
11	Brazil	1985	0.4	0.08	14.6
12	Argentina	1996	0.3	0.05	24.1
13	Peru	1984	0.2	0.05	4.6
14	Indonesia	1993	0.2	0.04	2.0
15	Thailand	1991	0.2	0.02	5.5
16	Sri Lanka	1994	0.2	0.02	1.4
17	Philippines	1984	0.1	0.02	1.1
18	Mauritius	1992	0.4	0.01	13.5
19	Venezuela	1992	0.5	0.00	15.1
20	Pakistan	1990	0.3	0.00	0.8
21	Nigeria	1987	0.1	0.00	0.3

Notes: [a] R&D financed by productive enterprise. [b] Last available total R&D as percentage of 1995 income using p.c. income data from *World Development Report*, 1997.
Source: Lall: *Competing with labour*, op. cit., table 8, p. 19, based on UNESCO: *Statistical Yearbook 1995*; OECD; national sources.

Figure 3.1 depicts four levels of development, each level and strategy requiring different kinds of skills and capabilities.

Figure 3.1. Human capital and industrial development patterns

Level/pattern of industrial development	**Human capital profile**	
	Skills	Technological capabilities
Low levels, mainly simple assembly and processing activity for domestic market	Literacy, simple technical and managerial training. Practically no in-firm training except informal on-the-job learning.	Ability to master assembly technologies, copy simple designs, repair machines, but many activities operate well below world best practice levels of technical efficiency.
Intermediate level, with export-oriented activities in light industry, some local linkages in low-tech products	Good secondary and technical schooling and management financial training. Low base of engineering and scientific skills. In-house training mainly by export-oriented enterprises. SMEs have low skill levels.	World-class assembly, lay-out, process engineering and maintenance in export-oriented industries. In others, capability to undertake minor adaptations to processes and products. Little or no design/ development capabilities. Technology institutions weak.
Deep industrial structure but mainly inward-oriented; technological lags in many activities	Broad but often low-quality schooling, vocational and industrial training. Broad engineering base. In-house training lagging. Training institutes de-linked from industry. Management and marketing skills weak. SMEs have some modern skills.	Process mastery of capital and skill-intensive technologies, but with inefficiencies. Considerable backward linkages, significant adaptation of imported technologies. Little innovation, low linkages with universities and technology institutions.
Advanced and deep industrial structure with many world-class activities, own design and technology base	Excellent quality schooling and industrial training. High levels of university-trained managers, engineers and scientists. Training institutes responsive to industrial needs. Large investments in formal and informal in-firm training. SMEs have high skill levels and competence.	Ability to monitor, import and adapt state-of-the-art advanced technologies. Good design and development capabilities in sophisticated technologies. Deep local linkages with suppliers, buyers, consultants, universities and technology institutions.

Source: Lall, *Competing with labour*, op. cit., p. 20.

Investments in skill creation: Educational enrolments

In his study, Lall (table 3.3) shows broad enrolment patterns for the main groups of countries, including developed and transition economies. The regional enrolment rates are simple averages, not weighted by the relevant populations. They show increases in enrolment rates in all regions. They also show large disparities, mirroring those shown earlier in technological effort. Sub-Saharan Africa lags at all levels of education, but particularly the tertiary level. The four mature "Tiger economies" of Asia lead the developing world at higher levels, lagging just slightly behind the developed economies. The four "new Tigers", as well as Latin America and the Middle East/North Africa (MENA), are roughly similar in their secondary- and tertiary-level enrolments, just behind the levels reached in the transition economies. South Asia and China have low levels of tertiary enrolment, but China is considerably stronger at the secondary level. To the extent that these simple indicators of skill formation are valid, they show large gaps in the education base for competitiveness.

Table 3.3. Enrolment ratios (percentage of age groups)

Mean for group (unweighted)	Enrolment ratios (1980)			Enrolment ratios (1995)		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Developing countries	88	34	7.0	91	44	11.0
Sub-Saharan Africa	74	17	1.3	78	23	2.9
MENA	88	42	9.7	92	59	14.3
Latin America	102	45	14.1	103	53	18.1
Asia	95	44	7.4	99	54	14.4
4 Tigers	106	72	13.0	100	82	36.4
4 new Tigers	103	43	12.3	102	60	17.3
South Asia	75	28	4.0	93	42	4.8
China	112	46	1.3	120	69	5.7
Others	96	37	3.7	98	35	5.9
Transition economies	100	77	14.6	95	76	22.2
Developed economies	102	84	27.2	104	113	50.6
Europe	101	82	24.5	104	113	44.6
North America	101	91	49.1	102	102	92.0
Japan	101	93	30.5	102	99	40.3
Australia/New Zealand	111	84	27.0	106	132	65.0

Notes: The four Tigers = Hong Kong (China), Republic of Korea, Singapore and Taiwan (China); the four new Tigers = Indonesia, Malaysia, Thailand and the Philippines; MENA = Middle East and North Africa.
Source: Lall, *Competing with labour*, op. cit., table 9, p. 21, calculated from UNESCO, *Statistical Yearbooks*, various.

Lall goes on to note that these figures conceal differences in completion rates, quality and relevance to skill needs. While we cannot correct for these, it is instructive to consider one indicator of the quality of mathematics and science school training. This is given by the Third International Mathematics and Science Study (TIMSS) scores for eighth grade students (table 3.4). Of the 41 participating countries in which half a million 13-year-olds were tested, the position of the Asian Tigers was a follows: Singapore reached first place in both mathematics and science; the Republic of Korea came second in mathematics and fourth in science; Hong Kong, China, came fourth in mathematics and 24th in science. Japan was the best of the developed countries, coming third in both. Of other developing countries, Thailand was half way down in both, while the Islamic Republic of Iran did poorly in science but better than Thailand in mathematics. Kuwait, Colombia and South Africa took the last three places in both subjects. These figures confirm that there are indeed large quality differences in two subjects of critical importance to technological skill development. While most developing countries are not in the test, it would not be surprising if the quality ranking were similar to the enrolment rates, with East Asia coming out on top and sub-Saharan Africa at the bottom.

Table 3.4. Grade 8: TIMSS assessment, 1994-95 (overall mean)

Science		Mathematics	
All countries	516	All countries	513
Singapore	607	Singapore	643
Czech Republic	574	South Korea	607
Japan	571	Japan	605
Bulgaria	565	Hong Kong, China	588
South Korea	565	Belgium (Flemish)	565
Netherlands	560	Czech Republic	564
Slovenia	560	Slovakia	547
Austria	558	Switzerland	545
Hungary	554	Netherlands	541
England, Wales	552	Slovenia	541
Belgium (Flemish)	550	Bulgaria	540
Australia	545	Austria	539
Slovakia	544	France	538
Ireland	538	Hungary	537
Russian Federation	538	Russian Federation	535
Sweden	535	Australia	530
United States	534	Islamic Republic of Iran	528
Canada	531	Canada	527
Norway	527	Ireland	527
New Zealand	525	Belgium (French)	526
Thailand	525	Israel	522
Israel	524	Thailand	522
Hong Kong, China	522	Sweden	519
Switzerland	522	Germany	509
Scotland	517	New Zealand	508
Spain	517	England, Wales	506
France	498	Norway	503
Greece	497	Denmark	502
Iceland	494	United States	500
Romania	486	Scotland	498
Latvia	485	Latvia	493
Portugal	480	Iceland	487
Denmark	478	Spain	487

Science		Mathematics	
Lithuania	476	Greece	484
Belgium (French)	471	Romania	482
Islamic Republic of Iran	470	Lithuania	477
Cyprus	463	Cyprus	474
Germany	431	Portugal	454
Kuwait	430	Kuwait	392
Colombia	411	Colombia	385
South Africa	326	South Africa	354

Source: National Science Foundation, 1998.

The breakdown of tertiary enrolments in *technical subjects* is more relevant than general enrolment for assessing capabilities to absorb technological knowledge and, of this, enrolments in engineering are probably the most significant. Table 3.5 shows the total numbers enrolled in tertiary education and in the three main technical subjects (science, mathematics/computing and engineering) by region in 1995. This time the regional averages are weighted by population. The figures show much wider dispersion in skill creation than the general enrolment rates. The Asian newly industrialized economies (NIEs) enrol over 33 times more people, as a proportion of their population, in technical subjects than in sub-Saharan Africa (including South Africa), twice as many as industrialized countries, nearly five times more than in Latin America and the new NIEs, and over ten times the number in South Asia and China. The leading three countries in terms of total technical enrolments – China (18 per cent), India (16 per cent) and the Republic of Korea (11 per cent) – account for 44 per cent of the developing world's technical enrolments; the top ten countries account for 76 per cent and the top 20 for 93 per cent.

Table 3.5. Tertiary level enrolments and enrolments in technical subjects (1995)

	Level 3 enrolment		Technical enrolments, numbers and % of population							
	Total	% pop.	Natural science		Maths, computing		Engineering		All technical subjects	
	No. of students		No. of students	%	No. of students	%	No. of students	%	No. of students	%
Developing countries	35 345 800	0.82	2 046 566	0.05	780 930	0.02	4 194 433	0.10	7 021 929	0.16
Sub-Saharan Africa	1 542 700	0.28	111 500	0.02	39 330	0.01	69 830	0.01	220 660	0.04
MENA	4 571 900	1.26	209 065	0.06	114 200	0.03	489 302	0.14	812 567	0.22
Latin America	7 677 800	1.64	212 901	0.05	188 800	0.04	1 022 701	0.21	1 404 402	0.30
Asia	21 553 400	0.72	1 513 100	0.05	438 600	0.01	2 632 600	0.09	4 584 300	0.15
4 Tigers	3 031 400	4.00	195 200	0.26	34 200	0.05	786 100	1.04	1 015 500	1.34
4 new Tigers	5 547 900	1.61	83 600	0.02	280 700	0.08	591 000	0.17	955 300	0.28
South Asia	6 545 800	0.54	996 200	0.08	7 800	0.00	272 600	0.02	1 276 600	0.10
China	5 826 600	0.60	167 700	0.02	99 400	0.01	971 000	0.10	1 238 100	0.13
Others	601 700	0.46	70 400	0.05	16 500	0.01	11 900	0.01	98 800	0.08
Transition economies	2 025 800	1.95	55 500	0.05	30 600	0.03	354 700	0.34	440 800	0.42
Developed economies	33 774 800	4.06	1 509 334	0.18	1 053 913	0.13	3 191 172	0.38	5 754 419	0.69
Europe	12 297 400	3.17	876 734	0.23	448 113	0.12	1 363 772	0.35	2 688 619	0.69

	Level 3 enrolment		Technical enrolments, numbers and % of population							
	Total	% pop.	Natural science		Maths, computing		Engineering		All technical subjects	
	No. of students		No. of students	%	No. of students	%	No. of students	%	No. of students	%
North America	16 430 800	5.54	543 600	0.18	577 900	0.19	904 600	0.31	2 026 100	0.68
Japan	3 917 700	0.49					805 800	0.10	805 800	0.10
Australia, New Zealand	1 128 900	5.27	89 000	0.42	27 900	0.13	117 000	0.55	233 900	1.09

Source: Lall, op. cit., p. 23; calculated from UNESCO (1997) and national sources.

Different regions place different emphasis on *science* v. *engineering.* This is of interest, since there is a general presumption that science is oriented towards basic research, while engineering is more directly related to production technology. Sub-Saharan Africa enrols one-and-a-half times as many science students as engineers (though the numbers are so small that this may not indicate a general propensity). With MENA, the opposite emphasis is evident. Latin America places heavy emphasis on engineering, with nearly five times more enrolments in engineering than in science. Asia as a whole appears less engineering-oriented than Latin America. However, this is misleading, reflecting the propensity of South Asia (dominated by India) to favour science, with enrolments in science some four times higher than in engineering. The mature Asian Tigers, by contrast, enrol four times more students in engineering than in science, China six times and the new Tigers seven times more. The transition economies are similar to China, while the developed economies have twice as many students in engineering as in science.

Engineering enrolments in the developing world are as highly concentrated as the total technical enrolments, but the leaders differ. China continues to lead, accounting by itself for *23 per cent* of the developing world’s total enrolments. It is followed by the Republic of Korea (14 per cent) and Mexico (7 per cent); these three account for 44 per cent of the total. India is in sixth place, after these three, Indonesia and the Philippines. The top ten account for 78 per cent and the top 20 for 94 per cent of all enrolments.

The absolute enrolment figures do not, however, indicate the *intensity* of skill creation (in relation, that is, to the size of the economy). The best way to gauge this is by enrolments as a share of the total population. By this measure, the leader, by a significant margin, is the Republic of Korea, followed by Finland and Taiwan, China. The fourth is Chile, followed by Japan. Large economies like China and India do not appear in this list; nor do the United States, United Kingdom, Netherlands or Italy. Clearly, the technological lead of the two larger Tigers shown earlier is based upon massive investments in human capital. [3]

[3] See Lall, op. cit., p.24.

Table 3.6 shows the changes in the period 1980-95 in the shares of the population enrolled at the tertiary level in all subjects specifically in technical subjects. The developed world raised its total tertiary enrolments by three times more than the developing world. Within the developing world, as noted, there are large differences. The four mature Tigers raised their tertiary enrolments much faster than the others (including the developed countries), followed by MENA and the new Tigers. Latin America and Africa show moderate increases, while the "other" Asian countries bring up the rear. The transition economies show the same increase as Latin America, but with a significant switch away from technical subjects.

Table 3.6. Change in tertiary technical enrolments, 1980-95 (as percentage of population)

	Level 3 enrolment (total)	Natural science	Maths and computing	Engineering	Total technical subjects
Developing countries	0.46	0.03	0.01	0.04	0.08
Sub-Saharan Africa	0.21	0.01	0.01	0.01	0.03
MENA	0.70	0.02	0.03	0.07	0.11
Latin America	0.34	0.01	0.02	0.03	0.05
Asia	0.48	0.04	0.01	0.04	0.09
4 Tigers	2.39	0.14	0.04	0.49	0.68
4 new Tigers	0.65	–0.02	0.08	0.05	0.12
South Asia	0.49	0.07	0.00	0.02	0.09
China	0.48	0.01	0.01	0.06	0.08
Others	0.13	0.05	0.01	–0.01	0.05
Transition economies	0.34	0.01	0.01	–0.11	–0.08
Developed economies	1.43	0.11	0.10	0.22	0.43

Source: Lall, op. cit., p. 25; calculated from UNESCO *Statistical Yearbooks*, various.

In science enrolments, the mature Tiger economies again took the lead, followed by the developed countries and South Asia. The new Tigers show a decrease. In engineering, the mature Tigers lead, followed by the developed countries. Transition economies show a decline, along with "other" Asia. Sub-Saharan Africa registers marginal increases in all categories. The two striking facts about this table are the exceptional growth of high-level skill creation by the mature Tigers, and the rapid rise in enrolments in the developed countries that already had very high levels of education at the start of the period. This again shows the pressure to create new skill in the new paradigm.

Training in the colour television manufacturing industry

Human resource development in the colour television manufacturing industry was one of the subjects covered by UNCTAD's Division of Investment, Technology and Enterprise Development [4] in a recently published study [5] of three countries – Mexico,

[4] Previously the United Nations Center on Transnational Corporations (UNCTC) in New York.

Malaysia and Thailand – which together accounted for one third of the world's exports of colour TV receivers to OECD countries in 1996 (see table 3.7). The study was the result of extensive interviews undertaken by a team of experts in a sample of subsidiaries of multinationals and domestic enterprises in the countries concerned supplemented by a review of the complex literature on the subject. In addition to the research and on-site surveys, two seminars contributed to the in-depth analysis of the findings.

Table 3.7. Principal suppliers of OECD imports of TV receivers, 1980-96 (percentage)

Country	Share in OECD imports, 1995-96	Percentage change in share, 1980-96
Mexico	20.7	>10 000
United Kingdom	9.7	175
Malaysia	7.9	>10 000
Germany	6.8	–70
France	5.7	957
Spain	5.3	1 585
Thailand	4.9	4 524
Belgium/Luxembourg	4.8	–31
Japan	4.6	–73
Austria	4.1	18
Top ten	*74.5*	*NA*
All others	25.5	NA

Source: UNCTAD (2000), table 3.2, p. 44; ECLAC CANPLUS.

As noted by UNCTAD, the international television manufacturing industry is increasingly organized in a chain controlled by a small (and steadily decreasing) number of multinationals. The emergence of Japanese enterprises (later followed by MNEs from the Republic of Korea) has shaped the competition, along with a few European firms that have survived the rigours of intense competition (at least until 2001). On the technological front, the drivers have been enormous economies of scale in the production of key components, along with rapid product development, continuous improvements in efficiency and quality, and new organizational practices. The industry is very linkage intensive, and the supply chain – notably the higher technology and scale-intensive components – has also become internationalized, with suppliers following the lead companies. Today, however, many companies such as Philips and Japanese companies are trying to sell off their units that make these mature products, in order to concentrate on high-tech product innovation.

According to the UNCTAD report, TV production in the developing world has gone through various stages. In the days of import substitution, it started with relatively small-scale assembly for domestic markets, with some deepening into component manufacturing in a few larger developing countries. This evolved into simple assembly of imported components for export, mainly in South-East Asia, where low-cost labour, strong export-orientated trade policies and liberal FDI regimes were the main competitive factors. A few sites graduated to larger scale manufacturing for export of finished TVs and

[5] M. Mortimore; H. Romijin; S. Lall et al: "The colour TV receiver industry", in *The competitiveness challenge: Transnational corporations and industrial restructuring in developing countries* (Geneva, UNCTAD, 2000), pp. 43-80.

assembly kits within a region; even fewer are in the process of becoming exporters for global markets. The capabilities required here are more advanced. Regional manufacturing calls for technical and organizational skills, along with excellent logistics and locational advantages. Global manufacturing calls for more advanced technological capabilities in this industry, which is in an evolutionary process. MNEs are not highly mobile: other things being equal, they tend to base themselves in specific sites that meet their initial requirements. There are thus strong first, mover advantages to host countries, displaced only by strong shifts in locational parameters.

Malaysia was the first major TV assembly site in a developing country for export markets, and over time grew to become a regional and partly global manufacturer, with massive scales of production. The depth and sophistication of operations rose over time, and several foreign component suppliers invested there to support the assemblers. There was also an increase in sourcing from local firms, but primarily at the low technology end of the components spectrum. The Government is concerned about this and is trying to help raise their capabilities. In response, MNEs are building local design and development capabilities, transferring the responsibility for smaller sets to their Malaysian affiliates and introducing leading-edge technologies and state-of-the-art work practices.

While skill levels in Malaysia are relatively low compared to industrialized or the more advanced newly industrializing countries, they have been rising over time. The base of technical education in Malaysia is particularly small. While MNEs have devoted considerable resources to worker training and upgrading the skills of higher level employees, this cannot be a substitute for university education. Future progress up the technological ladder will therefore depend crucially on Malaysia's ability to enlarge tertiary level technical skills.

Table 3.8 looks at North America, Europe and Japan separately as importers of colour TVs. Not surprisingly, Mexico supplies almost two-thirds of the North American market (although imports from the second tier of Malaysia, Thailand and China are on the rise). Malaysia accounts for 30 per cent of Japan's imports, while Thailand and China are also rapidly increasing their shares. The now mature NICs (Republic of Korea, Singapore and Taiwan, China) are steadily losing their shares to other developing Asian countries (partly because their own producers are relocating there). Western Europe, at least for the moment, has resisted developing country imports of colour TV sets – largely because of home-based industries located within the European Union.

Table 3.8. Principal sources of imports of colour TV receivers into North America, Western Europe and Japan, 1980-96

Rank 1995-96	North America			Western Europe			Japan		
	Source economy	% market share	% change 1980-96	Source economy	% market share	% change 1980-96	Source economy	% market share	% change 1980-96
1	Mexico	63.5	9 773	United Kingdom	17.4	251	Malaysia	29.5	>10 000
2	Malaysia	11.7	>10 000	Germany	12.4	–62	Thailand	19.8	>10 000
3	Japan	7.4	–72	France	10.5	1 251	Republic of Korea	16.7	–37
4	Thailand	5.3	>10 000	Spain	9.7	2 056	Singapore	10.2	187
5	United States	4.4	–56	Belgium/Luxembourg	8.6	–14	China	9.8	>10 000
6	China	2.1	>10 000	Austria	7.5	50	Taiwan, China	4	–92
7	Korea, Republic of	1.8	–92	Japan	3.8	–67	United States	3.3	–53
8	Canada	1.1	–78	Turkey	2.8	2 826	Philippines	3.2	9 166
9	Singapore	0.4	–87	Netherlands	2.5	–40	Mexico	2.1	2 948
10	Taiwan, China	0.3	–99	Republic of Korea	2.2	–33	Belgium/Luxembourg	0.7	–21
Top 10		*98.0*			*77.4*			*99.3*	
Others		2.0			22.6			0.7	
Total		100			100			100	

Note: – = loss of market share during 1980-96.
Source. ECLAC CANPLUS.

Table 3.9 gives some details of the leading consumer electronics companies and shows the prominence of Japan in this industry (in 1991, when the UNCTAD research was starting). Today's figures are included for purposes of comparison.

Table 3.9. Principal transnational corporations in the consumer electronics industry, 1991 and 2001 (billions of dollars and percentage)

Company	Sales electronics		Foreign sales as % of total sales
	Products	Share	
Matsushita (Japan)	36.6	19.4	48.9
Toshiba (Japan)	26.6	14.1	29.0
Hitachi (Japan)	25.2	13.4	24.0
Philips (Netherlands)	23.8	12.6	94.4
Sony (Japan)	23.0	12.2	75.0
Total (first division)	*135.2*	*71.7*	–
Thomson (France)	12.6	6-7	69.0
Mitsubishi (Japan)	12.5	6.6	21.0
Sharp (Japan)	9.7	5.2	50.0
Samsung (Republic of Korea)	7.1	3.8	58.0
Sanyo (Japan)	6.1	3.2	41.0
LG (Republic of Korea)	5.0	2.7	51.0
Total (second division)	*53.0*	*28.2*	–
Grand total	188.2	100.0	–

Source: "The electronic business international 100", in *Electronic Business*, Dec. 1992, pp. 84-85.

Malaysian electronics and the future of training

Malaysia's rise as an electronics-producing country has been rather spectacular starting with 19 Japanese companies in the late 1970s which had grown to over a hundred in the late 1990s. The employment upswing has been equally impressive, from 57,000 to 313,000 alone in the ten-year period 1986-95 (representing a 20 per cent annual growth rate). By 2000, it was well over 400,000. How was this achieved and did training play a role? A recent study [6] of 13 Asian consumer electronics plants – three of which were located in Japan and ten of which were located in Malaysia – provides some insights into the varying types of training provided. Three of the plants assembled televisions in Japan (two were owned by one company and the other by its competitor). Two of the plants in Malaysia (owned by the Japanese parents) assembled televisions, while three others (also owned by the two Japanese parent companies) supplied components to the assemblers. Of the remaining five plants in Malaysia, all of which supply components or packaging to assemblers, two are Japanese-owned, one is owned by a company from Taiwan, China, and the remaining two are domestically owned (see table 3.10 for details).

[6] B. Wilkinson et al.: "The new international division of labour in Asian electronics: Work organization and human resources in Japan and Malaysia", in *Journal of Management Studies*, 38:5, July 2001.

Table 3.10. Case plant characteristics

Plant	Year established	Ownership	Products	Plant-to-plant relationships
Assemblers in Japan				
MTV(J1)	1958	Japanese	HDTV, PDPTV, LCDTV, WTV	"Parent" of MTV(J2) and MTV
MTV (J2)	1967	Japanese	WTV, CTV	"Parent" of HTV
HTV (J)	1969	Japanese	HDTV, WTV, CTV, projectors, monitors, CD-ROMs	
Assemblers in Malaysia				
MTV	1989	Japanese	CTV	Subsidiary of MTV Japan
HTV	1989	Japanese	CTV, VCR	Subsidiary of HTV Japan
Suppliers in Malaysia				
M Tubes	1990	Japanese	CRTs	Affiliate of MTV(J1) Supplier to MTV
C Tubes	1989	Taiwanese	CRTs	Supplies MTV and HTV
A Components	1989	Japanese	Resistors, tuners, VCR heads, disc drives	Supplies MTV and HTV
H Components	1981	Japanese	DYs, FBTs, tuners	Affiliate of HTV(J) Supplies MTV and HTV
H Components	1993	Japanese	DYs	Affiliate of HTV(J) Supplies HTV
N Components	1990	Japanese	Capacitors	Supplies HTV
T Containers	1980	Malaysian	Cardboard packaging	Supplies MTV and HTV
F Polystyrene	1983	Malaysian	Polystyrene packaging	Supplies MTV and HTV

Notes: HDTV – high definition TV; PDPTV – plasma display panel TV; LCDTV – liquid crystal display TV; WTV – wide screen TV; CTV – conventional colour TV; VCR – video cassette recorder; CRT – cathode ray tube; DY – deflector yoke; FBT – fly-back transformer.
Source: B. Wilkinson et al., op. cit.

It has also been noted that the emphasis in Malaysia's electronics sector was initially on low-value components for export back to Japan for final assembly. [7] For example, 86 per cent of 1986 output was electronics components. Over time things changed, with the share of electronics components in the electronic sectors' output dropping to 43 per cent in 1995, with consumer and industrial electronics accounting for 25 per cent and 32 per cent respectively. Overall, the electronics sector accounted for over half the country's export growth and made a major contribution to value added and employment. Over time, as Japan shifted its own export base from consumer electronic products to industrial electronic equipment and components, the deficit was made up by importing more colour TVs and VCRs from Japanese subsidiaries abroad. This shift, however, only meant that the Japanese parent companies were willing to shift mature products (TVs, VCRs) to Malaysia, while retaining the new and more sophisticated products (high-definition TVs, flat screens, CD-ROMs) in Japan.

