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Preparation of the Second Consultation
on the Training of Industrial Manpower

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THE ROLE OF HUMAN RESOURCES DEVELOPMENT FOR INDUSTRIAL MAINTENANCE*

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* The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This paper has been reproduced without formal editing.

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ABBREVIATIONS USED

ACP Africa Carribean Pacific Countries (associated with EEC)
ADB Asian Development Bank
AfDB African Development Bank
AFNOR Association Francaise de Normalisation (French National Standards Organization
APSDEP Asian and Pacific Skill Development Programme (Islamabad)
ARCEDEM African Regional Center for Engineering Design and Manufacturing (Ibadan)
ASEAN Association of South East Asian Nations
CDI Center for the Development of Industry (ACP, Brussels)
CIADFOR Centre Inter-Africain pour le Developpement et la formation (ILO, Tanger)
CINTERFOR Centre International Régional pour la Formation (ILO, Montevideo)
CNC Computer Numerically Controlled
COFRANSID Groupement Francais pour la Construction d'Usines Sidérurgiques
DOM Design Out Maintenance
ECA Economic Community for Africa (Addis Abeba)
ECLAC Economic Commission for Latin America and the Carribean
ECOWAS Economic Commission of Western African States
EEC European Economic Community
ESCAP Economic and Social Commission for Asia and the Pacific (Bangkok)
FAO Food and Agriculture Organization
IBRD International Bank for reconstruction and Development (World Bank)
IDA International Development Association (World Bank)
IDB Inter-American Development Bank
IDDA Industrial Development Decade for Africa
ILO International Labour Bureau
IMF International Monitary Fund
INTIB Industrial and Technological Information Bank
IRSI Industrial Research and Service Institute
ISIC International Standard Industrial Classification
OAU Organization of African Unity
OECD Organization for Economic Co-operation and Development
SADDC Southern African Development
SENAI Servico Nacional de Aprendizagem Industrial
TCDC Technical Cooperation among Developing Countries
UNCTAD United Nations Conference on Trade and Development
UNDP United Nations Development Programme
UNESCO United Nations Educational, Scientific and Cultural Organization
UNIDO IV Fourth General Conference of UNIDO

PART I: INTRODUCTORY

SOURCES OF INFORMATION

References to Industrial Maintenance have been sought in the various sources listed below. If any important references have been overlooked this is regretted. Nevertheless a representative selection have been identified and included.

International Organizations

UNIDO ILO UNESCO

UNDP UNCTAD

UN General Assembly

Financing Organizations

World Bank IMF

IDB Asian Development Bank African Dev. Bank

Regional Organizations

ECA IDDA OAU

EEC/ACP OECD

At the National Level

Technical publications from a selection of Industrialized and Developing countries.

PURPOSE OF THE PAPER

The Paris meeting will prepare the way for the Second Consultation on the Training of Industrial Manpower. The First Consultation considered the question "How can international co-operation in the field of industrial training help developing nations to master the industrialization process?"[1/] Assistance towards the mastery of industrialization remains the ultimate aim

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1/ Issue Paper for the First Consultation of the Training of Industrial Manpower, ID/WG.331/1, September 1982

of the Second Consultation also, and the intention is that the Consultation shall deal with one or two specific subjects which are of importance at the present time for the progress of the developing nations.

Human resources development for industrial maintenance is one of the two subjects proposed by UNIDO for discussion at the Consultation, and the other is the human resources implications of new technology. Maintenance is concerned with mastering the developing nations' present industrial technology, while new technology looks towards mastering their future industrial evolution. Thus the two subjects complement each other.

UNIDO IV: Maintenance was raised as a subject of importance at the meeting held at Yaoundé in May 1983[2/] to discuss the accelerated development of human resources for industrial development, in preparation for the Fourth General Conference of UNIDO. The background paper for item 5(a) of the Fourth General Conference[3/] (accelerated development of human resources for industrial development) identified "critical capabilities" that are required for industrial development. These include repair and maintenance capabilities.

The subsequent Resolution of the Fourth General Conference (No.1 "Accelerated development of human resources for industrial development")[4/] recommends to UNIDO, in collaboration with the ILO and UNESCO, to accord special attention to the problems of maintenance of industrial plants, and develop programmes for that purpose (para.10(c)). It also (para.11) recommends that agreements and contracts on the transfer of technology to developing countries should include provision for training for maintenance.

In the Resolution on the Industrial Development Decade for Africa (No.8) the importance of maintenance and training for maintenance is also emphasized[5/]. Paragraph 9(g) reads "Recommends UNIDO, in co-ordination with other UN organs, to assist African countries and organisations in promoting effective maintenance and repair of industrial equipment and appliances, together with the encouragement of local manufacturing of spare parts, including, inter alia, the use and training of local human resources, in order to promote their technical capabilities."

2/ ID/WG.394/8 paras 64-67
3/ ID/CONF.5/9 paras 31 and 32
4/ ID/CONF.5/46 paras 13 and 14
5/ ID/CONF.5/46 page 31

The purpose of this paper for the Paris meeting is therefore to help to take all these directions relating to maintenance and maintenance training a step further.

CONCEPT AND TERMINOLOGY OF MAINTENANCE

Meaning of "Maintenance"

Everyone thinks he knows what is meant by "maintenance", but comparison with others soon shows there are considerable differences. Therefore, it is necessary at the outset to attempt to define the concept of industrial maintenance for the purposes of this paper and the Paris meeting.

Originally the term had a restricted meaning, referring solely to keeping machines going. Since about 1960 this view has been expanded to include the renovation and ultimate replacement of the machine. Sometimes the same word maintenance was used in this wider sense: sometimes new words were invented. These include for example (in approximate historical order):-

- "Estate management": relating to a complete industrial complex and all it contains.

- "Asset management": meaning the lifetime care and replacement of all physical objects, including buildings and systems, as well as machines and vehicles.

- "Terotechnology": which includes consideration of all the financial and economic factors which should influence the provision, operation, maintenance and replacement of physical assets.

It will be seen that the last term implies that "mere maintenance" has a restricted sense. On the other hand another recent use of the word maintenance is so broad that it includes not only keeping a factory going, but also modernising it and maintaining it at an accepted world-wide standard of efficiency.

New terms to express the broader interpretation are still being invented. See for example "post-investment", which was introduced in May 1985 at the Rabat Seminar on Post-Investment[6/]. "To initiate its campaign the UNDP office formed a new word "post-investment", which means the sum of activities aiming at the highest profitability of invested capital, in terms of volume and quality of yield, togetner with the longest possible life for the equipment installed by such investment. It encompasses three specific activities related to all physical equipment, namely adequate use, maintenance, and rehabilitation."

"Rehabilitation" itself is a term requiring definition. It is possible to argue that maintenance does not include rehabilitation, since rehabilitation only becomes necessary if maintenance is not done! Indeed in this interpretation rehabilitation is a confession of failure to carry out proper maintenance. On the other hand, it is also possible to see rehabilitation as a wider form of maintenance, involving renovation and replacement as well as repair.

The degree of vagueness about the use of these various terms is indicated by Article 65 of the Third Lomé Convention[8/], signed on 8 December 1984, which finds it advisable to use all of them to avoid doubt - as follows:-

> "The Community and the ACP States shall place special emphasis on the restoration, upgrading, reorganization or restructuring of existing industrial capacities which are viable but temporarily out of action or performing badly, and also on the maintenance of plant and equipment and of enterprises and, for this purpose, industrial co-operation shall be focused on assistance for the start-up or rehabilitation of such enterprises, and on the relevant forms of training at all levels."

