TABLE OF CONTENTS-VOLUME 1

PAPERS PRESENTED

1. INTRODUCTION TO THE SEMINAR

1.1 INTRODUCTION

The seminar was conducted in the Karibuni centre , Mbeya, Tanzania and took place over three days from 26 to 28 February 1990.

The seminar was organised and chaired by the ILO Regional Adviser for l abour-Based Technology , Mr.David Stield, on behalf of all practitioners in the Technology in Eastern and Southern Africa.

1.1.1 THE PURPOSE OF THE SEMINAR

As stated in the title, the purpose of the seminar was to review current practice by gathering together the experts and practitioners in the field. All participants were engaged in working on labour-based roads projects in East and Southern Africa. The aim was therefore to have an active exchange of ideas and information based on the participants' experience in the region and also to draw on their previous experiences in other areas. A list of participants is given in Annex 2 of the report.

The increased emphasis on the use of local resources for infrastructure programmes in developing countries has resulted in substantial increase in the number of projects adopting labour-based technology. There is now a pressing need to review and disseminate information on the various techniques which have been adopted to ensure that new and existing projects have the opportunity to modify or update their procedures to make optimum use of the labour-based approach.

Each programme should be able to learn from the problems, successes and failures of other programmes which will assist in the choice of methods of construction, management, planning, etc. Also by discussing common problems, solutions or suggestions for further study could be made.

1.1.2 FORMAT OF THE SEMINAR

In order to spark off the active exchange of ideas, several participants had been approached to present short topic papers, the topic having chosen to cover the principal areas of concern as expressed by practitioners in the region.

The topics covered the areas of :

- Low cost structures
- Control of alignment
- Haulage of Material
- Self Help
- Light equipment
- Training materials
- Maintanance
- Worker motivation
- Monitoring and control

The detailed programme is outlined in this report in Annex 1- Seminar Agenda.

Each topic presented was followed by a discussion period and where applicable the production of an Action Plan to specify follow - up required from the participants.

The action Plans are included in the relevant topic sections and summarised in Annex 3 of this Report.

1.2 STRUCTURE OF THIS REPORT

This report will consider each subject separately. The topic papers are presented in volume 1 whereas the subsequent discussions are reported in volume 11 including any conclusions or agreed plans of action. The final section - "Summary and Open Discussions - Where do we go from here? Looks at the proposals made at the seminar for the future exchange of ideas and experiences.

Although the report is presented in two volumes, volume 1 and volume 11 should be read concurrently.

The plans of action are structured on the following basis :

What	What information or assistance the experts need?
Why	Why is the information need and what benefit will it bring
Who	Who should provide the information and who should collect it and form a report ?
How	How should the information be gathered and from what sources ?

1.3 ACKNOWLEDGEMENTS

The ILO would like to thank all the participants for attending and their programmes of following them to be released. We hope that the knowledge gained more than compensated for their absence.

We would also like to thank the staff of Regional Road Maintenance (RMM) in Tanzania for providing so much assistance to the seminar in Mbeya, the staff of the special Public Works.

Programme in Dar es Salaam for all their preparatory and logistic support, and Ms. Ritchie and Mr. Selvarasa for recording the discussions.

We would like to thank the government of Tanzania and the Mbeya Regional Authorities for allowing us to hold the seminar.

Lastly, we would like to apologise to all those we were not able to invite to this, our first seminar in the region. We will try to widen the coverage for the next, and would be pleased to hear from those who would be interested in attending.

LOW COST STRUCTURES
LOCAL RESOURCES ALTERNATIVES TO HIGH SPECIFICATION MATERIALS

PRESENTED BY G A TAYLOR

Introduction

Considerable attention has been given to developing efficient methods for maximising local resource input (mainly labour) to formation works and gravelling for labour-based roadworks. Much less attention has been given to the structures associated with these roadworks. Heavy reliance continues to the made on high cost, high specification materials such as cement and steel. There are however many options for low cost structures which eliminate or considerable reduce the need for high specification materials. This paper briefly presents a series of ideas and methods for increasing the local resource input to retaining walls and cross-drainage structures.

Although reference is made throughout to roadworks the same ideas and methods are relevant to many other labour based construction activities.

Materials

The primary alternative to cement and steel for low cost structures is locally available stone. Ideally this would be material won from the road excavation. In practice often small rock outcrops or oversize material from quarries provide the most convenient source of the stone. Fortunately areas where large quantities of retaining walls and cross drainage structures are required are usually associated with steep terrain where stone is relatively abundant.

However a major problem is that the quality of stone which can be hand excavated close to the road site is often poor or very variable in quality and the alternatives of blasting rock or hauling good quality stone from further a field is both prohibitively expensive and defeats the object of increasing local resource input. The engineer therefore has to develop designs which take account of the likelihood of rather poor quality stone in order to keep costs low and the percentage of local resource inputs high.

Retaining Walls

The first choice of type of retaining wall for labour-based works is a gravity wall of dry stone. Experince from Nepal and Lesotho indicate that the alternatives to dry stone walling, such as cement-bound stone or gabions, are at least twice as expensive as dry stone.

Unfortunately dry stone walling when used is sometimes poorly executed. The following points should therefore be carefully noted in connection with dry stonewalls:-

1. A suitable cross - section tapering from a wide base (dependent on retained height and surcharge) to a minimum of 0.3-0.5m at the top should be chosen.
2. The front face should rake back into the slope.
3. The foundation should be excavated at least 0.5m into the original ground.
4. A cement-bound capping should be used to avoid loose stones at the top of the wall becoming dislodged. This capping need not be across the full width of the top of the wall.

(For illustration of points 1-4, see fig 1.)

5. There should be a considerable number of "through stones" in the wall (i.e.large single stones extending from the front face of the wall to the back face.
6. The backfill should be free draining, particularly immediately behind the wall.
7. The stone should be "dressed" to ensure a well constructed wall with maximum area of contact between stones and to ensure soft edges are removed.
8. Few or no small "packing" stones should be used.

Once established on a site to the required standard of workmanship, dry stone walling usually proceeds smoothly and efficiently with very few external resources required. Often however to establish the required standard some walling has to be condemned, taken down and rebuilt. Fortunately for a dry stone wall this is not to serious as the material can be easily re-used. It is also worthy of note that a poorly constructed dry stone wall will usually collapse fairly quickly of its own accord.

Well constructed dry stone walls can be built to a height of 4-5 metres even if high quality stone is not available.

Situations where dry stone walls are not appropriate are for retained heights over 4-5 metres; areas of unstable ground; areas with running water; and areas where vibration (e.g from traffic) is high.

One of the leading alternatives in these situations is gabion walling. This is particularly suitable in unstable ground or adjacent to running water due to its ability to accommodate large differential settlements. However the packing of the gabions should be carried out almost as carefully as the building of dry stone walls. The cost of gabions walls is often as high as fully cement-bound walls. Some minor savings can be achieved by the on -site weaving of gabion boxes at the expense of slightly lower quality.

Cement bound walls should be reserved for situation where other types of wall are not suitable, such as culvert headwalls. Even then the use of composite construction (panels of dry stone alternating with vertical and horizontal strips of cement-bound stone) should be considered to reduce the requirement for cement (see fig 2).

The location of walls relative the road is very important. Low toe walls of dry stone retaining fills tend to be more efficient and successful that high walls (often cement-bound)close to the edge of the road with less fill (see fig 3).

The following table indicates approximate resource requirements for dry stone, cement bound and gabion walls excluding excavation and backfilling.

TABLE 1: APPROX RESOURCE INPUTS FOR WALLS

Type of Walls	Labour Md/m³	Vehicle vd/m³	Cement kg/m³	Gabion no/m³
Dry Stone	2.0	0.065	0	0
Cement Bond	3.1	0.098	350	*
Gabion	2.7	0.120	0	0

* Depends on size on gabion box used

SOURCE: Manual for estimating Labour Intensive Works in Lesotho, SWK, 1986

Note: above table assumes vehicle haulage of stone (and sand) within 4-5 km. Vehicle was a 6m^3 tipper but similar figures would be applicable for tractors and trailers or flat trucks.,/p>

Cross Drainage Structures

Concrete pipes are perhaps the most widely used material for cross drainage structures. However the local resource input to these, even when they are cast on site,is quite low.

An alternative with a much higher percentage of local resource input is a cement-bound stone masonry arch. A semi-circular arch design as shown in fig.4 has been used for up to 2m span culverts in nepal using medium to poor quality stone. The arch needs temporary support during construction. This can be achieved using purpose - made timber shuttering (this usually has a "life" of about 6-10 uses). Alternatively permanent shuttering in the form of corrugated galvanised iron sheet curved to the required shape can be used. In lesotho bent roofing sheets have been successfully employed.

A further alternative is to use the "lost earth method". For this the arch walls are built up to springing level. Then the inside of the culvert is filled with earth shaped on top to the correct profile for the underside of the arch. The earth then provides temporary support for the arch stones during construction and is removed later.

The choice of size of the arch has to take account of the likely flood discharge; the physical constraints of the site; and the ease of access for removing arch centering, cleaning the culvert, and maintenance. For ease of access a 1m semi-circular span with 0.6 - 0.8 height to the arch springing was found a convenient minimum size in Nepal.

However much smaller arches can be built. Again in Nepal 0.6 m span arches 0.3 m high to the springing have been built using the "lost earth" method described above. These proved extremely inexpensive to construct.

Arches tend to be convenient where the depth of fill above the culverts is not too small. Where headroom is limited, an option is a slab culvert. This can be made with stone masonry side walls and a precast reinforced concrete slab over the top. In Lesotho slabs of sandstone have been successfully used for the top slabs of culverts up to 0.5 m span. The sandstone slabs used were 0.15 - 0.15 - 0.2 m thick.

For larger cross drainage structures multispan arches can be constructed using the same techniques as for single arches. Where greater spans are required "Armco" arches or ellipses has been used as temporary formwork for a stone masonry structure. The method of construction which has been used in thick)using "Armco" ellipses or arches (thinnest grade available)as temporary shuttering. A collar of lightly reinforced concrete is then poured around the Armco formwork and the remaining infill constructed of "plumb" concrete using a fairly lean mix concrete with a lot of large stones. However the structure itself is quite capable of being overtopped in a flood without suffering major damage, also maintenance costs are low and the "life" of the structure very long. The maximum size of ellipse type structure built in Lesotho consisted of 3 no. 8 m x 5 m ellipses. The maximum size of arch type structure consisted of 2 no. 9 m x 3.5 m high arches.

Wing walls for culverts are often poorly designed due to lack of proper consideration. The main functions of wing walls should be to retain backfill and to guide the flow of water. In addition with walls can add stability to a structure by buttressing the culvert headwalls. To perform these functions adequately the wing walls, if of stone masonry should be:-

1. integral with the culvert walls;
2. splay at 35 - 45% from the long axis of the culvert;
3. meet the inside wall of the culvert;
4. be of cement bound masonry with "weep holes"

For all types of cross drainage structure erosion protection in the form of aprons and toe walls at inlets and outlets should be carefully considered. In these situations cement-bound stone masonry or gabion mats can perform very adequately.

Finally drifts are a very efficient form of cross drainage structure in certain situations. These also have been very adequately constructed of cement bond stone masonry and gabions.