Although reportedly over 3,000 workers applied for the first 300 jobs at one plant in Malaysia, it is becoming increasingly difficult to recruit, train and retain workers.

[7] ibid.

Although recruitment teams are still sent to villages, even this pool of resources is drying up, as some factories increasingly rely on migrant labour from Indonesia and Bangladesh. These migrants account for between 20 and 40 per cent of the workforce in some factories and are actually preferred, since they cannot move from job to job with their work permits.[8]

On the whole, the companies studied place few demands on the skills of their shop-floor workers, and concomitantly little on training, preferring to emphasize workplace discipline.

Comparing plants located in Japan with those located in Malaysia, Wilkinson found that in the Malaysian final assembly and components plants, a couple of weeks of induction and on-the-job training (OJT) for operators was deemed sufficient. In the tubes plants, and in some of the highly automated sections of components assembly and final assembly plants, one to three months of OJT, depending on the specific task being trained for, was more common. Further training – mostly in-house – was available for those identified as having potential for promotion to line leader and supervisor, and some companies offered limited educational opportunities, such as foreign language classes which although beneficial, were not directly work-related. In contrast, at the three assembly plants in Japan, recruitment was followed by a two-week induction process, then six months on and off-the-job training. Workers' capabilities in rotating between jobs and in engaging in continuous improvement activities were clearly related to this greater emphasis on skills formation.

Survey evidence provided by other studies also suggest that these findings may not be untypical of Japanese-owned plants in Malaysia. This study reports that Japanese-affiliated companies in Malaysia and other ASEAN countries implement "Japanese-style" skills development methods (especially job rotation and OJT), but that they are modified to reduce "scope" in terms of the number of job categories prioritized and in the range of skills required in employees.

The TV industry in Thailand has not evolved to the Malaysian level, though it shares similar characteristics. MNEs transfer modern technologies and work practices, and export significant amounts. The principal companies are depicted in table 3.11.

Mexico is a rather different case. Its main competitive edge (as one low-wage country among many others) lies in its proximity and privileged access (via United States tariff provisions and NAFTA) to the world's largest national market. In the absence of this access, MNEs earlier showed a clear preference for export-oriented operations in South-East Asia. With such access, however, the locational parameters have changed significantly, in particular because local content is eligible for preferential market access under NAFTA. Changes in the trade and FDI regimes in Mexico triggered massive FDI inflows by Asian electronic MNEs. Two major TV production clusters have been formed, with assembly and growing production of components by the major firms, and recently their international suppliers also have established affiliates in the country.

[8] ibid.

Table 3.11. Principal companies in Thailand's television industry (end of 1996)

Company (Year of entry)	Country/territory of origin	Foreign share	Annual production capacity (units)
Group 1: Large-scale export operations			4 200 000
Thomson (1990)	France	Subsidiary	More than 1 000 000 units each
World Electric (1988)	Japan	Subsidiary	
JVC (1989)*	Japan	Subsidiary	
Group 2: Medium-sized firms, production mainly for export			3 200 000
NEC (1991)	Japan	Joint venture	Between 400 000 and 750 000 units each
Sony (1988)	Japan	Subsidiary	
Sharp (1992)*	Japan	Joint venture	
LG Mtr (1987)	Republic of Korea	Joint venture	
National Thai (1970)	Japan	Joint venture	
Tatung (1990)	Taiwan, China	Subsidiary	
Sanyo (1969)	Japan	Joint venture	
Group 3: Small and medium-sized firms, production mainly for domestic market			700 000
Hitachi (1970)*	Japan	Joint venture	Less than 200 000 units each
Samsung (1989)*	Republic of Korea	Joint venture	
Philips (1967)*	Netherlands	Subsidiary	
Toshiba (1969)	Japan	Joint venture	
Mitsubishi (1964)	Japan	Subsidiary	
Singer (1960)	Netherlands	Joint venture	
Others: Without full information			Not known
Distar (1992)	Republic of Korea	Joint venture	
Tri-Star (nd)	Not known	Not known	
TVI (1993)	Thailand	Not applicable	
Estimated total annual capacity of all principal companies			8 100 000

Note: Interviewed companies are marked with an asterisk.
Source: UNCTAD, based on Board of Investment of Thailand and the Brooker Group.

As a result, Mexico has become by far the largest supplier of TVs to the developed world. As with Malaysia, there has been considerable training to use state-of-the-art equipment and work practices. A process of technological deepening is starting, with R&D activities in product and component design. The main weakness, however, of the Mexican TV industry is its linkages with local suppliers: these are very low, the lowest of the three cases examined.

Although the sample companies interviewed by UNCTAD in Mexico (see table 3.12) employed mainly low-wage unskilled workers, efforts were being made to upgrade the skills of the labour force. Human resource development was listed as the second most important source of productive efficiency improvement (after technological upgrading). It was especially important for operating modern automated production processes, undertaking local R&D and applied engineering for design – activities which they have recently begun to undertake – and integrating backwards into the assembly and manufacture of more complex components. The Mexican content of more complex operations such as R&D in new TV designs and quality control had increased, which was crucial as the intensely competitive North American market requires increasingly complex, better quality and more sophisticated products with new features.

Table 3.12. Principal companies in the Mexican TV industry (end of 1996)

Company (Year of entry)	Country of origin	Models assembled	Annual production capacity (units)
Group 1: Tijuana cluster			
Sony (1985)*	Japan	Sony	3 000 000
Samsung (1988)*	Republic of Korea	Samsung	1 850 000
Matsushita (1980)*	Japan	Quasar, Panasonic, National	1 500 000
Sanyo (1982)*	Japan	Sanyo	1 100 000
Hitachi (1986)*	Japan	Hitachi	900 000
JVC (1996)	Japan	JVC	700 000
Group 2: The Ciudad Juarez cluster			
Thomson	France	GE, RCA	n.a.
Philips	Netherlands	Magnavox, Sylvania	n.a.
LG Electronics	Republic of Korea	Zenith, Goldstar	n.a.
Daewoo	Republic of Korea		n.a.
Orion	Republic of Korea		n.a.
Estimated total annual capacity of all companies			18 000 000

Note: Companies interviewed by UNCTAD are market with an asterisk.
Source: UNCTAD (2000).

Human capital formation involved training workers and quality-control staff, the employment of more skilled labour, and the implementation of changes in work organization (such as job rotation, to expose workers to a wider range of tasks and give them a broader perspective on operations). Every new employee was exposed to formal training for an average of 45 hours. Personnel with qualifications received more time – 74 hours in the case of technicians and 68 in the case of skilled labour. The average skill level of the TV labour force was rising. Technicians and engineers now represent over 5 per cent of total staff, and 4 per cent are supervisors. In addition, around 22 per cent of the production workers are skilled (up from 12 per cent in 1980 and 20 per cent in 1985). In 1975, 5,924 technicians and professionals were employed in the export-processing manufacturing industries of Tijuana. By 1995 this figure had risen to more than 10,000. The companies were no longer the “screwdriver plants” of one decade ago, which were based exclusively on low-wage unskilled labour.

The majority of technical centres, institutes and universities were oriented towards satisfying the demand of the in-bond assembly industry in their technical and electronics engineering courses. This was initially done on an informal basis. Recently, however, agreements had been reached between television firms and local technical education colleges and universities to adapt certain parts of the curriculum to the needs of the firms. Moreover, their students are provided with workplace experience, and qualified graduates are offered employment.

Box 3.1
Evidence on backward linkages in electronics

The extent to which foreign affiliates establish backward linkages with domestic suppliers is usually measured by the local content of production or local sourcing by foreign affiliates. In developing countries, the share of locally sourced inputs by foreign affiliates varies by industry and region. Local sourcing by foreign affiliates is particularly low in the garments industry – between 5 and 10 per cent.

However in the electronics industry, sourcing patterns appear to differ significantly by host country. For example, in 2001, foreign affiliates in the colour TV industry in Tijuana, Mexico, sourced about 28 per cent of their inputs locally, albeit only a very small proportion of which (3 per cent) was supplied by Mexican-owned firms. Meanwhile, in Malaysia, locally procured components by foreign affiliates in the electronics and electrical industries comprised 62 per cent of exports in 1994; the corresponding figure for Thailand was 40 per cent. However, in both countries, the most strategic parts and components were supplied mainly by foreign-owned companies rather than domestic ones. In the hard disk drive industry, the level of local content provided by affiliates and domestic firms in Thailand was estimated at 30 to 40 per cent of total production cost in 2001.

Source: UNCTAD: *World Investment Report 2001*, box IV.3, p. 135, based on various sources.

Table 3.13 summarizes the impact which multinationals manufacturing colour TVs have had on training in the three countries studied.

Table 3.13. Impact of multinationals on human resource development in Malaysia, Mexico and Thailand

Classification	Malaysia (ranging from national assembly centre to manufacturing centre)	Mexico (regional assembly centre, moving towards regional manufacturing centre)	Thailand (ranging from national assembly centre to regional assembly centre)
Impact on:			
– Production and exports	Significant	Highly significant	Moderate
– Human capital formation	Modest until mid-1990s but rising. Specialized staff still mainly foreign, but significant training by leading firms, also for partners in their regional TNC networks. Rising skill levels and increasing numbers of specialized technical and managerial staff.	Very limited until early 1990s; first signs of upgrading apparent. Significant training efforts and linking with local education institutions, rising labour skill levels and increasing numbers of specialized technical and managerial staff.	Very limited until mid-1990s. First modest signs of improvement. Low but rising skill levels of labour force and emphasis on labour training; not much evidence of increasing involvement of more highly educated specialized staff.
– Technology development	Significant progress in automation, quality improvement and localization of R&D and design is under way.	Significant progress in automation and quality improvement, but technology efforts limited to minor adaptive work. No independent R&D/design functions.	Top end of industry uses world-class technology and quality standards, but rest of industry is less developed. No local R&D and design capabilities.
– Local supplier upgrading	Limited involvement of domestic suppliers in less complex areas. Considerable sourcing by foreign component suppliers.	Involvement of domestic suppliers is almost zero. Some links with foreign suppliers beginning to occur	Limited involvement of domestic suppliers in less complex areas. Considerable sourcing by foreign component suppliers.

Source: UNCTAD, *The competitiveness challenge*, op. cit., p. 77.

Not surprisingly this chapter has revealed that those developing countries with high levels of FDI from multinational enterprises exported a significant amount of high-tech products (especially in the MEE industries) and that this superior performance could probably be attributed, at least in part, to technology transfer and training provided by

MNEs. In addition, higher levels of tertiary school attendance and enrolment in mathematics, science and engineering subjects, plus a viable vocational training system, also precondition a country's performance (in terms of production and export of these products).

Box 3.2

Government policy + a local company + a multinational = a successful partnership

1. Singapore's local industry upgrading programme (LIUP)

The Economic Development Board (EDB) of Singapore was established in 1961 as a government agency replacing the Industrial Promotion Board of 1957. Its initial aim was to increase employment by attracting FDI. It moved to more sophisticated and export-oriented industries – e.g. computer parts, computer peripherals, software packages and silicon wafers – in the 1970s, and began to target high-technology industries requiring specialist skills, such as integrated circuits, computers, industrial electronic equipment and speciality chemical products since the 1980s.

The EDB added a linkage programme to its FDI targeting strategy in 1986 when it established the local industry upgrading programme (LIUP) to upgrade, strengthen and expand the pool of local suppliers to foreign affiliates, by enhancing their "efficiency, reliability and international competitiveness". Simultaneously, the EDB created the Small Enterprise Development Bureau to provide support to SMEs. Most recently, under its "Industry 21" initiative, the EDB seeks to develop Singapore into a "hub of knowledge-driven industries" (Singapore, EDB, 2001a, p. 1). Singapore follows a long-term human resources development plan, based on projections of future growth industries. For example, university programmes and students are directed towards study courses in the light of future skills needs of the economy. The LIUP's activities include a variety of support measures. For instance, the EDB contributes to the salary of a foreign affiliate's representative seconded to a local supplier to make the affiliate's supplier more competitive.

Source: UNCTAD: *World Investment Report 2001*, box V.4, p. 177.

2. FJ Industrial and Hewlett Packard

FJ Industrial, a domestically-owned firm in Singapore, started its operations as a small manufacturer of aluminium and plastic nameplates. It graduated to become the first local firm to manufacture membrane switches and circuits, which are technologically more advanced and are intended to replace the mechanical push-buttons on computer keyboards, copy machines, calculators, microwave ovens, etc. Under the LIUP, Hewlett Packards' affiliate in Singapore assisted FJ Industrial in diversifying into these technologically sophisticated products. It helped its supplier to set up production facilities with process control equipment and sanitized rooms. FJ's factory manager and an engineer were provided training on the manufacture of membrane switches and circuits at the Olin Hunt Speciality Products factory in Los Angeles, Hewlett Packard placed a large order on FJ Industrial for switches and circuits for incorporation in its new generation calculators and computers.

Source: UNCTAD, based on Lim and Fong, 1991, pp. 130-131.

4. Recent examples of lifelong learning initiatives

This chapter will look at recent examples and initiatives in Germany, Spain, the United States and the European Union together with emerging worldwide business-government-community partnerships to change the way in which training is provided.

The Alliance for Employee Growth and Development: An American experience [1]

The Alliance for Employee Growth and Development is a non-profit corporation, jointly owned by the Communications Workers of America (CWA [2]) union and management. It is incorporated in the State of New Jersey. Equal numbers of union and management representatives sit as trustees. Two co-directors – one appointed by the company and the other by the union – run the day-to-day operations of the Alliance. It is fully funded through the collective bargaining process. [3] The Alliance functions through a bottom-up approach where frontline management, union leaders and workers have a direct voice in shaping the delivery of services and what programmes are provided. It is supported by the company (then AT&T, now Lucent) which sees it as a vehicle to allow workers to acquire new skills for new jobs in the company, or to leave the company for a second career in the event that a new posting is not available. The key to the success of the programme is the development of a workforce that is prepared for constant retraining and skills development, a workforce that is committed to lifelong learning.

The programme had its origin 20 years ago when the CWA created a "Committee of the Future" to take a long-range look at the union and its members. By 1984, the Committee issued its report concluding that: "In the past, a worker might expect that one set of skills would guarantee a job for 10 years, 20 years, or even a lifetime. But the flood of technological advances now sweeping the telecommunications industry and beginning to be felt in virtually every industry, means that workers are going to have to train and retrain all of their lives." The union already understand that the only way its members could remain employable was through lifelong learning and skills improvement. Their collective bargaining objectives had long since changed from merely seeking job security to trying to provide employment security now defined as affording opportunities for members to receive continuous training and education to improve existing skills or to learn

[1] The information in this section is based on a speech by Morton Bahr, president of the Communications Workers of America (CWA) at the University of Berlin on 24 Feb. 1998 (http://www.cwa-union.org/reports/bahr/bahrViewer.asp?ID=178, 13 Feb. 2002); on Mr. Bahr's contribution to a videoconference at an ILO Symposium on Information Technologies in the Media and Entertainment Industries (28 Feb.-3 Mar. 2000); and on an interview with Mike Grace, Associate Administrative Assistant to the president of CWA in Washington on 14 Sep. 2001. Further information can be found in: *Employment, employability and equal opportunities in the postal and telecommunications services* (Geneva, ILO, 2002), box 8.2, p. 100.

[2] The CWA also organizes a significant number of manufacturing workers at GE, Lucent and Bell Labs.

[3] By now this is so entrenched that the union regards it as an acquired right and not subject to any limitations or restrictions, although the company has attempted to reduce access by management to the programme.

new skills to make themselves more employable at their present employer or, if necessary, in the marketplace.

To date, the Alliance approach to lifelong learning – first pioneered in 1986 – has served more than 100,000 participants, with over 400,000 enrolments in various programmes and over 5 million training hours. A US Department of Labor study in 1991 and 1992 that tracked laid-off workers showed those AT&T workers who were retrenched and had availed themselves of Alliance programmes were unemployed for shorter periods of time and re-employed at higher wages than the average. The Alliance has created distance learning and college credit programmes with cutting edge technology, including the use of Internet and CD-ROM. The Alliance College Program, for example, is a distance-learning degree programme developed with Empire State College in New York. The programme provides college credits for prior learning and uses fax, video, email, computer software and Internet conferencing. Five hundred Lucent Technologies technicians [4] are now participating in this programme. They are located all across the United States. On graduating, they will receive an associate degree in telecommunications technology.

In the view of CWA, the greatest challenge for the Alliance today is for companies to find a way to more accurately forecast job and skill needs across all lines of business. And employees should have the opportunity to train for all jobs, such as computer programming, regardless of the line of business or whether the work is union-represented or not. To underscore the commitment of labour and their employers to lifelong learning, the Alliance is one of the founding organizations of the National Association of Joint Labor-Management Education and Training Programs. One of the stated goals of the Association is to promote workforce development and lifelong learning across the nation.

Box 4.1
Warner pushes vocational-ed:
Proposal would require schools to stress training programmes

Richmond, 31 May – Democratic gubernatorial candidate Mark R. Warner called today for a new state commitment to vocational education that would offer Virginia's 1.4 million public school students the chance for some technical training before the ninth grade.

"Too often our public schools put their focus on kids going to college. Too often we treat vocational education as a second-class education."

Warner proposed a state requirement that all local school districts make their students more aware of job opportunities in technical fields and blue-collar trades that he said are often overlooked in Virginia's quest to be a national leader in the high-technology economy.

Although basic career training is offered in some school districts as early as kindergarten, the focus of vocational education in the State has been at the secondary level to prepare older high school students for the job market.

State government already has a commitment to a range of career and technical programmes at nine centres across Virginia, costing nearly US$26 million annually.

Last year, 31,369 young people completed the required course work to win certification in technical fields, according to the State's Education Department.

Warner said there should be a cultural change in Virginia schools to put a new premium on training for specialized trades, in the same way that educators encourage students to pursue careers in law, medicine and other fields that require years of postgraduate work.

He proposed the creation of a public-private foundation that would marry state funds and industry money into a programme of grants to expand technical training in local schools.

[4] See the case study on Lucent Technologies later in this report.

> Johnny Cates, who oversees a state-wide youth training programme sponsored by the Virginia Automobile Dealers Association, said companies would embrace a state initiative that gives students hands-on experience for jobs after graduation from high school.
>
> "Industry is the key", said Cates, whose programme trains students at technical centres in a number of localities, "Industry is dying and bleeding for these types of students."
>
> Source: R.H. Melton, in *The Washington Post*, 1 June 2001, p. B4.

From "Alliance for Jobs" to "initiatives for learning": A German perspective

New focus on training as a bargaining chip

Although popularly known as the "Alliance for Jobs" the full title of this new permanent tripartite arrangement created in December 1998 is "Alliance for Jobs, Training and Competitiveness". [5] However, it was not until March 2001 that the alliance could turn its attention to the second element of its title. The main purpose of the new agreement on qualifications and training is to improve the employability of workers and the better placement of young persons seeking training and lifelong qualifications. In the future, the social partners will also focus on initiatives to improve company-level training.

According to the joint statement, it will now be the responsibility of the social partners to prepare the ground for lifelong training by including stipulations in collective agreements which are negotiated at the sectoral level. Through the introduction of long-term working time accounts and similar provisions, employees could be encouraged to invest part of their working time credits in training schemes. In exchange, employers would be asked to contribute to the costs of updating qualifications by allowing working time to be used for training. The social partners also intend to restructure work organization in a way which would permit company-level actors to provide better opportunities for learning and, in addition, to provide all employees with basic computer skills.

The Alliance for Jobs also agreed on a programme to improve the quality of company-level training. Among other measures, this programme includes the modernization of rules for further training, as well as developing new tests to measure the quality of training. Up until now, although Germany was renowned for its approach to initial apprenticeship training ("dual system" [6]), further training was usually at the discretion of the employer, with smaller companies often not having any agreements at all.

IG Metall's new focus on training comes at a time when many companies consider a sound skills base and lifelong learning to be a major precondition for staying competitive. Although this subject is gaining importance, unions as well as works councils were

[5] Bündnis für Arbeit, Ausbildung und Wettbewerbsfähigkkeit. Source: The European industrial relations observatory online (eiro-nline) http://www.eiro.eurofound.ie (13 Feb. 2002).

[6] However, in order to respond to the rapid expansion of information and communications technology (ICT), the German dual system was compelled to add four new publicly recognized apprenticeship occupations in 1997: ICT systems electronics specialist, informatics specialist, ICT systems sales and marketing specialist and informatics analyst. Over 24,000 new apprentices joined the programme over the first three years and it is expected to turn out 15,000-20,000 new apprentices annually. See *World Employment Report 2001*, box 7.11, Adapting the German dual system of vocational training to new realities, p. 234.

excluded up until now when it came to determining the rules for company-level training. According to a recent survey conducted by the Institute for Economic and Social Research (Wirtschafts- und Sozialwissenschaftliches Institut, WSI) in collaboration with the University of Duisburg, further training measures are widespread. Some 72 per cent of all establishments surveyed reported that they had conducted training activities during the past three years and an average of 42 per cent of all employees had participated. However, as table 4.1 indicates, training remains mostly at the discretion of the companies' management. While works agreements and semi-formal works agreements on training are quite common among medium-sized and large companies, the many small companies tend not to have any agreed rules, either written or unwritten.

Table 4.1. Determinants of company-level training (per cent of companies)

Basis of training	Number of workers employed by company				
	19 or less	20-199	200-499	500+	All
Collective agreement and works agreement	3	4	7	13	3
Collective agreement	5	4	8	8	5
Works agreement	6	11	15	26	7
Semi-formal works agreement	4	16	21	20	6
Individual contract of employment	2	2	3	3	2
Informal agreement	5	9	7	6	5
No rules or agreement	74	54	38	23	71

Source: WSI/University of Duisburg company survey 2000. Quoted in: The European Industrial Relations Observatory online (eiro--nline) http://www.eiro.eurofound.ie (21 Jan. 2002).

According to the same survey, 66 per cent of all cases of training had been unilaterally initiated by management, while the parties to the relevant collective agreement initiated training in only 10 per cent of cases.

Landmark training agreement in the metalworking and electronics industries [7]

This first ever agreement (19 June 2001) will entitle employees to determine their training needs in annual consultations with their employer, with the latter paying for the subsequent training. The parties also agreed to set up a new agency which will assist companies and employees to improve the maintenance, adaptation and upgrading of skills.

The new agreement will entitle every employee to have an annual consultation (evaluation meeting) with their employer to determine their future training needs. Training measures can focus on either maintaining workers' skills, or adapting their qualifications to new occupational demands, or providing skill upgrading to achieve a more qualified position within the company. Training is to be paid for by employers and conducted during regular working hours.

[7] Based on information obtained from the web site of the International Metalworkers' Federation (IMF) (15.01.02) and the European Industrial Relations Observatory online (eiro-nline) http://eiro.eurofound.ie/2001/07/InBrief/DE0107233N.html (21 Jan. 2002). See also M. Behrens; M. Fichter and Carola Frege: *Unions in Germany: Groping to regain the initiative*, discussion paper presented at an International Seminar on the Labour Movement (Geneva, 19-21 April 2001).

In companies with more than 300 employees, a new “parity commission”, comprising three representatives of management and three from the works council, will mediate in the event of disputes related to the determination of employees’ further training needs. If mediation fails to produce a compromise, a new “Agency for the Promotion of Continuing Training” *(Agentur zur Förderung der beruflichen Weiterbildung)* will be consulted. A representative of the Agency will then join the parity commission with a casting vote.

Box 4.2
The experience of Lange Uhren and Glashütte Uhrenbetrieb (GUB)

Lange Uhren, along with Glashütte Uhrenbetrieb (GUB), the two luxury watchmakers in the town of Glashütte, have revived a local tradition of mechanical watchmaking that dates from 1845 but was almost destroyed by war and Communist-era dispossession.

In the workshops of Lange Uhren, the staff are young and predominantly female and the mood is relaxed. Elderly men with oily hands and leather aprons are nowhere to be seen. However, in Glashütte, with a population of 5,000, the main problem is how to find qualified workers to aid expansion.

Walter Lange, great-grandson of Ferdinand Adolph Lange, who set up the town’s first watch factory in 1845, returned to Glashütte from Western Germany only weeks after reunification. More recently, 90 per cent of the company was bought in 2000 by the Swiss-based Richemont. On the ground floor of Lange, technicians work at electronic drawing boards and supervise the computer-programmed cutting machines that prepare the parts. On the upper levels, trained assemblers put the complex timepieces together piece by piece. “We could sell more without losing our exclusive image”, says Mr. Lange. To do so, the company hopes to boost its workforce of about 260 by another 100 in the next two to three years.

At one point the other company, GUB, employed (under East German control) more than 2,000 people making cheap quartz watches. By the time the company was bought from Germany’s federal liquidators in 1994 it was near bankruptcy, with only a handful of staff. It now employs 170, a figure the new owner Mr. Pfeifer expects to double within three years. The company was sold in 2000 to a Swiss watch company, the Swatch Group.

Like Lange, GUB uses hand assembly and modern technology to make its “Glashütte Original” branded watches. Recruitment problems and skill shortages are the company’s biggest headaches, with the local reservoir of well-trained former East German watchmakers almost drained. Potential new employees are often put off by the lack of amenities in the area.

Both companies stress that they use only skilled watchmakers to assemble their products, yet such specialists need at least three years for basic training. Lange Uhren set up an apprenticeship scheme in 1997 with 25 trainees now on the books. GUB set up a similar scheme last year.

Selling out to multinationals was necessary to keep the brands alive, although in terms of marketing both companies play down their ownership ties.

Source: H. Williamson: “Watchmakers turn back the clock”, in *Financial Times*, 17 Jan. 2002, p. 7.