Technical terminology of maintenance

The situation concerning terminology is no better when one considers the detailed technical content of maintenance. In November 1970 UNIDO held a Symposium on Maintenance and Repair in Developing Countries, at Duisburg, Federal Republic of Germany, "as a first step in the promotional activities planned by UNIDO in this field". In its report[7/] the Symposium appealed (paragraph 15) for the preparation of a glossary establishing a common

6/ Rabat Seminar on Post-Adjustment

7/ ID/65.

maintenance vocabulary, as a priority matter. Since that time some progress may have been made in industrialized countries by national and regional maintenance associations. If so (and it is hoped that participants will be able to give definite information to the meeting) it should be possible to transfer the benefit to developing countries. In that case it is for consideration whether UNIDO should undertake the production and publication of such a glossary.

REHABILITATION OF EXISTING ENTERPRISES

It is necessary to clarify the situation concerning the rehabilitation of a complete plant or factory. Whereas at first rehabilitation of a factory referred solely to physical renovation and renewal of machines and equipment, the meaning has been extended gradually to the much broader concept of the total economic revival of a plant or industry, taking into account not only its physical assets but also its choice of technology, product range, and even its present and potential markets.

It is in this total economic sense that the word appears to be used in Article 65 of the Lomé III Convention, quoted above. It will be for the Paris meeting to decide whether to recommend that industrial maintenance should be interpreted in such a broad manner. For the purpose of this paper the subject is considered to be wide enough in its sense of physical rather than economic rehabilitation.

MEANING OF "INDUSTRY"

The scope of this paper is related to the scope of the Consultation on the Training of Industrial Manpower which it precedes. It is therefore advisable to say something about the meaning of "Industry" for the purpose of the Consultation.

UNIDO's starting point is the International Standard Industrial Classification (ISIC)[9/], taking as its main responsibility Major Division 3 "Manufacturing". Within this range Consultations have taken place in 11 major industrial sectors, namely agricultural machinery, building materials, capital goods, fertilizers, food-processing, iron and steel, leather and leather products, petrochemicals, pharmaceuticals, vegetable oils and fats, and wood and wood products.

9/ United Nations Publication Series M No. 4 Rev. 2/Add.1

For the Consultations on Training this scope is extended to include the other main branches of industry of interest to developing countries, namely extraction industries (such as mining), service industries, and infrastructure industries.[10/] The wider view is also closer to the ILO's view, which embraces all employment, including agriculture, and service industries such as tourism.

Infrastructure industries

The problems of maintenance in developing countries do not fall solely on manufacturing companies - far from it. The major infrastructure and service industries, which include road and rail transport, telecommunications, power, water, and construction (both buildings and roads etc.), are of fundamental importance in all developing countries. In the case of the least developed countries they form by far the greater part of all industry, since manufacturing is as yet little developed.

The importance of the infrastructure industries is heavily underlined in the Industrial Development Decade for Africa. See for example the "Second Special Memorandum by the ECA Conference of Ministers: International Action for Long-term Development and Growth in Africa" of April 1985, at paragraph 42: "It is important to emphasize that while new capacity will have to be built, there is an immediate need for assistance in maintaining and rehabilitating existing infrastructure. The poor state of rural transport infrastructure and services also calls for special attention. Technical assistance must, in particular, be directed to manpower training in all aspects of transport through the expansion or creation of training facilities and institutions."

Maintenance of all kinds relevant to the development of industry needs to be viewed as a whole. For example, industry needs roads. Therefore, the paper includes a reference to road maintenance. Left to themselves these related separate elements can be lost to sight. The Consultation could be (if the Paris meeting agrees) the occasion for bringing all of them before a wider audience of decision makers.

10/ See the background paper for the First Consultation on the Training of Industrial Manpower (UNIDO/PC.94).

11/ E/ECA/CM.11.11/7/Rev.1

AGENCIES CONCERNED WITH INDUSTRIAL MAINTENANCE

Agencies concerned with industrial maintenance in developing countries, together with its human resources and training aspects, include:-

United Nations
UNIDO
ILO
UNESCO
UNDP
UNCTAD

UN Regional Organizations
ECLAC
ECA
ESCAP

ILO Regional Organizations
CINTERFOR APSDEP CIADFOR

International Financing Agencies
World Bank
IDA

Regional Development Banks
IDB
ADB
AfDB

Regional Economic Organizations
EEC/ACP
CDI/ACP
ASEAN
Andean Pact
OAU

Regional Technical Organizations
Union of African Railways etc.

Bilateral Agencies
National governments

Field observation shows there are advantages in co-operation between the agencies involved, since maintenance has not always been seen as a unified subject, and activity has therefore tended to be fragmented, and to be taken by individual agencies in isolation.

An important purpose of the Paris meeting is to focus attention on the subject of industrial maintenance as a whole - and especially of course the human resources development and training aspects of it. Participants, especially from the international organizations themselves, will be invited to propose ways and means to gain further benefit from such co-operation.

PART II: SUMMARY

SUMMARY OF THE PAPER

FINANCE AND MAINTENANCE

Capital cost (project planning)

- Every capital project should build in maintenance as a matter of insurance for the success of the project.

- All major project agreements and contracts should positively demand training experience during the construction phase for national staff, especially young engineers needing to gain practical and project experience.

- Major project planning should always involve engineers qualified in maintenance, especially those who will have future responsibility for the operation and maintenance of the project.

- All planners of turn-key and "produit en main" projects, representing both industrialized country sellers and developing country purchasers, should pay careful attention to the need to ensure adequate provision for maintenance in project agreements.

- National planning organizations should ensure that the necessity to plan for future maintenance is not neglected by project management during the start-up phase of a new project.

- Major physical rehabilitation costs many times more than normal routine maintenance. To avoid the necessity for major rehabilitation:-

  - normal maintenance must never be deferred or omitted
  - provision for progressive renewal and replacement of equipment must be built into every project, and scrupulously carried out.

Mixed credit financing

- Use of mixed credits should be considered for the training component of major capital projects set up under bilateral aid and trade arrangements. This partnership can result in training of wider scope than purely commercial funding.

Recurrent maintenance costs

- For accurate maintenance planning systematic maintenance expenditure records must be kept, using a recognized standard system.

- Agreements by project donors to fund recurrent costs should always include adequate provision for maintenance.

MAINTENANCE PLANNING

- Maintenance needs to be planned systematically. Competent senior staff should be made responsible for the total maintenance function, and given suitable training.

- Computers offer valuable benefits in management of maintenance, but complete computerization is unnecessary and sometimes undesirable.

- Individual maintenance managers can obtain computer aid, on a "club" basis and under their personal control, enabling them to organize and supervise maintenance operations, and also to analyse maintenance performance as a necessary preparation for future planning.

- Maintenance consultants perform valuable functions in industrialized countries, and developing countries should encourage and promote the establishment of their own consultants. A sample study and/or pilot project may be desirable.

National support for industrial maintenance

- Developing countries should take steps to establish central repair workshops to undertake heavy and difficult repairs, as a service to industry.

- Small enterprises require a similar service on a smaller scale.

- National training organizations providing training for maintenance should co-operate with other national training organizations, on a TCDC basis.