Conclusion

This paper has briefly reviewed the use of stone masonry for low cost structures as an alternative to more conventional high specification materials such as cement and steel.

The series of ideas and techniques described is not intended to be an exhaustive list but rather a set of examples to provoke further discussion. Certain materials such as timber have bot been discussed at all. Also several types of construction such as stone "grips" for road cross drainage have not been mentioned. It would take a much longer paper than this to give a comprehensive description of all the local resources alternatives for low cost structure.

Perhaps a major conclusion is that the engineer responsible for designing and con structing low cost structures for labour based construction works must gain an awareness of the range of possible solutions available in any situation. By adopting a highly flexible approach and avoiding "stereotype" solutions a good engineering decision can then be made based on the technical adequacy and the economic cost of the options.

ALIGNMENT CONTROL
MORE SCIENCE AT SITE
PRESENTED BY JOHN MARSHALL

This paper will make the proposal that there exists a need for a more "scientific" - that is, a more engineering approach - to the site control of alignment and of drainage levels for labour-based road works.

First of all the reason why a more engineer approach is considered necessary are explored. Secondly the need that this control should be applied as site by people at the foreman level is explained. Finally the means by which this engineering control can be applied are discussed.

WHY WE NEED IT

There are a number of reasons why a more engineering-sound approach to road construction and rehabilitation is needed, and these can be grouped under three headings: the technical requirements, the public relations question and the maintenance problem.

TECHNICAL REQUIREMENTS

It should never be forgotten that we are constructing a civil engineering facility and that basic technical criteria cannot be overlooked. The fact that we are constructing or rehabilitating roads by labour-based method should not be a reason for neglecting sound engineering principles is the cause of simplicity of side control methods. 0ur purpose should be, within the capacity of site supervisory staff, that meet fundamental technical requirements.

This need is made even more pressing by the increasing use of labour-based methods to rehabilitate roads which have a higher classification ranking in the national road network than was previously the case. This trend offers great opportunity for vastly increased potential for the use labour-based method , but also presents a challenge to us to develop systems that ensures the ability to consistently construct roads to national specifications and appropriate technical standards..

Appropriate technical standards are taken to mean the most economic solution to construction problems, whilst at the same time complying with basic engineering principles. It is possible, within nationally set limits, to relax geometric specifications on lightly trafficked roads in difficult terrain, but the need to provide a working and effective drainage system is essential on roads. The requirement is, therefore to control side drain and outlet drain levels so that they will produce a functioning drainage system. Side drain levels are directly related to the vertical alignment, so control of the vertical alignment is necessary for all road construction rehabilitation.

Unfortunately on many labour - based projects this relationship between vertical alignment levels and a working economical drainage system is either not understood or not applied in the field. Too often construction and setting out methods are designed to minimize earthworks in order to reduce costs, without due regard to acceptable engineering standards. In these cases earthworks are completed to minimum quantities and only then are drainage problem tackled, this invariably leads to a drainage system that is either mal-functioning or explosive, usually both .

The need is for setting out method that contains, in the procedures , an element of design, permitting a variety of options to be tried and find adjustments made to produce the most sensible and economic alignment before earthworks commence. Too often we find setting out methods in use that are slow , cumbersome and inadequate in providing engineering control. The results are a lack of on-site design investigation, unsatisfactory drainage provision, poor alignment, and, eventually, because of the nature of these methods, partial or total neglect of level control and general lack of respect for site setting out.

For example a setting out method that relies, almost entirely, on producing a level foundation, with minimum earthworks, as the basic setting out procedure is unlikely to result a satisfactory rehabilitation to sunken and severely degraded road. It is quiet often in these cases that the primary rehabilitation requirement is to reinstate original road levels (or at least levels that permit economically free discharge from the side drains). This requirement demands that there exists, in the field, the ability to test and adjust set-out levels as to their effectiveness in producing the most rational solution to alignment and drainage problems before construction begins. A further all too frequent situation is the failure of mitre drains due to the inability of sites staff to set out free drainage gradients (it has to be said that in some cases these drains are constructed sloping uphill). In addition it is not uncommon to find excessively long mitre drains because the implications in providing side drain outlets were not considered until after the road levels were constructed. The ability of site staff to make rapid checks on the relative work involved in constructing long mitre drains (with their inherent maintenance problems) compared to raising the side drain levels is lacking in these cases.

A disadvantage of labour-based construction is that the works are executed in short units dictated by daily task rates. It is essential that each unit length of work is set out to suit the overall construction levels of a longer section designed to solve total alignment and drainage problems. This requires the setting out of a length of some 200 or 300 m of road to determine the most economical and satisfactory alignment before work

We must have design and setting out method, in the field, that enables site staff to make judgements to produce an alignment that suits the terrain and the drainage requirements over such a length, prior to construction.

One of the great advantages of labour-based methods over merchandised methods is the ability to set-out and construct to quite fine tolerances.

We should be able to compete with mechanical construction as far as the riding quality of the road is concerned and provide a superior drainage system. This advantage will be lost, however, if we do not provide the site staff with an accurate and practical means to set out the works and exert quality control. In fact in many cases there is no option, if labour-based methods are to capture an increasing share of rural road works, to demonstrating, in practice, that we have the means to construct technically sound roads consistently and sustainably.

A common argument against greater engineering control on the site is that costs increase. This argument doesn't hold water. It is true that on projects that have introduced greater technical control during setting out and construction, costs have marginally increased, but that is only when compared against work constructed to a lower, often sub- standard, level of lowest possible cost regardless of quality, but to build roads that are technically sound and meet national specifications. If this costs a little more, then so be it - that is what it costs. We do not need, now, to re-fight the battle to prove the economic viability of labour-based methods, that battle has been won. What we need now is to show conclusively that labour-based methods can consistently construct roads that are technically sound and are comparable to mechanically constructed roads in quality. This is the challenge.

PUBLIC RELATIONS

One of the most depressing aspects of working in this field is the need to apologise for poor standards of construction on labour -based projects. Too often these criticisms are well-founded. The problem usually can be traced back to a a lack of level control and quality control on the work site. Labour-based projects always have to struggle for acceptance by Government decision makers, and poorly constructed roads do not help this process. The only proven way for labour-based to gain acceptance is to demonstrate physically that technically sound, comparable quality roads can be built in this way. The fact that such roads are demonstrably cheaper cuts little ice if the result is sub-standard roads, often with a short effective life span.

One of the problems is that many labour-based projects are initiated by inexperienced engineers who have no exposure to traditional, tried and tested road setting out practices. They are trained in sophisticated surveying methods and have very little documented guidance in applying engineering control to labour-based projects in an appropriate manner. There is an urgent need for practical guidelines in technically sound setting out methods to be produced. It could well be that this grouping of experienced ILO engineers could be the means to achieve this. The introduction of a greater capacity for engineering decision making site, would have a beneficial impact on the public image of labour-based road construction and lead to a greater willingness to use these methods.

MAINTENANCE

One consequence of constructing roads to minimal cost, with minimal earthworks and to minimal standards is the effect on the subsequent maintenance of such roads. Too often maintenance problems are built into the roads (non-functioning drains, non-standard cross-sections and inconsistent camber) with the hope that somehow routine maintenance will cope. As I am sure we will discover later in this conference, we are still a long way from developing a really effective maintenance system.

Any effective maintenance strategy must begin prior to construction to ensure that all roads built are as damage resistant as is economically practical. This calls for a greater degree of engineering input during construction to ensure to ensure that completed roads are handed over to maintenance in a maintainable condition. Our limited maintenance resources are unbearably stretched if construction faults and the resulting damage has to be corrected by routine maintenance workers. These workers cannot cope, they are not able to carry out routine functions, they become demoralised and the deterioration of the condition of the road accelerates. The solution must be to introduce a more"scientific" approach to our road building whereby work is set-out and and built to correct levels, the drainage system is considered as a whole and set-out accordingly, and protective works are done during construction as standard practice.

Again it may be argued that this will add to the cost of construction, but costs should be seen as total costs, including maintenance, reduced service standards and earlier rehabilitation costs. The cheapest way to build a road must always be to build it right the first time.

WHY SETTING-OUT METHODS SHOULD BE DESIGNED FOR SITE SUPERVISORY STAFF USE

It may appear form the above that what is being argued is that there should be a greater presence of engineers on site and that all design and setting out be done by engineers. This is not so.

Unless we can develop technically sound setting-out procedures that can be undertook and applied at the foreman level we will fail to exert engineering control on the work site. There are insufficient engineers to provide cover to all sites. Engineers have other project duties, have transportation problems and in practice tend to make infrequent and irregular site visits. Unless an appropriate level of intermediate technology is transferred to the people resident on site and responsible for the day-to-day setting out of the work there is little hope of introducing improved setting out and quality control methods.

Many setting out procedures succeed on training sites and pilot project phases where concentrated engineering support is applied, but fail once the project expands and the site presence of engineers is reduced. Unless the means and the basic theory of setting out road works is introduced at the foreman level, the production of good quality roads will remain in a hit and miss affair - relying too much on luck and individual personalities and too little on sound basic methodology.

This will require a greater emphasis during training of construction skills and construction decision making by resident site staff. What is needed is site staff who can think on their feet and adapt the alignment of the road to the changing terrain. The old approach of trying to control site works from the centre by means of a rigid conveyor belt system of construction will not suffice if we are to produce technically sound roads sustainably. We should aim for a situation whereby routine alignment decisions are made on site at foreman level and that valuable Inspector and Engineer inputs are directed towards spot checks, quality control and guidance in unusually difficult and localised locations. Experience on projects that have introduced a higher degree of technical responsibility at foreman level shows that this approach works. Not only is there a dramatic improvement in the quality of the work, but this quality can be sustained with scant engineering support. The reasons are that foremen generally respond to the introduction of a system that makes their job more interesting and more challenging and provides them with them the means to produce work that is admired both by their superiors and by the local community. Site staff morale rises, greater interest in the work is generated and a general tightening up of all aspects of site management is usually observed.

What we need to do is to identify the most effective and appropriate setting-out equipment, give guidelines on the application of those setting out methods that will provide adequate technical control in various terrain conditions and provide trainers and training institutions with basic material that we need to be included in their courses.

THE MEANS AND THE METHODS

First lets look at the surveying equipment in use on various projects. It ranges from the overly sophisticated to the overly simple, from the most weird and wonderful inventions to the most crude and cumbersome. The general situation is not good. I have visited a fair number of projects over the past 12 months and I am sorry to say that you are more likely to find this survey equipment in the site store that in use in the field. The reason being that they are difficult to use, not accompanied by clear methods of application, require specialised training or are difficult to manhandle up and down a work site. Once the use of surveying equipment fails to be routine and habitual its use declined rapidly and respect for accurate setting out is lost.

What should we look for when selecting survey equipment?

1. It should be simple in use, yet effective and reasonably accurate.

2. It should be cheap and robust.
3. It should be locally available or readily obtainable.
4. It should be versatile in use (in order to reduce the range of equipment needed on site.
5. It should be highly portable, that is small and light.

In my experience there is only one item of survey equipment that meets all the above criteria. That is the string line level. When used in conjunction with profile level boards it is capable of covering, in respect of construction levels, all the surveying needs on site.