New “Agency for the Promotion of Continuing Training”

The joint body will:

- advise companies and their workers on how to develop their qualification potential more completely;
- develop appropriate measures for further training, in particular benefiting older and low-skilled workers;
- observe changes in companies’ skill demands and suggest measures which are appropriate to avoid skill shortages and provide employees with better job opportunities;

- provide additional information on training courses;
- develop new curricula and models for continuing training;
- provide advice for companies (in particular small and medium-sized firms) and their works councils; and
- develop quality standards for continuing training and evaluate and certify those institutions which offer training courses.

The creation of the new Agency was favoured by the sectoral employer's organization, Südwestmetall. It is also believed that the Agency will in particular benefit small and medium-sized firms because it will help them to keep pace with technological change. Because the Agency will employ "neutral" training experts, it is expected to avoid controversial issues. In all probability, company-level training agreements will be flexible enough to fit the companies' needs and thus enable them to adapt to emerging market conditions.

The bargaining parties also agreed on provisions which will make it easier for employees to participate in long-term training at educational institutions. After five years or more in a company, employees now have the right to a leave of absence of up to three years to obtain further qualifications. After completion of the training, employees will be entitled to return to a comparable or more highly qualified job within the same company.

For the moment it is understood that this agreement is limited to Baden-Württemburg.

Box 4.3
Mondragón: The cooperative approach

Mondragón, a worker-owned cooperative in the Basque country, has recently embarked on a €3.3 bn (US$2.83 bn) investment programme over the next four years, designed to double group turnover and create 16,000 jobs.

Mondragón is Europe's largest industrial cooperative and Spain's eighth largest industrial group. It posted sales of €7 bn last year and employs 53,000 people in activities ranging from machine tooling and car components to the manufacture of washing machines.

The lack of shareholders has been Mondragón's strength. It does not have to pay dividends and can sacrifice profitability in order to expand.

In addition, its expansion plans are not subject to the short-term demands on profits that characterize groups listed on the stock market. "Mondragón, from the beginning, has shown a real concern for the quality of management and the creation of stable jobs", says Santiago Ivarez De Mon, a researcher at Lese Business School in Madrid.

Its success has also depended on its ability to maintain efficiency. The promotion of worker education through its university and research centres has helped productivity.

"We prefer to create jobs ourselves", says Constan Dacosta, who heads Mondragón's retail unit. "But sometimes buying companies is unavoidable in order to improve one's overall competitive position."

Antonio Cancelo, Mondragón's chairman, insists that job creation remains its fundamental aim.

Under the rules of the cooperative, established nearly 50 years ago by José María Arizmendiarrieta, a Basque priest, Mondragón's members receive a share of the group's profits, but they are also required to dig into their pockets in case of losses.

Members have a voice in the running of Mondragón's 150 companies but they must also pay an entry fee of €9,000 to join, which is the worker's contribution to the cooperative's capital stock.

The investment programme puts a strong focus on growth abroad, especially in Brazil and Mexico. Mondragón wants to raise the stake of its international businesses to 14 per cent of the group's total industrial output and double the proportion of employees abroad to 20 per cent.

Source: T. Schafer: "Mondragón reaps the dividends of the cooperative approach", in *Financial Times*, Tuesday, 26 June 2001.

European High-Level Task Force on Skills and Mobility launched

On 20 June 2001, the European Commission launched a High-Level Task Force on Skills and Mobility. [8] The Task Force has three main objectives:

- to identify the main "drivers" and characteristics of the so-called "new" pan-European labour markets, focusing particularly on skills and mobility. Particular areas to be examined include the supply of and demand for skills and lifelong learning and skills gaps at national, regional, sectoral and occupational levels. The focus will be twofold, covering information and communications technology (ICT) skills and the basic and intermediate skills needed to participate in the "new economy";
- to identify the main barriers to the further development of these labour markets in Europe and to review and make use of good practice and experience in other countries, particularly in the United States. The task force will also identify the measures needed to make Europe an "attractive market place" for the "knowledge economy"; and
- to draw up a set of policy initiatives to ensure that these labour markets are open to everybody by 2005 and to make recommendations for their implementation at European and national level.

The Task Force comprises nine members from a range of European countries. It is chaired by Ulrich Schumacher, president and chief executive officer of Infineon, part of the German-based Siemens electronics group.

Box 4.4
A sector partnership: Overcoming the ICT skills shortage in Europe

With the support of the European Commission, seven major ICT companies in Europe (IBM Europe, Nokia Telecommunications, Philips Semiconductors, Thomson CSF, Siemens AG, Microsoft Europe and British Telecommunications Plc.) have formed an "ICT Consortium" and embarked on a pilot project to explore new ways of addressing the skills shortage. The objective of the project is to put in place a framework for students, education and training institutions and governments that describes the skills and competencies required by the ICT industry in Europe.

To achieve that objective the sponsor companies have developed generic job profiles relevant to their main activities and created a dedicated web site, www. career-space.com.

The aim is for these job profiles to: attract more students into ICT courses and employment by providing attractive, plain-language profiles of the jobs, roles and opportunities in the industry today; provide higher education ICT curriculum designers with clear, up-to-date and easily accessible information on the skills needed by the industry; and assist governments in developing policies to foster the growth of ICT skills in Europe.

Source: Career Space web site at http://www. career-space. com/project_desc/serv.htm (quoted in *World Employment Report 2001*).

[8] See European Industrial Relations Observatory online (eiro-nline), http://eiro.eurofound. ie/2001/07/InBrief/EU0107225N.html (21 Jan. 2002).

Box 4.5
Corporate-government-community partnerships

A healthy dose of self-interest can be a powerful tool when combined with corporate social responsibility. And in recent years, the shortfall in skilled IT and telecoms workers has encouraged many large corporations in the information and communications technology sector to direct resources into initiatives aimed at tackling the global digital divide.

One of the most successful examples has been Cisco Systems Networking Academy, a scheme that trains young people to design, build and maintain computer networks. Operating throughout the US and in more than 50 other countries from Brazil to Mongolia, the Web-based curriculum and extensive exercises help students to learn skills through a programme that leads to a university-recognized certification.

For Cisco, the project represents far more than a marketing opportunity or an exercise in corporate charity. “Philanthropy alone is not a long-term solution. There has to be a reason to be in this for the long haul”, says Bob Lewis, Cisco Systems’ manager for learning and development. “There simply aren’t enough people in the world with the skills to design, build and maintain the networks that underpin the Internet economy, so we felt we needed to find a way to help address this shortage.” Ironically, as telecoms and technology companies continue to experience difficulties, dotcoms disappear and recession looms alarmingly over the US, the labour shortage has abated somewhat. In addition, in an economic climate increasingly dominated by cost cutting, some companies are reluctant to invest money and resources into non-essential aspects of the business when they are struggling to keep staff lay-offs to a minimum.

Yet technology companies still dominate the list of those supporting initiatives addressing the digital divide. This indicates that many of them see lack of training in and access to technology for large sections of the world as a threat to their long-term business prospects. Motorola, for example, last year established a school of telecommunications in Hyderabad in partnership with the Indian Institute of Information Technology (IIIT). The IIIT will extend its core on-campus offerings to thousands of off-campus students through web-based programmes of study.

And Japan’s Softbank has linked up with the International Finance Corporation in an initiative to spawn start-up Internet companies in developing countries.

But it is not only high-tech companies that are focusing on the issue. In South Africa, for example, where established corporations operate in a country facing grave poverty, Investec, the South African banking group, has given over one of its properties in Johannesburg free of rent to small businesses providing services to emerging micro-entrepreneurs.

Increasingly, partnerships are being set up between corporations, governments and community groups to address the digital divide. The United Nations Development Programme, for instance, is trying to help developing countries assist themselves through initiatives like the Digital Opportunities Task Force, or DOT force, in which the G8 group of leading nations, developing countries, the private sector and civil society are cooperating.

But while the developing world is an obvious target for such initiatives, many companies find the digital divide exists, too, in their own backyard. In the US, for example, a study conducted by the New York city-based Jupiter Communications last year found that income rather than race was the predominant factor determining whether or not Americans were online. Of all households on line in 2005, only 9 million will be found in those with annual incomes of less than US$15,000.

This has big implications for the growth of high-tech companies in their home market, and many are starting to address the issue. Gateway, the computer maker and retailer, last year teamed up with Goodwill Industries, a US and Canadian group that gives people with disabilities and other needs the training necessary to overcome barriers to employment. Gateway Country Stores offered a US$100 discount off a new PC to anyone donating a functioning computer to Goodwill.

December 2000 saw the launch of the Club Tech Initiative, a joint project between Microsoft and the Boys and Girls Clubs of America designed to bring technology access to more than 3.3 million youngsters across the US.

Tapping into corporate philanthropy is one thing. But Amanda Blakeley, a partnership specialist at the World Bank’s Business Partnership and Outreach Group, stresses the need for non-governmental organizations and charities to treat projects involving the private sector as more than a cash handout.

“The biggest pitfall is looking at the company simply as a source of funding”, she says. “What we try to do when a company approaches us is to find the mutual benefit; to look at where the business benefit links with the developmental gains. And that involves more discussions with the company initially. We spend less time going to companies and proposing ideas. We tend now to let an idea bubble up during the conversation.”

Source: S. Murray: “Bridging the Digital Divide”, in *Financial Times/Responsible business in the global economy*, Oct. 2001.

5. Three country experiences

This chapter will look at the current situation and recent initiatives in Japan, the United States and China, countries with three very different experiences. Japan and the United States were obvious choices because the vast majority of companies in the MEE industries are headquartered in these two countries. Japan was also chosen because of the radical changes which are now taking place in its employment system and the various implications of these changes for training. It also interesting to note that the electronics giants have not yet followed the survival strategy of their automobile counterparts. [1] The United States was singled out because of an interesting case study of apprenticeship training in the machine tool industry in a country where apprenticeship training is not as advanced as, for example, in Germany. Finally, China was selected because of the sheer size of the industry in that country and the fact that more and more foreign companies in the mechanical and electrical engineering industries are flocking to China and the apparent ability of the workforce to acquire the requisite skills.

From long-term employment to lifelong learning: Lessons from Japan

The Japanese employment system [2]

Although lifetime employment – derived from the term “permanent employment” coined by J.C. Abegglen in *The Japanese Factory* (1958) – has long been considered one of the defining characteristics of Japanese corporate culture, it is perhaps more of a myth than reality. Nevertheless the misnomer has gained currency and is still widely used today, despite the fact that it is not particularly accurate. In reality, smaller firms employ very few graduates, if any, direct from university, and workers at these firms frequently quit and move on to other jobs in mid-career. Even in large corporations with an established tradition of long-term employment, it is not unusual for employees to be farmed out *(shukko)* or transferred *(tenseki)* to other companies, or for the firms concerned to offer early retirement options (as is increasingly the case with the electronics giants – see box 5.1). Another arrangement adopted by some companies is to allow employees to hold more than one job (see box 5.2). This has resulted in many employees choosing to quit their jobs before reaching retirement age. The only category to whom the term “lifetime employment” might still really apply are some non-career track civil servants. Therefore, the term “long-term employment” probably describes the Japanese employment experience better than “lifetime employment”.

[1] Nissan has entered a partnership with Renault, Mitsubishi with DaimlerChrysler and Mazda with Ford.

[2] Information for this section on the current wave of restructuring by the Japanese electronics giants and proposals for various training reforms was contributed by the Japan Institute of Labour (JIL).

Box 5.1
Japan downsizes a job tradition

A mounting toll of job cuts by major Japanese corporations underscores the country's deepening economic woes and delivers another blow to its weakening lifetime employment system.

Matsushita Electric Industrial Co., one of the founders of the lifetime employment tradition, said it expects to eliminate several thousand jobs by offering payoffs to employees who quit. Another electronic giant, NEC Corp., said it would cut 4,000 jobs globally this year as it reorganizes its chip business.

The job cuts, particularly those at Matsushita, have shaken the confidence of many Japanese, because the latest job cutters include some of the most faithful practitioners of the practice at blue chip companies of guaranteeing employees a job for life.

Konosuke Matsushita was an originator of the lifetime employment system. Now, the company he founded is offering to pay employees as much as 40 months' salary to quit. Matsushita has had an early retirement programme since 1996, but it was open only to managers between 50 and 58 years old.

The new programme is open to all employees aged 58 and under, and offers bigger benefits for quitting. Matsushita, which makes Panasonic brand goods, has been hit by slackening global demand.

Matsushita director Tetsuya Kawakami insists the company is not encouraging people to quit. The incentives are just a way of smoothing the transition for employees who feel they could use their talents better elsewhere, he says.

Still, Japanese media are treating Matsushita's move as symbolic of lifetime employment's demise. "Matsushita Shock: It Will Cut Workers", the weekly magazine *Aera* declared in a headline.

Meanwhile, the chairman of Toyota Motor Corp. yesterday called on the Government to employ some of those workers as teachers, police officers or nurses, since "it's impossible for private companies alone to create new jobs".

Source: T. Zaun and P. Landers, Tokyo, in *The Wall Street Journal*, reprinted in *The Globe and Mail* (Toronto), 5 Aug. 2001, p. B7.

Box 5.2
Job cuts Japanese style: Hitachi workers can hold two jobs!

Tokyo – In what could signal a new work order, a major corporation, Hitachi, has allowed some of its employees in Japan to hold a second job at a different company.

The 2,000-odd employees at three Hitachi plants were given the go-ahead after the company reduced their working hours with a corresponding cut in their pay in November. With many corporations likely to introduce work-sharing and reduced working hours, Hitachi's move could well set the standard and change the norms of a corporate culture that has to date emphasized company loyalty.

Employees with a second job will not be able to stay in the workplace beyond the official hours. Under the current corporate culture, employees invariably stay on until after the boss leaves, even though they have finished their work for the day. Hitachi officials said that the measure would be subject to review in April, and could be extended if the Japanese economy continues to ail.

Hitachi has become a pioneer of sorts here in coming up with new ways to cut costs for a healthier bottom line. It was one of the first big companies in Japan to experiment with a merit-based pay and promotions system, and led the way in hammering out a work-sharing scheme with its workers in November. Its move to reduce working hours has led to a drop of at least 20 per cent in income for affected workers.

The "two jobs per worker" solution is unprecedented as Japanese corporations used to give the boot to workers who moonlighted at other companies. Workers at Hitachi, like many others in Japan, rely heavily on overtime pay, which sometimes can amount to as much as half their basic salary. However, this practice is now hard to sustain.

According to a government survey, the scarcity of jobs means four out of ten fresh graduates can only look forward to part-time posts when they enter the labour market.

Source: Hau Boon Lai: "Job blues", in *Straits Times Japan Bureau*, 25 Feb. 2002.

Indeed, while the Japanese economy was in its continuously expanding phase, it was possible for firms to offer their employees long-term security, but in this era of globalization, companies can no longer do this to such a high degree. One of the first signs of this is the offer by the electronics giants of voluntary early retirement. Since the benefits offered were in some cases two-and-a-half times that offered if the workers chose to work until retirement age, many more workers applied for early retirement than the companies had anticipated, demonstrating with unusual force the magnitude of the changes taking place.

Corporate employee training

At companies still offering long-term employment, the most effective and common form of employee training is on-the-job training (OJT) for both blue-collar and white-collar workers. These companies also offer off-the-job training (Off-JT). The large electronics giants also have their own training facilities where they conduct comprehensive training courses, including pre-employment orientation.

According to figures on average length of employment, few workers who have joined a firm immediately on graduating from university switch jobs in mid-career. [3] (It should be noted that employee reduction measures undertaken by the electronics giants and other companies (i.e. early retirements) mostly target workers in their fifties.) At the same time, there has been a noticeable increase in job departures among long-term employees. Half of the companies that took part in a Ministry of Health, Labour and Welfare survey replied that they do not have a special commitment to long-term employment.

These results show that, while traditional employment patterns still remain an entrenched part of Japanese corporate culture, signs of change are also visible. Many firms are exploring different options in their approach to employment in their attempts to cope with the transformations taking place in the Japanese economic and industrial framework.

If Japan goes through with its structural reforms, many more workers will be forced to switch their jobs, resulting in fewer long-term employees. Firms may well be divided into enterprises that plan to maintain long-term employee relations and those that do not.

The skills that workers obtain through their work can be classified as basic skills (which can be useful to any company) and specialized skills (which can be useful only to the company in which they are acquired). Basic skills can be obtained through schools, skills seminars and other ordinary education and training programmes. Specialized skills involve knowledge of the specific quirks of the equipment that workers handle, as well as knowledge associated with the specific organization to which the workers belong. Generally, in work involving only basic skills, who the worker is affects productivity very little. In work involving specialized skills, switching a worker results in lower productivity.

If the Japanese employee training framework remains unchanged, the overall system will be unable to deal with the forecast increase in the number of people who will be forced to switch jobs. Companies will be unable to find the workers with the specific skills they need; workers will be unable to find companies that can make use of their particular skills. However, the types of training programmes that the companies implement or the individuals choose to undergo are the key to improving future labour productivity.

[3] *Basic survey on wage structure* and *survey on employment trends* (Ministry of Health, Labour, and Welfare, Tokyo, various years).

Government and labour-management measures

To deal with these likely changes, the Japanese Government has introduced measures designed to ensure smooth evolution of the management structure and to establish a more efficient labour market. Chief among such measures is the Education and Training Benefit System, introduced on 1 December 1998. The benefits in question, paid from employment insurance funds, are designed to ensure stability in the labour market and promote re-employment by subsidizing workers who engage in skills development on their own initiative. People who pay into the unemployment insurance scheme, or who have paid such insurance in the past and who meet certain criteria, are reimbursed 80 per cent of what they spend on skills training courses that are approved by the Ministry of Health, Labour and Welfare, up to a maximum of 300,000 yen. This benefit system makes it easier for workers to volunteer for skills enhancement and training courses.

Trade unions have proposed their own measures as well. For example, the Japanese Electrical, Electronic and Information Union (membership 740,000) has recently announced that it will establish a union-funded objective system of skills assessment called the “Electronics Industry Vocational-Academy Concept”. The union hopes to apply this concept throughout the industry in order to enable workers to move more smoothly between companies or between different types of work. The union has asked for the cooperation of Matsushita, Hitachi, Fujitsu, Toshiba, NEC and Mitsubishi Electric in accepting the concept. According to union president, Katsutoshi Suzuki, the plan would allow the establishment of an assessment system in which a worker who receives an “A” assessment in a skills development curriculum at the Academy will be treated as an A-grade worker no matter where he goes. The thinking behind this system is that the enormous structural changes taking place in the industry make it impossible for any single company to ensure its workers lifetime employment or to conduct full employee training. In the union’s view, the establishment of such an academy would enable the industry to: (1) offer skills training programmes to existing workers; (2) establish better training curricula; (3) create a universal industrial qualifications system; (4) make more effective use of personnel in the industry; and (5) offer counter-proposals to the Government’s employment measures.

To date, the employers have not yet openly embraced these proposals. This reluctance may arise because employers can easily hire temporary or part-time workers. On the other hand, they clearly recognize the need to change the scope and quality of their education programmes to better respond to the present set of realities. Because significantly increased revenues are unlikely to be achieved in previous core sectors of business such as home electronics and power generation, electronics firms are expected to cut back on training investment in these uncompetitive mature product sectors and shift technical personnel tied up in the manufacturing sector to the software sector to ensure better labour and management efficiency.

The evidence available indeed suggests that such steps are already being taken. Toshiba, for example, has announced that it will increase the number of workers in the software services division by 10,000 over the next year by shifting workers from other sectors. In shifting these workers, Toshiba plans to make maximum use of its own training centre and to offer a better skills development and training curriculum. Other firms in the industry have also been forced to carry out major corporate restructuring programmes to cope with their worsening finances.

The MechTech – MAP Programs: Lessons from America [4]

Introduction

MechTech illustrates how inter-firm collaborations, when supported by a public sector training apparatus keen to listen to what industry wants, can resolve what appear to be intractable labour market problems. A 1997 survey of 14,000 member companies carried out by the National Association of Manufacturers found that: Employers reject one-third of all applicants because of inadequate reading and writing skills, nearly one-third because of insufficient computer skills, and one-quarter because of poor communication or math skills. The most pressing problem was lack of industry-specific technical skills. A related survey in 1998 found four out of ten executives of manufacturing firms cited the shortage of skilled workers as the principal obstacle to purchasing new machinery and equipment, along with hardware and software.

Without an adequate skill base and investments in new production technologies, it is increasingly difficult for industrial enterprises to keep up with today's shortened product and technology cycles, accelerating the drain of well-paid jobs from manufacturing regions of the United States as corporations search for cheaper wages to offset these deficiencies. However, "learning regions" require workers capable of applying their intelligence to production and an education and training infrastructure which can facilitate the lifelong learning required for knowledge-intensive production.

Since the late 1980s, member firms of the Western Massachusetts chapter of the National Tooling and Machining Association (NTMA) have participated in an education, training, and technology diffusion network characterized by a high degree of inter-firm cooperation. A non-profit corporation, MechTech prepares crafts workers for the machining industry. Full-time apprentices spend four years in participating firms and leave the programme as machinists, tool and die makers, or mouldmakers. In a conspicuous departure from the short-term, narrow-focused, firm-specific training that occurs in much of American industry, MechTech involves a quarterly work rotation for apprentices among participating firms. High-school pre-apprentices and full-time apprentices participate in a rigorous academic schedule that leads to graduation from the programme with an associate degree in manufacturing technologies. The collaboration makes it possible for small and medium-sized workshops to have an apprenticeship programme that approximates what was once the dominant machinists' training model among large US metalworking firms, like Pratt and Whitney, Brown and Sharpe, and General Electric – a model these firms dropped in the 1960s and 1970s in an attempt to cut "non-production-related" expenses.

The Machine Action Project (MAP)

The Western Massachusetts Machine Action Project (MAP) received $100,000 a year for three years with the original goal of assisting in the orderly transition of the regional economy from metalworking towards service industries. However, over time, MAP acted as a catalyst between the region's metalworking firms, their industry association, local education and training providers, and state and federal agencies, to provide industry-focused training and technical assistance to hundreds of managers and workers employed in the region's metalworking industry. By the mid-1990s, there were signs of life among the hundreds of firms engaged in the manufacture of precision fixtures, tools, gauges,

[4] This section was contributed by Prof. R. Forrant, University of Massachusetts at Lowell.

subassemblies and prototype components for aircraft, automotive, computer, medical and electronics manufacturers. However, growth was hampered by a lack of skilled workers, prompting the establishment of a comprehensive education and training programme for the region.

A series of well-constructed social and political interventions altered the downward industrial trajectory that many policy-makers and development experts assumed was inevitable. These activities – first embodied in the state-supported Machine Action Project (MAP), and today carried out under the private sector auspices of the local chapter of the National Tooling and Machining Association – were built upon existing social relations among firms that were able to stimulate and maintain a rich and continuous inter-firm learning process.

It is ironic that after the steep business decline in the late 1970s and through much of the 1980s, the most persistent inhibitor of metalworking expansion in Massachusetts today is the dearth of skilled machinists. A survey and skills audit of firms revealed that the workers losing their jobs in the region were, at best, machine operators, who lacked the blueprint reading and maths skills required by the precision shops. In fact, workers in small firms were three times more likely to have machinery set-up skills and could operate several different kinds of equipment. In other words, typical small-firm workers had greater depth and breadth of skill than their large-firm counterparts being laid off.

In 1992, when MAP staff learned that their state funding was to end, they submitted a proposal to the MassJobs Council, then the State's clearing house for workforce development funds. State agencies provided the group with $300,000 for a two-year programme. Firms agreed to defray 50 per cent of the cost of hands-on training for their employees. A 23-week, full-time training programme for dislocated workers began and a $200,000 US Department of Labor grant supported in-plant industrial modernization activities. The umbrella programme also provided planning and oversight assistance to MechTech.

What had MAP accomplished? MAP was highlighted by a number of influential academic researchers as a "best-practice" model of regional industrial and training policy. Analysts observed two particularly innovative features related to the localized nature of its strategy and activities. First, MAP provided detailed analysis of the local industrial base – and designed an alternate course of action. Second, by acting as a broker between firms, trade unions, educational institutions and state agencies, MAP translated the requirement for higher skilled workers into specific training courses. Observers noted that this strategy represented a vast improvement over centralized job training programmes, as it compelled the local education and training infrastructure to be responsive to the genuine needs of workers and industry.

The MechTech Program

MechTech began operating in Cranston, Rhode Island and the south-eastern region of Massachusetts in 1986. As a spin-off of the Rhode Island experience, a non-profit MechTech corporation was started in Western Massachusetts by a handful of NTMA shop owners. It received a significant boost with the establishment of the MAP-initiated metalworking consortium. MechTech is the employer of record for all apprentices, and participating firms pay into it approximately $5.00 per hour above the wages they would ordinarily pay pre-apprentices and apprentices. Funds are used to staff the programme, test and select trainees and monitor their progress, purchase medical and dental insurance for participants, and reimburse college tuition. MechTech pays participants their wages and benefits, including medical and dental insurance, ten paid public holidays and one week of paid vacation. Raises are built into the salary structure after completion of each

1,000 hours on the job. As increments towards their apprenticeship and academic work participants receive a $0.50 to $0.60 an hour increase. Ten technical high schools and 80 firms now participate in MechTech. In 2000, roughly 65 full-time apprentices and 40 high-school pre-apprentices were in the programme.

A unique feature is MechTech's hands-on training, whereby apprentices work in several shops over the four-year period to gain knowledge on all aspects of the tooling and machining industry. Apprentices experience machine shops, tool and die firms, production companies working in large volumes, mould manufacturers, pattern-makers, and firms with the latest in numerically controlled machine tools and computer-aided design technologies.