- In order to assist the establishment of specialist maintenance sub-contractors developing countries should: -

  - Encourage both enterprises and individuals to go into business to offer maintenance services
  - Provide systematic training for maintenance workers and contractors
  - Establish a national system of standards and certification, to guarantee employers an adequate standard of work

- National Industrial Research and Service Institutes (IRSI) should be encouraged to provide a specialized maintenance consultancy service to industry, pending the establishment of private sector consultancy companies.

Choice of technology

- To reduce and simplify maintenance the national technology policy should guide project planners to choose the simplest available technology which can achieve the desired objectives.

- When advanced technology must be adopted, beyond the present capacity of the national technological base, special attention must be given to training for maintenance.

MAINTENANCE TECHNOLOGY

Effect of design on maintenance

- Designers should avoid inessential technological complexity, because it introduces maintenance problems unnecessarily.

- Project planners can also introduce maintenance problems, when they select mechanical or other equipment for which the national technological support base is not yet ready.

- Designers should take into account local climatic and other significant factors.

- Developed countries need improved feedback between supplying country designers and local industrial users. Larger foreign manufacturers should be encouraged, and smaller companies may need to be helped, to investigate the performance of their products on the spot. This relationship would benefit both developing country buyers and industrialized country sellers, and UNIDO should consider ways to assist.

- Developing country IRSIs and standards organizations should be closely involved in all efforts to improve design and assure standards of imported equipment, as well as local manufactures.

Standardization

- Standardization is critically important for any successful maintenance plan. Developing countries have great difficulty achieving standardization, due to the wide variety of equipment supplied to them under technical assistance.

- Concerted efforts should be made by aid donors to eliminate this problem:-

  - All non-standard equipment gifts should be accompanied by a full lifetime supply of spares (also as a gift), or
  - Only standard equipment should be presented.
  - World Bank, UNDP and relevant UN agencies' support should be sought for this policy.

- Standardization within enterprises should be a normal part of both enterprise and national maintenance policies.

Spare parts

- This subject is absolutely critical and deserves further study. There is no field in which UNIDO (in co-operation with other international agencies) can confer greater benefit on developing countries.

- The spare parts problem needs to be worked on in both developing and industrialized countries.

- In developing countries:-

  - Governments should give priority attention to availability of spare parts for maintenance.
  - Ministries of Finance should release foreign exchange for essential imported spare parts.
  - IRSIs should set up spare parts/maintenance support units.
  - Local manufacture of spare parts should be encouraged.

- In industrialized countries:-

  - Maintenance consultants and others should work for the improvement of the spare parts situation in developing countries.
  - All contracts for sale of equipment to developing countries (including model contracts prepared by UNIDO) should give full attention to continuity of spare parts supply.
  - Consultation should take place with financing agencies, with a view to including adequate foreign exchange for purchase of spare parts in all project financing agreements with developing countries.

Renovation of machines and components

- Renovation of components offers big potential savings of time and money (especially foreign exchange).

- The national IRSI should inform local industries about suitable rebuilding and renovation processes.

- The IRSI should also consider offering this service itself, if it is not yet commercially available.

- Training for renovation (e.g. rewinding large electrical machines) should be provided by the national industrial training service.

- Enterprises should be encouraged and advised how to establish a unit rebuilding/replacement scheme in suitable cases.

- Ordering and control of stocks of spare parts should be treated as an exact science, of priority importance.

- The national IRSI should take the initiative in advocating and establishing a national spare parts policy, involving all interested parties in continuing consultation and co-ordination.

- The meeting is asked to advise in what ways UNIDO could assist to achieve these objectives.

MAINTENANCE TRAINING

Maintenance and safety

- Maintenance training must stress safety throughout, and try to include this attitude with the other attitudes which it has to impart.

Psychology of maintenance

- Maintenance is an attitude of mind, and should be based on an understanding of the needs of machines.

- Lack of maintenance demotivates workers. Preventive maintenance is more motivating than crisis maintenance.

Social aspects of maintenance

- Effective maintenance planning may have social aspects, which should not be overlooked.

Who needs training for maintenance?

- All of the following need an appropriate form of maintenance training: operators, craftsmen, technicians, engineers, managers, planners, designers, consultants, and owners of small enterprises.

Organization of maintenance training

- There is an urgent need for the establishment of a nationally recognized new skill of "maintenance mechanic", where this does not already exist, together with appropriate training.

Numbers requiring maintenance training

- In modern industries there is a tendency for both the number and the skill level of maintenance workers to increase relative to the total work force.

Skill content of maintenance

- The first objective of training for maintenance is to establish correct attitudes to maintenance.

- Each industry requires different maintenance skills, and training for maintenance must be able to cover the whole range of these, in sufficient numbers.

Teaching methods and training technology

- Planning of maintenance training should make use of the recently devised methods of analysis of technological complexity.

- UNIDO may prepare manuals, video tapes, etc. to be used by developing countries where problems are by and large similar but differ greatly from those in developed countries (for which manuals exist).

MAINTENANCE: SECTOR DIFFERENCES AND SPECIAL CASES

Main industrial sectors

- Each main sector has its own characteristics concerning maintenance.
- In addition there are common factors affecting all sectors equally.

Key maintenance: Control and instrumentation

- As automation increases control and instrumentation become key functions. Maintenance of control and instrumentation equipment requires priority planning attention.

- Training of control and instrumentation maintenance technicians also requires priority attention, in co-operation with other users of comparable equipment.

Maintenance and small industries

- Small industries need training to give them a stronger technical base, and support to help them to maintain the machines on which they depend.

- To assist small industries to achieve competitive quality standards the national standards organization should adapt standards to local conditions thus facilitating small industries to reach national standards, and the national small industries organization should assist and encourage this.

- The national small industries organization should establish a central maintenance service to maintain machines used by small industries.

- Small industries should be encouraged to provide a maintenance service for larger companies.

- The national industrial training organization should provide skill improvement training up to recognized standards, for small industries and self-employed workers.

Training for small industries and the informal sector

- Formal training methods are not suitable for small industries or the informal sector. Practical research is needed to adapt and devise suitable methods.

- Successful examples of small industries with high standards of skill exist in several developing countries. Studies should be carried out to see how knowledge and skill are acquired and passed on in these cases.

Road maintenance

- Improved road maintenance often depends on training for better management of maintenance of plant and equipment fleets.

TECHNICAL CO-OPERATION AMONG DEVELOPING COUNTRIES (TCDC)

Exchange of information

- A national focal point for exchange of information on industrial maintenance should be designated in each country.

- UNIDO should take an active role in establishing this international information network.

Training and consultancy help

- Training and consultancy help between developing countries usually requires assistance with costs of international travel. The Fourth General Conference of UNIDO in its Resolution on Human Resources Development, resolved (para 7) "Developed countries and multilateral financial institutions should provide assistance for international travel of trainees under TCDC and similar arrangements".

Existing TCDC

- TCDC within some regions is already good. The potential exists for one region to help another, and means should be found to facilitate such interregional TCDC.

- Certain developing countries have special aptitude for maintenance. Practical research is needed to enable this knowledge and skill to be successfully transferred to other countries and regions.