When used on site this combination is capable of determining existing terrain slopes, conducting preliminary route investigation surveys, setting out road levels, setting out drain levels, setting out structure levels, setting out approach slopes to bridges and culverts, establishing the length of necessary outlet drains and estimating earthwork quantities. All this can be achieved by means of simple equipment, easy to follow procedures and basic practical field training of foreman.

The necessary road profiles can be fabricated by any reasonably competent local metal workshop. They consist of metal ranging rods made from galvanised water pipe (with a metal point for driving into the ground), and adjustable, sliding, this gauge metal profile boards, that can be clamped to the ranging rods at te required height.

The basic method involves setting out a visual set of construction levels 1 m above actual construction. The work is then controlled and checked by means of "travelling" profile boards, 1 m in height, which are used at boning roads between the fixed profile boards. Finished levels above ground level are set out using string attached to pegs at the correct levels, found by measuring down from the profile boards.

One great advantage of this method of setting out is that labourers are provided with clear guidelines of the finished levels that they must produce. This results in a reduction in the amount of unsatisfactorily completed tasks, improved standards of workmanship and makes much easier the foreman and gangleaders task of checking work.

A short description of the basic procedures would be as follows:

-The centre line of the road is set out using the ranging rods spaced 20 m apart.

-Profile boards are fixed to each ranging rod 1 m above the existing ground level. Existing and proposed drainage structures usually have a deciding influence on road levels and these should be set out in advance so that the road alignment will suit culvert cover heights and drift and bridge approach slopes.

-The resultant vertical alignment indicated by these profile boards is inspected and minor adjustment (10 cm) made to produce a satisfactory vertical alignment with sighted-in vertical curves.

-The centre line levels are then transferred to outer ranging roads off-set at right angles on the drain line.

-The set-out road levels are then inspected for suitability, including the demands of an effective drainage system. (Low spots in the vertical alignment are located by the stringline level between adjacent profile levels along the road. Mitre drains are located and setout to determined invert slopes, and the length of the drain found by using the "travelling" profile. Culvert locations and levels are fixed). In rocky terrain it may be found advisable to lift road alignment over difficult excavation rather than try to dig through.

-Once these considerations have been made, the set out levels are adjusted to suit and finalised. Work then proceeds.

These procedures are designed so that, as far as possible within technical considerations, thevertical alignment follows, and is adapted to, the natural existing terrain. In exceptional cases where the alignment calls for embankments, raised approaches and heavy cut and fill, these would receive engineering appraisal before the centre line levels are finalised.

Basically this suggested method is a more practical and "scientific" approach to the old slot method. In this case the formation levels are not set by physically digging slot platforms -which makes the subsequent adjustment and alteration of these levels tedious and unpopular(hence not often done) - but my means of easily set out profile levels. The advantage being that the implications of set out profile levels. The advantage being that the implications of set out road levels on the amount of earthworks, the height of rock outcrops etc., and the overall needs of the drainage system can all be assessed before construction begins. Fine adjustments, and even realignments, where necessary can be made rapidly, without loss of mandays. This encourages site staff to refine road levels and produce the most economic and technically sound alignment.

In some cases, such as excavation in rock or heavy cut, it may be prudent to to excavate slots in order to more accurately determine the task rates; but this would only be done after road level profiles have been set and then the profiles would be used to guide the digging of the slots to correct levels.

This method involving the combined use of string line levels and profile boards has been introduces, and is in operation, on projects in Botswana, Zambia and Ethiopia. In all cases the method has been well received, and is being applied, by the site works. In all cases there has been an appreciable improvement both to the quality and to the technical soundness of the finished product. As the use of this method extends into a wider variety of countries and terrain types, experience is being gained that is enabling more accurate setting out to be achieved under quite difficult conditions.

It is not thought wise to lay down rigid methods of setting out and construction for all projects to follow. Each project will best decide the correct procedures for their situation. However, it is high time that basic standards are set for the technical quality of alignment setting-out which each project should achieve. I would propose that the current recommended surveying practices are critically reviewed and improved procedures, such as the one described here, are included in all future training. The choice of methods and procedures must rest with the project staff as long as they meet the criteria that they can be understood and applied by site staff at foreman level and that they produce economic and technically sound roads, sustainable once artificially high levels of engineering supervision and guidance are removed.

SESSION 4

HAULAGE OF MATERIALS THE OPTIONS FROM OXCARTS TO TIPPER TRUCKS

A SUMMARY OF THE PAPER PRESENTED BY WALTER ILLI, RRM TANGA

1. The following options may be used for haulage of materials:
   1. Animal carts:
      - Oxen or donkey
      - Tipping or non-tipping carts
      - 1 to 4 animals per cart
   2. Tractor /trailer
      - combination of 1 or 2 trailer per tractor
      - tipping or non- tipping trailers
      - hydraulic hitch or mechanical jack
   3. Trucks:
      - tipper or flat bed lorries
      - direct hand loading with shovel
      - loading with baskets or wheel barrows
2. The first haulage study is taken from the Kenyan Rural Access Roads Programme [RARP]. Gravelling was carried out using the tractor \ trailer combinations specified below:
   - 45 hp tractor (International)
   - 2,8 cm tipping trailers with balloon tyres
   - Heavy duty pick-up hitch

   For the period 1975-1983 RARP constructed 6000 km of earth road and gravelled 2500 km. The gravelled carriageway width was 4.0 m with an average depth of gravel of 0.1 m. For the earth road construction 1800 mandays per kilometre (md/km) was average productivity, and for gravelling 1400 md/km. The yearly output was 30km per year per unit. The gravelling unit consisted of 4 tractors, 6 trailers and approximately 80 labourers.

   After 1982 RARP made some changes in their gravelling programme:
   - The contracting out of roads with longer haulage distances (i.e. greater than 5km)
   - There was no replacement of tipping trailers with broken tipping system therefore all off loading of materials was carried out by hand.
   - There were two separate gangs, one for quarry preparation and excavation, and second for gravelling work i.e. loading and spreading.
3. The second haulage study was carried out in Tanga Region, Tanzania using animal haulage. The contractors were offered a contract ,a copy of which is attached in Annex A of this paper. They were responsible for excavating, loading and hauling the material and spreading the material on site. The trial site employed for 3 up to 7 contractors with hauling distances of 0.5 to 2.0

kilometres (km) with the resulting cost of gravelling 250,000 Tsh/km which equals approximately US $1250/km. The average output 420 cubic metres per month which was approximately 0.6 km per month. This method proved less costly than the equivalent equipment based gravelling. Figure 3.1 illustrates the progress.

4. The donkey carts used for the trial carried 0.5 to 0.6 cu.m. The carts had two shafts for hitching to one donkey. A second donkey could be attached to assist in steep incline or just an additional help. The weight from the cart was carried by a wooden saddle placed on the donkey. These details were illustrated by slides.

One cart with two donkeys would cost about 60.000 Tsh, and their maximum haulage distance would be 2 to 3 km. To gravel 2km of road per month would require 12 to 15 contractors.

Animal haulage is cost effective and efficient where haulage distances are kept below 3 km.

SESSION 5

SELF-HELP
A VIABLE OPTION FOR ROAD CONSTRUCTION AND MAINTENANCE?

PRESENTED BY JANE RICHIE

The short answer is no for the engineering, and perhaps for the community.

The choice to adopt the use of self-help labour for the construction of a road cannot be taken by the engineers , or the politicians . This option can only be considered by the communities who will be directly involved in the constructions and the use of the road.

PLANNED ROADS

Most rehabilitation work on roads is planned at regional , or district level based on some assessment of priorities ,such as the value of crops evacuated along a particular road . These decisions are made with out direct consultation with the people living along the road .this is then classed as top down planning. The decision to rehabilitate the road having been taken at regional or district level the entire work should be carried out by paid labour.

If the authorities decide to implement part of the works by self-help, there are many problems for the engineer.

- Will the people cooperate in a project they did not choose for themselves?
- Will they appreciate the reason for some roads in the region being rehabilitated using paid labour when they are asked to give their labour free?
- Will the project staff find themselves working with people who have been "mobilised" using force and/or intimidation?
- Is this type of free labour acceptable to the project staff and/or any finding agency?
- Can the villages involved be realistically excepted to say 4 or 5 kms of road to a good standard?
- Can an acceptable finish be achieved?
- Will the standard of road, or access achieved by self -help be identified in the minds of the administrators, politicians, and public as the only quality of road achievable using labour-based methods and therefore prejudice them against adopting these methods on regional or district roads?

From our experience in Rukwa we would like to say that the self -help section of the pilot project has not been successful, especially when compared with the good results achieved on the paid labour section. The self-help site was adjacent to a paid labour site which highlighted the difficulties. At no time were the people forced to work. A lot of meetings were held to try and clarify the reason for using self -help, and to encourage people to come forward for the roadworks. However the interest and motivation to join in the work was just not there. The short sections of the road that were completed were of a much poorer standard than on the paid labour site.

2. COMMUNITY ROADS

When should we as engineers become involved in self-help road rehabilitation?

Under the umbrella of integrated rural development projects, through a community development office, or perhaps in some special public works programmes, it may be possible for requests to emerge from villagers for assistance in rehabilitating a stretch of road that falls outside the regional or district network. If the village, or villagers have identified the improvement of road as their most urgent priority when compared with other possibilities such as water supply, school buildings, dispensaries, etc. then the engineers should consider lending technical support to ensure that the communities efforts are wasted in inappropriate work.

A second possibility for self-help roads may arise as the result of members of the community being involved in paid rehabilitation of a nearby regional road and then deciding to link into the regional road from their own village. The labourers will have learned the road building steps from their earlier work on the regional road and the foreman can be encouraged to assist in technical matters.

This type of self-help road was started adjacent to the paid labour site in Rukwa. It was completely instigated by the village who approached the foreman, employed on the paid works, to assist them with the setting out.

MAINTENANCE

If a community is uninterested in rehabilitating a road by self-help they will be equally uninterested in maintaining it to a satisfactory level. The only maintenance which may be done will be emergency repairs when vehicles can no longer pass.

A road which has been rehabilitated by paid labour will most likely be seen by the villages to be the responsibility of the government and therefore they will feel no responsibility for carrying out maintenance unpaid. It could also be argued that given the uncertainty of self-help maintenance that having provided money for the rehabilitation it is false economy not to ensure the maintenance by paid labour.

4. CONCLUSION

Engineers and Technicians should bot be slow to respond to the genuine requests for technical advice on a self-help project, provided they are satisfied that the request has come from the communities involved and that the people are aware of the level of participation to which they are committing themselves.

Self-help should not be considered if it has been proposed by the authorities only.

SESSION 6

SITE VISIT

THE USE OF LIGHT EQUIPMENT IN ROAD REHABILITATION

ORGANISED BY DEJENE SAHLE

The was no paper prepared for the site visit. The discussion at site and subsequent meeting at the seminar centre are reported in Volume II.

SESSION 7

TRAINING MATERIALS
CAN THERE BE A DEFINITE SET?

PRESENTED BY BENET SUNDIN AND JOE CONNOLLY

TRAINING MATERIAL

1. SUMMARY
2. PRE-CONDITIONS
3. PLANNING
4. PREPARATION
5. A-V SUPPORT
6. CONTROL/TESTING
7. ADJUSTMENTS/REVISIONS
8. FINAL REMARKS

SUMMARY

- The aim of this paper is to comment on a few points of general importance and interest, related to preparation of training material.
- It is in no way trying to cover all aspects of subject, but could form a basis for discussions and exchange of ideas and experience.
- Someone said: "- A lecture is never better that its lecturer -" and wisely so.