In addition to the hands-on machining, there is a mandatory college-level curriculum that includes technical report writing, mathematics, machine design, fluid mechanics, computer-aided machining and design, and physics. Apprentices earn an Associate of Applied Science degree [5] and can transfer to an accredited engineering programme at a four-year college or university. MechTech reimburses students' tuition and monitors their progress. Students who do not do well in school must leave the programme. In 1996 MechTech recruited high-school students as registered pre-apprentices. Students must maintain a minimum grade point average of 2.5 and have at least 95 per cent attendance at school. If they remain in good academic standing and master the technical requirements of the programme, they are enrolled full time in MechTech at graduation. They are then guaranteed a job, credited with 1,000 hours earned toward their formal apprenticeship, and will have their college education paid for.

The machinery and electronics industry in China [6]

Profile of the MEE labour force within manufacturing

Although the statistical data presented elsewhere in this report do not reveal sharp declines, the data in table 5.1 collected by the China National Statistical Office paint a bleak picture, with employment down by between one-third and 40 per cent in most of the MEE industries in the last five years (although consistent with trends in the other sectors of the economy).

[5] An interim certificate granted in the United States after two years of college and short of a full four-year university course.

[6] The study was largely compiled by Tian Feng, Department of Training and Employment, Ministry of Labour and Social Security.

Table 5.1. Total employment (millions)

Industry	1995	1996	1997	1998	1999	2000
Manufacturing	54.39	52.93	50.82	37.69	34.96	32.4
Ordinary machinery	4.05	4.22	4.03	2.75	2.49	2.22
Electric equipment and machinery	2.44	2.36	2.27	1.70	1.58	1.45
Electronic and telecommunications equipment	1.72	1.63	1.65	1.34	1.33	1.38
Instruments, meters, cultural and clerical	0.086	0.082	0.079	0.053	0.048	0.046
Special purposes equipment	0.304	0.280	0.274	0.197	0.179	0.163
Other manufacturing	0.177	0.129	0.115	0.86	0.077	0.076
Mining and quarrying	0.914	0.886	0.851	0.702	0.650	0.581

Source: China National Statistical Office.

Latest developments in the MEE industries

In March 1998, after a series of reforms over the past few decades, a new Ministry for the Information Industry was created through the merger of the former Ministry of the Electrical Industry with the Ministry of Post and Telecommunications. At the beginning of 2001, the previous State Administration for the Machinery Industry (formerly also a ministry) was integrated into the State Economic and Trade Commission to form one department.

Overview of training in China

(a) Apprenticeship training

The apprenticeship system was the major means of imparting technical skills to workers ever since the 1950s, when China launched large-scale economic reforms. Until the beginning of the 1980s, the recruitment and training of apprentices was done entirely by enterprises. However, with the reform of the employment and enterprise system, the apprenticeship system was also in need of an overhaul. During the 1980s, China tried to launch the "dual system" in accordance with the principle "training first, then employment". In 1981, the Government had also decided to train students – under the national policy for a labour preparatory system – and thus to discontinue the practice whereby companies recruited apprentices directly.

(b) Vocational training

Technical schools are the primary means for training skilled workers, while employment-training centres are the places for providing training for unemployed jobseekers. In addition, there are enterprise-sponsored training centres and training providers run by various organizations or individuals which deliver on-the-job training and other training programmes. By the end of 2000, there were 3,792 technical schools with an enrolment of 1.4 million. In addition, there were 3,751 employment training centres and another 15,000 training providers. Altogether, training was provided for 8.96 million trainees.

In China most large and medium-sized enterprises have their own training agencies.

With the advent of the information industry, vocational training and education via distance learning are important. Under the Ministry of Education, there is a Chinese National Education Television Station which has its own channel to broadcast teaching programmes nationwide. The Ministry of Labour and Social Security has established the China Employment and Training Technical Guidance Centre, which organizes vocational training via distance learning and is trying to establish a nationwide vocational training service.

Nevertheless, enterprises recruit skilled workers mainly by hiring workers who are self-trained. These account for almost 80 per cent of new recruits. Self-training is the first choice for employers because it can save them from having to spend on training funds. Secondly, enterprises send workers back to school or other social training agencies. Thirdly, they hire workers through the labour market. Fourthly, enterprises attract the more highly-skilled workers through higher salaries

Figure 5.1 shows the overall structure of the vocational training system and employment services in China.

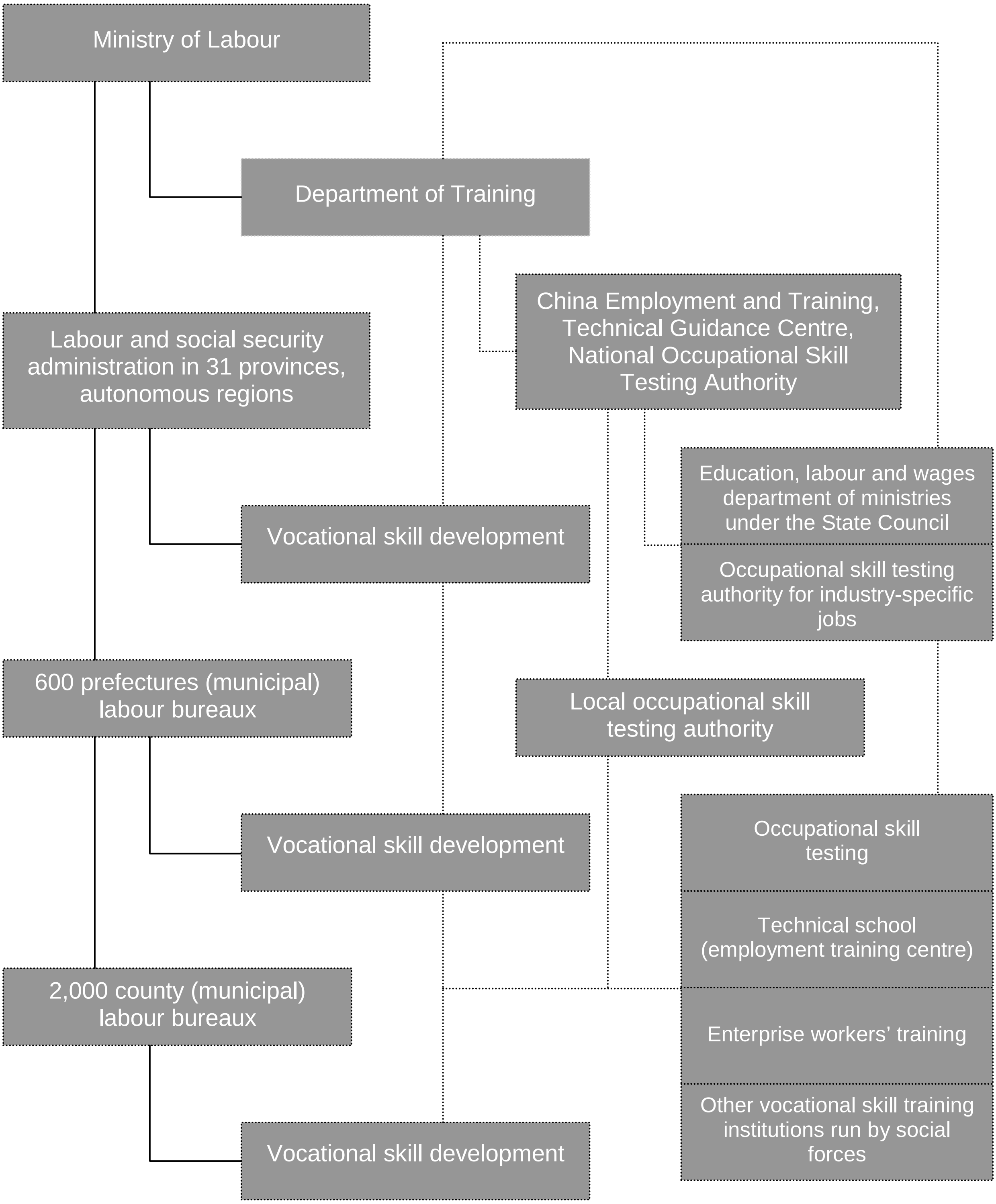
The curriculum for mechatronic engineering

By 1990, some technical secondary schools had begun to set up courses based on the integration of mechanical engineering with electronics, but there were great differences. Later on, the Ministry of Mechanical Industry and the Ministry of Electrical Industry were merged to form the Ministry of Mechanical and Electrical Industry. Thereafter, the technical secondary schools tried to focus on how to combine the study of the machine tool industry with electronics and trained students in mechanical and electrical engineering. At the same time, in order to permit students to practice what they have learnt, some factories helped the schools to provide hands-on experience. With the development of information technology, computers and microelectronics, many schools set up the new curricula to cater to the needs of new technology.

Many technical schools and training institutes now provide training focusing on practical skills and flexible training methods which are demand-driven and based on market requirements. Taking the technical schools for the MEE industries as an example, the Ministry of Labour and Social Security recently had experts from universities, technical schools, enterprises and factories amend the syllabus and curriculum for the MEE industries in 1999. The principles for the new syllabus and curriculum are to serve economic reform and promote employability. They also require that the curriculum taught by technical schools and training institutes meet the needs of high technology. In 2001, the new syllabus and curricula for 24 of the MEE occupations were completed. The main features of the new syllabus and teaching plan focus on the following:

- First, the ratio of time devoted to theory and practical training for the MEE industries is 1:1. Graphics and electronics have been merged into one.
- Second, while the new syllabus places less emphasis on theoretical knowledge, it emphasizes competences such as the ability to conduct experiments, as well as basic and integrated skilled training and on-site practical experience.
- Third, to guarantee a good foundation for lifelong learning, the teaching of basic theory is included in addition to MEE subjects.
- Fourth, the curriculum structure reflects newer knowledge and technology, and emphasizes cultivation of students' ability "to live and develop in the future".

Figure 5.1. Organization structure of vocational training system and employment services in China



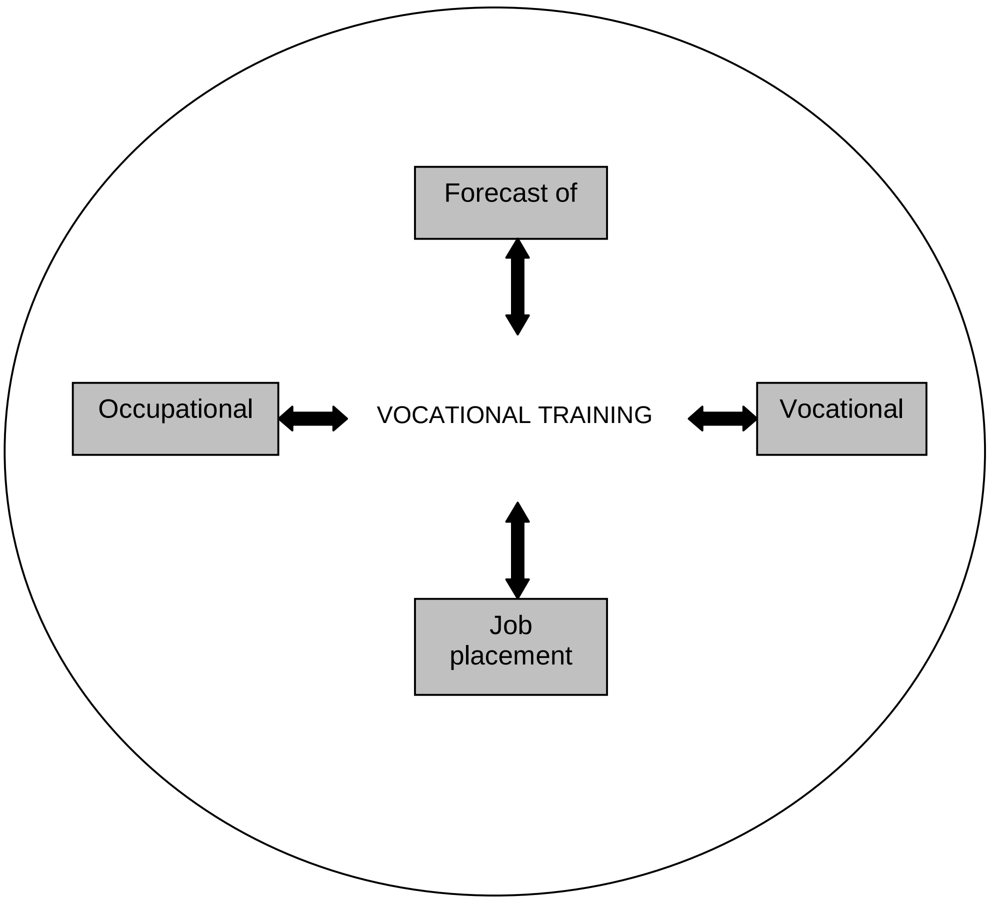
MEE training and MEE industrial occupations

Many institutes and universities just offer theoretical knowledge. However, some, such as the No. 2 Secondary School Affiliated to Beijing Normal University, send their students to training centres to receive short-term MEE training. Many universities, such as Tsinghua University and Beijing Polytechnic University, have their own occupational skill testing agency.

As mentioned earlier, employment in the MEE industries has been decreasing yearly, partly because wages in the machinery industry are lower and, as China has moved from a planned economy to a market-oriented one, the industrial structure has also adjusted in recent years, with some enterprises being closed, merged or taken over.

As the IT industry develops rapidly in China, many workers would like to enter these occupations. But the IT industry needs workers with high qualifications which many workers still lack.

Figure 5.2. Functions of comprehensive vocational training base



Training by foreign v. *domestic enterprises operating in China*

The conditions for training offered by foreign enterprises operating in China are quite different than those of domestic enterprises. Chinese enterprises operating at a loss spend less on training because they prefer to invest more in production. Some private and township (village) enterprises focus on earnings to the neglect of the training. However, some well-run enterprises pay more attention to training. The more profitable an enterprise, the more attention it pays to training.

> Box 5.3
> Haier moves abroad
>
> Despite suffering from low brand recognition, Haier has been extremely successful in the United States where it has captured just over one-third of the market for small refrigerators under four cubic metres, mainly used as mini-bars in hotels and motels, but also popular in student dormitories. Much of its production is also undertaken in the United States and altogether it has ten overseas manufacturing sites and 16 R&D centres abroad.
>
> Recently it has negotiated a strategic alliance with Sampo of Taiwan, China, for cooperation both in marketing and manufacturing. There are plans for joint distribution, technology sharing and expected orders from Haier ranging from flat television screens to mobile phone components. Earlier, Haier announced a marketing alliance with Sanyo Electric, the Japanese electronics company, under which it will distribute Sanyo products in China, while forging a joint venture to promote its own branded goods in Japan.
>
> Source: M. Dickie: "Sampo and Haier plan alliance", in *Financial Times*, 21 Feb. 2002, and *China Daily News* (various issues, 2001).

The Haier Company is an example of one of the more profitable enterprises in China that produces mainly refrigerators and other electrical appliances. It has good sales not only in China but throughout the world. Training in the Haier Company consists of pre-job training, on-the-job training and further improvement training. There is a clear training requirement for each worker. Each year the training section in the Haier Company evaluates every worker's qualifications. It operates a system of training in fixed time for each staff member. Every manager has to be released from his or her job to receive over 100 hours of training each year, and workers must each receive more than 20 hours of training. In order to enhance this training endeavour, Haier has established its own university. There are five colleges at Haier University: basic management, research and development, marketing, overseas promotion and enterprise culture.

Township and village enterprises: Training and development

Township and village enterprises (TVEs) are another type of enterprise which has recently emerged in China and today employ some 120 million workers. Essentially they are collectively owned rural enterprises (or cooperatives) which differentiate themselves from the state-owned enterprises (SOEs) in terms of property rights and ownership and thus have a more diversified organizational and HRD structure. As cooperatives they pursue a strategy of employment-generation rather than one of exclusive profit maximization. A recent study looked at the human resource management practices [7] of six such enterprises in Guangdong Province, four of which were in the MEE sector making

[7] D.Z. Ding, G. Lan and M. Warner: "A new form of Chinese human resource management? Personnel and labour-management relations in Chinese township and village enterprises: A case-study approach", in *Industrial Relations Journal*, 32:4 (2001), pp. 329-343.

household appliances and electronic goods (such as cookers, water heaters, fans, air conditioners and transformers). One enterprise, Shun De, was a joint venture in which Bosch (Germany) owned 51 per cent. The main characteristics of the TVEs studied are shown in table 5.2. The largest company, Media, was able to offer 70 per cent of its workforce some kind of training in 2000 and to attract MBAs and PhDs from abroad.

It was found that in general TVEs tend to recruit line-workers locally to satisfy the employment objective of township village government, but take on managerial and technical staff from the broader labour market.

In many TVEs, training is not very advanced or elaborate as it varies in its organization and intensity. In the available sample of such firms, some emphasized training but a minority did not. In the former cases, it was formalized but in the latter it was relatively informal (see table 5.2).

Table 5.2. Main characteristics of six township village enterprises (TVEs)

A summary of the major characteristics of the TVEs

Characteristics	Name					
	Longji	Shenzhou	Heygey	Hehe	Media	Hongjian
Location	Dong Guang	Shun De	Shun De	Nan Hai	Shun De	Dong Guang
Product	PVC material	Gas cookers	Electric cookers	Decorative construction materials	Electric fans, air conditioners, compressors and motors	Electric cables and transformers
Established	1985	1958	1979	1981	1968	1995
Initial investment in thousands RMB	500-600	300	1.8	2.6	5	NA*
Total production value in millions RMB (1999)	22	500	200	130	8,000	30
Product market	Mainly local; small percentage for export	Mainly local; small percentage for export	Totally local	Mainly local; small percentage for export	Mainly local; small percentage for export	Totally local
Number of employees	400	1,400	1,000	700	30,000	500
Ownership type (after reform)	Shareholding cooperative (the specific share distribution is not available)	51% held by Bosch (German), 49% held by China	More than 90% held by the general manager, top managers hold the remaining 10%	100% held by the general manager	Public-listed company	50% held by the local government, 50% held by all the employees

Conditions of employment and work and HRM in TVEs

Characteristics	Name					
	Longji	Shenzhou	Heygey	Hehe	Media	Hongjian
Recruitment	Line-workers: non-local Management: local	Line-workers: local Management: non-local	Line-workers: local Management: non-local	No specific characteristics	Line-workers: local Management: non-local	No specific characteristics
Training	Not emphasized	Emphasized and formalized	Emphasized but not formalized	Not emphasized	Emphasized and formalized	Not emphasized
Rewards	Line-workers: around 700 yuan Technicians: 1,500-2,100 yuan Marketing personnel: 6% of sales	Line-workers: around 800 yuan Technicians: 1,600-2,400 yuan Marketing personnel: basic + 5% of sales	Line-workers: 500-1,200 yuan Technicians: 2,000-3,500 yuan Marketing personnel: basic + commission	Line-workers: 800 yuan Technicians: 1,600-2,500 yuan Marketing personnel: basic + commission	Line-workers: 1,000-1,200 yuan Technicians: 2,000-3,000 yuan Marketing personnel: basic + commission Elite shareholding system[1]	Line-workers: around 800 yuan Technicians: 1,600-2,400 yuan Marketing personnel: basic + commission
Social security[2]	Abide by the Labour Law except the pension fund	All five funds according to the Labour Law	All five funds according to the Labour Law	Medical fund only	All five funds according to the Labour Law	Pension and medical funds only
Turnover	Low for line-workers; high for managers, marketing and technical personnel	Low for line-workers; high for managers, marketing and technical personnel	High for both line-workers and managerial personnel	Low for line-workers, managers and technicians	High for both line-workers and managerial personnel	Low for line-workers; high for managers, marketing and technical personnel
Disputes	Few	Some	Some	Few	Few	Few

[1] Elite shareholding system is both a reward and an incentive system in which elite (top managers of Midea) have the right to hold the "legal entity share" of the company. [2] The 1994 Labour Law requires all employers and employees to join and make contributions to five separate funds: pension, accident and injury, maternity, unemployment and medical funds.

The Shengzhou and Midea factories both have systematic and formal training programmes but Shengzhou emphasizes the training of technicians, while Midea emphasizes the training of management personnel. As there was no university in China providing a "major" in the techniques used by Shengzhou and, since Shengzhou was "the leader in its market", it thus had to train its technicians itself. The general manager of Shengzhou said that it normally took two or three years to "grow" a new graduate into an independent engineer. There are now around 100 engineers in its Research and Development Centre, which has become one of the largest centres on gas utensils in China. While Midea imported its major technology from Japanese and European firms, its independent research and development capability is not strong. Midea is so big (i.e. 30,000 employees, six divisions, 1.5 billion yuan net assets and 8 billion yuan output in 1999) that it emphasizes its own company management style. Each year Midea invites experts from university campuses in China to give seminars, and sends managers at various levels to attend MBA courses or the like. In 1999, they sent some top managers abroad to the National University of Singapore. In contrast to larger firms like Midea, training was minimal in small ones. Thus, it was found that TVEe tend to develop an appropriate training model to suit their needs and stages of development.

In general foreign enterprises in China pay much more attention to training. Today, nearly 400 of the *Fortune 500* firms have invested in over 2,000 projects in China. These include[8] not only the world's leading MEE companies such as the manufacturers of computers, electronics, telecommunications and power-generating equipment, but also pharmaceuticals and petrochemicals. These multinationals also focus on human resource development and building competencies. First of all, they have enough money to invest in training. Secondly, they think skill is important in improving productivity. Thirdly, they are even investing in R&D (see box 5.4).

Box 5.4

The evolving profile of FDI in China

The portfolio of FDI in China has been evolving over the past two decades, and the country's old image is giving way to that of a rising competitive location for technology-intensive activities for TNCs.

Most recently, even R&D activities have emerged as a bright spot for FDI, with over 100 R&D centres established by TNCs. Microsoft, Motorola, GM, GE, JVC, Lucent-Bell, Samsung, Nortel, IBM, Intel, Du Pont, P&G, Ericsson, Nokia, Panasonic, Mitsubishi, AT&T, Siemens, to name but a few, all have R&D facilities in China. Motorola, for example, has established R&D centres in the area of electronics, based on $200 million in investment and 650 research personnel. Microsoft invested $80 million in a Chinese research institute and has announced the investment of a further $50 million to create a Microsoft Asian Technology Centre in Shanghai. The need for the adaptation of technology to the huge local market has been one of the push factors for TNCs to locate some of their R&D activities in the country. The availability of extensive hard and soft R&D infrastructure (particularly well-educated and hard-working researchers at low costs, including many graduates returned from abroad) is the main pull factor. Furthermore, the Government has introduced policy measures to reform the nationwide science and technology system, promoting self-sustained and market-oriented research institutions. As a result, Chinese R&D institutions are becoming proactive in seeking partnerships with TNCs.

The prominence of FDI in technology-intensive industries is also manifested in China's foreign trade. Exports of new and high-technology products by foreign affiliates increased from $4.5 billion in 1996 to $29.8 billion in 2000 (see table below). They accounted for one-fourth of the total exports by foreign affiliates and 81 per cent of the country's total exports in high-technology products. Since the second half of the 1990s, China has significantly reduced its imports of complete sets of advanced equipment and is now relying more and more on FDI to acquire foreign technology. In fact, FDI has become the engine of growth of China's high-technology exports and an essential means of inward technology transfer.

Exports of high-technology products from China by ownership of production, 1996-2000

Year	Total (million dollars)	State-owned enterprises (per cent)	Foreign affiliates (per cent)
1996	7 681	39	59
1997	16 310	–	–
1998	20 251	25	74
1999	24 704	23	76
2000	37 040	18	81

Source: UNCTAD, based on China, Ministry of Science and Technology.

In parallel with the above trends, the share of FDI flows into those industries in which FDI traditionally concentrated (e.g. footwear and travel goods, toys, bicycles and electrical appliances) has been declining. Moreover, driven by the excessive productive capacity in the country and encouraged by their increased competitiveness in exports, Chinese firms in those industries are now expanding to set up processing or assembly plants overseas. The Government promotes those outward investments by providing such incentives as loans at preferential terms and tax rebates. Special guarantees and financial support through official development assistance are also granted to the investments in those countries that are identified as high-risk locations.

Source: UNCTAD.

[8] UNCTAD, *World Investment Report 2001*, p. 26.

Foreign enterprises in China often dispatch their staff abroad to study management practices and technology. Companies such as Siemens select suitable staff to study in Germany. In addition, they often establish relationships with polytechnic universities to jointly train their employees. They also invited national or international experts to provide on-site training in China. Motorola has established a Centre for Enterprise Excellence with the State Development and Planning Commission which has already provided training to over 500 enterprises with plans to double that number (see box 5.5).

Box 5.5

Motorola's training programme in China

Since its establishment in China in 1987, Motorala has become one of the country's largest inward investors, with a direct investment stake of more than $3.4 billion, two wholly owned affiliates, 8 joint ventures and 18 R&D centres.

Working in full partnership with China's State Development and Planning Commission (SDPC), Motorola has established the *Centre for Enterprise Excellence*, a programme to provide high-level training to selected state-owned enterprises. The main objective of the programme is to develop Motorola's supplier base by strengthening quality, production and productivity through classroom and on-site instruction as well as outreach activities. Motorola and the SDPC have developed a three-step model for that purpose: training of participants for two weeks; selection of high-potential state-owned enterprises for further development (after a 6-12 months' joint effort, Motorola qualifies selected enterprises as suppliers); and provision of finance, jointly with the SDPC to selected firms. This final step has so far not been implemented as the firms selected have had access to alternative sources of funding.