HUMAN RESOURCES DEVELOPMENT FOR INDUSTRIAL MAINTENANCE

CHECK-LIST FOR ACTION AT THE COUNTRY LEVEL

Necessary/Desirable Maintenance Activity	Resulting Training/ Human Resources Development
MAJOR NEW PROJECTS	
Project financing and negotiating phase	
- Build maintenance and training into the capital cost of the project, as necessary investments, and insurance for its success.	- Sensibilisation of negotiators and training of project planners
Project technical planning phase	
- Associate local maintenance specialists and those responsible for future maintenance of the project with its detailed planning.	- Training of project planners and project engineers in maintenance planning and control systems.
Project construction phase	
- Project maintenance staff should be involved throughout the construction phase, in order to learn the characteristics of the equipment from the inside out.	- At this stage local engineers should be fully involved in learning as the work progresses, both on the site in the developing country, and in the supplier's or manufacturer's works while the equipment is assembled. - At the same time the future maintenance staff should be learning to operate and maintain equipment similar to their own, and in real conditions. Such training is normally more appropriately provided by a user, rather than the manufacturer.

Necessary/Desirable Maintenance Activity	Resulting Training/ Human Resources Development
Project start-up phase	
- The project maintenance team (who ought by now to be fully trained) should work alongside the contractor's commissioning team.	- This is a critical phase both for the local management and for the foreign technical partner. The local counterparts must be fully involved, not as mere observers. Commitment and competence will depend on real involvement.
Project hand-over	
- If there are "teething troubles" with equipment the project maintenance engineers must be able to observe the action taken by the contractor's engineers.	- If the local management and technical team have been fully and genuinely involved in the previous stages hand-over should produce no problems.
"Steady state" production phase	
- At first, when "teething troubles" have been overcome, maintenance will tend to be pushed to the back by urgent production demands. Management should nevertheless not overlook the necessity to set up efficient maintenance systems ready for the future.	- Sensibilisation of project managers to the necessity for preparing and implementing maintenance plans and control systems.

Necessary/Desirable Maintenance Activity	Resulting Training/ Human Resources Development
NATIONAL SUPPORT FOR INDUSTRIAL MAINTENANCE	
Reducing the amount of maintenance required	
- National technology policy should avoid unnecessarily complex technology	- Sensibilisation and training of national planning staff
- Selection of imported equipment should take into account reliability and maintainability	- The national Industrial Research and Service Institute (where it exists) should accept this task
- Feedback between developing country users and industrialized country designers should be encouraged and facilitated.	- The IRSI should assist to form designer/user links, and work for a policy of "design out maintenance".
Reducing the complexity of maintenance	
- Standardization should be a priority aim: -	
- within government plant and vehicle fleets	- try to persuade foreign donors to supply standard equipment (or a full stock of spares)
- in major project planning	- train project planners
- internally within enterprises	- training of management, including finance and purchasing staff
Carrying out repairs and maintenance	
- Ensure specialized repair facilities already available within local enterprises are made nationally available to other enterprises requiring them.	- The IRSI should make an inventory of all such facilities, and draw attention to any skill deficiencies found.

Necessary/Desirable Maintenance Activity	Resulting Training/ Human Resources Development
- Where essential repair facilities beyond the capacity of individual enterprises do not exist help to set these up.	- The IRSI should encourage the establishment by local entrepreneurs of specialized repair and maintenance companies. - If this fails the IRSI should consider providing such a service itself, or setting up a central national repair workshop.
<u>Renovation of components, units and machines</u> - National policy should be to renovate and rebuild equipment locally, rather than spend foreign exchange on importing new components.	- The IRSI should spread information about metal deposition and other renovation processes, and if necessary provide or arrange training in their use. - Rewinding of heavy electrical machines (for example) requires specialised advanced training.
<u>Assuring the supply of spare parts</u> - Foreign exchange must be made available to purchase spare parts which cannot be manufactured or renovated locally.	- Sensibilization of Ministry of Finance and other national financial policy makers
- Contracts for purchase of equipment from abroad should always include provision for a <u>continuing</u> supply of spare parts	- The Ministry of Industry should prepare model forms of contract (using UNIDO models where available), organize seminars to publicize their existence, and train negotiators and managers in their use.

Necessary/Desirable Maintenance Activity	Resulting Training/ Human Resources Development
- Management of spare parts stocks and supply is of priority importance	- Systematic training needs to be organized.
<u>Manufacturing spare parts locally</u> - It should be national policy to encourage by every possible means the local manufacture of spare parts	- The Ministry of Industry and the national small industries organization should locate suitable entrepreneurs, and help them to set up local manufacturing of spare parts. - These companies could also provide specialized training in certain cases (in conjunction with the national industrial training organization). - Guidance will need to be given to identify spare parts which can potentially be manufactured locally, and to prepare project studies on them.
<u>Maintenance consultancy</u> - Specialist maintenance consultants can assist industry to overcome maintenance problems and introduce effective maintenance plans	- The national IRSI should encourage the establishment of locally-based maintenance consultancy firms, and the training of specialist professional staff for them.

Necessary/Desirable Maintenance Activity	Resulting Training/ Human Resources Development
TRAINING FOR MAINTENANCE	
- Maintenance must be recognized as a national priority subject for industrial training	- The Ministry of Industry, together with the national industrial training organization, should negotiate with industry (both private sector and public sector) to establish nationally recognized trades of maintenance mechanic etc.
- Maintenance skills vary from industry to industry, and maintenance training must cover all these skills	- The national industrial training organization should carry out surveys of training needs in each industry, and make use of methods of analysis of technological complexity when appropriate.
- Maintenance training of one kind or another is needed by all levels from management to operators.	- The national industrial training organization must ensure that suitable means exist nationally for training all these levels.
- Maintenance training should use all appropriate training techniques, and seek to add new techniques when needed for special cases.	- Examples are "distance learning" for remote industries, and use of models for people who cannot read engineering drawings.
- Good maintenance is a matter of attitudes	- All maintenance training should seek to impart correct attitudes as well as skills, especially concerning safety.

Necessary/Desirable Maintenance Activity	Resulting Training/ Human Resources Development
- Specialized training for maintenance requires to be built on suitable technical education.	-"Traditional" maintenance requires mechanical skills, plus some science and mathematics, and knowledge of engineering drawing. - Advanced technology maintenance (especially electronics) requires less mechanical skill but much diagnostic ability.
- Maintenance engineers need in addition to receive suitable university education.	- The education of engineers, especially maintenance engineers, requires practical experience as well as knowledge of theory. "Sandwich" training (formation en alternance) is ideal.
SMALL INDUSTRIES	
- Small industries represent an important national resource for: - - sub-contracting for larger manufacturing companies - setting up maintenance and repair service companies.	- "The training system in most countries virtually by-passes the informal sector". The national industrial training organization must try to put this right.

Necessary/Desirable Maintenance Activity	Resulting Training/ Human Resources Development
- Small industries themselves need maintenance support for their machines.	- The national small industries organization should train small industries' workers, and consider setting up a central maintenance workshop for small industries.
- Customers, both enterprises and individuals, need to have confidence in the technical standard of maintenance services offered by small industries.	- The national small industries organization should cooperate with the Ministry of Labour to establish skill standards and testing facilities, together with training to help small industries to reach these standards.

PART III: THE ROLE OF HUMAN RESOURCES DEVELOPMENT FOR INDUSTRIAL MAINTENANCE

1. INTRODUCTION

There is not much on the subject of industrial maintenance, or training for maintenance, which has not already been said. Accordingly the present paper attempts to draw attention to part of this material, in the expectation that some of it may be new to some participants, and to point out significant features, so that the paper will serve as a starting point for discussion.