Allow me to add: - "The better the training material, the better the conditions for the lecturers to give a good lecture.

BENET SUNDIN
ILO TRAINING ADVISOR
BOTSWANA

PRE-CONDITIONS

Before the actual planning in detail of material for a training course, there are some important questions the designer should ask him/herself, - and take time to find the answers. -The training material will be based on these answeres.

For example:

- What is the aim of the course?
- What are the trainees expected to know, after the training?
- What is the previous education of the trainees?
- Are all trainees on an equal level regarding previous education, or are there big difference?
- What time is available for training?

The aim of the course, - what the trainees are expected to learn and, - Time available, are more complicated to deal with.

Only a personal interview, and/or a simple test will tell if you have to start by explaining why 5 x 6 = 30, or you can go straight to calculation of the volume of a ditch to be excavated.

PLANNING

When all facts concerning trainees and training requirements are collected, the Planning of the course can start.

The interview and/or test, mentioned above, will indicate if the candidates, intended for training, will form a homogeneous group i.e. only minor varieties in previous education. If this is the fortunate case, preparation of material can start.

Most often, however, that is not the case.

If the range of education is wide, several alternatives exist:

- Prepare a basic course for the lower level, (usually in maths and English), to be conducted prior to the actual training course.
- Prepare two courses, on different levels, accepting the fact that the result of the training will be differentiated.
- Prepare a course, the contents of which, spread wide enough to cover all categories of trainees. -This procedure is however NOT recommended. -When you lecture to the higher level, the lower will not understand and when you address the lower level, the higher level will sleep!

In the planning, the availability of teachers, must be considered. - Is it going to be a one-man-course" or will assistance be needed, and - in that case - will assistance be available?

Class-room and training facilities are other important points to consider in the planning phase. - You may end up with a perfect class-room, - good blackboards - but no chalk!

To come to the last, but surely not the least, point of importance in the planning work: - Copying facilities. Even if all training documentation, exercises, examples, tests, etc. can be compiled in sufficient numbers before the start of the course, the availability of a "reliable" copying-machine is invaluable.

There will always turn up ideas, proposals to changes, additions and deletions, during a course. However good the intentions of the teacher; "I'll copy it later and send it to you". ... Will it be done?

PREPARATION

Preparation of training material could roughly be divided into three phases.

- Collection of data
- Selection of data
- Editing

In the whole process of planning - Preparation - Editing, it is important that a close and continuous cooperation has been established and is maintained, with officers in the field of work, - familiar with local conditions, praxis and laws, to obtain advice and information and to avoid unnecessary mistakes and errors.

Today, a lot of suitable "raw material" regarding LIM can be found in already developed training manuals form projects around the world.

Textbooks from technical schools, colleges and universities are other sources of information. - And - of course, - material based on the designer's personal experience.

Usually, a lot more material that really needed, will be the result of the data collecting phase, but a good stock of "raw material" to select from, is a basic condition for a good end-product.

To my personal experience, selection of suitable material from data collected, is a very time-consuming and brain-twisting task.

Judgements and decisions continuously must be made whether selected information/examples/drawings etc. Should be used, or not. - Maybe I should use my own words to elaborate on the issue? - Maybe it should be deleted? -

Whatever the decision, all material selected must be adjusted to suit country related conditions, before accepted. Sometimes an excellent piece of information, prepared for a specific country, has to be deleted just because it cannot be "translated" to suit an other country.

During the selection phase the pre-conditions must be kept in mind:

- The ability of the trainees
- The time factor
- The required training result.

It is not unusual that a selection phase is followed by one or more re-selctions phases before the material is ready for editing.

Before editing, the Lay-out of the training material has to be decided, i.e. - Head lines,- Sub-head lines, - Numbering of paragraphs etc.

In the editing, the selected material is put together , with the aim to produce an informative, interesting and "easy-to-read" training manual.

This activity requires attention to, continuity, correct sequencing of the material, a clear arrangement of drawings and diagrams, etc. The designer, of course, must be able to write connecting text between information of different kinds.

A-V SUPPORT

- When electricity is available, which is not always the case, A-V equipment should be considered. An Overhead-projector to show pictures/drawings/forms/charts etc. is excellent for detailed explanation and discussions.

  NB. - with a minimum of TEXT!
- A slide-projector with series of slides is a good way to break the monotony of lectures and still feed information.
- TV and Video are expensive equipment, but, if available, maybe the best way to show LIM in

action. - A video tape, showing the various activities in construction and maintenance usually gives a remaining impression.

I have noticed that a video sequence showing the wrong way of doing things and results, followed by the correct procedure, usually is very well remembered.

An A-V equipment, not depending on electricity, is the "Sand-tray". A common desk (1.50 m x 0.75 m) supplied with a 10-15 cm high frame along the desk-top edges and filled with sand, is useful for demonstration of e.g. alignment, cross sections, drainage etc. - A low-cost equipment.

CONTROL/TESTING

A control of the text as such, i.e spelling, grammar, choice of words, formulations etc., should be left to somebody, with English being his/her mother-tongue. The money spent (if any) is well used.

The technical control of the training material is equally important and assistance can usually be provided by colleaques, asked to read through the material.

Errors detected before copying and distribution of a material, will facilitate corrections and, furthermore, contribute to the impression of a thoroughly prepared training material.

The actual testing of the training material will take place during the first course. Remarks, views and advise from colleaques and others are valuable, but only the tranineees, who are supposed to understand, benefit and draw from the course material, are in a position to give a valid picture of the quality of the material. Such comments will form the basis for adjustments and revisions of the training material later on.

The first course, based on a new material, will always be a "test-course". This, however, doesn't necessarily mean that the trainees from this first course will suffer from a poor training course, on the contrary, they may have learnt things they really don't need to know.

ADJUSTMENTS/REVISION

Based on the findings from the courses the necessary adjustments and alterations of the training material should be made.

In fact, this procedure is (or should be) a never-ending activity, as long as the course is repeated.

If the training material has been used for somewhat extensive period, an entire revision may have to be considered new working methods developed, new tools and equipment on the market, the general level of education raining etc. In other works, to keep the material up to date.

A revision of existing training material, in a way means to start from scratch again,considering the points mentioned in this paper. The advantage being the experience already gained from the use of the training material.

FINAL REMARKS

However high the quality of the training material, one has to remember that it is - THEORY - and must be recognised accordingly, i.e as a basic introduction to a subject/activity, later to be exercised practically.

Experience indicates that, the shorter the time - span between Theory and Practice, the better the training result.

Another reason for emphasising the desired close relation between theoretical and practical training, is the tendency among many trainees to study a training module, more or less problem; how to applay their knowledge to daily working conditions. This problem is also take up in the Module "Supervising People".

MAINTENANCE
DOES THE LENGTHMAN SYSTEM WORK?

PRESENTED BY JAMES AGINGU

LABOUR-BASED ROAD MAINTENANCE
THE LENGTHMAN SYSTEM

A paper presented at the International Labour Organisation seminar on Labour-Based Technology - A Review of Current Practice.

ABSTRACT

Lengthman system is a labour-based road maintenance method. Individual workers are contracted immediately after road construction to maintain a certain section of road. The workers are former employees of the construction unit. It is ensured that they live in the immediate vicinity of the section of the road they are to maintain. Consequently, no transport is required and they have a knowledge of road construction and of the standard to which the road has to be maintained.

INTRODUCTION

It is true that road network breaks up at a faster rate than it is added to, meaning that without proper maintenance, that money spent on construction would money wasted. This calls for routine maintenance to be carried out at the right time and regularly. If a road is difficult or impossible to pass for prolonged periods of time then the economic and social costs to the region concerned are high. Because of this and scarcity or resources, the standard solution to the problem has been to attempt to increase the efficiency of the maintenance operations so that as little part of maintenance expenditure as possible is lost in overheads or in badly executed work.

The system should be able to provide minimum level of maintenance services to maximum number of kilometres of road as well as depending to the minimum extent possible on external financial and material (transport etc) resources. The only option therefore is to identify, develop and apply cheaper, alternative approaches of road maintenance.

2. BACKGROUND

The Rural Access Roads Programme (RARP) was started in Kenya in October 1974 with the original purpose.of constructing 14.000 km of access roads using labour-based methods in districts with high agricultural potential. In 1986 the system was restructured as the Minor Roads Programme (MRP). By this time approximately 8,000 km of Rural Access Roads has been completed and the majority of them gravelled and brought under maintenance.

At the moment, the MRP is operating in 26 districts in Kenya. The overall objective of the current five year phase is to carry out improvement of 4,500 km of classified "D" and "E" roads and care for the maintenance of the existing network of roads, again with the special feature of using labour intensive techniques.

THE KENYAN MRP MAINTENANCE SYSTEM

3.1 GENERAL

In Kenya, maintenance activities are grouped into Routine Urgent and Periodic for planning, organisational and funding purposes as follows:

ROUTINE:	Operations required to be carried out once or more per year on a section of road. The need for these can, to a degree, be estimated and planned.
URGENT:	Certain unforseen situations necessitate remedial action to be taken as soon as possible.
PERIODIC:	Operations that are occasionally required on a section of road after a period of a number of years. They normally require significant or skilled resources to implement. These operations require specific identification and planning for implementation.

Out of these, routine maintenance can be shown to be the most cost effective activity in the road sector (along with "urgent" work). Its cost-to-benefit ratio is normally far higher than for new construction or periodic maintenance. For many roads about 1% of the asset value per year. Failure to carry out proper routine maintenance can lead to earth or gravel road becoming unserviceable in a period as little as 5 years. The consequence would then be a total rehabilitation requirement at substantial additional cost representing rate of asset depreciation of up to 20% per year. This cost- benefit relationship in terms of the road asset alone is significant, without considering direct user costs and consequences of delays, etc.

From the above consideration it is therefore sensible to give the higher priority to routine maintenance in terms of financial and physical resources, and management effort.

It is strongly recommended that in national terms the priority for maintenance funds should always be given to routine maintenance and the provision for urgent work. The amount of periodic maintenance and rehabilitation should be then adjusted within the balance of available funds.

3.2. The Lengthman System

Consideration was given to various ways of maintaining the completed Rural Access Roads and a "lengthman contractor" system was chosen as being labour based and most appropriate for these roads. The alternatives considered included the traditional MOTC equipment based practice , and the possibility of recruiting a gang of casual labourers two or three times a year to carry out the maintenance under the direction of an overseer equipped with a vehicle, caravan and mobile store. However , the costs , logistics and management problems of these alternatives weighed against their adoption .

For the chosen lengthman system an ex-construction worker appointed to each section of road, typically 1.5 - 2.0 km length. He is provided with hand tools and instructed on worker. The head man is visited once in two weeks by the Overseer to monitor the condition of the road and record the quantity of work per month on selected days for the road. This is, however, subject to the reported mondays. The contractor may be replaced if the consistently performs badly.