Since 1998, Motorola and SDPC have developed a training curriculum in quality and productivity management for the chief executive officers, managers and technical staff of selected Chinese state-owned enterprises. They recruit and train professors from major universities in Beijing and Tianjin to provide courses in areas such as leadership development, strategic planning, marketing, quality control (Six Sigma), internal controls, finance, and human resource development. By early 2001, 449 enterprises from 23 provinces, covering 1,516 chief executive officers, middle-level managers and technicians, have participated in the programme. The trainees come from a wide range of industries, including electronics, telecommunications, computer hardware, software, media, and general trading or commercial enterprises. Motorola and the SDPC plan to expand this programme to reach 1,000 enterprises over the next few years.

Recently the programme was extended beyond Beijing to the interior of western China. In 2000, Motorola and SPDC held sessions in Xian and Chengdu. By 2001, 400 chief executive officers, middle -evel managers and technicians from 85 enterprises had participated in the programme there. There are plans to continue this programme in western China through 2001. By offering to share the company's experience in quality and productivity management with Chinese companies, it contributes to the reform of state-owned enterprises, a priority objective of the Government of China. Taking this programme outside Beijing serves the Government's objective of promoting more balanced growth. The successful reform of the state-owned enterprise sector contributes, in turn, to a more favourable business environment.

At the same time, the programme supports Motorola's efforts to expand its supplier base and achieve localization goals, which helps Motorola minimize costs, control inventory and reduce new product cycle time, all of which are critical factors for success in an industry characterized by rapid technological change. Moreover, the programme has generated goodwill and enhanced corporate access to central and provincial government leaders.

The programme has been adjusted over time. Initially, the plan was to undertake the training effort together with four or five other TNCs. However, after about a year, these plans were scrapped because each company had its own training priorities and corporate culture and it was difficult to make the programme work for multiple firms. The content of the programme is also continuously updated and new training methods are introduced, such as e-learning, as a means to accelerate the dissemination of the training materials.

As of end-2000, 63 of the participating state-owned enterprises had joined the 700-plus Chinese firms currently supplying Motorola. Companies that become certified suppliers to Motorola continue to receive various types of support to ensure they remain qualified. By 2000, the average percentage of locally manufactured parts and components in a cellular phone manufactured in a Motorola plant in China had reached 65 per cent. It is expected that Motorola's local procurement will exceed $1.5 billion, and the number of local suppliers will exceed 1,000 by the end of 2001.

Source: UNCTAD, based on Motorola, 2001.

6. High-performance work organizations (HPWOs): Global best practice?

Is the jury still out on HPWOs?

Up until now much debate has centred around high-performance work organizations (HPWOs) without much empirical evidence to support arguments one way or the other. Are they good for the worker, employer, both or neither?

"High-performance working" can be defined in a number of ways. [1] Generally, speaking high-performance working practices consist of new ways of organizing work, rewarding performance and involving employees in the decision-making process at the workplace. Some of these practices, such as job rotation, performance-related pay and self-directed work teams, have been around for a number of decades. Many remain just management fads if not implemented in a coherent fashion. Others, such as 360-degree appraisal and personal development plans, are relatively recent innovations. What is new in high-performance work is the way in which these practices can be combined to create a working environment which not only provides the potential for developing the personality of the worker, but also raises the productivity of the organization. This does not eradicate differences in the interests of management and workers, but it does minimize the conflict of interest and significantly improves their combined ability to increase wealth and raise standards of living for all. [2]

Box 6.1
Main "buzz words" associated with high-performance, alternative or innovative work practices or systems

QC

TQM

Pay-for-skill

Job rotation

Cross-training/multiskilling

Benchmarking

Self-managed teams

Meetings/team briefing

Gain-sharing/profit-sharing

Source: Adapted from P. Cappelli and D. Neumark: "Do 'high-performance' work practices improve establishment-level outcomes?", in *Industrial and Labor Relations Review*, Cornell University, Vol. 54, No. 4 (July 2001), pp. 768-769, and T. Riordan, ILO, forthcoming, 2002.

[1] See D.N. Ashton and J. Sung: *Supporting workplace learning for high-performance working* (Geneva, ILO, 2002, pp. 1-2).

[2] See also G. van Liemt: *Applying global best practice: Workers and the "new" methods of production organization*, Employment and Training Department, Paper No. 15 (Geneva, ILO, 2000).

What is high-performance work(ing) (HPW)?

A recent ILO project [3] used a definition that included a high level of customer service and the generation of value to the customer in ways that mark out or differentiate one organization's product or service from that of its competitors. The ILO project identified the following factors as those that, acting together, can provide the core of an approach to a high-performance strategy based on differentiation.

The starting point is leadership, vision and benchmarking – to create a sense of momentum and direction and measure progress constantly.

- The main drivers are:
  - decentralized, devolved decision-making made by those closest to the customer, so as to constantly renew and improve the offer to customers;
  - development of people capacities through learning at all levels, with particular emphasis on self-management and team capabilities to enable and support performance improvement and organizational potential.
- The support systems and culture are:
  - performance, operational and people management processes aligned to organizational objectives to build trust, enthusiasm and commitment to the direction taken by the organization;
  - fair treatment for those who leave the organization as it changes and engagement with the needs of the community outside the organization – this is an important component of trust and commitment-based relationships, both within and outside the organization.

The ILO research looked at nine different companies (some unionized and some not), three of which were in the MEE industries – Motorola, Thorn Lighting and W.H. Smith (Tools). In addition, a case study of Lucent which was specially commissioned for this report will also be presented. They are summarized below and compared with other findings on HPW practices.

Some initial empirical findings

The authors of a study [4] of over 4,000 employees between 1995 and 1997, involving 45 establishments and three industries, looked at a number of variables – self-directed teams, offline participation, autonomy and communications – usually associated with high-performance work practices. On the whole they concluded that "high-performance work systems give workers the opportunity to use their creativity, imagination and problem-solving abilities, while in traditional systems the use of theses characteristics is discouraged or, at best, not expected". Nevertheless, practices which contribute to promoting productivity in high-performance organizations may be different from those that

[3] See IFP/Skills web site.

[4] T. Bailey, P. Berg and C. Sandy: "The effect of high-performance work practices on employee earnings in the steel, apparel, and medical electronics and imaging industries", in *Industrial and Labor Relations Review*, Cornell University, Vol. 54, No. 2A (2001), pp. 525-543.

would improve productivity in more traditional systems. Employers in apparel and steel had to rely more on both formal and informal training to prepare employees to work in high-performance systems, whereas managers in the medical electronics and imaging industry tended to rely on recruiting workers who already had a higher level of formal education, usually at university level.

Table 6.1. Characteristics of workers in HPWOs, by industry (in per cent)

Characteristics	Steel	Apparel	Medical instruments and imaging
Education			
Primary school	11.30	34.90	8.20
Secondary school	49.10	39.50	35.60
Some college	29.30	16.00	26.20
University	10.30	9.60	30.00
Unionization rate	50.00	10.00	4.00
Hourly wage (1996 US$)	13.91	8.58	15.83

Source: T. Bailey, P. Berg and C. Sandy: "The effect of high-performance work practices on employee earnings in the steel, apparel, and medical electronics and imaging industries", in *Industrial and Labor Relations Review*, Cornell University, Vol. 54, No. 2A (2001), p. 529.

The study also found that workers in HPWOs in the apparel and steel industries earned more than those in traditional workplaces. There was no difference for the medical electronics and imaging industry where the employer favoured hiring workers with higher formal education when involved with innovative work systems.

Another recent study [5] of manufacturing industry in general has concluded that "high-performance" practices raise labour costs per employee, suggesting that they may raise employee compensation. Higher compensation is a cost to employers, although some statistically weak evidence points to these practices raising productivity. However, the authors find little effect of high-performance work practices on overall labour efficiency, which they measure as the output per dollar spent on labour.

A third academic study [6] of over 500 Canadians in 1997 in alternative workplaces (AWPs) found that "the results suggest that conventional assumptions of proponents and of many of the critics of AWPs are oversimplified. In particular, these results indicate that AWPs tend to have a number of implications for employees, but these implications appear to vary depending on the level of AWP involvement, the form of work organization, and ultimately the specific AWPs adopted". [7]

[5] P. Cappelli and D. Neumark: "Do 'high-performance' work practices improve establishment-level outcomes?", in *Industrial and Labor Relations Review*, Cornell University, Vol. 54, No. 4 (July 2001), pp. 737-769.

[6] J. Godard: "High performance and the transformation of work? The implications of alternative work practices for the experience and outcomes of work", in *Industrial and Labor Relations Review*, Vol. 54, No. 4 (July 2001), pp. 776 ff.

[7] ibid., p. 797.

A case study of Alcoa Packaging Machinery (APM) by the International Association of Machinists and Aerospace Workers (IAM) [8] concluded that by using HPWO partnership guidelines developed by the IAM, the local union and management at Alcoa were able to take a proactive approach to critical decisions at the workplace. While there were no guarantees of success, the HPWO partnership had increased profitability, reduced cycle time and improved product quality, resulting in greater job satisfaction and employment security.

Case study of Motorola

Creating a learning and training culture [9]

Founded as the Galvin Manufacturing Corporation by Paul Galvin in 1928 with six employees and less than US$600, Motorola now has global sales approaching US$40 billion and over 142,000 employees worldwide.

The firm's decision in 1980 to build its own university outside the human resource department of the corporation was a radical one. By the end of the 1980s, the university had expanded its operations both in the United States and around the world. It also began offering new and more comprehensive services, such as online learning systems, translation and cultural training and an expanded portfolio of executive education programmes. By 2000, Motorola University had 99 sites in 23 countries on five continents, delivering over 100,000 days per day of training to employees, suppliers and customers.

At the company university, factory workers study all types of business-related topics, from the fundamentals of computer-aided design to robotics, communication skills and customized manufacturing. They learn not only by reading manuals or attending lectures, but by inventing and building their own products as well. The university does not employ many staff of its own. Instead, it relies on a cadre of outside consultants, including engineers, scientists and former managers. Their role is to guide people into thinking as well as remembering. In a class on reducing manufacturing-cycle time, for example, senior managers break quickly into teams to devise new ways to get a product to market faster.

Motorola University has its own board of trustees (general managers of the corporation) with a mission to be an agent of change, with an emphasis on retraining workers and redefining jobs. Motorola's training programme is regarded as a model in corporate circles because of its strong link to the company's business strategy. "Motorola's whole system is driven from the shop floor", explains Antony Carnevale, a labour economist with the Committee for Economic Development in Washington. "The company trains to solve performance problems. It doesn't just put a little red schoolhouse in the workplace."

Motorola has extended its training programmes to every one of its workers around the world. It also monitors its training programmes. It now also offers an increasing number of on-the-job apprenticeships. Motorola has calculated that every US$1 spent on training

[8] B. Olsson: "Globalization and the US Machinery Industry – One workplace's response", in *The machinery industry: Globalization – Employment – New enterprise strategies*, Report on an IMF-ILO World Conference (Geneva, IMF, 1997).

[9] ILO: IFP/Skills: High-performance working research project Motorola – United States (http://mirror/public/english/employment/skills/training/casest/motorola.htm).

delivers US$30 in productivity gains within three years. Since 1987 the company has cut costs by US$10 billion by training workers to simplify processes and reduce waste. In 1999, Motorola spent over US$300 million to deliver a minimum of 80 hours of training to each of its 132,000 employees. Altogether, the company lays out more than 4 per cent of its payroll for training, far above the 1 per cent average invested by American industry. Over the past five years, Motorola has seen annual sales increase by an average of 18 per cent, while annual earnings growth has soared to 26 per cent. According to the company, productivity measured by sales per employee has climbed 139 per cent during the same period.

Motorola University: Three key principles of learning

Three key principles of learning and how it can impact on business success have emerged. The *first principle* is that learning and change need to go hand in hand for all of Motorola, as the company's initial experience with training initiatives yielded little or no change in business operations. Motorola University has helped the organization evolve from a view of change as something done to others for the benefit of a few to one of change as something done collectively for the benefit of the whole.

The *second key principle* is that innovation is much more likely to occur when people participate in formulating the solution, rather than having it handed to them. Everyone needs to participate in the details of change within their sphere of influence. Action learning was not originally an effort at improving educational delivery systems, but rather an outgrowth of the strategic agenda of the firm. Thus, organization context dictates learning strategy, which, in turn, evolves models of educational implementation.

The *third principle* of learning for Motorola was the importance of creating the proper tension between a single-mindedness of purpose within the organization and a broader frame of reference extending beyond the organization.

Training: From employee development to business redefinition

In today's uncertain and turbulent business environment, the university's role, which parallels the changing competency requirements of individuals within the organization, is to raise the level of inquiry within the company through a diversely structured dialogue with customers, experts and industry representatives (suppliers, regulators, policy-makers and special interest groups).

Motorola University's initiatives in recent years look more like new business development activities than classic educational programmes. In raising questions to which the answers do not yet exist for the company, Motorola University is creating the forum within the company to explore beyond the known boundaries of its business and its industry.

Research

Motorola University is also creating a research agenda that has moved it closer to the classic university charter. In 1995, the university hosted its first research colloquium in Malaysia, which looked very much like an academic university conference. Its unique feature was that presentations were all delivered by Motorola employees, for Motorola employees and invited guests. A similar research conference was held at the Motorola University facility in Arizona in 1997.

Technology for learning and high performance on a global scale

The College of Learning Technologies (CLT) is a department of Motorola University and involves a cadre of experts in instructional, multimedia design and educational technology to develop educational delivery systems around satellite, Internet and virtual reality technologies. The charter is to provide innovative learning via classrooms, online experiences and multimedia components such as video and satellite conferences. The department develops courses, learning tools and methodologies and conducts applied research.

Employee training is now so deeply ingrained at Motorola that all employees – from top executives to factory workers – are responsible for identifying courses they wish to take each year. If supervisors spot performance deficiencies at annual reviews, they weigh in with their recommendations, and a remedial plan is set up. The CLT makes ongoing individual learning possible for every Motorola employee.

Case study of Thorn Lighting [10]

Thorn Lighting Ltd. was founded in 1928 in the United Kingdom by Jules Thorn and subsequently became part of the Thorn-EMI Group. The company separated from Thorn-EMI in 1993 through a management buyout. It is one of the world's leading suppliers and manufacturers of lighting systems and products having a broad application in commercial, industrial and public amenity markets. In November 1998, the company was taken over by Wassall plc, the current owners.

Thorn Lighting has some 20,000 product items available to customers. With operations in 30 countries, 11 of which have manufacturing facilities, the group sells to customers in 140 countries worldwide. Within Europe, where it is the second largest supplier of light fittings, Thorn Lighting is the market leader in the United Kingdom and has strong positions in France, Germany and the Nordic region. The group is the leading supplier in the Australasian market and is developing its established presence in the Far East, where it is a market leader in Hong Kong, China.

Thorn Lighting Ltd. is the United Kingdom business of the Thorn Lighting Group. In 1998, sales increased to £392 million and the operating profit was £26.4 million. The group employs 4,200 people worldwide, including 1,800 people in the United Kingdom across ten sites, three of which involve manufacturing operations.

The focus for this case study is the Spennymoor operations plant in the United Kingdom which employs just over 1,000 people.

Since 1989, Thorn Lighting has undergone major organizational and cultural changes enabling its market share to approximately double. Much of this has been attributed especially to more effective performance management and teamwork. It is estimated that 40 per cent of group sales are generated from products introduced in the last three years.

[10] ILO: IFP/Skills: High-performance working research project, Thorn Lighting (UK) (http://mirror/public/english/employment/skills/training/casest/thorn.htm).

Principal managerial practices

The main practices Thorn has adopted to achieve a high-performance output have stemmed from decisions to introduce a new culture to assist the acceleration of the pace of change, including cellular-based manufacturing and a focused commercial operation. For the vast majority of the workforce, this has meant radical change in the relationships of teams and people across the whole business, as well as equipping people with the "tools" to perform effectively. More flexible working practices and a move towards self-managed teams have also taken place.

Culture formation

The prospects of Thorn Lighting becoming independent in 1993 lead to a programme of "exploration" to identify and learn from best practices within world-leading companies. A major shift then began to take place, from a culture of relative "introversion" to one that is more "customer-focused and outward-looking". Thorn's manufacturing operations began to address the issue by asking key managers to review Japanese manufacturing techniques and to discuss their transferability into the company.

Cellular-based manufacturing

In the early 1990s, the manufacturing sites moved to cellular-based manufacturing on the shop floor. This allowed for better management of the product range. A team typically has up to 20 members and is led by a working team leader. The team members are multiskilled operators, and teams usually incorporate a dual-skilled engineer. The team leader role is a supervisory/first-line management position enabling Thorn to reduce the number of management levels in the company structure. Because operators are able to perform many tasks, a team is competent in most of the skills required to do a job. Teams carry out their own maintenance, but there is still a supporting maintenance function for higher level skills. One operator is typically competent in three jobs. To support teamworking, Thorn simplified the pay structure and eliminated manufacturing bonus schemes.

Changing relationships

Early on in the change process, the company decided that employees needed to understand the importance of teamworking for the overall business, not just how it affected individual departments. A human resources strategy was developed for the UK operation in which team-building was identified as a key element in enabling the company to achieve its business goals which included information about all business functions from cash flow to material inflation and the marketplace. Monthly team briefings by line managers for their employees are another important feature.

Regular management and union workshops were held under a "partners in change" programme. Annually, the union and senior management meet for a business review and planning workshop. The company provides the trade unions with details of performance, market conditions and the forthcoming strategy for the year.

Implementation of practices

When cellular-based manufacturing was first introduced, teams were made up of employees already in the area. However, as new production lines are opened, wider selection is taking place. Line operators undergo a basic assessment and are given a mini presentation on teamworking. Team leaders undergo a three-day course which also covers management skills. Potential leaders are assessed not only on their technical skills but also on their interpersonal and team-leading abilities. The “UK team building” business-awareness programme is a two-day programme run by line managers for 14 people. Training sessions take place every two weeks over a four-and-a-half year time span.

In addition to the training programme which aims to ensure that all employees understand the team-working concept, there is also in-house training for multiskilled line operators. Team leaders receive further training, especially in team skills, which includes leading meetings and managing people. Training sessions are also held for the team as a whole.

Communications

A monthly site liaison and improvement committee was formed encompassing trade unions, shop-floor employees and managers. Team briefings are also held monthly to ensure that information cascades down through the tiers of teams and thus through the organization. Confidential attitude surveys amongst employees are conducted regularly and appraisals are conducted with employees to develop their skills, knowledge and awareness of the business. When the teamworking ideas were first implemented, the major problems were the fear of change and the lack of understanding why the change had to occur.

High unemployment and pre-employment training

A series of work experience courses has been set up at Thorn in which unemployed people, including school leavers, visit the factory to experience working conditions and receive training. The courses are run in partnership with local bodies as part of a service to the community and partly as a recruitment process.

Since 1994, Thorn has also run pre-employment training courses. The courses were designed to meet the company’s need for a ready pool of flexible individuals who could fulfil the need for temporary short-term labour in line with new working practices. Generally, individuals enter the company through the pre-employment training route on a temporary short-term contract. If they are still with the company after six to 12 months, they are normally confirmed as permanent employees.

Workshops are run only if insufficient trained people are on the database and ready to work at short notice. A strong working relationship has been forged with the local employment service. When extra staff are required, the employment service performs a pre-screening of candidates. This consists of a brief interview, a medical questionnaire and simple dexterity tests. The courses vary in length between three and ten days and introduce trainees to Thorn and its processes. They cover basic business knowledge, team-building, health and safety and actual assembly-work training.

Trainee costs

During the training, individuals continue to receive state benefits as they are technically available for work. The company does not pay trainees but does provide free meals. Travelling expenses are paid by the employment service, and trainees do not perform work having a commercial value. On the last day of the course, trainees are presented with a certificate of achievement. This certificate has become widely respected by other employers. The trainees are then placed on a database and Thorn gives them preference when either temporary or permanent direct operator vacancies arise.

Up to the end of May 1999, 329 people had completed the Spennymoor programme. Of that total, 150 have gone on to take up full-time employment with Thorn. A significant number of the remainder have managed to obtain permanent employment elsewhere. Such a throughput has led to a high turnover of individuals from the Thorn register, thus necessitating further courses.

W.H. Smith & Sons (Tools) Ltd. – United Kingdom [11]

W.H. Smith & Sons, Ltd. (WHS) is a family-owned business based in Sutton Coldfield, near Birmingham in the United Kingdom. The company also has a subsidiary plant in East Kilbride, Scotland. Plastic injection moulding and tool making are its core activities, together with the manufacture of subassemblies and leather-covering products. The business was expected to turn over £30m in 1999. From a turnover of £10m in 1994, which had doubled two years later, it has continued to expand and currently employs a combination of full-time and part-time employees. The total number is 500 but is equivalent to an aggregate of 400 full-time employees.

The company was founded in 1933 by William Henry Smith to produce quality components in the revolutionary new Bakelite. Since then, plastics technology has developed at an accelerating pace, and WHS is increasingly recognized as a leader in the field. Injection moulding began on site in 1966, and the company has grown with an expanding customer base in the automotive, leisure and electronics industries. Major customers include Rover, Toyota, Honda, Nissan, Triton, Black and Decker, Lucas and Mars.

At one point each of the 25 line managers was asked how many hours a week he or she needed to spend on learning how to keep abreast of developments in all aspects of his or her work. After due consideration, the answer to the Managing Director's question was "between five and six hours". The line managers were asked a similar question with regard to the employees under them. The response was "between two and three hours" – approximately half of what they themselves had wanted. When it was known that the expectation of the Managing Director was that the managers would spend their forecast amount of time engaged in learning, they complained that they had insufficient time and their job objectives would suffer as a result. Following discussions on the importance of learning as a process which is central to achieving business objectives, the Managing Director offered to reduce the managers' workload so that they could free the five or six hours needed for learning and training purposes. In the end, none of the managers sought a reduction of their workload, and found new ways of working so that time could be devoted to their own learning process within working hours. The managers also took their responsibilities seriously with regard to their own employees' learning. It is also significant that the company does not have a specialist human resource development department or personnel department.

[11] ILO: IFP/Skills: High-performance working research project, W.H. Smith (Tools) (UK) (http://mirror/public/english/employment/skills/training/casest/smith.htm).

Investment in learning centres

Two learning centres were opened that were both visible and accessible to all employees. Such a resource was a key to keeping up with the demands for job-related learning. In addition, the learning centres remained open to employees outside their normal working hours to enable them to undertake subjects of particular interest to them. A further feature which dramatized the importance of learning, not only in the company but to society in general, was the invitation to employees to bring members of their families into the factory and encourage them to learn alongside them.

Partnerships with specialists

Decisions to work inside the organization in partnership with specialists who have a reputation for quality work is a further important feature of creating the learning culture. Care is taken to select such specialists, who usually have a long-term relationship as a supplier of services to the company. Specialists could embrace any aspect of the learning process, from diagnosis of needs to giving recognition for company or individual success. The opportunity for existing employees to work alongside such specialists should not be underestimated in terms of recognition and their own personal learning and motivation. Senior management is acutely aware of this advantage, which is often over and above the reasons for inviting specialist suppliers.

Customer relations

A final feature which in the management's view helps to create a learning culture is the policy for leaders on the shop floor to communicate directly with the end customer and to invite his or her involvement in the manufacturing process. Beyond the traditional sales/customer relationship, this means that a team leader with ideas or concerns can speak directly with the customer for advice, suggestions or confirmation, while products are being manufactured. An invitation is often extended from the manufacturing team leader to the customer's representative to visit the factory to exchange ideas and resources.

Management training

Training programmes for all WHS employees are implemented as close to the workplace as possible, which is the quickest route for the transfer of learning from theory to practice and for bringing about work performance improvement. The scheduling of all programmes is designed to fit in with operating conditions in the factory. This usually means intermittent periods of time away from the workplace over an extended period. In the case of management programmes, this has meant one or two half days a week over a year, with part of the time during normal working hours and the other part in the managers' own time.

The advantages to the managers of this pattern of programme are the opportunities to reflect by themselves, or with others, upon new ideas and to have the time to apply their learning to work immediately after gaining new knowledge. The additional advantage of sharing the results of learning application at subsequent sessions on the programme serves to consolidate and reinforce the learning.

The level of quality assurance imposed upon the training includes the opportunity for each individual to be accredited for the competencies acquired. The National Council for Vocational Qualifications (NCVQ) and the National Examining Board for Supervisory Management (NEBSM) both include the compilation of a portfolio by each individual as part of their accrediting criteria. Such a feature has played a prominent part in helping to sustain progress in putting ideas into practice. The company has trained selected employees as assessors and verifiers in order to ensure a consistent standard of application across the organization.

The nature of this type of programme demands maximum flexibility and resourcefulness from the tutoring staff. It is they who are unfamiliar with the environment at the start of the programme. It is they who need to adjust their work programmes to fit in with company requirements.

Partnership in action

A partnership playing a prominent part in the development of people has been forged with East Birmingham College. A small nucleus of staff from the college has worked inside the company on a part-time basis in support of the range of programmes already identified. The launching pad for the partnership was a programme in 1993 when management processes were strengthened by 15 of the most senior managers. The programme was designed and facilitated by East Birmingham College, and the participants qualified for an externally accredited certificate at the end.

Lucent Technologies [12]

This case study focuses on Lucent's Merrimack Valley Works, which has been in North Andover, Massachusetts, for almost half a century. Its previous owners include Bell Labs and AT&T. In October 2000 it employed about 5,600 people, down from well over 7,000 in the 1970s. Employment was restructured over the years toward more capital-intensive and high-skill systems integration processes that required far fewer assembly-type workers. During the reorganization period, Lucent relied on several regional education and training institutions to prepare the remaining workers for the skill requirements of optical networking. This was so effective that "at the height of the boom, two of Lucent's major competitors in optical networking, Cisco Systems and Nortel Networks, set up systems integration operations in close proximity to the works, and sought to hire its skilled labour".