"Training for Maintenance " does not make sense by itself. This training is the final stage of a long process in which all the important decisions have already been taken, by the time that the trainers are faced with their tasks. Therefore the meeting needs to look at maintenance as a whole, including training, and not merely training alone.

However, the paper is not intended to explore every facet of maintenance to its limits, but to remind readers of the existence of these sub-subjects, so as to provide a framework for discussion about priorities for further action. It being understood, of course, that such action will not be uniform worldwide, but will be based on the needs of each Region and Sub-Region.

When the importance of industrial maintenance was suddenly rediscovered in the developed industrialized countries during the 1960s much work was done which is still valid today. This is not a subject which changes at the whim of fashion. What was true then is true today, and will remain true in years to come. And it is as valid for industry in developing countries as it is in industrialized countries. So no apology is made for quoting "old" material. It will be found to have stood the test of time. Indeed those who gathered together for the Symposium on Maintenance and Repair in Developing Countries at Duisburg in 1970[12/] will be glad to feel that further action may be taken on the entirely sensible recommendations they made at that time, few of which appear to have been adequately followed up in the intervening years.

12/ Ibid ID/65

HISTORY OF INDUSTRIAL MAINTENANCE

"Traditional" technology: In the days of "traditional" technology - steam engines and heavy, slow moving machines - maintenance was symbolized by the man with a spanner and an oil-can who went peacefully around looking at the machinery and tapping it here and there. Nobody troubled to work out the costs or economics of his work, which was something which had existed since engineering began. The 1960s was a period of close analysis and logical enquiry into many engineering processes which had until then been taken for granted. That was the decade of the introduction of new planning techniques such as "PERT" (Project Evaluation and Review Technique) and "CPA" (Critical Path Analysis). It was also the beginning of "value engineering" and "value analysis", in which the entire process of engineering design was looked at again, in order to maximise performance and establish the most economical use of labour and materials.

Following these tendencies industrial maintenance itself received a great deal of attention at this time, and the new practices of "planned maintenance", and its associated derivatives conditional maintenance and predictive maintenance, were devised. A beginning was also made to reduce the need for maintenance, through the process called "design out maintenance" (DOM). These techniques were further developed during the 1970s, leading to considerable reductions in the amount and frequency of maintenance required for some types of modern machines.

As in the case of quality control the industrialized nations are now following the lead of Japan, where special attention is being given to reducing maintenance still further. This is causing very great attention to the technology of maintenance in all industrialized countries.

New technology: The new technologies, starting with automation of production processes, have completely changed the nature of maintenance, and vastly increased its importance. In a fully robotized factory maintenance can indeed be the sole remaining activity carried out by human beings. In order to cope with this extremely critical function maintenance is itself drawing on new technologies, particularly computer assistance and information science. At the same time the economics and planning of maintenance has ceased to be simply a matter of repair or replacement, and now embraces the total life cycle of a machine, as discussed in "Concept & Terminology".

There is no need for developing countries to seek to emulate this process exactly, which is still continuing to evolve rapidly in the industrialized countries. They should take the opportunity of selecting only practices which have proved themselves, and learn from the mistakes which will be made by the industrialized countries, as these countries develop the subject of industrial maintenance still further.

MAINTENANCE IN DEVELOPING COUNTRIES

The physical conditions in which maintenance has to be carried out are more severe in developing countries than in most industrialized countries. The effect of this is to introduce added difficulties which do not exist in the countries from which most equipment originates.

Mechanical and electrical equipment for developing countries has long been "tropicalized", but with certain new technology equipment this is no longer sufficient, and problems are being experienced which are not yet solved.

The additional maintenance problems in developing countries are climatic, geographical, economic and human. Typical examples of climatic effects are as follows: -

Heat - Indian Railways is introducing CNC machines into their maintenance workshops. The computerized controls of these machines have to operate at temperatures well in excess of the safe limit for solid state technology. This means that workshops either have to be completely air-conditioned, which is impossible, or special arrangements have to be made to cool each individual machine. This point had not been taken into account when the machines were designed, ordered or delivered. It only became a problem when operation actually began.

Damp - Hot wet conditions cause very rapid corrosion in all equipment made of mild steel. Again in Indian Railways there are parts of the country where passenger coaches and freight vehicles become completely unserviceable due to corrosion after a relatively short period, and are then painstakingly rebuilt using the same material, and occupying a very great amount of badly needed workshop space and time. There is no doubt that the economics of the situation demand a change to a material less subject to corrosion, and that the extra expense would be justified.

Dust - In an extreme case it may be better not to maintain at all! For example in the Motor Transport Department in Sudan engine rebuilding takes place in conditions where dust cannot fail to enter the reassembled engine. The result is that "renovated" engines have a shorter life than those which have not been touched at all! A further example of problems with dusty conditions, which will shortly have to be faced, is the introduction of computerized stores control systems. This would demand the placing of delicate electronic printers in conditions where dust will almost certainly make them unusable after only a short time. The benefits of the new equipment are potentially very great. Efforts need to be made, with the help of the designers of the equipment, to overcome this problem, which is common to many countries.

The geographical factors making maintenance more difficult in developing countries include distance, isolation, communication problems and consequent time delays. None of these can be eliminated, but systematic effort and planning can help to reduce their effects. The problems are common to most developing countries and there should be an exchange of information between them, so that worthwile ideas can be shared.

Economic factors hampering maintenance in developing countries are first and foremost lack of foreign exchange for essential imported spare parts, and also difficulty in negotiating project agreements with foreign contractors which make adequate provision for maintenance in the long term.

Human factors adversely affecting maintenance include lack of mechanical skills, lack of spare parts and supplies control skills, lack of managerial experience, lack of negotiating experience, and now (increasingly) lack of diagnostic skills for maintaining new technology equipment.

COMMON FACTORS AND PROBLEMS OBSERVED

From experience gained certain common factors relating to industrial maintenance in developing countries emerge. These common factors and problems are set out in this part of the paper. They are not claimed to b· complete or exhaustive, but it is hoped that starting with what is found here participants will be able to add further information and specific examples. These examples should be relevant to industries in developing countries which seek guidance to overcome maintenance problems, and to reduce the physical and financial burden of maintenance, in order to run their businesses more efficiently. Particular attention should be given to anything having an implication for human resources development and/or training for maintenance or rehabilitation.

2. FINANCE AND MAINTENANCE

CAPITAL COST

Budgeting for major new projects often introduces, without realizing it, serious or even insuperable maintenance problems from the outset. In all financial negotiations there is an obvious tendency to reduce the total expenditure, and to eliminate items thought to be "unnecessary" or dispensable. Thus training is often discarded, when the going gets tough, as something which can be attended to later, or done without.

In the case of maintenance the problems arise principally from the desire to purchase from the "cheapest" source. In the long run this cheapest source may prove to be more expensive. The initial quality of equipment often determines its ease of maintenance and its potential length of life. A "saving" on first cost may prove to be a very false economy.

Such wrong decisions at the negotiating and/or purchasing stages of a project can arise if planning does not involve technically qualified people, in particular the engineers who will in the future be responsible for maintenance of the project.