The contractor would live adjacent to the road and would therefore not require government accommodation or transport which consume considerable resources in a traditional equipment based on maintenance system. A principal attraction of the system is a comparatively low level of equipment requirement and consequently support problems.

The lengthman system also creates productive paid employment in rural areas where there are few opportunities for such work. The contractor is able to live at home with his family and the part time terms give him opportunity to work on his own land as well.

3.2.1.1. Lengtman-contractor

The lengtman should ideally be a person who had worked on the construction or improvement of the road. This is usually feasible when initial maintenance operations are set immediately following the improvements /construction of the road. Lengthmen appointed at a later date are not likely to have this prefered background and therefore extra care must be taken in their selection. There would also be a need for on-the-job training of a new lenngthman.

The lengthman should leave adjacent to his section of road to minimise walking to and from the worksite

the lengthman is completely responsible for all routine maintenance activities R1-R11 as defined in appendix A on his section of road.

To facilitate supervision and control the lengthman works on specified days each week. The overseer arranges these days to suit his inspection programme.

The lengthmen is directed to carry out specific activities each week and task rates are laid down.

3.2.1.2. Headmen

The Headman is responsible for day to day supervision of the lengthman. The physically set out the tasks for each lengthman and check the productivity and quality of work. They also make a simple report to the overseenon progress on the directed activities for each lengthman.It is the responsibility of the Headman to bring to the notice of the Overseer any physical personnel problems.

Such requirements necessitate that the headman must be a responsible person and must have a basic understanding of all of the maintenance activities involved. He should therefore preferably be selected from the construction/Improvement headman, or have been a lengthman with qualities of responsibility and able to command the respect of other contractors.

3.2.1.3 Routine Maintenance Overseer

The Routine Maintenance Overseer is responsible for this organisation and control of all routine maintenance activities within his designated area. He is also responsible for identifying the need for any urgent works and making arrangements through the OIC Maintenance for them to be attended to. The urgent work is usually supervised by the Routine Maintenance Overseer.

His duties include:

- ROUTINE INSPECTION.

  Visiting all roads under his responsibility at least twice per month to direct, control and monitor the routine and urgent maintenance work with the assistance of the headmen.
- Specifically:
- Directing the headmen and contractors in the priority activities and setting productivity rates.
- Instructing the headmen and contractors in the correct maintenance techniques for each activity.
- Monitoring the quantity and quality of work achieved since the previous inspection.
- Identifying the need for an URGENT work.

The Overseer is accompanied by the headmen during inspection.

3.2.1.4 Officer-in-Charge, Maintenance

He has overall responsibility for a day to day functioning of the maintenance of the MRP network in the District. He assists the DMIE in all matters relating to Planning, Organising, Supporting, Monitoring and reporting on maintenance. He is normally of the grade Inspector.

His duties include:

- Annual inspection of all MRP roads in December/January/February with or without the DMIE to objectively determine the condition of each section and the need for Periodic Maintenance.

From this Inspection he assists the DMIE to prepare the draft District MRP Maintenance Plan for the following GOK financial year. The plan will be finalised when the actual funds allocation is advised.

- The preparation of work programmes for each Maintenance Overseer, and monitoring the work progress to ensure that they are implemented correctly.
- To ensure that the Overseer maintain their equipment correctly and have adequate transport, fuel, construction materials and any other resource required.
- To ensure that overseer supervise the work correctly and complete the necessary Reports accurately on the progress of the work.
- To ensure the prompt, correct and full payment of all casual labourers and contractors engaged on the maintenance work.

3.2.2 Routine maintenance activities

The routine maintenance operations required are as follows:

R1 - Inspection and removal of obstruction

R2A - Clean culvert and inlets

R2B - Clean culvert outfalls

R3 - Repair culvert headwalls

R4 - Clean mitre drains

R5 - Clean side drains

R6A - Repair scour checks

R6B - Repair side drains erosion

R7A - Repair shoulder erosion

R7B - Grass planting

R8A - Fill potholes in carriageway

R8B - Fill ruts in carriageway

R9A - Grub edge of carriageway

R9B - Reshape carriageway

R10 - Grass cutting

R11 - Bush clearing

All of the above operations are within the capability of lengthman .

Priorities have been established for the routine maintenance activities for each season. These priorities ensure that the most important activities are tackled first in the pre rains and rainy season . However, each activities will be achieved at some time of the year as it rises in priority.

3.2.3 Maintenance reporting system

The reporting system is based on printed report forms which are filled out by the supervisory staff and passed as reports to higher levels in the MRP organisation. The forms are designed in such a way that they would facilitate planning, monitoring and controlling work. They are listed below in the order in which they are normally filled.

a) E4 - Road inventory: formal description of a completed road which is maintained as a record and used in the planning of maintenance work. Filled by the engineer immediately after improvement.

b) M1 - Resource planning guide : to determine the length of maintenance contractors section and the number of contractors required for each road filled by the engineer when routine maintenance organisation for the road is being set up.

c) Maintenance inventory : To record all information relevant to the maintenance of the road. Filled by the Inspector after the maintenance contractors have been employed .

d) M 2 - Annual inspection: to carry out assessment of the condition of each road and the effectiveness of the routine maintenance. Filled in jointly by the Engineer and Inspector before the preparation of the work-plans for the following financial year.

e) Routine Maintenance Plan and Report: to plan the work of the contractors for the next period and check the report of the work carried out during the previous period. Filled by the Overseer at each visit to a road.

f) M 3 - Headman Instructions Maintenance: to instruct the headman on the tasks given to each contractor. Filled by the Overseer during his visit to the road after completing the Plan and Report.

g) M 4 - Monthly Sub-unit Report: summaries the information from the "Report", for each zone. Filled by the Inspector at the end of each month.

h) M 5 - Monthly Unit Report: to summarise the workdone and resources used by each maintenance sub unit during the month. Filled by the Engineer at the end of each month.

3.3 Improvements on the Maintenance System

Under the RARP a Technology Unit was set up to carry out investigations and trials into suitable techniques for RARP. This work was largely accomplished. However, with the commencement of the

MRP, it was appreciated that certain modification to the RARP methods of working would be required. Consequently in February 1987 a Technology Unit was again set up. To date several significant studies have been completed by the MRP Technology Unit, some of the most recent being the Maintenance Study 11 Phase 1- Productivity Standards , which was completed last year and the Maintenance Study 11 Phase 1 B - Supervision Arrangements, whose report is just being compiled. At the movement the Technology Unit is preparing guidelines for the full implementations of the Interim Maintenance System in all MRP districts sa well sa setting up Maintenance Study 11 Phase 2 - Maintenance Requirements.

CONCLUSION

Lengthman system has proved to be the most appropriate labour-based road maintenance method for the Kenyan Minor Roads Programme(MRP). The system has a number of advantages over the traditional equipment based maintenance practice. Firstly the contractor is a local man, his relatives and friends use the road that he maintains. He is responsible for "his own" section, hence he is most likely to take it as a personal obligation to ensure that it is properly maintained lest he is penalised. The work is not directly dependant on the availability of equipment and vehicles and the amount of equipment and transport required is reduced to the absolute minimum.

The system relies on an abundant labour resource which exist in the areas of RAR's and MR's and does not have the high accommodation and transportation expenses and constrains suffered by the equipment based maintenance system. The labourer has the added advantage of living at home with his family.

Significant permanent employment is created in the rural areas.

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SESSION 9

WORKER MOTIVATION
DAYWORK, TASKWORK, PIECEWORK

WHAT DIFFERENCE DOES IT MAKE?

PRESENTED BY ULF BRUDEFORS AND WALTER ILLI

PRODUCTIVITY STUDY
BOTSWANA 1989

Haulage of material
Excavation of drains
Clearing of road reserve

Ulf Brudefors
ILO Gaborone February 1990

TABLE OF CONTENTS

PREFACE

The purpose t of this paper is to brief the participants in the Mbeya ILO seminar 1990 on a productivity study. It covers Haulage of material, Excavation of drains and clearing of road reserve. The productivity study was carried out in Botswana during 1989.

This paper focuses on Haulage, and will consequently not cover the entire study. Some examples presented are taken from training sites for on-the-job training of gang leaders.

A comprehensive report will be presented to all Road Units in Botswana at a later stage.

The annexes contains tables with some background information.

INTRODUCTION TO PRODUCTIVITY STUDY

1.1 Background

The productivity of the road work in the Botswana districts in expressed by man days per km and cost per km constructed road. The country average for constructing earth roads is somewhat more that 2000 md/km and the average cost is close to P 15 000 per km (US$ 7 500 per km). The output can be regarded as acceptable.

Man days and cost per km road are relevant measures of productivity, but they are only crude indications. It is impossible to count for all variable factors which influence on the work output.

The use of task work has previously been implemented in the programme for hauling and excavating activities. Task work is widespread, but not always used correctly. Standard task tables are used by the gang leaders. They are trained to set out task work. During my field visits i have learned that task work is carried out with varied results. Gand leaders trained during the recent years seem to have a better understanding of using task work than 'older' gang leaders. The standard task tables are often used straight ahead without any adjustments for various conditions. The major problem seems to be lack of judgement and adjustment of tasks.

On some work sites the labourers refuse to have task work more than 2 -3 days a week. This seems to be a problem on work sites close to towns and major villages. The work is obviously too hard for the low salary of P 4.66 per man day (US$ 2.35 per man day). For various reasons some work sites do not have task work.

With experience from my field inspections I thought that a closer supervision and a correct use of task works would probably increase the output by 25 - 50%. An adjustment of the standard task rate tables would give an even higher output.

In order to improve the work output and find the bottlenecks of productivity a more detailed study was necessary.

1.2 Scope of the Study

The objectives of the study were to measure the cost and productivity of:

- -Haulage of material
- -Excavation of drains
- -Clearing of road reserve

The study was introduces in order to review indicative values for productivity of the various activities within the three main categories of work. The productivity used is measured by;

- -m^3m/man day and P/m^3km for hauling
- -m^3/man day or m^3/h and P/m^3 for excavation
- -m^2/man day and P/ha or P/km road reserve for bush clearing

The productivity study was initiated in April 1989. The closing date was set to the beginning of December 1989. The report period covers accordingly both the winter and summer seasons.

The study was first tested at our training sites for on-the-job training of gang leaders.This institution is called the Field Training Unit (FTU). The FTU is located outside Molepolole in Kweneng district. The monitoring was later carried out in all districts except for Ghanzi and Kgalagadi districts, Boteti and mhalapye sub-districts in Central district in North West district. Reports have been obtained from almost all work sites.

Diagram 1.2 shows the number of records in the study. The work carried out under'clearing of road reserve' is executed in teams of labourers. The number of labourers observed in this study is shown in the second pie chart.

1.3 Study Methodology (See diagram 1.3)

Three new forms were designed (see annexes A,B and C). The forms were first tested by the gang leaders at FTU. The road work at FTU is executed in the same manner as on all other work sites. FTU's total overall productivity is close to 1500 md/km. After the test the study was introduces to the other districts. Spot checks were later on carried out on a random basis. The gang leaders completed the forms and the Technical Assistant was responsible for reporting to the head quarters.

The forms are compiled on a computer in database programme. The programme used is an integrated data programme, called Microsoft Works version 1.05 Database models were set up on the computer for each district. The next step was to enter the information of the forms. When having a lot of data an input check is necessary to avoid typing mistakes. Control of input credibility is essential. Approximately estimated 5 - 10 % of all observation were taken off the records.