The telecommunications cluster along Route 128/495 [13]

Important firms located along Route 128/495 include Lucent Technologies, Nortel Networks, Alcatel, Cisco Systems, Ciena, EMC and Sycamore Networks. The highest concentration of jobs are in computer and communications hardware and software and in communications services. Most of the major global optical networking companies had a strong presence in the region, where they can not only tap into the advanced research carried out in the universities of the Greater Boston area but also benefit from the highly skilled managerial, engineering and production labour forces available there and an abundance of venture capital. The growth of optical networking in the Merrimack Valley also attracted electronic manufacturing service providers who supply modules and circuit

[12] This study was prepared for the ILO by Prof. R. Forrant (University of Massachusetts at Lowell) and draws on a number of sources to track these developments throughout 2000-01.

[13] See also "Revenge of the brahmins: Boston's high-tech suburbs", in *The Economist*, 9 Feb. 2002, p. 59.

boards to the optical networking equipment companies. This rapid infusion of firms soon generated a major skills shortage by the late 1990s.

Surveys have found a vacancy rate of 10.6 per cent for scientists, 8.4 per cent for engineers, 5.3 per cent for technicians, 3.6 per cent for managers and 3.1 per cent for skilled production workers. One year later it was determined that the vacancy rate was highest for skilled production workers (8.6 per cent), followed by managers (8.4 per cent), technicians (7.6 per cent) and then scientists and engineers (5.4 per cent). Taken together, skilled production workers and technicians made up 24 per cent of the workforces of these companies, so that shortages in these categories were significant.

Because of the extremely high cost of housing in the region, it was unlikely that production workers and technicians would migrate to Massachusetts. While the national labour force grew by 11 per cent throughout the 1990s, it increased by just 1.5 per cent in Massachusetts, the nation's fourth lowest rate. Thus, the worker shortage had to be overcome through "indigenous development", that is, development within the firm. The larger question was how, over the long-term, a so-called "grow-your-own" strategy could work in a rapidly changing high-technology industry such as optical networking? Specifically, what roles do the region's major employers play in the process of skill formation? What is the relation between corporate skill-formation systems and the regional support structure of educational and training institutions and relevant government agencies? Do the skill-formation systems that worked in the "old economy" also work for the "new economy"?

The tester skill shift

In November 1998, Lucent Technologies approached the University of Massachusetts Lowell to seek help in the company's attempt to respond to increases, both current and projected, in the demand for skilled labour at the Merrimack Works. Based on industry sources, the company claimed that the global optical networking market was growing by 19 per cent annually, with accelerated growth projected to double the total size of the market from about US$9 billion in 1997 to about US$18 billion in 2001. As Lucent's major manufacturing plant for optical networking, switching and transmission systems, the works needed workers in unprecedented numbers to meet the projected growth of the industry. The need was not just for quantity, but also quality.

At the works, testers are members of the Communications Workers of America. The collective agreement contains one tester job classification, with pay of US$20-24 per hour, although with overtime some testers can earn US$75,000-80,000 per year. The formal educational qualification for tester certification consists of seven college-credit courses and preparatory maths that are offered on-site by instructors from the nearby Northern Essex Community College (NECC). Having obtained these qualifications, prospective testers must then pass an internal company examination to gain entry into the position.

Notwithstanding the single formal job classification in the union agreement, in assigning tasks and responsibilities, the works' management divides testers into three categories: testers, tester analysts and layout operators. Given the shortage of qualified testers during the boom, the company created the category of "provisional testers" – employees who were taking the courses to meet the tester educational requirements but had not yet passed the internal company exam.

On 7 June 2000, Lucent announced that its Merrimack Valley manufacturing facility would become the global systems integration centre for Lucent's extensive portfolio of optical networking products (http://www.lucent.com/press). There was now increased pressure for the works to augment and upgrade its capabilities for systems integration.

Systems integration is the process of combining and configuring the components of an optical networking system into a product to be shipped to the customer. The testing function is central to systems integration.

Initially, test engineers developed the software required to test specific products. However, such intensive development of customized software was no longer cost-effective once the pace of technological change, new product development and competition picked up, as it did after 1997. Engineers now had to rely on the most skilled "tester analysts" to provide information useful in solving problems of product performance. [14]

Tester training

After negotiations with the union, the company decided to provide all of the testers with academic training, and invited NECC, Middlesex Community College (MCC) and the University of Lowell (now UMass Lowell) to apply to provide this training. In accordance with its long-standing policy, the company covered the cost of tuition, and because certification had become mandatory – and as part of the collective agreement – workers took these courses in company time.

By the beginning of the 1990s, the company had enough certified testers to meet its needs, but shortages appeared in the mid-1990s as many experienced tester analysts retired. The works used the services of NECC to train 100 current employees – most of them between 35 and 45 years of age, and with 15 to 20 years of seniority – to be tester analysts. Employees took the courses on-site at the works' Learning and Performance Center in their own time, with tuition paid by Lucent.

Tester analysts and layout operators can apply for promotion into "senior technical associate" (STA) positions, and make the transition from being an hourly rated unionized employee to a member of salaried management. The educational requirement for promotion to STA is an associate degree. [15] Employees could take the courses for an associate degree on-site, in their own time, with NECC providing the instruction and the company paying for tuition. In 2000, STAs were paid US$46,500 per year, a salary that could mean a substantial cut in pay since, as a member of management, an STA was no longer eligible for overtime pay. But the STA position is designed to be a step toward to becoming a full test engineer. To be eligible for promotion to test engineer a worker must obtain a bachelor's degree in engineering, again in his or her own time, with tuition assistance from Lucent. During the boom, Ken Eisenberger, the Director of the Learning and Performance Center at the works, began working with UMass Lowell to deliver on-site courses towards optical certification and bachelor's degrees in electrical engineering and computer science. In the spring of 1999, Professor Michael Fiddy, Chair of the UMass Lowell Department of Electrical and Computer Engineering, began teaching graduate electro-optics courses at the works.

Labour competition

Until the end of 2000, the booming high-tech economy meant that Massachusetts faced severe shortages of scientists, engineers and skilled production workers, which meant that all companies needed to develop strong internal educational training

[14] Lazonick interview with L. Centariczki, Lucent Technologies Merrimack Valley Works, 2 Oct. 2000.

[15] The equivalent of about two years of university study and therefore short of a full degree.

programmes to transform their current workforce into one proficient in the production of optically based products.

Since the late 1980s, the works had recruited virtually all its testers from its large pool of production workers. Now, however, with persistent shortages, the works was actively recruiting testers from the street, including from technical colleges as far away as Vermont and Maine, where the new employees would have taken some or all of the courses required for tester certification. Many of the new entrants were eager to take advantage of Lucent's tuition assistance programme once they entered the works. Some of them were looking to upgrade their education and skills to make the transition into the engineering ranks. These new recruits were not necessarily looking to Lucent for careers. They were well aware that there was fierce competition for their labour from other companies. Many of these companies reportedly offered signing bonuses and relocation packages to recruit into both production and engineering jobs.

From training to termination

Beginning in January 2001, it became evident that demand for optical networking products would not be sustained at anything like the level that had been driving investment decisions over the past two years. In part the boom had been driven by a massive investment in fibre optic capacity; it is estimated that in 1999 and 2000, 100 million miles of fibre had been laid worldwide. In 2001, service providers cut back capital expenditures, several newer companies went bankrupt and huge inventories of networking gear accumulated. For example, in March 2001 Cisco Systems announced that it was taking a record-setting US$2.5 billion charge for inventory write-offs. This charge resulted from massive long-term commitments that Cisco had made to purchase gear from suppliers the previous spring. In addition, in order to win new orders and book sales (which in turn helped to boost a company's stock price), equipment suppliers such as Lucent, Nortel, and Cisco had extended extremely generous, and highly risky, vendor financing to service providers. With the failure of some of these providers, much of this financing turned into a mountain of bad debt. In 2001 Lucent announced layoffs of 39,000 (close to 30 per cent of its labour force), Nortel 50,000 (over 50 per cent), and Cisco 8,500 (over 20 per cent).

The waves of layoffs at the works that began in April 2001 were the direct results of the dire financial difficulty in which Lucent as a whole found itself in 2001. Since 1999 the works had been outsourcing circuit board manufacturing, but the growth of demand for systems integration activities had sustained the level of employment at the works at around 5,600 during the boom. With the slowdown, Lucent's corporate office viewed the works as too big, and launched a process to sell half of the plant to a contract manufacturer. One part of Lucent's plan was that the new contract manufacturer would employ as many former works' personnel as possible, and that employees would continue to be represented by their union, Communication Workers of America. Indeed, in the summer of 2001 Celestica took over two of Lucent's manufacturing plants – one in Columbus, Ohio (which it bought), and the other in Oklahoma City (which is leased), with the workers continuing to be represented by their union, in these cases the International Brotherhood of Electrical Workers.

In April 2001, Lucent Technologies and the Communications Workers of America entered into a Memorandum of Agreement (MOA) that detailed the treatment of unionists affected by the company's decision to subcontract or outsource bargaining unit work. In the first wave of 2001 downsizings at the works, 440 employees volunteered for the retirement package, while 450 were laid off. In June, more of the works' managerial employees were asked to take voluntary retirement as part of a company-wide reduction that ultimately involved 8,500 Lucent managers and engineers. In mid-July, the company offered enhanced voluntary retirement to union employees at the works in a planned layoff of 275 (239 volunteered for retirement). By the end of July, Lucent announced its intention to sell most of the works, reducing employment by the end of the year to about 600-800 employees doing high-end systems integration.

H-1B visa training programme

Ironically, at the precise moment when the business outlook in optical networking dimmed, a new retraining programme – the Northeast Skills Training Project (NSTP) – that had its origins in the boom was gearing up at the works. At the initiative of the CWA union local and with the support of the Massachusetts AFL-CIO, the union and management received a two-year US$2.3 million training grant from the US Department of Labor under its H-1B visa training programme. Companies pay US$1,100 for an H-1B visa, of which US$1,000 goes into funds to retrain US workers, ostensibly for the types of positions that are currently being filled by foreign workers through the H-1B programme. The main use of H-1B training grants is to upgrade the skills of production workers to enter more highly skilled production jobs. Testers are a prime occupational group for such training. The works was well positioned to get an H-1B training grant because it had a skill-formation system for testers in place and because Lucent was one of the largest users of H-1B visas in the country.

The grant is administered by the University of Massachusetts Labor Extension Program. It provides up to 640 training slots for CWA Local 1365 employees and up to 110 training slots for members of the International Union of Electrical Workers (IUE) Local 201 who work at Ametek Aerospace (a subcontractor to General Electric whose plant is slated to be relocated outside the United States). The main purpose of NSTP was to help the works deal with the need for more testers. NECC teaches the courses on-site at the works, while Lucent provides an “in-kind” match in the form of payments for 50 per cent of the time that enrollees spend on courses (amounting to US$243,000 in the first semester), plus a one-off expenditure of US$161,000 for the construction and equipping of a new on-site classroom. With the current round of layoffs, the grant has become important for helping to retrain laid-off Lucent workers to position themselves for re-employment with other companies. To that end, NSTP is trying to get the Department of Labor to allow the courses to be taught off-site at NECC, since many of the people who were supposed to benefit from the training no longer work for Lucent and are now looking for new employment.

The prospects for “Growing your own”

With the downsizing of the works’ labour force and the pending sale of most of the works to a contract manufacturer, its skill-formation system will no longer be in place. Lucent will only employ production workers who have already attained tester certification. As for the contract manufacturer who takes over the facilities that Lucent sells off, it will also likely only do higher end systems integration work in Massachusetts; contract manufacturers typically relocate routine, cost-sensitive work out of the United States, while focusing on high value-added activities in a high wage area such as Massachusetts.

Laid off were the very production workers the company had hired and trained, which is what makes the case so interesting. Does the rapid turn of fortunes at Lucent send a signal to high-tech manufacturers that persistent education and training is of little long-term value? Does the sequence of events call into question public expenditures for firm-specific education and training? The sharp decline in employment at the end of 2001 provides a cautionary tale for regions of the world that link their education and training infrastructures to the fortunes of one or two so-called key industries.

Sound labour-management relations: A viable alternative

The new ILO study cited at the beginning of this chapter has concluded [16] that high-performance systems are indeed no "quick fix". For them to work effectively, changes are required in four main areas. First, jobs have to be designed in such a way that they use the full intellectual and practical experience of all employees and engage them in the decision-making process (e.g. practices such as teamworking and self-managed work groups). Second, employees at all levels will not be able to make use of their new situation to improve performance if they do not have the requisite knowledge of the business environment. Therefore, the second set of practices must include those which are associated with the dissemination of knowledge within the organization (e.g. regular meetings of the workforce, the regular dissemination of business information to all employees). In order to make the most effective use of this information, employees must be committed to the organization's values and objectives, and must want to use that information to improve their performance. Third, they must be supported in the process of learning the requisite skills, hence the importance of regular coaching or mentoring sessions, feedback on performance through appraisals and the opportunity for further training to acquire and practise new skills. Finally, none of this is likely to produce improved results unless the employee is rewarded, both financially and in the everyday process of learning, through acknowledgement by colleagues and superiors. To put all four sets or bundles of practices in place takes a tremendous amount of effort, energy and time. They must also be built upon mutual trust and respect to ensure that neither of the parties is exploited at the expense of the other.

One might also add that they need to be producing a product or continuously inventing new products, unlike fibre optic cables, where the demand for the product and the workforce dried up overnight.

[16] Ashton and Sung, op. cit., p. 4.

7. Summary and topics for thematic discussion

Major developments in the mechanical and electrical engineering (MEE) industries

Chapter 1 presented data – in the areas of production, exports and employment – to situate the various subsectors of MEE industries within the overall economy. It also identified office and telecommunications equipment and components as the “hardware that drives the IT revolution”.

Two-thirds of machine tool production is concentrated in four countries (Japan, Germany, United States and Italy), and the top ten countries accounting for 90 per cent of world production and exports, a figure that has remained largely unchanged for a number of years. Ten countries produce over 80 per cent of the world’s ICT equipment, led by the United States and Japan, with significant segments also accounted for by Asian countries – Republic of Korea, Singapore, Taiwan, China, and Malaysia – and by the United Kingdom, Germany and France. Eighty-five per cent of the world’s exports of office and telecommunications equipment (OTE) comes from just 15 countries; 47 per cent from developing countries. Most of these developing country exports of OTE originate in export processing zones (EPZs). For many countries OTE accounts for a sizeable amount of their exports, often over 25 per cent, sometimes over 50 per cent. But when small countries are dependent on the exports of one company or industry, an economic downturn can have severe consequences.

Moore’s law is accelerating. Not only are computer chips doubling their capacity every 18 months, but knowledge is also becoming obsolete just as fast, if not faster with many implications for education and training.

Despite the extent of recently announced job cuts, employment growth over the past five or six years has been substantial. Research and development (R&D) spending is a good indicator of where new products are likely to be discovered and provides a proxy indicator as to where new skills may be required.

Responses to the challenge of lifelong learning (just “learn.IT”)

Chapter 2 identified the need for a paradigm shift from purely vocational education and training to lifelong learning, and provided examples of what companies were currently doing.

Many large corporations have in-house universities or learning centres (often combined with distance learning) in order to target precisely the learning needs of their employees and prevent duplication of material. Nevertheless, there may be duplication where companies are individually teaching material that might be better handled in group lessons for several companies. There is increased use of distance or e-learning which is also proving to be a cheaper alternative to more formal classrooms. However, people in developing countries without a reliable electricity supply and Internet connections find it more difficult to take advantage of distance training opportunities.

Some universities are reaching out to enterprises in an attempt to respond to demand-driven training. Companies generally find that teaching and learning are best done as close to the workplace as possible, and a number of universities and colleges send staff to the shop floor to conduct tailor-made courses. While learning may be lifelong, professional "certification" certainly is not. In occupations where membership of a professional association is mandatory, some thought has been given to setting an "expiry date", whereby without proof of some sort of continuous professional development certification would cease to be valid after a certain time. The learning curve is also accelerating rapidly. Whereas professional engineers talk of certification limited to five years, some companies offer online certification valid for two years, or subject to quarterly updating.

An important issue that needs to be addressed is the question of how to recognize tacit knowledge which a worker may have acquired on the job but for which no specific certification has been or can be issued. Much of it may be firm-specific and some of it self-taught. But who can certify it? How can employers test and recognize such tacit skills which are uncertified? Providing training when another enterprise does not or providing better training raises the question of poaching. On the other hand, many employers increasingly view the provision of opportunities for lifelong learning as a means of retaining staff, rather than as something that increases the risk of losing them. In fact, without training workers might well leave anyway. Workers are also attracted by the training packages which companies offer. But in any case, staff who leave do not always represent a complete loss; they may end up working somewhere else in the supply chain making or repairing components for the company they left. In countries where the labour market is fluid, they may even return one day to their original employer.

While identifying the prerequisites for lifelong learning, Chapter 2 does not necessarily provide complete answers to questions such as:

- how to develop an educational system capable of turning out the required skills;
- how to modify current VET and apprenticeship systems;
- how to upgrade the skills of those currently employed;
- how to select and retrain workers for a completely new occupation;
- how to reintegrate the unemployed;
- how to deal with unemployed youth who have never worked; and
- how to finance all of the above.

Potential for developing countries to participate in the global economy

Chapter 3 looked at factors which are favourable for the establishment of portions of the consumer electronics industries in developing countries, and included an in-depth analysis of one particular segment – colour TV sets. This is a sunset industry in most industrialized countries, and many multinationals transferred such operations to developing countries many years ago. Today many even want to rid themselves altogether of this mature product and concentrate on hi-tech R&D. Three-quarters of all foreign direct investment (FDI) by multinational enterprises (MNEs) is concentrated in just ten countries. Several Asian countries invest heavily in education, especially science, mathematics and engineering subjects, and undertake considerable R&D. Not surprisingly, these countries are also the ones that manufacture and export much OTE. Geographical proximity has also played a role. Japanese companies went to Malaysia and Indonesia, and American firms went to Mexico. By and large, European countries have been less affected by imports from developing countries. Nevertheless, it was initially only the manufacture of low-tech components and assembly which were initially transferred to developing countries. As far as the Japanese enterprises go, it was often felt that the training provided related more to mastering techniques of work organization than to human resource development, since R&D and the manufacture of newer products were largely kept at home. It was also suggested that the more frequently developing countries could establish backward linkages with suppliers, the more successfully they could participate in the global economy.

Examples have been found of corporate-private partnerships, whereby large companies offer computers and online learning opportunities to increase the pool of qualified staff. Such partnerships have even resulted in small suppliers to multinationals growing to become large enterprises themselves.

Recent initiatives

Chapter 4 listed a number of recent initiatives in lifelong learning, many of which were the result of collective bargaining. Increasingly, unions are including retraining or continuous training in collective agreements, either with individual companies or industry-wide. Emphasis is increasingly placed on continuing employability through increased employment security, rather than on mere job security. Workers who had participated in such programmes and were laid off found a new job sooner and at higher wages than those who had not participated.

Employability is at the centre of the debate on high skills and skill formation in many countries:

> The volatile nature of consumer markets, the challenge to assumptions about lifetime employment, and the pace of technological innovations with built-in occupational obsolescence that demand regular periods of retraining, have all served to bring the question of employability to prominence. It has highlighted the balance of responsibility between the individual and the State. [1]

While Chapter 4 refers to new initiatives in the European Union, [2] many other international bodies have placed the subject of lifelong learning on their agendas and have embarked on ambitious work programmes. They include the OECD which is examining possible means of financing lifelong learning [3] and UNESCO, as well as the ILO which has commissioned a number of background studies in preparation for the development of a new standard on human resource development. [4]

[1] P. Brown; A. Green and H. Lauder: *High skills: Globalization, competitiveness and skill formation* (Oxford University Press, Oxford, 2001), p. 258.

[2] See Commission of the European Communities: *Communication from the Commission – Making a European area of lifelong learning a reality*, Brussels, 21 Nov. 2001, which begins its report with the following quotation: "When planning for a year, plant corn. When planning for a decade, plant trees. When planning for life, train and educate people." Chinese proverb, Guanzi (c. 645 BC).

[3] OECD: *Economics and finance of lifelong learnin*g (Paris, 2001).

[4] See for example W. Norton Grubb and P. Ryan: *The roles of evaluation for vocational education and training: Plain talk on the field of dreams* (Geneva, ILO, 1999), which provides an excellent overview and analysis of existing vocational education and training systems.

The big three: United States, Japan and China

Chapter 5 took a closer look at developments in three of the major countries employing workers in the mechanical and electrical engineering industries – the United States, Japan and China. The United States case study recognized that small and medium-sized companies generally do not have the resources for continuous training. Examples of group training endeavours include the establishment of some kind of corporation as the official employer of a group of apprentices who are then rotated between a number of companies. Such schemes are essentially "win-win" situations which enable smaller firms to participate in vocational training to an extent that might not otherwise be possible. The schemes provide trainees with greater exposure to a variety of companies, and enable the companies concerned to recruit from a wider pool of trained workers. The report for the 1998 meeting in this sector provided information on similar group training schemes in Australia. [5]

China faces perhaps the greatest challenge of any of the countries studied, as it continues to restructure and adapt to membership of the World Trade Organization (WTO). Restructuring already resulted in job cuts of about 40 per cent between 1997 and 1998. Entry to the WTO, while providing increased export opportunities, will also open its domestic markets to increased competition. Nevertheless, there seems to be no shortage of foreign multinationals eager to set up a base or to expand in China, and MNEs provide an effective means for human resource development.

In Japan, the recalibration of the system of long-term employment will have repercussions on the learning system. Changing employment practices may result in greater labour market flexibility and lead to workers switching employers more frequently than in the past and acquiring new skills along the way.

High-performance work: An example of best practice?

High-performance or alternative work practices are becoming more common. Chapter 6 examined some aspects of this means of work organization, which is very closely linked to the concept of lifelong learning. A recently published ILO study [6] sets out the conditions under which such a system can operate for the benefit of all in a spirit of openness and trust. Nevertheless, suspicions persist that such "smart work" means working harder and faster, and these concerns will need to be addressed.

* * *

As stated in the introduction, the Governing Body decided at its 283rd Session (March 2002) that this Meeting would be organized around a series of thematic discussions on the following topics:

1. The economic performance of the MEE industries: 2001 recession and outlook.

2. The social impact of restructuring the MEE industries.

3. Lifelong learning in the MEE industries: Concepts and examples.

[5] ILO: *Impact of flexible labour market arrangements in the machinery, electrical and electronic industries*, Report for discussion, 1998, Geneva, Ch. 5, p. 73.

[6] Ashton and Sung, op. cit.

4. The right curricula for the various aspects of lifelong learning.

5. The roles of the social partners and governments in lifelong learning and beyond in the MEE industries: Implications for the ILO.

Appendix. Supplementary tables and figures

Table I. Leading exporters and importers of office machines and telecom equipment, 2000 (billion dollars and percentage)

	Value	Share in world exports/ Imports			Annual percentage change			
	2000	1980	1990	2000	1990-2000	1998	1999	2000
Exporters								
United States	153.45	19.5	17.3	16.3	12	–4	10	22
Japan	108.18	21.1	22.4	11.5	5	–11	7	18
Singapore	74.05	3.2	6.4	7.9	14	–11	5	22
Domestic exports	41.75	2.5	4.9	4.4	11	–12	5	8
Re-exports	32.30	0.7	1.5	3.4	22	–10	6	47
Taiwan, China	58.39	3.2	4.7	6.2	15	–3	16	30
Hong Kong, China	50.07	–	–	–	15	–3	5	30
Domestic exports	4.00	2.0	1.6	0.4	–2	–17	–16	11
Re-exports	46.07	–	–	–	19	0	8	32
United Kingdom	49.60	6.4	6.5	5.3	10	3	2	13
Germany	45.12	9.9	7.5	4.8	7	7	8	17
Malaysia [a, b]	44.27	1.4	2.7	5.7	21	–5	28	
China a	43.50		…	4.6	…	18	19	44
Korea, Rep. of [b]	42.92	2.0	4.8	5.5	13	–6	35	
Netherlands	36.06	4.0	3.4	3.8	14	–3	12	7
México [a]	32.99	0.1	1.5	3.5	22	21	22	25
France	32.42	4.7	4.1	3.4	10	15	–1	14
Ireland	25.45	0.9	1.7	2.7	17	17	23	12
Philippines [a]	24.12	0.1	0.6	2.6	29	31	24	4
Above 15	774.50	78.4	85.4	84.3	–	–	–	–
Importers								
United States	218.73	15.9	21.1	22.5	13	3	13	24
United Kingdom	61.12	7.0	8.0	6.3	10	4	9	18
Japan	60.87	2.6	3.7	6.3	18	–13	21	38
Hong Kong, China	59.37	–	–	–	17	–9	1	36
Retained imports	13.30	1.7	1.4	1.4	12	–28	–18	52
Germany	57.54	9.7	9.8	5.9	7	17	8	8
Singapore	54.29	2.6	4.5	5.6	15	–18	14	28
Retained imports	21.99	1.9	2.9	2.3	10	–27	24	8
China [a]	44.43		…	4.6	…	32	38	46
Taiwán, China	38.73	1.4	2.5	4.0	18	5	23	33
Netherlands	38.28	3.9	4.1	3.9	12	6	17	3
France	36.11	6.4	6.0	3.7	7	16	–1	18
Canada [c]	30.42	4.1	3.5	3.1	11	0	10	22
México [a, c]	27.05	0.9	1.5	2.8	19	19	26	27

	Value	Share in world exports/ Imports			Annual percentage change			
	2000	1980	1990	2000	1990-2000	1998	1999	2000
Malaysia [a, b]	25.23	1.6	1.9	3.2	18	–10	16	
Korea, Rep. of [b]	24.73	1.3	2.6	3.1	14	–20	49	
Italy	20.28	4.6	4.4	2.1	4	9	7	8
Above 15	751.10	63.5	74.9	78.5	–	–	–	–

[a] Includes significant shipments through processing zones. [b] 1999 instead of 2000. [c] Imports are valued f.o.b.