A further problem may arise (often involuntarily), if the source of equipment to be purchased under the project is limited by political or financial considerations. Standardization is of vital importance for efficient maintenance, and the introduction of non-standard equipment, for which support facilities do not exist in the country concerned, will place a very heavy burden on the project, which will inevitably result in uneconomic production, and therefore disappointment at the financial results of the project.

Experience shows that every capital project should build in both maintenance and training, as a matter of insurance for the success of the project. They should be treated as essential parts of the project, and not as dispensable extras.

Project planning and preparation should always take into account the opportunities to gain experience for national staff, both in construction and also in maintenance. All project agreements should stipulate this as a positive requirement. Those who will be responsible for the maintenance of a new road, hospital or airport should be associated with the project during the design and construction stages. When this is done very considerable benefit can be shown to result.

Surprisingly it can be shown that over-generous capital investment in a project can be harmful to maintenance. For example if a railway operates a fleet of diesel locomotives, there is an optimum number required to maintain the fleet in service at an adequate level, and at the same time to economize in the use of scarce national capital resources. If this amount is exceeded it will be found that there is not enough incentive for the management of the railway to maintain locomotives in service. It will be easier for them to call on a new locomotive from the reserve shed, than to organize maintenance efficiently as they should do.

Another problem arising in capital investment can be found where external capital is combined with local funding. In such a case if local funding is used for the construction of the buildings for the project, it can happen that when the equipment is delivered the buildings are not yet ready, and the equipment starts under the severe disadvantage of being damaged by being left in bad conditions for long periods.

Project planning

For all these reasons maintenance considerations should be taken carefully into account during the planning and negotiating phases of a project, and people with specialist knowledge should be associated with the project planning. Even greater care is needed if the project will use new technology not yet found elsewhere in the country.

Traditional project planning tends to see physical completion and start up as the objective. Once this is achieved the project is handed over to its owners and the job is regarded as done. In these circumstances maintenance can be an afterthought. The concept of a turn-key project may take this a little further, and a "produit en main" project definitely includes the necessity to ensure that the plant is in full producing order. Nevertheless maintenance may not receive adequate attention.

Even in the case of some UNIDO guidance material maintenance may be relatively little mentioned. For example there is little reference in the 1980 "Guidelines for the Preparation of Industrial Feasibility Studies for Consulting Firms"[13/] even to normal maintenance, and none to the question of total lifetime costs, asset management, or continuing provision for maintenance and spares throughout the life of the project.

Nevertheless such information does exist. For example see Section 4 of the 1975 "Introduction to Maintenance Planning in Manufacturing Establishments"[14/], which gives very precise guidance on how to ensure that all aspects of lifelong maintenance are fully taken into account in the planning and commissioning of a new project. Because experience shows the necessity to build in maintenance - and also training - into the planning of all new projects, there is a need for a new look on the part of developing country planners, and also those in industrialized countries responsible for planning projects for developing countries. Such a new look has in fact already begun with UNDP help - see for example the National Seminar on Post-Investment held at Rabat from 15-17 May 1985[15/]. This considered on a national level the whole situation with regard to life-time maintenance of industrial projects in Morocco.

There is an important psychological difficulty to overcome in the case of new projects. Understandably those concerned are anxious first and foremost to get the project into operation and production. At this stage they have no leisure to think of anything other than immediate day-to-day necessities. Short term training may be one of these, but long term training certainly will not be considered. Even less so will be maintenance of the machines, which are new and giving excellent service. "That can look after itself in the future". Thus no thought is given to the need to maintain and replace, on a systematic basis, both the production machines and the men who work them. Unless there is a national watch-dog to ensure that proper preparations are made there will inevitably in the course of time be a problem of falling production due to inadequate maintenance.

13/ UNIDO/IO.401
14/ ID/156
15/ Rabat Seminar on Post-Adjustment

Use of mixed credits

A method of financing training for industrial development projects which is capable of producing good results is the use of mixed credits, in which the commercial partner supplies the main investment capital while the collaborating government provides a relatively small amount of funding for the specific purpose of training. This method could be used to finance training for maintenance of a project, and the result could be a training plan of wider scope than would be the case with a purely commercial investor. In particular such a partnership can ensure that the important element of training of trainers is included in the training plan, so that the project is able to replace staff who leave and to continue training in the future.

RECURRENT MAINTENANCE COSTS

Systematic planning and control of maintenance expenditure is only possible if careful records are kept throughout and if a standardized system is used, for comparability. A few years ago there was insufficient standardization in maintenance costing, but since that time considerable efforts and progress have been made in industrialized countries, and this experience is now available for developing countries.

Maintenance costing methods can also vary considerably from industry to industry. In some cases visible costs (expenditure on spare parts etc.) are clearly recorded, but there is insufficient recognition of the hidden costs of lack of maintenance - in the form of machine unserviceability and production downtime. It may be difficult to quantify these hidden costs, but if this is not done the management will remain unaware of the true cost of production. The true cost figures may show that additional investment in maintenance would have the effect of reducing downtime and saving money.

A further consequence of the variety of costing systems in use, and of failure to appreciate the basics of maintenance economics, is difficulty in demonstrating in financial terms the savings resulting from efficient maintenance. Added to the fact that the introduction of a planned maintenance system may result in a temporary apparent increase of costs (due to the initial costs of establishing the system). A financial management which has

not been fully familiarized with the real benefits of maintenance can resist attempts to improve the maintenance situation of the enterprise.

The shortest and simplest statement of the necessity for maintenance is that contained in a World Bank paper on the subject of road maintenance[16/] "Maintenance only costs money when it is not done".

An important aspect of maintenance costs is spare parts. If these have to be imported from abroad they inevitably impose a heavy drain on limited foreign exchange reserves. If on the other hand a proportion - hopefully increasing as time goes on - of spare parts can be manufactured in the country (either in the enterprise itself, or in some common service, as discussed in "Support for Maintenance") then foreign exchange requirements will be much reduced. Financial management should realize that investment in local manufacturing facilities may therefore pay handsome dividends even in the short term.

Sometimes foreign aid donors provide not only the capital cost of a project but also the recurrent costs. When these include sufficient provision for maintenance this is all good. However, there is danger in providing recurrent costs over an extended period. If this is not done on a reducing scale it will face the country with a sudden shock, and a financial problem at the end of the honeymoon period.

It is much kinder to phase out recurrent support on the basis of four fifths in the second year, three fifths in the third, and so on, until the transition to local funding can be made relatively painlessly in the sixth year. If possible, such an arrangement should include the planned establishment of a local spare parts manufacturing scheme, to reduce future needs for foreign exchange.

Major physical rehabilitation costs many times more than normal routine maintenance. To avoid the necessity for major rehabilitation:-

- normal maintenance must never be deferred or omitted
- provision for progressive renewal and replacement of equipment must be built into every project, and scrupulously carried out.

16/ "Finance and Development", World Bank, Washington

3. MAINTENANCE PLANNING

Maintenance planning clearly has to be taken seriously if the benefits of advancing maintenance technology are to be obtained. This is a matter for management, and it is first necessary to emphasize that to be effective the top maintenance man in an enterprise must have senior management status. The next step in planning is to designate competent senior staff to be responsible for the total maintenance function, and to give them essential basic appreciation and training. Their training will inform them about the various systems which are available to help them to carry out the maintenance planning. In brief these systems include the following:-

- Manual planning: Traditional card index
This for a small factory is still perfectly valid and has none of the potential maintenance problems of more sophisticated systems. (Maintenance systems themselves also need maintenance!)