The result of the study submitted with new guidelines will be presented to all District Councils Road Units. A second simplified to all District Councils Road Units. A second simplified presentation will be given to the gangleaders at their work sites. The study could also be used in teaching at Road Training Centre (Road Supervisory Level) and Field Training Unit (Gang leader level).

2. PRODUCTIVITY STUDY ON HAULAGE OF MATERIAL

2834 hauling activities have been observed and recorded in this study. Somewhat more than one third is recorded under daily work. Task work represents the remaining two thirds (Diagram 2.01).

Almost half of all work is carried out by women.

Diagram 2.02 shows the distribution of daily and task work in the various districts. Annex D shows the number of observations per site.

The new form included 'general information' such as Labour number, age, sex etc.and 'hauling information' such as number of trips, haul distance and sloping ground etc. (See annexes A,B and C).

The condition of the ground should reflect the work effort to push a wheelbarrow or pull a donkey cart on the ground. The variable is subjective and is difficult to check afterwards. The variable has therefore not been considered in the analysis.

The slope of the ground is of course also subjective. One gang leader might for example indicate a slope downhill even if the slope is hardly noticeable while his colleaque indicates a flat fround. The analysis have been divided into flat, downhill and uphill grounds. 76 % of all observations had a flat ground, 16 % had a slope downhill and 8 % had a slope uphill. No significant deviation has been notified for the three categories.

The maximum load of a wheelbarrow is 70.1 spot checks at FTU indicates that 50.1 is a more credible load. Spot checks in other districts indicates an even smaller load. A load of 50.1 has been used in the calculations.

The records of donkey carts is not included in the analysis due to insufficient number of records.

2.1 Standard Task

The standard task table is probably established by an ILO expert. I have not been able to find any background information of this issue. A table of standard task for hauling is currently used (table 2.1). The table is well known in all districts. At FTU the trainees have been taught to used the table, but also told to adjust for local conditions. Adjustments are very seldom done on the work sites. A volume of 50.1 per wheelbarrow has been assumed in the calculation of the work output. Diagram 2.1 shows the output against haul distance.

The work output is expressed as m3*m per man day. A comparison of productivity between daily work and task work is shown in Diagram 2.2. The average m3*m/md is presented by work site. This first presentation is a bit rough. For example, it is not evident that site 4031 has the best performance on task work. As a matter of fact the standard task table gives a higher work output for longer haul distances. For a better judgement each site has to be studied separately. However, the comparison between day and task work indicates a clear pattern. The productivity on task work is considerably much higher for some sites. The diagram also tell us that three sites (1121,1126 and 4022) have a very low output. Accordingly, they have not used adequate tasks.

2.3 Costs of Haulage

The cost per m3*km is another relevant measure of productivity. The cost parameter is often easier to use in a comparison with other haulage alternatives. Diagram 2.3 shows the cost for the work sites at FTU. The gangleaders on sites 5063 and 5065 have a better control over the daily hauling activities thatn the other gang leaders. They have all used the standard task table correct. The average cost of haulage at FTU is somewhat more than P 25 m3*km (US$ 12.5 per m3*km. Hauling is expensive and should be minimized.

2.4 Site presentation

To avoid a hasty conclusion an analysis of each work site should be done. Is there any difference in haul distance for the two types of work? One could assume that the labourers prefer to have task when the haul distance is short and day work on long distances. If the gang leader is easily influenced by the labourers requests this will of course affect the work output.

Site 5061 at FTU is shown as an example (see Diagram 2.4). There is no significant difference in haul distance between day and task work (2^{nd} chart). The senior gang leader on site has a correct level of tasks according to the standard table. He is obviously not aware of the output when he is using day work. The dots in the scattered chart represents the number of trips for each labourer on day work. The dotted line represents this work site's average of all trips by 10 metre sections. It is an obvious decrease in haulage when the labourers are pm day work. The cost is somewhat more than 2.5 times higher than for task work. The average working time for task is 5.18h, which is adequate.

2.5 Haul Distance

An analysis of haul distance intervals gives more information. It is possible to detect if some haul distances intervals have a lower output tht the others.

Table 2.5 shows the result of task hauling for distances for 20 - 30 meters. Annex E shows the same example of a database printout. The annex includes hauling on daily work.

60 % of all hauling is carried out with a distance of 40 meter or less. 80 % is carried out with a distance of 60 meter (see Diagram 2.5).

Diagram 2.51 shows the number of trips per 10 meter long section up to a 60 meters haul distance. The average number of trips on day work for all the 35 work sites is compared with standard task.

The average is 57 trips in the first interval. This is only 47 % of the standard task in this interval. The output of daily work is closer to the standard tasks for longer distances.

2.6 Working Time

The working time indicates to what extent the measured tasks are appropriate. A labourer should be able to finish a task work within 5 - 6 hours. A working time of 6 hours represents 75 % of an 8 hour daily work. The study provides working time per 10 meter long sections.

The average working time for all sites is almost 5 hours. The lowest site average is 3.7 hours and the maximum is 6.6 hours.

2.7 Women in work

Almost half of all work is carried out by women. A productivity comparison between men and women at FTU indicates that there is no difference in the work output. Men on day work transport in average 142 m3*m/man day while women transport 135 m3*m/man day.

A further spot test of the observations in Kweneng district gives the same pattern. 193 of the 311 observation on day work are carried out with a distance of 60 meter or less. Within this haul distance men transport 116 m3*m/man and women 113 m3*m/man day.

2.8 Conclusions on Haulage

60 % of all hauling is over a distance of 40 meter or less. Within this haul distance the cost of day work is times higher for day work than for task work. The total average costs are P 50 per m3*km for day work and P 31 for task work. Hauling of material is accordingly an expensive activity in labour-based road construction and should be minimized. Task work must be used.

The standard task rate table will be revised.

Sites with an incorrect setting of task have been identified, and the gang leaders should attend a refresher course.

RESULT OF THE STUDY

The study will provide information for adjustments of various tasks. The result of the study submitted with new guidelines will be presented to all District Councils Road Units. A second simplified presentation will be given to the gang leaders at their work sites.

Refresher courses at our Field Training Unit will strongly emphasize the advantage task work in order to improve the work output. Seminars and workshops are well suited for studying and discussing technical issues with Technical Officers and Technical Assistants.

The supervisory personnel is well motivated for introduction of improvements and innovations in order to increase the work output. However, for the casual labourers increased output will normally mean harder work and many labourers prefer to take it easy in 8 hours with day work that to work hard in 5 - 6 hours with task work.

The only incentive the labourers accept is a pay high enough to be considered as a fair compensation for the work they have to do. The current salary of P 4.66 per day (US$ 2.35 per day) is far behind an acceptable pay. In many parts of the country it is difficult to attract labourers for the current wage level, and it is increasingly difficult to maintain a stable work force on some work sites closer to major villages and towns in the Eastern Botswana.

LIST OF CONTENTS

1. INTRODUCTION

RRM Tanga started labour-based road rehabilitaion trials in July 1987. During the first nine months approximately 15 km of roads were rehabilitated. The trials were carried out using a task rate system. Problems were experienced in recruiting sufficient labour and in achieving the output required to make the operation viable. It appeared that the low wage rate, combined with the hard work, were the main cause for the situation. Therefore an alternative to the task rate system was sought.

After consultaions with the PMO, MCW, MOL and the Regional Authorities it was agreed that a piece work system could be established to attract more labour, increase the output and possibly lower the costs. The following paper is a proposal for the rehabilitation sites. If the system proved successful, similar systems for gravelling and maintenance sites could be developed at a later stage.

2. DAILY TASK RATES FOR ROADWORKS AS RECOMMENDED BY THE INTERNATIONAL LABOUR ORGANISATION

During the trial periods of various labour based programmes in different countries,ILO and other agencies carried out extensive studies on the amount of work one person is able to do within a day, Main objective of these studies were, to set uppler limits in protection of the Worker's health.

It is obviously not possible to find fixed measures for each and every type of work in roadconstruction. Too many factors vary from place to place. Some can be valid for whole programme, but others might vary from region, district or be even different on one and the same road. Additionally some are bound to seasonal variations, relevant for fair setting of daily task or piece rates are:

SESSION 10

MONITORING AND CONTROL
FORMS OF COMPUTER PACKAGES
CAN WE ACHIEVE A STANDARD?

PRESENTED BY JOHN DE BLAQUIERE AND TERJE TESSEM

Introduction

In the context of Road works, Monitoring is the link between planning and implementation.

Planning involves answering the following questions:

1. What to do?
2. How to do it?
3. What is needed to do it?
4. When to do it.

Answering these questions involves making assumptions:

(1) What to do?

Assumptions made in the economic assessment and prioritization of projects. Such as generated traffic, stimulated agric activity.

Assumptions made in specifying works to be carried out to achieve certain standard of road: i.e. that by doing certain drainage improvements, gravelling, culvert construction etc. and all-weather road will result.

(2) How to do it?

Assumptions made to decide the best mix of labour and machine and mode of labour employment - contract, direct labour, task work etc. - include: that labour will be or not be available, that labour can or cannot perform certain tasks, that certain productivities and costs can be achieved.

(3) What is needed to do it?

This involves estimating the resources needed such as manpower, machinery, materials and finance.

(4) When to do it?

In deciding on this assumptions may be make on such aspects as relative productivity achievable in various climatic seasons, varying availability of labour during different seasons.

Without a great deal of research or relevant experience many of the assumptions made may be wrong - certainly some of them will be less that accurate.

The main purpose of monitoring is to check on these assumptions made for planning purposes.

Monitoring is a normal function of supervision and even where there is no formal system a good supervisor will accumulate within his experience much of the information which a monitoring system is designed to establish.

Such information however is not always readily available to management and is not verifiable and possibly not comprehensive. Monitoring might therefore be considered as a tool of management.

LABOUR BASED ROAD WORKS

MONITORING

1. Basic consideration in setting up a monitoring system

(i) How is the information derived from the monitoring system going to be used?

(ii) What specific reports are required by Higher Authority (Provincial or national H/Q., donors etc.) and what specific feed back is needed to satisfy this?

The system must be suited to the institutional framework of the organization. How many tiers in the structure of the organization?

(iii) What is the capacity of the Organization to collect data and process it?

- (a) Ability of site foreman to measure and record.
- (b) Ability of controlling office (e.g. District Council Office) to process field data.
- (c) Manual or computer processing.

(iv) What capacity has the organization for planning and programming? In what degree of detail is the work plan prepared?

(v) The system must be related to type of work, the construction method and the method of deployment of labour (e.g. task work piece work, contract etc.)

(vi) What information needs to be derived from the monitoring process?

(vii) Avoid collecting and processing data which is not going to be used.

2. What will the feedback be used for

(i) To check productivity:

(a) to ensure reasonable output from labour

(b) to adjust rates used for estimating/planning

(c) to draw attention to deficiencies in working methods and supervision and to possible anomalies and malpractices in the employment of labour.

(d) to compare with productivities on other sites in the areas as well as with norms used in other regions and by ILO.

(ii) To compare progress with programme and to explain any differences, e.g. unrealistic programme targets , inefficient operation, variation fro original work plan, work plan in/accurate etc.