Table II. Exports of office machines and telecom equipment of selected economies, 1990-2000 (million dollars and percentage)

	Value					Share in economy's total merchandise exports	
	1990	1995	1998	1999	2000	1990	2000 [a]
World	298 490	600 650	699 270	780 440	939 880	8.8	15.2
Australia	738	1 882	1 627	1 617	1 801	1.9	2.8
Austria	2 887	2 012	2 706	2 785	3 463	7.0	5.4
Belgium	–	–	–	8 725	10 744	–	5.8
Belgium-Luxembourg	3 491	6 203	8 392	–	–	3.0	5
Brazil	692	749	1 068	1 345	2 376	2.2	4.3
Canada	5 622	11 544	12 997	14 040	20 631	4.4	7.5
China [b]	...	14 506	25 344	30 139	43 498	...	17.4
Czech Rep. [b]	–	4 88	682	676	1 283	–	4.4
Denmark	1 351	2 280	3 036	3 221	3 385	3.7	6.8
Finland	1 496	4 672	7 765	8 405	10 696	5.6	23.4
France	12 304	20 934	28 789	28 377	32 422	5.7	10.9
Germany	22 435	32 124	35 652	38 487	45 122	5.3	8.2
Greece	33	94	206	210	...	0.4	2.1
Hong Kong, China	12 886	34 051	36 633	38 418	50 067	15.6	24.7
Domestic exports	4 772	5 935	4 297	3 610	3 997	16.5	16.9
Re-exports	8 114	28 116	32 336	34 808	46 070	15.2	25.8
Hungary [b]	505	537	4 232	5 432	7 132	5.1	25.4
Indonesia	124	2 281	2 356	2 976	7 280	0.5	11.7
Ireland	5 145	11 708	18 547	22 751	25 447	21.7	31.9
Israel	1 226	2 369	4 173	4 880	6 939	10.2	22.1
Italy	7 804	10 627	9 562	9 460	10 417	4.6	4.4
Japan	67 007	106 611	85 030	91 372	108 179	23.3	22.6
Korea, Rep. of	14 339	33 217	31 824	42 918	...	22.1	29.9
Luxembourg	–	–	–	545	...	–	6.9
Malaysia [b]	8 207	32 721	34 644	44 268	...	27.9	52.4
Malta	472	1 064	991	1 059	...	41.7	53.5
Mexico [b]	4 535	11 616	21 682	26 485	32 988	11.1	19.8
Netherlands	10 137	20 424	30 061	33 651	36 058	7.7	17.0
Philippines [b]	1 835	7 564	18 625	23 091	24 119	22.7	60.6
Poland	342	406	1 146	1 206	1 279	2.4	4.0
Portugal	607	1 203	1 156	1 468	1 367	3.7	5.9
Singapore	19 235	60 322	57 547	60 601	74 046	36.5	53.7
Domestic exports	14 685	40 318	36 755	38 615	41 750	42.1	53.0
Re-exports	4 549	20 004	20 792	21 986	32 296	25.4	54.6
Spain	1 770	3 767	4 745	5 142	5 129	3.2	4.5

	Value					Share in economy's total merchandise exports	
	1990	1995	1998	1999	2000	1990	2000 [a]
Sweden	4 173	7 999	12 222	14 003	15 068	7.3	17.3
Switzerland	1 520	2 257	2 397	2 730	2 967	2.4	3.6
Taiwan, China	14 105	32 568	38 623	44 769	58 389	21.0	39.4
Thailand	3 520	11 660	14 303	15 240	19 138	15.3	27.7
Turkey	259	255	895	821	1008	2.0	3.8
United Kingdom	19 262	36 608	43 232	44 044	49 602	10.4	17.5
United States	51 658	97 990	113 893	125 664	153 448	13.1	19.6
Memorandum item:							
European Union (15)	92 894	160 656	210 279	225 270	252 953	6.2	11.2
Intra-exports	65 803	106 315	140 933	149 852	158 747	6.7	11.4
Extra-exports	27 091	54 341	69 346	75 418	94 206	5.1	11.0

[a] Or nearest year. [b] Includes significant exports from processing zones.

Table III. Leading exporters and importers of machinery and transport equipment, 2000
(billion dollars and percentage)

	Value	Share in world exports/imports			Annual percentage change			
	2000	1980	1990	2000	1990-2000	1998	1999	2000
Exporters								
United States	413.5	16.4	15.1	16.1	9	2	3	12
Japan	329.7	14.5	16.7	12.8	5	-8	8	14
Germany	272.1	16.3	17.2	10.6	3	5	0	0
France	136.1	7.0	6.5	5.3	6	12	-1	4
United Kingdom	133.3	7.6	6.2	5.2	6	0	-2	4
Canada	111.4	3.2	3.9	4.3	9	4	16	10
Korea, Rep. of	100.3	0.7	2.1	3.9	15	-4	20	29
Mexico [a]	99.4	0.1	1.3	3.9	20	14	19	22
Singapore	93.2	1.0	2.2	3.6	13	-11	4	23
domestic exports	49.9	1.0	1.5	1.9	11	-12	4	11
re-exports	43.2	0.0	0.7	1.7	18	-11	4	40
Italy	91.3	4.8	5.2	3.6	4	5	-4	0
Taiwan, China	87.1	0.9	2.2	3.4	13	-7	11	28
China [a]	82.6	0.2	0.9	3.2	23	15	17	40
Hong Kong, China	77.7	-	-	-	14	-5	4	28
domestic exports	5.8	0.5	0.6	0.2	-2	-21	-15	12
re-exports	72.0	-	-	-	18	-3	6	29
Netherlands	65.2	2.4	2.5	2.5	8	-3	8	5
Malaysia [a]	60.6	0.3	0.9	2.4	19	-2	21	15
Above 15	2081.5	75.9	83.4	81.1	-	-	-	-
Importers								
United States	570.9	12.1	17.5	21.6	10	7	13	17
Germany	179.3	6.6	9.4	6.8	5	10	4	1
United Kingdom	153.5	5.7	6.9	5.8	6	4	4	5
Canada [b]	124.8	5.1	4.8	4.7	8	3	9	9
France	121.9	5.5	6.5	4.6	4	16	2	7
Japan	106.1	1.6	3.0	4.0	11	-10	14	24
China [a]	91.9	1.0	1.8	3.5	16	8	22	32
Hong Kong, China	90.8	-	-	-	15	-10	-4	30
retained imports	18.9	0.7	0.7	0.7	8	-24	-30	34
Mexico [a, b]	88.8	1.6	1.6	3.4	17	16	18	26
Singapore	82.0	1.4	2.2	3.1	12	-19	9	23
retained imports	38.7	1.3	1.5	1.5	8	-26	13	8
Italy	78.5	3.8	4.4	3.0	4	13	7	1
Netherlands	71.7	2.9	3.2	2.7	6	5	10	2

	Value	Share in world exports/imports			Annual percentage change			
	2000	1980	1990	2000	1990-2000	1998	1999	2000
Taiwan, China	70.4	1.0	1.7	2.7	13	4	13	30
Spain	62.2	1.1	2.7	2.4	6	17	17	-2
Korea, Rep. of	59.1	0.9	2.0	2.2	9	-36	40	35
Above 15	1879.9	51.1	68.4	71.0	-	-	-	-

[a] Includes significant shipments through processing zones. [b] Imports are valued f.o.b. -

Table IV. Exports of machinery and transport equipment of selected economies, 1990-2000 (million dollars and percentage)

	Value					Share in economy's total merchandise exports	
	1990	1995	1998	1999	2000	1990	2000 [a]
World	1 212 940	1 903 840	2 189 120	2 310 380	2 565 860	35.8	41.5
Argentina	712	2 277	4 200	2 790	...	5.8	12.0
Australia	3 167	6 792	6 725	7 092	7 262	8.0	11.4
Austria	15 701	20 756	23 932	24 051	24 199	38.0	37.9
Belgium	–	–	–	52 407	54 897	–	29.5
Belgium-Luxembourg	32 268	45 958	52 009	–	–	27.4	29
Brazil	5 829	8 847	12 599	11 387	15 532	18.6	28.2
Canada	47 229	73 651	87 393	101 708	111 436	37.0	40.3
China [b]	10 833	31 368	50 217	58 836	82 600	17.4	33.1
Croatia	–	778	1 380	1 247	1 195	–	27.2
Czech Rep. [b]	–	6 585	10 874	11 336	12 894	–	44.5
Denmark	9 197	12 260	13 185	13 683	13 027	24.9	26.2
Finland	8 251	14 304	18 043	17 854	20 727	31.1	45.4
France	78 378	112 675	131 936	130 594	136 059	36.2	45.6
Germany	209 175	256 319	269 803	271 139	272 074	49.7	49.3
Hong Kong, China	21 176	56 261	58 597	60 761	77 730	25.7	38.4
Domestic exports	7 206	8 810	6 000	5 121	5 755	24.8	24.3
Re-exports	13 970	47 451	52 597	55 640	71 975	26.2	40.3
Hungary [b]	2 565	3 292	11 956	14 331	16 853	25.7	60.0
Indonesia	367	3 830	4 656	5 293	10 769	1.4	17.3
Ireland	7 447	15 128	23 446	27 864	30 698	31.4	38.4
Israel	2 930	5 111	7 804	8 418	11 172	24.3	35.7
Italy	63 233	86 894	94 521	91 029	91 299	37.1	38.4
Japan	202 934	311 501	268 466	286 790	329 661	70.6	68.8
Korea, Rep. of	25 545	65 646	65 090	77 954	100 275	39.3	58.2
Luxembourg	–	–	–	1 813	2 062	–	26.3
Malaysia [b]	10 513	40 679	43 381	52 671	60 637	35.7	61.7
Malta	581	1 269	1 192	1 256	...	51.3	63.4
Mexico [b]	16 152	41 577	68 041	81 305	99 369	39.7	59.7
Netherlands	30 730	47 217	57 428	61 916	65 230	23.3	30.7
Philippines [b]	2 160	8 902	21 266	27 232	29 201	26.8	73.4
Poland	3 754	4 829	8 021	8 278	10 821	26.2	34.2
Portugal	3 201	6 266	8 002	8 368	7 997	19.5	34.3
Romania	1 451	1 038	1 209	1 429	1 949	29.3	18.8
Russian Fed. [c]	–	4 943	6 439	5 708	6 857	–	6.5
Singapore	26 437	77 604	73 025	76 018	93 183	50.1	67.6
Domestic exports	17 951	47 791	43 336	45 077	49 940	51.5	63.4
Re-exports	8 486	29 813	29 689	30 941	43 243	47.4	73.2

	Value					Share in economy's total merchandise exports	
	1990	1995	1998	1999	2000	1990	2000[a]
Slovak Rep.	–	1 615	3 961	4 010	4 672	–	39.2
Slovenia	–	2 614	3 319	3 035	...	–	35.3
Spain	21 611	37 999	46 718	48 360	48 168	38.8	42.3
Sweden	24 860	32 620	39 587	4 0183	4 1841	43.2	48.1
Switzerland	20 116	25 673	24 794	24 518	24 978	31.5	30.6
Taiwan, China	26 224	54 956	61 404	68 311	87 136	39.1	58.7
Thailand	5 070	18 997	21 878	24 505	31 969	22.0	46.3
Turkey	855	2 402	4 056	5 037	5 667	6.6	21.3
United Kingdom	74 903	103 537	130 538	128 284	133 289	40.5	46.9
United States	182 600	281 488	358 168	369 298	413 516	46.4	52.9
Memorandum item:							
European Union (15)	579 293	792 812	918 955	929 306	958 909	38.4	42.6
Intra-exports	360 776	469 762	554 191	572 651	567 705	36.8	40.8
Extra-exports	218 517	323 050	364 764	356 654	391 204	41.3	45.5

[a] Or nearest year. [b] Includes significant exports from processing zones. [c] Includes secretariat estimates.

Table V. Total paid employment in the mechanical and electrical engineering industries (thousands)
(Total men and women)

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Argentina			49.819	49.933	51.893	46.333	33.74	45.711	53.221	62.091	63.359	50	29
			1.9	1.5	3.4	1.9	1.4	2.7	1.5	0.8	3.6	3.6	30
			28.9	21.8	17.1	19	15.5	21.6	27.4	20.1	18.5	17.3	31
			6.8	5.4	7.4	4.4	2.8	4.8	12.8	9.1	8.5	6.8	32
			2.9	5.5	9.5	5	4.8	9.9	11.4	6.1	6.3	10.9	33
Australia	382	70.3	67.3	62.3	59.4	207.2	205.9	210.5	192.3	185.7	202.6	194.9	29-35
	383	53.5	50.5	45.4	38								
Austria								63.94	63.77	67.14	65.02	67	29
								0.41	0.26	0.35	0.69	0.71	30
								28.06	26.93	28.61	26.53	27.58	31
								28.84	28.67	27.56	27.72	28.48	32
								12.43	12.04	11.43	10.26	10.92	33
Azerbaijan	382	78.4	72.2	62.2	57.1	52	50.4	43.3	25.2	23.4	19.3	16.6	29
	383	11.5	10.4	9.1	8.4	7.7	7.2	6.1	1	0.9	0.7	0.6	30
									6	5.6	4.5	4.5	31
									2.5	2.2	1.8	1.5	32
									3.4	3.2	3	2.8	33

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Belgium						41.9	43.3	42.9	42.4	43.5	42.1		29
						0.6	0.6	0.5	0.5	0.5	0.5		30
						23.8	23.9	22.6	21.9	22.3	22.7		31
						20.2	20.2	20.2	19.1	19.3	19.2		32
						7	7.1	7.3	7.4	7.3	7.9		33
Bermuda		0.011	0.009	0.012	0.008	0.006		0.001					29
		0.015	0.015	0.019	0.021	0.017	0.007	0.007	0.008				31
		0.007	0.008	0.008	0.004	0.003	0.003		0.002				33
Botswana	381-385	4.496	3.941	4.147									29
													30
													31
													32
										0.583			33
Brazil	382	352.511		301.528	274.85	257.256	227.196						
	383	298.051		217.353	201.458	203.592	191.74						
Bulgaria	382, 385	201.2	156.5	129.1	106.7	83.5	91.1	109.59	103.3	94.9	80.3		29
	383	145.2	114.2	87.4	66.2	54.1	50.8	6.17	5.44	4.8	3.8		30
								27.61	25.52	24	20.3		31
								10.09	8.36	7.3	5.9		32
								9.38	8.46	8.2	7.1		33

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Canada		89.3	80.1	74.1	68.7	78.6	89.9	94.7	102.3	102.4	109.6	119.2	29
		39.8	28.8	32.3	27.3	29.8	28.2	28.7	34.3	29.4	34.1	35.4	30
		92.4	90.8	78.6	68.1	74.4	85.2	86.8	90.4	87.5	93.8	98.6	31
		29.3	26.1	23.1	25.4	23.6	20.6	23.3	23.2	24.7	38.8	53.5	32
		25.8	30.3	26.6	25.2	28.8	25.3	26.8	33.6	35.6	37	35	33
China	382				4 186	2 943					2 489		
	383				1 514	1 634					1 789		
Colombia	382	15.80	16.20	19.13	19.80	20.08	20.86	19.05	19.40	17.84	15.35		
	383	18.20	17.44	19.41	19.51	19.80	19.99	18.45	16.32	14.46	11.99		
Costa Rica								2.58	1.50	1.37		1.30	29
								0.12	0.86	2.27		4.79	30
									0.75	1.45		1.13	31
								7.04	9.52	6.67		5.58	32
								0.38	1.20	0.38		0.78	33
Croatia	382	43.8	30.06	26.04	23.71	21.1	18.26	16.87	15.86	14.7	14.68	13.18	29
	383	36.34	28.94	25.73	24	21.59	20.61	20.85	1.75	2.1	1.49	1.42	30
									13.02	12.21	11.41	11.31	31
									3.74	3.29	4.26	5.07	32

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
									2.11	2.27	2.22	2.11	33
Cyprus											0.312	0.497	29
													30
											0.452	0.314	31
													32
											0.192	0.199	33
Czech Republic (1)					215	194	191	179	160	162	154	132	29
					9	5	4	5	6	6	5	9	30
					58	54	60	56	58	58	67	63	31
					30	27	28	26	29	29	33	34	32
					19	14	18	20	17	14	16	18	33
Czech Republic (2)	382	220	201	162	122	108	108	98	106	106	95	90	29
	383	80	63	57	50	49	2	2	1	1	1	2	30
							37	38	48	52	51	56	31
							11	11	14	16	17	22	32
							13	13	14	13	12	14	33
Denmark						74.6	82.1	78.5	75.8	81.4			29
						0.7	4.4	1.9	2.1	2.6			30
						19.2	21.9	24.5	26.9	21.4			31
						6.5	11.8	12.0	10.8	12.1			32
						10.7	15.0	10.7	11.7	13.4			33

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Estonia	382			8.5	8.2	6.1							
	383			5.7	6.1	3.7							
Fiji	382	0.117			0.179			0.181					
	383	0.069			0.049			0.119					
Finland		53	47	41	39	41	49	55	60	61	61	61	29
							2	3	4	3	2	1	30
		39	37	32	31	34	18	17	16	18	19	17	31
							21	23	25	29	33	36	32
		5	4	4	6	6	7	9	8	10	11	9	33
France		351.0	346.0	333.1	317.4	307.7	313.5	310.9	310.0	313.3	316.1	320.4	29
		26.9	39.8	37.3	29.6	29.1	29.2	30.2	30.3	31.1	31.8	32.8	30
		166.1	167.6	165.1	161.9	156.7	159.2	159.0	156.4	158.2	159.6	163.4	31
		152.4	140.9	128.7	113.8	118.4	122.0	121.4	123.7	125.2	126.9	129.3	32
		152.0	148.4	144.7	135.2	127.9	127.8	129.8	129.0	130.0	131.2	130.5	33
Germany							1 168	1 220	1 157	1 148	1 146	1 188	29
							106	121	135	124	113	103	30
							511	449	438	414	413	422	31
							228	245	216	223	226	268	32
							262	266	254	244	241	262	33

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Greece					13.9	17.3	15.3	18.6	17.0	19.6	18.2	18.4	29
					0.7	0.8	0.3	0.5	0.5	0.3	0.5	0.6	30
					7.9	8.2	7.6	8.2	7.6	6.1	8.1	7.2	31
					2.8	1.6	2.0	2.3	2.4	2.3	3.0	2.9	32
					1.4	2.1	0.6	1.9	2.5	1.6	2.8	3.3	33
Hong Kong, China	382-383		97.54	91.79	76.90	69.88	62.50	53.18	43.67	38.19	41.41	38.65	
Hungary	382	136.4	125.0	92.3			53.1	58.6	59.7	57.5	57.6	58.2	29
	383	119.9	95.2	69.9			1.9	3.8	6.2	4.6	11.4	12.9	30
							31.7	35.0	38.3	52.0	61.2	68.0	31
							20.7	22.4	27.3	27.6	29.6	43.2	32
							14.8	15.4	15.4	12.7	13.7	14.3	33
Iceland			0.2	0.1	0.1	0.4	0.4	0.6	0.9	0.6	0.6	0.9	29
													30
						0.1	0.1	0.2	0.1			0.1	31
			0.1										32
			0.1	0.1	0.2	0.2	0.3	0.2	0.1	0.2	0.1	0.2	33
India	382	392					389	369					
	383	424					472	453					
Ireland		10.2	9.3	17.8	16.9	13.6	12.7	16.1	16.8	12.9	16.4		29
		9.6	8.3	6.9	10.8	11.8	13.5	20.0	21.1	31.4	15.7		30

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
		8.0	9.2	17.6	14.6	15.0	14.4	13.3	14.0	11.0	7.8		31
		6.1	6.3	6.4	5.1	5.0	4.2	5.5	6.5	4.5	19.4		32
		23.7	23.4	9.1	9.4	9.8	11.6	10.0	13.4	14.4	15.6		33
Israel										18.0	17.8	18.1	29-30
										9.2	9.6	9.0	31
										30.7	32.2	35.0	32-33
Italy					528	514	526	519	521	532	565	582	29
					70	66	62	55	56	49	42	44	30
					142	150	155	158	170	181	175	176	31
					70	80	70	63	67	72	68	63	32
					47	48	58	61	58	58	67	70	33
Jordan	382		1.17	1.60	1.63								
	383	0.68	0.53	0.66	0.76								
Kazakhstan	382	165.1	157.5	154.8	138.1	135.8	113.8	96.8	83.2	71.1			29
	383	5.7	5.4	4.6	1.4					0.3			30
										9.0			31
										0.7			32
										2.4			33
Kenya	382	1.49	1.48	1.50	1.50	1.51	1.50	1.52	1.53				
	383	2.37	2.59	2.77	2.80	2.80	3.22	3.22	3.25				

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Kuwait	382	4.679	2.736	4.120	4.504	4.698							
	383	0.557	0.473	0.966	1.150	1.353							
Latvia									10	10	7	7	29
													30
									5	4	3	3	31
									5	4	2	1	32
									1	1	1	1	33
Lithuania (1)							24.676	19.687	17.614	15.297	12.269		29
							1.816	1.469	1.219	0.851	0.264		30
							8.479	6.147	5.119	4.426	3.404		31
							14.132	11.778	10.250	8.696	7.374		32
							5.507	3.314	3.182	2.396	2.415		33
Lithuania (2)					39.0	31.8	26.1	24.1	19.7	17.8	17.4		29
					4.8	3.1	2.0	1.7	1.3	1.2	0.4		30
					9.8	7.8	8.2	7.6	7.5	5.1	5.0		31
					27.0	21.3	15.2	12.8	11.1	9.1	9.5		32
					9.3	9.3	5.3	3.7	3.7	4.2	4.0		33
Macau, China	382	0.138	0.160	0.086	0.099	0.055	0.080	0.104					
	383	0.888	0.529	0.657	0.660	0.904	1.341	1.151					

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Macedonia, The former	382	3	3	3	3	3	2	1	1	1	1		
Yugoslav Rep. of	383	11	11	10	10	9	9	9	8	7	7		
Malaysia	382	26.8	34.3	36.1	45.5	48.1							
	383	217.5	261.9	286.5	334.6	373.0							
Malta	382					0.590	0.618	0.590	0.622	0.748	0.660		
	383					4.142	4.494	4.777	4.814	5.264	5.114		
Mauritius	382	0.72	0.71	0.67	0.63	0.70	0.71	0.71	0.64	0.72	0.64	0.60	
	383	0.98	0.96	0.87	0.81	0.77	0.88	0.67	0.62	0.67	0.71	0.61	
Mexico			70.9		72.0		66.6	72.1	76.7	77.5	63.8	90.4	29
			11.8		2.8		6.1	15.2	35.7	39.7	25.1	35.8	30
			113.1		159.9		168.5	163.6	151.6	209.1	252.7	252.6	31
			155.6		116.8		135.8	170.1	158.5	207.6	232.5	250.2	32
			29.0		28.1		30.3	42.7	40.7	48.9	42.5	56.0	33
Moldova, Rep. of	381-385	127	114	101	56	57	48	23.5	19.0	16.5	13.1	10.5	29
								2.2	1.1	0.7	0.5	0.3	30
								3.2	2.6	2.1	1.8	1.6	31
								3.4	6.0	3.6	2.4	2.0	32
								4.9	4.9	4.4	4.0	3.5	33

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Netherlands	382	102	97	100	99	84							
	383	133	122	114	110	105							
New Zealand									15.2	17.5	16.0	10.9	29
													30
									12.5	10.4	13.5	14.5	31
													32
									1.0	1.6	1.0	1.2	33
Norway	381-385	101	99	101	98	102	110	26	22	24	23	23	29
								1	1	1	1	1	30
								12	15	14	12	10	31
								5	6	6	6	5	32
								5	6	7	6	8	33
Panama				0.127	0.123	0.086							29
													30
				0.146	0.301	0.329							31
				0.037	0.022	0.021							32
				0.103	0.086	0.088							33
Peru								13.4	18.7	11.1	2.2	12.8	29
													30
								3.7		10.1	1.1	7.9	31

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
								1.4			1.4		32
								0.9	2.6	1.5	2.8	0.5	33
Philippines	382		19.503	20.728	19.636	21.564	28.738	30.506	32.036				29
	383		89.807	101.974	98.604	107.784	126.942	12.076	14.438				30
								48.597	50.252				31
								88.345	98.077				32
								29.473	34.083				33
Poland	382	416.4	358.6	324.4	307.9	293.5	292.3	286.9	277.1	266.0	240.9		29
	383	236.5	186.8	6.3	4.7	3.6	4.1	4.1	4.5	4.7	5		30
				85.1	82.6	84.0	86.5	91.0	96.6	96.0	94		31
				59.7	51.9	47.3	43.5	42.2	40.5	38.1	34.7		32
				42.3	39.0	37.1	37.2	42.6	40.9	40.8	39.5		33
Portugal				26.8	29.0	31.3	33.0	30.5	28.0	30	33.4	38.7	29
				0.9	1.8	2.9	1.9	1.4	0.9	1	1.6		30
				30.3	28.2	31.0	29.7	29.3	27.1	24.4	28.1	32.1	31
				10.2	13.2	17.1	18.4	14.1	10.4	13.1	15.1	14.8	32
				4.2	4.7	5.9	4.9	5.7	4.5	4.8	4.3		33
Puerto Rico	382	3.41	2.85	2.66	2.46	2.54							
	383	17.30	16.34	15.58	15.05	17.10							