- Semi-mechanized systems: Punch cards
Still in use in many companies and avoid the problems of power supply voltage fluctuations, heat, dust, etc. which affect computerized electronic equipment.

- Fully computerized systems
These are suitable only for the larger firms, in which technical support facilities are sophisticated, and the cost of lost production is so high as to justify very expensive and elaborate maintenance planning measures.

- Computer aided systems
There is no need to go totally into advanced computerization. The persuasions of computer equipment and software salesmen must be resisted. Depending on the size and level of technology of the country semi-computerized methods will probably be best at the present time, using new much cheaper mini and especially micro equipment now coming onto the market and software which has already been developed.

It is also possible to obtain computer aid for maintenance managers on an individual basis, as a member of a "club". This arrangement is suitable for the maintenance manager of either a small or a large company, and requires no special computer expertise or training. The use of a personal micro computer in the manager's own office gives him the benefit of the astonishing ability of computers to classify, analyse and display facts.

Keeping a plant register with a record of maintenance carried out, maintenance scheduling, and work instructions become easy tasks, and maintenance history and performance analyses, previously highly desirable but impossible by manual methods, now also become easy. This is a low cost and low technology means of gaining the advantage of the computer without being caught up in all its intricacies.

Maintenance planning techniques of value to maintenance managers, which are also in use in other branches of engineering, include PERT (Project Evaluation and Review Technique) and CPA (Critical Path Analysis). In complex cases these can themselves be computerized.

Maintenance Consultants

A maintenance manager, however experienced, cannot be expected to know everything about maintenance. Specialist maintenance consultants exist to give advice about all aspects of maintenance. Their services can be especially valuable during the planning and implementation of a major new industrial project.

It is pointed out elsewhere that standard project preparation guides do not always give detailed attention to maintenance planning. A specialist consultant can ensure that the following points, among others, are fully taken into account: -

- at the design stage: design out maintenance
- at the equipment selection stage: reliability and maintainability study
- at the production planning stage: planned maintenance information and control system
- at the negotiating stage, continuity of spare parts supply
- at the purchasing stage: spare parts standardization and system
- at the training stage: machine operating and maintenance documentation
- at the installation and commissioning stage: training of maintenance managers, operators and maintainers.

It is extremely desirable that such consultants should be encouraged and developed in the developing countries themselves, since to be effective their advice must combine both detailed knowledge of supplying country equipment manufacturers and receiving country conditions. How to encourage the development of such specialist consultants is a matter on which it is hoped the meeting may be able to put forward ideas and advice.

MAINTENANCE METHODS

This is not the place to go into the technology of maintenance, which is now enormously researched in industrialized countries and available for use and adaptation in developing countries. The purpose of the Paris meeting and the Consultation (should the meeting decide to include maintenance as an issue for discussion at the Consultation) will be to explore ways and means - political, administrative and managerial - to get the benefits of the new maintenance technology to industries in developing countries which need help to organize maintenance better, and to help train the necessary workers and managers.

This section therefore is merely a brief summary list of some of the main forms of maintenance (in the sense of the total physical life cycle of a single machine or a complete factory) now available.

- Maintenance is either Planned or Unplanned.
- Unplanned maintenance is emergency or crisis maintenance, also referred to as "fire-brigade maintenance". This is the old unhappy state of affairs still found all too often in developing countries.
- Planned maintenance is either Preventive or Corrective.
- Some preventive maintenance can be carried out while the machinery or plant is running. For major tasks, however, it must be shut down, and this involves substantial loss of production time, even though hopefully less (and much less inconvenient) than unplanned breakdown or emergency maintenance.
- Because of the loss of production time ways and means have been sought to avoid stopping the machine or plant until the last convenient moment before a breakdown is about to occur. This has resulted in the growing importance of condition monitoring maintenance (or "machine audits") which use sound, vibration, analysis of lubricating oil etc., to monitor the condition of critical moving and other parts. The results then constitute planned corrective maintenance.
- To reduce the amount of maintenance reliability studies are carried out leading to efforts to improve maintainability.

To ensure that the maintenance performance of new plant meets the specification quality assurance is carried out.
Spare parts are kept in readiness by means of computerized supply systems.
The systematic total life care and replacement of machines, equipment, structures or buildings is the subject of asset management (also now called "post investment").
The mechanical condition of machinery or components is scientifically observed and studied by terotechnology.
The science of lubrication is called tribology.

It can be seen that there is a risk of jargon obscuring the basic facts. This should not be allowed to happen - the aim of all maintenance technology is simple: "Prevention is better than cure".

Use of new technology for maintenance in developing country conditions

Technical advances now being made offer the prospect of valuable improvements for maintenance in the special circumstances of developing countries. For example, for people who are literate but lack diagnostic skills the new machines which report on a screen the fault they are suffering from, and direct the user to the appropriate section of the instruction manual, are a remarkable maintenance innovation. For illiterate people, the spoken warnings being incorporated into the latest cars (for example) are potentially of value for giving important maintenance instructions relating to sophisticated production machines. (It is a fact of developing country life that many production workers in charge of modern machines are illiterate, or only semi-literate).

NATIONAL SUPPORT FOR INDUSTRIAL MAINTENANCE

The Yaoundé Meeting in preparation for the Fourth General Conference of UNIDO recommended[17/] "the establishment of multi-purpose industrial maintenance institutes capable of ensuring training, research, counselling, assistance in the maintenance of industrial equipment and the manufacture of certain spare parts." (paragraph 67.2)

17/ ibid ID/WG.394/8

Many developing countries already have technical institutes which can be expanded or adapted to act as national maintenance advisory and assistance centres. In particular in many countries there is an Industrial Research and Service Institute (IRSI). A large number have received support from UNIDO. Potentially the IRSIs have great value as design and technical centres for maintenance, in addition to their other functions. In most cases they are controlled by Governments. Another class of institutes exist in many countries which can be potentially helpful, namely national standards organizations. As in industrialized countries (e.g. AFNOR in France) these can be very influential in assisting to raise standards of maintenance.

Enterprises (depending on their size) need the following maintenance support:-

Technical advice: This could be provided by the national IRSI, in conjunction with the national standards organization, as decribed above.

Spare parts: Some parts must be obtained externally. The support of the Ministry of Finance (foreign exchange) and Customs (import procedures) will be required. Some parts can be manufactured by the company itself. Some parts can be bought in from other companies under contract, especially small enterprises. The national small enterprise organization should fully exploit this excellent opportunity.

Specialized repairs: In industrialized countries there are specialized repair and maintenance firms which can undertake heavy and difficult repairs. In developing countries these do not usually exist. The Ministry of Industry and/or IRSI should ensure that specialized repair facilities available within local enterprises are made nationally available to other enterprises requiring them.

Where essential repair facilities beyond the capacity of individual enterprises do not exist help should be given to provide them. One way to overcome the difficulty is to establish central repair workshops to handle repair and maintenance operations that are beyond the means of individual industrial enterprises. In addition they can be useful as training centres for skilled workers and can help in the manufacture of spare parts in emergencies. This was another recommendation of the Duisburg Symposium in 1970.

18/ ibid ID/65 (paragraphs 49-52).