(iii) To compare the effectiveness and efficiency of the labour-based operation with that of machine operation.

(iv) Monitoring is also required to control the following aspects:

(a) Vehicle usage

(b) Stores control

(c) Expenditure

(d) Tools

(e) Quality

Special formats may need to be designed for these aspects but it is considered preferable to use any existing formats in use by the local authority and if necessary adapt these to the needs of the labour-based operation

Quality control is mainly a matter of supervision.

(v) To check on the overall performance of the project in achieving the objectives and outputs for which it was designed including socio-economic factors and employment patterns.

This aspect is outside the scope of this presentation except to mention that data collection needs to be continuous through the life of the Project, particularly for such aspects as:

- Employment of Women
- Employment patterns generally
- Traffic data, if significant

(vi) Every organization is responsible to somebody and that "somebody" may be an institutional structure of several tiers comprising for example District Headquarters not to mention donors and consultants. Any of these may require feedback of specific information/statistics to satisfy their bureaucratic obligations. For this reason it may be necessary to monitor certain facets which are not directly of use to the local management, but may be required in the context of regional/national planning.

3. The Capacity of the organization to collect and process data:

(a) Collection of Data

The data on which the system is based relies upon information from site recorded by the gang leader/foreman.

In some cases, for example, the gang leader may not be able to measure the completed days work of ditching and sloping in m^3 - at least not accurately. Where the task work system is in operation he may allocate the daily tasks of ditching and sloping in terms of the length of side drain by reference to table relating the depth and width of drain to the task length for various daily task rates of say 3.5, 4.0, 4.5, m^3 by multiplying the task rate by the number of workers. The productivity derived from this will not help in checking on task rates.

In such cases there is a constraint on the details in which productivity can be monitored. Side drains and camber may have to be monitored in terms of worker days per kilometre of road

(b) Processing of Data

Where the office in which the data is to be processed is a District Council Office which may be already short-staffed and lacking in facilities to carry out its existing functions it would be advisable that the monitoring should be as simple as possible.

The system to be devised will also depend on whether a computerised or manual system is to be used. Where the system is to be used by District Councils it is unlikely that computer facilities will be available and therefore a manual system should be devised.

4. Planning/Programming/Targets

The methods and procedures for formulating annual programmes and shorter term work plans must be considered at the same time as the methods and procedures for monitoring.

The degree of detail on which the planning estimates are based may vary from a detailed bill of quantities to application of rates per km for various categories of road. Whatever way it is assessed however, the work plan should include an estimate of the resources of labour, materials and equipment required. The output of the monitoring system should be aimed at verifying the assumptions and rates used in drawing up the work plan.

5. Type of Work/Working methods

Different formats and procedures will be needed for different types of work. e.g. general road improvements, gravelling and structures.

The procedure for monitoring will also vary depending on how the labour is organized, e.g. Day - work,Task - work,Piece - work, Contract

6. What information is to be derived from the monitoring system

Giving consideration to all these factors it should be possible to decide what information is to be derived from the system and to devise formats whereby such information can be obtained reliably and reasonably accurately.

The system devised for the LBRP, Zambia, Northern Province, comprises 3 sets of monitoring formats for:

(i) Road Rehabilitation

(ii) Gravelling

(iii) Structures

For each of these there are 3 forms.

(a) The weekly report in which the gang leader enters data daily and which he submits to the office at end of the week.

(b) The monthly summary in which the office summarizes the weekly totals of all weekly reports received in one month for each road project.

(c) The monthly progress and productivity report for each road project.

For structures there is a structure completion report instead of a monthly progress and productivity report.

These formats are designed for manual processing and to give a monthly progess and productivity report.

ROAD REHABILITATION

The monthly report shows Progress, inputs and Productivity :

- for current month
- cumulative to end of current month
- for total programme.

Clearing, drainage and carriageway construction are measured in Km of completed road and productivity in w.d./km.

Splashes and scour checks are measured as completed units and productivity as w.d./unit.

Equipment input is measured in days and productivity as equipment -days per km.

Non-productive labour is shown as a percentage of total labour.

Women's participation in worker-days is also shown as a percentage of total labour.

The final monthly report on completion of a particular road gives a comparison of the inputs and productivities achieved with those programmed.

GRAVELLING

This is considered as four operations:

- Quarry Preparation: clearing overburden, access etc.
- Quarrying: excavation, stockpiling and loading.
- Gravelling: preparing formation, off-loading and spreading.
- Haulage:

Quarry preparation: The percentage of the total work to be done on this activity which has been completed in the month is assessed by the supervisor or engineer and the labour input recorded. Productivity is not computed but at the end of the project the input in this activity may be evaluated as worker days per m^3 extracted or per km of road gravelled.

Quarrying: is measured in M^3 of gravel hauled assuming that at the end of the project no stockpile will be left. If a stockpile is left the volume can be measured and added to the quantity hauled on the final monthly report. Productivity is measured as w.d./m^3.

Gravelling: is measured as length of completed gravel road in km and productivity as w.d./km.

Haulage: The average haul distance and average number of trips per day are derived and these results can be compared from one site to another.

Non Productive Labour and Women's participation are recorded as percentage of total labour.

As for Road Rehabilitation, Progress, Inputs and Productivity are shown for current month, cumulatively and for total programme.

As for Road Rehabilitation, Progress, Inputs and Productivity are shown for current month, cumulatively and for total programme.

STRUCTURES

It has not been found practicable to monitor productivity in various activities such as excavation, backfilling, masonry, concrete etc.

Instead the inputs of labour, equipment and materials, under various categories, are recorded and on the final report they are evaluated at current prices and compared with the estimate.

Most of the structures involved in the Project will be culverts and drifts of various descriptions. The important output of the monitoring system is to find out the actual inputs of labour equipment and materials for a particular type of structure and compare these with the estimated quantities.

Simplicity - Sustainability - Flexibility

It is not unusual to find in a civil service organization the remnants of a monitoring system which has become defunct.

Typically the system will have been set up in the past by a work study team, consultant or project team. When the authors of the system depart it is left to the in-house organization to put it into practice. It works for a time but can easily die like a plant without water.

Like a plant the roots are often the last to die. The roots of the monitoring system is the basic recording done by the field staff. Field reports continue to arrive in the Office but are not followed up and just collect dust on a shelf.

The reasons for this failure may be many:

- The system not fully understood by officials in the office
- The office staff inadequate to process the information
- The system is too complex
- Staff changes in the office
- General lethargy
- Breakdown in communications
- The system is no longer relevant

To ensure that a monitoring system will continue to operate effectively.

(i) it must be fully understood and accepted as being useful to the management staff.

(ii) It must be simple to operate and not impose too much extra work load on the office.

(iii) The system must be kept under review and modified if necessary with changing circumstances so that it continues to fulfill a useful purpose. This will not happen unless the management find it useful and are therefore interested.

MONITORING AND CONTROL

Monitoring and Control is the subject for this session. I will however start by discussing the need for what we with a general work call monitoring. More specific, monitoring of the project execution is, in this paper, a close look at the activities undertaken in the fproject by relating the outputs to the inputs.

THE NEED FOR MONITORING

Why do we or should I rather say why should we introduce monitoring of our projects? (The latter is prompted by looking at the situation in many projects)

The monitoring is on the one hand linked to the control function as indicated in the title for this session. There is a need for data to control the achievements in the project as against the inputs provided. Lack of such data is mainly the reason why a lot of review and evaluation missions stress the need for monitoring. I would however stress the other, important reason for the monitoring, that is the need for inputs for the planning of project activities. For the project engineer, this is also felt more essential than the control.

Some of the advantages of using monitoring systems are probably worth repeating in spite of the fact that most of you know the advantages very well.

We need data on project achievements for:

1. Promotion of Labour-based methods

Labour-based methods are still not universally accepted as an efficient means of infrastructure creation. There is, undoubtedly, a need to provide data on labour productivity and unit costs in order to have some substance in the promotion of labour-based methods. It is in fact a precondition to convincing government officials, development organisations and donors of the efficiency and viability of labour-based technology. Such data can only be obtained on the basis of an organised monitoring system.

2. Improving quality of work through planning and evaluation

Most of our projects are aiming at the development of a capacity at district, regional or national level, in the planning, execution and evaluation of labour-based projects. An indispensable tool necessary for the creation of such a capacity, and not to mention a sustainable capacity, is an effective monitoring system. This system will enable the personnel to make informed decisions concerning the most appropriate technology to be used in a given situation.

PLANNING AND REPORTING

General

Planning and reporting include a whole range of different plans and reports. That is, the supervisor and foremen prepare plans for the site activities and they are requested to report to the engineer on the same. Equally, project headquarter engineers prepare project plans and reports, the districts and regions under the different Ministries (either a so-called line Ministry or Ministry of Finance/Planning) have the same responsibilities for annual plans and reports. Many other players are included here and even the ILO and Geneva will sometimes be included in the planning or reporting line when we are the executing agency for a project or a programme.

Planning

Monitoring and proper reporting can only be prepare when achieved data can be related to planned inputs. Planning is a prerequisite for a meaningful monitoring. This situation can thus be compared with the discussion regarding the chicken and the egg - who came first?

I do remember that I earlier said that projects are monitored and that report are prepared in order to plan projects. This is however not a contradiction. Planning and reporting is an interactive process and good monitoring and reporting systems will provide reliable data for improved planning purposes.

Reporting

Reliable data is also necessary to enable a proper comparison of techniques. This comparison has become increasingly important since the early comparison of labour-intensive methods in general. Today, we use the terminology of labour-based, rather than labour-intensive methods. This reflects the increased use of mixed technology which requires comparison of techniques at the activity level. The monitoring system should therefore provide reliable data on productivity by activity, enabling a continuous assessment of the inputs by the project management. The data will also be a valuable asset for new project managers to compose the best team based on appropriate technology.

MONITORING AND REPORTING - MICRO MANAGEMENT PACKAGE

Let us now have a look at the development of a monitoring and reporting system in ILO, EMP/INFRA. MMP, the Micro Management package, developed by ILO in cooperation with David Stiedl in 1988-89, is providing a tool for a simple and easy way of collecting data from site and reporting of the activities undertaken in the project.

Basic Principles

The system evolved for this ILO Micro Management Package draws on procedures and manual monitoring systems commonly used in labour-based projects.

The system has been designed to make maximum use of the facilities offered by a computerised package but it has also been necessary to impose some restrictions on report format and scope, due to limitations imposed by both the software and hardware.

However certain basic principles have been adhered to as set out below.

(i) The system reflects actual daily site record data and not a synthesis produced from monthly visits of a supervisory engineer.

(ii) The system is as simple and concise as possible so as not to discourage its use. To maintain this objective it should only contain data that is directly relevant to site progress and productivity. The data collected should follow a specified list of activities that has been thoroughly worked out by the project management. The feedback to the site should be limited and appropriate for the needs defined by the site supervisor.

(iii) The system must be flexible and able to accommodate a wide range of individual contraction and maintenance activities. However it must also be able to summarize them within a narrow band of key progress activities, i.e. operations, if any meaningful comparison between projects is to be feasible.

(iv) The system has to fit within the storage and data manipulation constraints imposed by the computer software and handware.