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Romania		602.5	582.6	443.9	391.4	362.1	323.3	292.5	253.3				29
		4.1	3.9	3.8	3.0	3.0	3.3	3.0	3.3				30
		127.2	105.0	92	85.1	75.2	74.9	73.3	66.5				31
		39.8	31.0	27.3	26.0	24.1	17.9	15.0	17.0				32
		50.2	43.7	38.2	24.6	25.5	19.5	18.2	19.2				33
Russian Federation	382				3 090.2	2 622.3	2 331.2	2117.7	1 568.1	2 280.1			29
	383				664.1	516.0	471.0	440.0	414.2	27.0			30
										228.2			31
										364.4			32
										250.9			33
San Marino	381-383	1.365	1.363	1.427	1.508		0.419	0.467	0.557	0.603	0.659		29
							0.008	0.008	0.012	0.012	0.033		30
							0.500	0.549	0.542	0.605	0.614		31
							0.043	0.050	0.057	0.062	0.079		32
							0.010	0.011	0.017	0.023	0.026		33
Slovakia					74.71	72.52	73.20	67.90	68.20	59.16	53.70		29
					1.62	1.22	1.20	1.20	1.10	1.43	1.31		30
					14.89	15.79	19.00	21.10	19.30	23.67	24.46		31
					10.67	9.82	9.30	8.60	9.10	8.26	8.55		32
					10.53	9.31	8.60	6.70	8.70	7.67	5.38		33

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Slovenia					19	16	17	17	21	23	21		29
					1					1			30
					22	18	26	21	21	20	22		31
					3	6	7	7	4	4	4		32
					1	5	2	5	5	4	4		33
South Africa	382	82.2	75.2	70.7	66.9								
	383	86.1	92.0	95.5	89.8								
Spain	382	138.1	131.0	122.3	128.8	120.6	128.7	143.2	148.8	156.0	163.0	163.9	29
	383	162.9	149.9	140.9	12.2	8.6	11.6	12.9	16.0	19.7	21.5	21.5	30
					58.6	59.8	60.1	59.4	62.4	79.4	77.7	78.4	31
					33.1	31.8	30.3	25.2	31.9	30.0	32.0	42.3	32
					23.8	21.8	14.7	18.0	21.1	21.7	21.7	18.9	33
Sri Lanka	382	4.28	3.10	3.38	2.08	1.82	1.95	2.91	1.48	1.81			
	383	1.79	2.85	3.70	4.23	6.21	4.77	9.82	6.13	7.15			
Sweden (1)		126	114	103	92	92	98	100	102	103	98	92	29
		104	99	88	79	80	87	94	93	94	97	101	30-33
Sweden (2)	382	68.48	60.15	54.88	48.66	51.36	55.43	54.92					29
	383	36.13	31.55	29.25	2.24	2.03	1.78	1.69					30
					11.69	11.75	13.47	13.91					31

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
					12.12	13.34	15.47	16.13					32
					7.00	7.39	8.10	8.02					33
Switzerland				134.5	125.7	115.1	113.2	111.9	110.3	110.0	108.3	108.5	29
				4.0	3.8	3.6	3.6	3.5	3.4	3.3	2.9	3.1	30
				49.6	49.0	47.4	47.3	44.7	39.9	37.6	36.1	37.5	31
				23.8	21.7	19.5	18.2	18.4	18.4	20.2	20.2	20.6	32
				72.7	69.6	66.6	65.6	65.7	66.4	69.1	69.6	71.0	33
Turkey	382	54.8	48.6	49.8	50.2	48.0	46.8	49.0	53.3				
	383	47.9	45.1	45.8	44.4	39.7	41.4	45.2	58.3				
Ukraine	382	701	718	627	618	542	487	444	406	363	341	313	
	383	224	233	233	217	191	168	152	142	128	126	115	
United Kingdom		493	451	417	376	373	386	390	389	389	369	356	29
		65	51	42	36	39	44	42	40	48	52	52	30
		170	152	147	147	156	169	180	184	190	187	180	31
		161	143	122	111	113	125	132	134	133	125	129	32
		159	134	130	128	130	137	144	150	147	139	131	33
United States	382	2 095	2 000	1 929	1 931	1 990	2 067	2115	2 168	2 206	2 136	2 120	
	383	1 673	1 591	1 528	1 526	1 571	1 625	1661	1 689	1 707	1 672	1 719	

Countries	ISIC Rev. 2	1990	1991	12992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
Yugoslavia, Fed. Rep. of									53.925	49.417	47.226		29
									3.131	2.868	2.708		30
									23.885	23.631	21.941		31
									9.902	9.312	8.569		32
									8.605	8.964	7.517		33
Zimbabwe	382			4.7	4.3	4.4	4.3	4.1	4.3	4.1	4.1		
	383	7.0	7.2	7.0	6.9	7.3	6.5	6.7	6.8	6.7	6.7		

Table VI. Women as a percentage of total paid employment in the MEE industries

Countries	ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
Argentina			16.06	14.42	8.29	5.18	10.67	17.50	11.46	8.21	18.15	11.40	29	Machinery
								55.56	66.67	12.50	61.11	27.78	30	Off.&Comp.Equipment
			22.15	17.89	18.71	13.16	28.39	10.19	17.52	8.96	8.65	5.20	31	Elec.Mach.&Apparatus
			42.65	29.63	20.27	34.09	35.71	27.08	37.50	39.56	41.18	22.06	32	Radios TV+Telecom.
				25.45	37.89	42.00	10.42	1.01	32.46	37.70	15.87	59.63	33	Med. + precision etc.
Azerbaijan									28.97	23.93	28.50	26.51	29	Machinery
									30.00	33.33	42.86	50.00	30	Off.&Comp.Equipment
									40.00	28.57	28.89	33.33	31	Elec.Mach.&Apparatus
									44.00	50.00	50.00	26.67	32	Radios TV+Telecom.
									35.29	34.38	33.33	39.29	33	Med. + precision etc.
Belgium						11.46	11.09	11.42	10.85	10.57	10.93		29	Machinery
						33.33	33.33	40.00	40.00	40.00	40.00		30	Off.&Comp.Equipment
						23.11	23.01	22.57	22.37	21.52	21.15		31	Elec.Mach.&Apparatus
						35.15	35.64	35.15	34.03	34.20	33.33		32	Radios TV+Telecom.
						34.29	35.21	32.88	32.43	32.88	30.38		33	Med. + precision etc.
Bermuda		9.09	22.22	8.33	12.50								29	Machinery
		33.33	33.33	21.05	23.81	23.53	28.57	28.57	25.00				31	Elec.Mach.&Apparatus

Countries		ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
			42.86	50.00	50.00	50.00	33.33	33.33		50.00				33	Elec.Mach.&Apparatus
Bulgaria									34.55	32.93	31.51	30.64		29	Machinery
									53.97	49.26	50.00	50.00		30	Off.&Comp.Equipment
									47.77	46.28	45.42	44.33		31	Elec.Mach.&Apparatus
									56.19	52.99	53.42	52.54		32	Radios TV+Telecom.
									47.97	46.10	47.56	47.89		33	Med. + precision etc.
Canada			19.15	20.85	18.62	18.49	14.38	19.02	17.11	15.74	14.55	16.42	19.04	29	Machinery
			33.92	31.94	31.58	31.50	26.85	29.43	29.97	32.65	34.35	38.71	34.18	30	Off.&Comp.Equipment
			32.47	32.27	32.70	33.63	30.91	30.52	33.53	36.39	35.09	34.75	36.31	31	Elec.Mach.&Apparatus
			47.10	42.91	43.72	40.16	37.29	27.18	34.33	41.38	26.32	34.54	34.58	32	Radios TV+Telecom.
			46.51	44.55	45.11	42.06	41.32	45.06	43.66	42.26	40.45	38.38	39.14	33	Med. + precision etc.
Colombia	Machine	382	13.42	14.07	13.90	15.00	14.99	17.74	16.85	17.37	17.54	18.57			
	Elec. mach.	383	31.04	30.62	32.25	33.06	37.88	39.87	33.01	33.58	31.26	31.03			
Costa Rica									21.71	2.67	16.79			29	Machinery
									100.00	52.33	24.67		39.87	30	Off.&Comp.Equipment
										14.67	66.21		30.09	31	Elec.Mach.&Apparatus
									53.27	37.71	32.08		31.00	32	Radios TV+Telecom.
									36.84	31.67	60.53		42.31	33	Med. + precision etc.

Countries		ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
Croatia	Machine	382	15.23	14.80	14.48	14.85	14.88	14.57	15.06	19.29	18.64	18.73	17.22	29	Machinery
	Elec. mach.	383	38.97	39.53	39.53	39.13	39.32	40.03	39.38	45.71	45.71	30.20	28.87	30	Off.&Comp.Equipment
										38.02	38.25	39.09	38.46	31	Elec.Mach.&Apparatus
										37.70	37.39	46.71	45.17	32	Radios TV+Telecom.
										40.76	44.05	42.79	43.13	33	Med. + precision etc.
Cyprus												19.55	14.49	29	Machinery
												55.09	79.30	31	Elec.Mach.&Apparatus
												30.21	27.14	33	Med. + precision etc.
Czech Republic (1)						29.30	28.35	26.18	26.82	24.38	25.93	25.32	24.24	29	Machinery
						55.56	40.00	25.00	40.00	33.33	33.33	20.00	33.33	30	Off.&Comp.Equipment
						37.93	37.04	43.33	44.64	43.10	46.55	46.27	47.62	31	Elec.Mach.&Apparatus
						53.33	51.85	53.57	53.85	55.17	55.17	57.58	58.82	32	Radios TV+Telecom.
						47.37	50.00	50.00	50.00	41.18	57.14	43.75	50.00	33	Med. + precision etc.
Czech Republic (2)	Machine	382	25.00	24.88	24.69	24.59	19.44	22.22	21.43	21.70	20.75	20.00	20.00	29	Machinery
	Elec. mach.	383	52.50	52.38	52.63	52.00	46.94	50.00	50.00	100.00	100.00	100.00	50.00	30	Off.&Comp.Equipment
								43.24	47.37	47.92	48.08	50.98	53.57	31	Elec.Mach.&Apparatus
								54.55	63.64	57.14	62.50	58.82	63.64	32	Radios TV+Telecom.
								46.15	53.85	50.00	53.85	50.00	50.00	33	Med. + precision etc.

Countries	ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
Denmark						22.92	24.48	23.44	19.39	21.25			29	Machinery
						42.86	25.00	26.32	28.57	34.62			30	Off.&Comp.Equipment
						35.94	21.92	31.02	31.97	28.04			31	Elec.Mach.&Apparatus
						41.54	43.22	53.33	48.15	46.28			32	Radios TV+Telecom.
						50.47	54.00	42.06	44.44	45.52			33	Med. + precision etc.
Finland		16.98	17.02	14.63	15.38	17.07	14.29	14.55	16.67	14.75	13.11	11.48	29	Machinery
							50.00	33.33	50.00	33.33	50.00		30	Off.&Comp.Equipment
		41.03	40.54	40.63	38.71	41.18	38.89	35.29	31.25	33.33	31.58	29.41	31	Elec.Mach.&Apparatus
							42.86	39.13	36.00	37.93	39.39	38.89	32	Radios TV+Telecom.
		40.00	50.00	50.00	33.33	33.33	28.57	33.33	25.00	30.00	36.36	33.33	33	Med. + precision etc.
Germany							18.75	17.70	18.41	18.12	17.80	17.59	29	Machinery
							29.25	27.27	25.19	28.23	29.20	25.24	30	Off.&Comp.Equipment
							29.35	29.40	28.31	28.99	30.51	31.52	31	Elec.Mach.&Apparatus
							30.26	32.65	33.33	33.18	32.74	32.46	32	Radios TV+Telecom.
							42.37	42.86	39.37	40.57	41.08	41.60	33	Med. + precision etc.
Greece					11.51	10.98	14.38	15.05	12.94	11.22	13.19	15.22	29	Machinery
					14.29	25.00	33.33		20.00			16.67	30	Off.&Comp.Equipment
					20.25	24.39	28.95	28.05	26.32	27.87	12.35	23.61	31	Elec.Mach.&Apparatus

Countries		ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
						35.71	18.75	25.00	26.09	33.33	34.78	33.33	37.93	32	Radios TV+Telecom.
						28.57	28.57	33.33	36.84	36.00	43.75	42.86	39.39	33	Med. + precision etc.
Hong Kong, China	Machine	382-383		44.27	43.08	41.96	41.39	42.74	44.15	42.20	42.08	41.66	42.23		
Iceland										11.11	16.67	16.67		29	Machinery
														30	Off.&Comp.Equipment
														31	Elec.Mach.&Apparatus
														32	Radios TV+Telecom.
				100.00	100.00	50.00	50.00	33.33						33	Med. + precision etc.
India	Machine	382	2.30					2.57	2.71						
	Elec. mach.	383	9.43					10.38	10.82						
Ireland			13.73	13.98	14.61	13.61	25.74	24.41	25.47	20.24	21.71	17.68		29	Machinery
			38.54	38.55	34.78	42.59	43.22	44.44	40.50	39.81	45.22	43.95		30	Off.&Comp.Equipment
			17.50	13.04	50.57	45.21	44.67	47.22	45.86	49.29	39.09	44.87		31	Elec.Mach.&Apparatus
			57.38	46.03	48.44	39.22	24.00	47.62	38.18	41.54	44.44	41.75		32	Radios,TV+Telecom.
			49.79	50.00	50.55	53.19	59.18	55.17	54.00	58.21	54.17	57.69		33	Med. + precision, etc.
Italy						16.10	16.34	17.68	16.76	16.70	16.73	19.47	20.10	29	Machinery

Countries		ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
						28.57	31.82	30.65	30.91	33.93	32.65	26.19	27.27	30	Off.&Comp.Equipment
						27.46	28.67	30.32	31.65	28.82	29.28	30.29	31.82	31	Elec.Mach.&Apparatus
						30.00	31.25	34.29	34.92	31.34	33.33	36.76	36.51	32	Radios,TV+Telecom.
						38.30	37.50	43.10	42.62	43.10	43.10	43.28	41.43	33	Med. + precision, etc.
Latvia										30.00	30.00	28.57	28.57	29	Machinery
										40.00	50.00	33.33	33.33	31	Elec.Mach.&Apparatus
										60.00	50.00	50.00	100.00	32	Radios,TV+Telecom.
										0.00	0.00	0.00	0.00	33	Med. + precision, etc.
Macau, China	Machine	382	5.80	11.88	18.60	13.13	20.00	8.75	12.50						
	Elec. mach.	383	66.78	73.53	71.69	75.15	74.23	77.33	74.02						
Macedonia,		382	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
The former Yugoslav		383	27.27	27.27	30.00	30.00	33.33	22.22	22.22	25.00	28.57	28.57			
Rep. of															
Malaysia	Machine	382	25.00	33.53	34.35	35.82	31.60								
	Elec. mach.	383	75.36	72.70	72.95	71.16	69.57								
Malta	Machine	382					7.12	6.47	5.42	5.95	9.49	8.18			
	Elec. mach.	383					38.58	37.96	39.69	38.70	41.53	42.12			

Countries		ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
Mauritius	Machine	382	5.56	5.63	4.48	4.76	5.71	5.63	5.63	6.25	5.56	6.25	8.33		
	Elec. mach.	383	25.51	26.04	16.09	18.52	19.48	21.59	25.37	24.19	25.37	29.58	31.15		
Mexico				20.31		9.03		21.62	15.95	20.73	14.19	23.04	18.14	29	Machinery
				94.92		0.00		18.03	34.87	31.09	43.58	38.25	39.11	30	Off.&Comp.Equipment
				31.92		42.71		44.04	42.54	38.13	36.87	31.02	41.88	31	Elec.Mach.&Apparatus
				53.02		54.02		51.33	56.55	57.60	53.13	54.67	52.36	32	Radios,TV+Telecom.
				40.34		25.98		32.01	48.24	44.72	36.81	33.41	40.36	33	Med. + precision, etc.
Netherlands	Machine	382	10.78	12.37	11.00	10.10	9.52								
	Elec. mach.	383	17.29	15.57	18.42	17.27	20.00								
New Zealand										14.47	13.71	14.38	15.60	29	Machinery
										40.00	34.62	28.15	34.48	31	Elec.Mach.&Apparatus
										40.00	31.25	40.00	33.33	33	Med. + precision, etc.
Norway									15.38	18.18	16.67	17.39	13.04	29	Machinery
													100.00	30	Off.&Comp.Equipment
									25.00	20.00	14.29	16.67	20.00	31	Elec.Mach.&Apparatus
									40.00	33.33	33.33	50.00	40.00	32	Radios,TV+Telecom.
									40.00	33.33	28.57	33.33	25.00	33	Med. + precision, etc.

Countries		ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
Panama						24.39	25.58							29	Machinery
						10.96	9.42							31	Elec.Mach.&Apparatus
						13.64	9.52							32	Radios,TV+Telecom.
						29.07	19.32							33	Med. + precision, etc.
Peru									12.69	21.39	4.50	18.18	2.34	29	Machinery
														30	Off.&Comp.Equipment
									0.00		34.65	100.00	0.00	31	Elec.Mach.&Apparatus
									0.00			0.00		32	Radios,TV+Telecom.
									100.00	0.00	0.00	0.00	0.00	33	Med. + precision, etc.
Philippines	Machine	382		15.97	15.08	22.06	39.83	48.23	14.73	15.86				29	Machinery
	Elec. mach.	383		69.46	69.73	66.51	67.30	70.00	65.62	68.42				30	Off.&Comp.Equipment
									60.44	59.80				31	Elec.Mach.&Apparatus
									71.73	74.02				32	Radios,TV+Telecom.
									84.69	84.70				33	Med. + precision, etc.
Portugal					13.06	17.59	20.13	20.30	18.69	20.36	27.67	24.25	24.55	29	Machinery
					44.44	27.78	17.24	31.58	50.00	22.22		6.25		30	Off.&Comp.Equipment
					37.62	35.11	38.71	43.43	37.88	33.95	43.85	53.02	54.52	31	Elec.Mach.&Apparatus
					50.98	59.09	49.71	51.09	60.28	51.92	56.49	55.63		32	Radios,TV+Telecom.
					21.43	42.55	40.68	38.78	36.84	40.00	39.58	51.16		33	Med. + precision, etc.

Countries		ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
San Marino	? Machine	381-383	24.10	24.28	24.11	23.34		10.02	11.13	13.46	13.27	14.26		29	Machinery
	Elec. mach.							12.50	25.00	25.00	25.00	21.21		30	Off.&Comp.Equipment
								31.00	29.69	28.41	26.61	26.87		31	Elec.Mach.&Apparatus
								6.98	6.00	7.02	4.84	6.33		32	Radios,TV+Telecom.
								40.00	36.36	35.29	30.43	30.77		33	Med. + precision, etc.
Slovakia						29.01	28.30	28.28	27.84	29.03	26.72	25.68		29	Machinery
						50.00	32.79	41.67	41.67	45.45	51.75	55.73		30	Off.&Comp.Equipment
						43.32	45.22	47.89	49.76	50.26	53.87	56.21		31	Elec.Mach.&Apparatus
						47.89	49.49	49.46	51.16	54.95	58.47	58.25		32	Radios,TV+Telecom.
						43.21	44.04	44.19	40.30	47.13	41.20	40.52		33	Med. + precision, etc.
Slovenia						31.58	31.25	23.53	23.53	23.81	21.74	23.81		29	Machinery
														30	Off.&Comp.Equipment
						45.45	44.44	42.31	42.86	42.86	45.00	50.00		31	Elec.Mach.&Apparatus
						66.67	50.00	42.86	57.14	50.00	50.00	25.00		32	Radios,TV+Telecom.
						100.00	40.00	50.00	40.00	60.00	25.00	50.00		33	Med. + precision, etc.
Spain	Machine	382	8.83	8.93	9.98	8.93	10.20	9.32	10.96	14.52	12.56	11.47	12.20	29	Machinery
	Elec. mach.	383	23.94	22.35	21.29	24.59	33.72	18.97	31.01	34.38	21.83	22.79	35.81	30	Off.&Comp.Equipment
						22.87	28.60	21.80	16.84	19.71	21.66	23.68	28.70	31	Elec.Mach.&Apparatus

Countries		ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3	
						25.98	29.87	33.99	33.33	21.63	19.00	25.31	35.22	32	Radios,TV+Telecom.
						37.39	32.11	17.69	38.89	36.97	28.57	26.27	29.63	33	Med. + precision, etc.
Sri Lanka	Machine	382	8.18	19.35		4.81	13.19	11.79	28.18	6.08					
	Elec. mach.	383	41.34	49.12		70.69	67.79	69.18	53.87	65.09					
Sweden (1)			19.84	20.18	20.39	18.48	20.65	18.37	18.00	18.63	17.48	17.35	19.57	29	Machinery
			32.69	31.31	28.41	29.11	30.00	32.18	31.91	34.41	35.11	34.02	35.64	30-33	OCE,Elec,Telecom,Med
Switzerland					16.80	16.95	16.42	16.34	16.18	15.87	15.82	15.60	15.76	29	Machinery
					30.00	28.95	25.00	25.00	25.71	23.53	24.24	24.14	22.58	30	Off.&Comp.Equipment
					30.04	29.59	29.75	30.23	30.20	29.82	29.79	29.36	30.13	31	Elec.Mach.&Apparatus
					30.25	30.41	31.28	31.87	32.07	32.07	32.18	32.18	33.01	32	Radios,TV+Telecom.
					39.89	39.08	39.19	39.18	38.20	38.70	39.36	39.22	39.30	33	Med. + precision, etc.
United Kingdom			18.66	19.07	19.42	19.95	19.30	18.65	17.69	17.74	18.77	19.51	19.10	29	Machinery
			32.31	31.37	33.33	33.33	28.21	29.55	30.95	30.00	29.17	28.85	30.77	30	Off.&Comp.Equipment
			31.18	32.89	33.33	32.65	33.33	33.73	31.67	31.52	32.11	28.34	28.89	31	Elec.Mach.&Apparatus
			37.27	37.76	38.52	37.84	38.05	37.60	34.85	34.33	31.58	32.80	32.56	32	Radios,TV+Telecom.
			33.96	33.58	34.62	33.59	33.85	32.85	31.94	31.33	31.29	28.06	27.48	33	Med. + precision, etc.
United States	Machine	382	21.67	21.75	21.82	21.75	21.71	21.53	21.56	21.91	21.89	21.96	21.93		

Countries		ISIC Rev. 2	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	ISIC Rev. 3
	Elec. mach.	383	42.68	42.43	42.41	42.27	42.08	41.78	41.42	41.33	41.24	40.85	40.78	
Zimbabwe	Machine	382			4.26	4.65	4.55	4.65	4.88	4.65	4.88	4.88		
	Elec. mach.	383	7.14	8.33	7.14	7.25	6.85	7.69	7.46	7.35	8.96	7.46		

Figure I. Employment in the manufacture of machinery except electrical (ISIC 382 Rev. 2) 1995

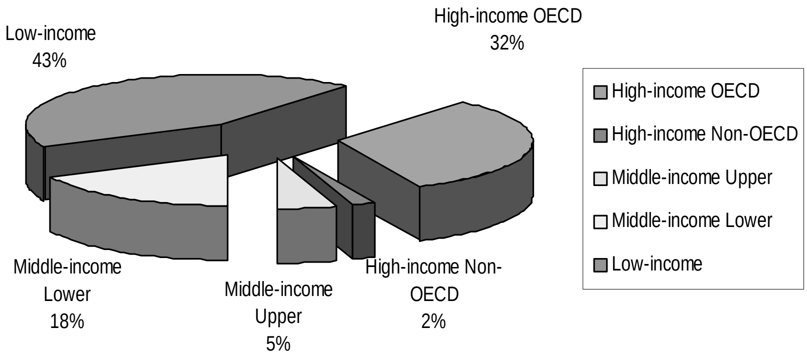


Figure II. Employment in the manufacture of electrical machinery (ISIC 383 Rev. 2) 1995

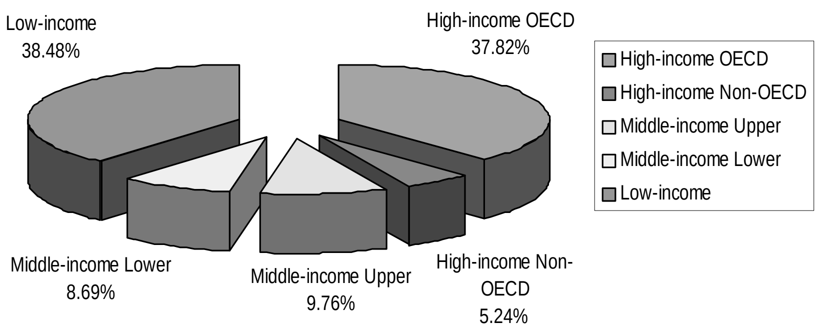


Figure III. Employment in the manufacture of machinery except electrical (ISIC 382 Rev. 2) 1998

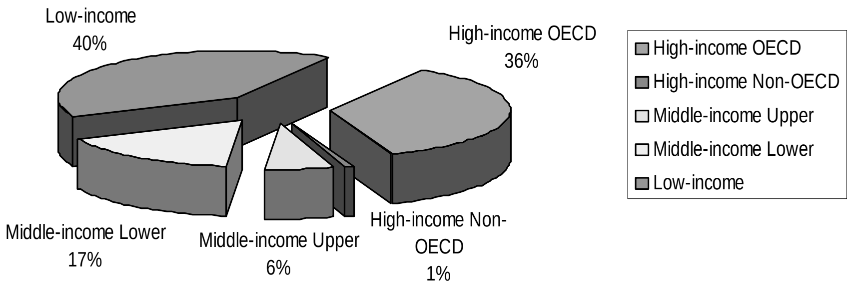


Figure IV. Employment in the manufacture of electrical machinery (ISIC 382 Rev. 2) 1998