(v) The system should act as a management training aid for site and office staff. It should therefore provide very relevant data for different levels of management of a project. A feedback should be given to the site every week or month (dependant communication possibilities) as well as necessary information to programme and branch officials.

It should be noted that the system does not have to replace existing procedures. It can be viewed as a complementary productivity and progress monitoring tool to collect and collate information. This information can then be used in more detailed reports if so required by the organisation in which the project has been established. Data will thus, based on this monitoring package , be readily available for such a reporting.

Although there is a bias towards roads and road construction in the format, the system can accommodate any type of labour- based construction or maintenance project. The only requirement is that daily activities can be separated into labour and equipment categories (activities)and that key progress can be defined in terms of a maximum of three key parameters called operations.

Operations

Typical operations by construction type or sector are given on the following page.

SECTOR	OPERATIONS	OUTPUT	PRINCIPAL INPUT
Roads:	Formation Gravelling Structures (Culverts)	km km Number	Worker-days Worker-days, tractor-days (haulage) Worker-days, tractor-days (haulage)
Irrigation Works:	Channel Excavation Lining Structure	km km Number	Worker-days Worker-days, tractor-days Worker-days, tractor-days
Earth Dams:	Key trench Excavation Embankment Armouring	m m m	Worker-days Worker-days, donkey-cart-days Worker-days, donkey-cart-days
Wells:	Excavation Line Equipment	m m Number	Worker-days, pump-days Worker-days, pump-days Worker-days, pump-days

System Hierachy

The basic flow of information is as follows:

In the project office:

- The project officer uses the computer application to prepare the site reporting forms to the formathe requires and sends them to site. (Thisneeds only to be done once per project). There are two forms to be prepared; one for daily activity recording on a weekly form and one for monthly progress and resources recording (see Figure 2 and 3).
- Based on a plan for the project, the project manager enters the anticipated inputs, outputs, progress, unit costs and budget into the computer.

On the project site:

- information on worker productivity is recorded daily and summarised on the already mentioned weekly reporting forms (the weekly activity summary in Figure 2)
- Information on achievements in terms of physical progress and resources used in summarised on the monthly reporting forms (the monthly progress summary in Figure 3).
- The weekly activity summary forms and the associated forms for monthly progress and resources are sent to the project or programme office for analysis.

In the project office:

- Site data is entered into the computer by a clerical officer.
- A corrected set of the weekly and monthly summaries are produced to be returned to site for information and if necessary any follow up of production failures (Figure 4 and 5).
- After having checked the weekly and monthly summaries, the data is stored in the archives and monthly report is produced (Figure 6)
- Other reports can be produced as required from the archived monthly data. The new version of MMP that is under development will iclude some applications of graphical presentation like bar charts for comparison of achieved productivity with a planned figure, S-curves for comparison of progress achievements with targets set and pie charts for the cost distribution (see Figure 7 and 8). Other presentations can easily be obtained by using the MMP software (Dataease) or others like LOTUS. However, the current version of MMP (Release 2.3) is only programmed to produce weekly and monthly summaries, for the monthly reports.

Reporting Forms

In designing the forms, it has been necessary to anticipate the maximum possible project variation while keeping to a standardised and simple approach. All the formats should be seen in that perspective.

The Weekly Activity Summary

The Project Manager decides on the nature of the activities with the corresponding units of production that he wishes to be recorded and sets up a master for the report form on the computer (Figure 2). This can be printed (also in a different format if wanted), photocopied and distributed to site.

The format is divided into unskilled workers, skilled workers equipment activities. Each of these activities can be further grouped into one of three operations a, b and c. I.e.for a typical road construction: earthworks/ formation, gravelling , structures (culverts/ drainage). It only remains for the site supervisor to report the date, worker/ equipments inputs and outputs under each activity for each day.

Outputs have been deliberately proposed to be kept to actual quantities rather than linear chainage achieved. This is because task work and the setting of realistic quantities has been shown to be the key to effective and labour management. This system is intended primarily as a practical management tool and the record of the amount of material being moved by a worker gives a much more realistic indicator of site efficiency than nominal chainages of ditching or site clearance.

The project manager has the facility to give default of values for every activity by defining the acceptable range of output that can be expected. The relation between the recorded inputs and outputs will be controlled according to this range and values outside that range will automatically be corrected to the default value. The facility has been included primarily to exclude big errors and the range can be set very wide.

The two parts of the checked form, page 1 productivity summary and page 2 error report, will be found in Figure 4.these two pages will be returned to the site manager.

The Monthly Progress Summary

This form allows the actual progress to be defined, i.e. progress by operation. Storage limitations have restricted the number of operations to three, but in fact these should be more than sufficient for monitoring purposes.

Each of the operations can be defined in terms of principal activity, units of output and input in worker days and equipment days. The inputs are directly related to the productivity inputs in the weekly summary sheets and a computer application will generate the correct figures. To facilitate this , each activity on the weekly activity summary is given a code number (a, b or c) to indicate which operation the activity relates to.

Only one type of equipment should be allocated to any operation. That is because we propose to only follow in detail the most important equipment under each operation. Although this is somehow a limitation, it is thought to be adequate for a labour-based project. In addition, all items of equipment are recorded on the daily records or a present on site on the monthly reporting form.

This monthly form also allows the site officer to enter the actual number of workers (woman and man), staff and equipment present during the month against the theoretical allocation. The number shown here will only be averages and are not critical.

The last item on the monthly programme summary is the section for materials used. This serves to give some overall control of consumption and costs. The number of items is deliberately restricted to five which is thought to be more than sufficient for the principal consumables on a labour-based construction site.

The checked monthly progress summary (Figure 5) will also be sent back to the manager.

The Monthly Report

The monthly report (Figure 6) can be automatically produced from the archived data; i.e. the site data and the default project plan information entered by the project manager at the commencement of the project. (The latter information can also be overwritten at any time if the project manager wishes to revise the plan).

The monthly report includes three pages and can be produces when all data for a month has been entered and the update procedure for the archives has been followed.

Page 1

The first page of the report contains the following information:

- a summary of working days for the last month and the cumulative number of working days to date in the project.
- a summary of the last month's and cumulative progress divided by operation with inputs, outputs and average productivity. This progress is compared with the planned target for the month and for the completion of the project.

Labour-based project planning is based on an accurate estimation of labour-days and equipment-days required for each operation. This unit resource approach is in fact more relevant that unit costs for all aspects of labur-based project control. While overall cost is important projects must be completed on budget, unit resource monitoring gives an accurate picture of the interplay of the planned elements of labour and equipment in the operations. Thus it not only provised an early warning of production shortfall and hence cost overrun, but is also pinpoints the problem areas. For this approach to be effective, it is essential that the project manager prepares a comprehensive plan in terms of resource inputs and outputs. A target plan "menu" is provided in the computer application for the project manager which can provide global default values for the whole project period or values that vary from month to month, as desired.

Page 2

The second page in the monthly report summarises the inputs, outputs and productivities for all the individual project activities recorded in the weekly activity summaries. These figures are compared with the previous month data and the cumulative figures to date. The primary purpose of this data is to monitor individual productivities and look out for specific problem areas, hence the comparison with the previous or any other month's figures. Inexperienced labourer usually start with very low productivity and increase markedly over the month and this trend should be anticipated. Drops in productivity may be due to poor organization but may indicate unresolved engineering problems or poor handtool maintenance.

Good productivity data is the basis of all unit resource estimating. Obtaining such data in a form suitable for inter project and inter country comparison is generally very difficult ant it is one of the aims of this computer application to improve that situation.

Page 3

The third page gives an overview of the resources in tro different sections. It first contains a summary of the labour, staff and equipment resources present on the project compared with the theoretical allocation. This information is just another presentation of the monthly recorded data from site.

Page 3 also contains details of the project costs for the month, the cumulative to date, the balance of funds remaining and percentage spent to date (based on the budget set-up when starting up the project). In addition the costs are split according to the principal catergoies of staff, labour, equipment and materials awell as sundries.

The costs for the month are authomatically derived from the monthly worker and equipment input totals and general resource figures (general equipment, staff and materials multiplied by the unit costs set-up by the project manager in the computer system). However the facility exists to overwrite those figures with the actual costs as contained in the accounts books.

It must be emphasised that this computer package is not intended as a definitive cost control system. Every project in every country tend to have its own mode of accounting depending on the local procedures, regulations and staff resources. In general it is rare to find a proper cost control procedure and most systems rely of simple commitment/ expenditure entires in a "Vote Book". The figures contained in this often differ wildly from the perceived value of the works, as commitments are often imsallocated under wrong headings or large items are not broken down by project. However they do represent the official auditable document.

This computer package therefore allows the project manager to evolve whatever form of monthly control is most appropriate for his situation and maintain that record for checking against official accounts. This allows the project manager to have some degree of control as he can discuss major deviations with this accountant and initiate journal corrections as required.

The computer cost summary may be maintained as a parallel record or updated in line with the actual accounts as required. A facility in the cost record on page 3 allows for a record of the last reconciled month to be entered when producing the report. Typically, expenditure reconciliation lags some months behind commitments.

Further development of MMP

The development started some two years ago and a "final version" was sent out for testing in April last year. The test period has given valuable feedback about its usefulness and proposal for improvements have as well been received. A revised version is expected to be finalised in June this year. This version will be of a much better operational standard and include the new reports already mentioned.

The new users manual will also include a manual version of the programme. It is expected that the revised versions of the programme and manuals will be available in English and French later this year.

Summary

In a brief summary, the monitoring package, MMP, consists of:

(i) Detailed project planning basis where key works are:

(a) Division of project into sites/number of projects;

(b) Project operations and activities, following a standard list. A norm for operations and activities should be developed;

(c) Project inputs and outputs, i.e. targets for the monthly development over the project period;

(d) Describe resources (staff, equipment and materials), unit costs and currency;

(e) Project budget

(ii) Project plan to be entered in the setup part of the programme.

(iii) Produce data collection forms.

(iv) Data collection:

(a) Daily records on activity input and output

(b) Monthly record on operation progress and resources used.

(v) Data entry and calculation of totals:

(a) Daily data is entered and weekly controls printed giving achievements and errors. This report will be returned to the site manager.

(b) Monthly Progress and Resources is entered and the updating of progress made automatically. A control sheet can be returned to the site manager.

(vi) Archives:

The package provides an archive system bases on the monthly data produces from the site reports. The archives can later be used for alternative reporting purposes.

(vii) Reporting:

The monthly report is printed. This report is mainly for reporting upwards in the hierarchy, but the report could also be returned to site.

For the purpose of quarterly/annually reports etc., another reporting possibility has been created, giving an option of including several projects. Another new feature is the graphical prepresentation of productivity achievements, progress and resources against target and costs.

Experiences

What are the limitations experience so far or are there any "real" limitations?

As earlier mentioned, the feedback from the site has given inputs for changes to the programme and the further development. However, these changes has been of a minor art.

The obvious problem many people have idientified is that the package does not include all necessary forms for project monitoring. Such forms include a muster roll for control of presence at work and later payment, further forms like stores control, and vehicle user control.

Our answer to this is that the package is not meant to replace existing standard governmental forms. In most countries, the requested forms have been developed and are in normal use. The package is aimed at assisting the project personnel in site managment and project planning rather than introducing new systems and procedures in an already established organisation.