Recently in Tanzania action has been taken by the Government, public sector and private sector acting in co-operation, to set up jointly-owned companies to carry out major overhauls and specialized maintenance for the metal and engineering industries, and for the automotive industries. This initiative (which has started very successfully) could prove to be an excellent model for other developing countries to copy.

Small enterprises generally lack resources to maintain and repair their machines, and need a central service on a collective basis. This should be organized by the national small industries organization.

Training: This can be provided by the national industrial training organization. A wealth of technical and practical field experience exists world wide, on both types of training needed for maintenance - namely appreciation/ sensibilization of decision-makers, and actual techniques of maintenance for the maintainers themselves.

The national training organization can call on outside advice about techniques and methods of training - for example UNIDO arranges numerous group training programmes (see "UNIDO activities"). Under TCDC arrangements discussed below (see "Maintenance and TCDC") it could also call on other national training organizations.

Sub-contract maintenance labour: In the developed countries there are well established companies that supply contract maintenance labour to supplement an enterprise's own maintenance force at times of peak load. There are also many freelance tradesmen of all kinds who can be called in to assist with maintenance work.

For the developing countries this offers both needs and opportunities: -

- Opportunity - for useful remunerative employment for entrepreneurs, both companies and individuals
- Need - to encourage both enterprises and individuals to go into business to provide maintenance services
- Need - for the national training system to provide systematic training for maintenance workers and contractors
- Need - for a national system of standards and certification, to guarantee employers an adequate standard of work.

Maintenance consultancy skills: Developed country enterprises which are cost, efficiency and maintenance conscious employ specialized maintenance consultants. Many developing country enterprises would benefit from such advice. It can be obtained from industrialized countries, at a high cost. Much better for the long term will be to encourage the development of local maintenance consultants, who know local circumstances well. This should be part of the maintenance support functions of the IRSIs, whose potential value has been pointed out above.

Participants are invited to comment on these proposals, and to make further suggestions.

CHOICE OF TECHNOLOGY

This is a matter for national policy, through the IRSI in each country. Objective thinking is essential. If emotion is allowed to intervene future difficulties are inevitable.

Choice of technology should always involve technical people experienced in maintenance, and must take into account the level of technical support services available in the country. If these are insufficient for a new technology an enterprise will have to create them itself, greatly adding to costs - if it can be done at all. If not the enterprise will become dependent on foreign suppliers, and even on foreign technical staff, making maintenance extremely expensive.

All things being equal the choice of technology should always be the simplest available to do the job adequately. However, in some cases only advanced technology is suitable, and for these projects extreme care must be taken in planning (see "Project Planning").
In such cases the choice of advanced technology may be determined because production efficiency/volume/speed cannot be achieved by simpler technology. In other cases, for example airlines and mechanized coal mining, safety is a paramount factor and maintenance is mandatory to legal standards. In these cases training of maintenance staff demands priority attention even before the project is initiated - since people may take longer to train than the project takes to set up on the ground.

It may also be the case, as design and production evolves in supplying countries, that simpler technology may no longer be available, and the choice is therefore forced. Work is being done by the ILO on the blending of new and old technologies, to help countries which find themselves increasingly in this position. The training implications of the use of new technology are discussed below in "Maintenance training".

If a country is not yet ready to absorb a new technology, then it is wrong to introduce it in such a way that a desirable project will fail as a result. (Unless the introduction of the new technology is itself the object of the new project, which will therefore make maintenance of the new technology a main feature of the plan.)

An example of premature introduction of technology having a high maintenance content is an agricultural development programme in a non-mechanized developing country, which introduces a large quantity of tractors and/or other mechanical equipment. Such a programme can only succeed if very serious efforts are made to establish and build up a centralized maintenance service. Otherwise another project like the following will result: "Within a year, 85% of the new tractor fleet was inoperative due to maintenance failures and lack of spare parts".

4. MAINTENANCE TECHNOLOGY

EFFECT OF DESIGN ON MAINTENANCE

Maintenance begins with design, the significance of which was not appreciated in the industrialized countries until about 20 years ago.

A designer can:-

- eliminate maintenance altogether (to a limited extent): for example by using permanently lubricated bearings. This is called "design out maintenance" (DOM)
- reduce maintenance: making it less in quantity and cost, and at longer intervals
- simplify maintenance: by reducing the technological complexity of the design
- make maintenance easier: for example by improving access. This is called "maintainability".

A designer can also increase maintenance, or introduce it totally unnecessarily. An example is an architect who deliberately introduces technical complexity into his design, for the sake of fashion, or to make an impression. Instances of this which can actually be observed in developing countries include:-

- rooms without windows , necessitating permanent lighting (and depending also on power supply which may not always be reliable);
- permanent air conditioning needed for totally enclosed rooms (a second result of the absence of windows);
- lifts, when high rise buildings are erected for prestige, rather than need;
- the use of automatic doors, when they are not really required;
- a hospital, in a remote area of a developing country, in which the architect specified a computer controlled laundry!

All such technical complexity, when not really necessary for functional reasons, will inevitably cause problems of maintenance in the future, as well as additional running costs.

In addition to equipment designers (and architects) project planners can also design in maintenance unnecessarily, and a mistake at this stage will have very serious long-term effects. Examples were given in "Choice of technology" above.

Design in the sense of choice of technology can also introduce, or increase, maintenance problems in other ways. For example railway brake systems can be vacuum or pressure. To use a vacuum system in a sandy desert climate invites the sand to rush into the system and wreck it as soon as the vacuum is broken!

An increasing amount of mechanical equipment produced in industrialized countries is now being assembled by robots. Mechanised assembly of this sort may make it impossible to dismantle and repair the article by hand. This can be an insuperable obstacle to maintenance in a developing country, and those who select equipment (both purchaser and sellers) should be aware of such crucially important technical points. Possibly national standards organisations - in both industrialized and developing countries - could look into this important matter, which vitally effects maintainability.

Such points can only be appreciated by technical people who have responsibility for the care of equipment. Hence the plea made elsewhere in this paper for the association of maintenance specialists with the choice of technology (the broad first decision), and the subsequent selection of actual equipment (the detailed decision on which maintainability - and even possibly economic viability - will rest when the project is implemented).

Improvement of design

Design improves because users demand it. This is the fundamental motivator, and to achieve the progressive improvement of design therefore requires a close relationship between the designer and the user.

There is an analogy here with engineering production. A close relationship between the design office and the manufacturing shop floor will lead to better methods of production. Similarly a close relationship between the design office and the ultimate user will lead to less and easier maintenance.

In industrialized countries this relationship is automatic and easy. Furthermore the designer readily understands the conditions in which his product operates, and so is able quickly to modify the design as soon as he is made aware of a problem.

For equipment imported into developing countries, however, the situation is not as simple. The designer is both physically remote from the user, and also not in tune with the conditions in which his equipment is being used. So the developing country user can suffer for years the effect of unsuitable design (not bad design, since the equipment works well enough in its country of origin), while the designer lives on in happy ignorance of avoidable failings - including avoidable maintenance - of his product.

There is both a need and an opportunity here for outside intervention, and UNIDO would appear to be well placed to provide help. Whereas large manufacturers have the resources (if motivated) to carry out in-country studies of their products, smaller companies do not. A smaller manufacturer may indeed wish to have the opportunity to improve the performance of its product in a certain developing country - because after all the company survives only if it sells, and wishes to increase its sales. Closer co-operation between the designer and the user could therefore be of benefit both to the developing country purchasers and to industrialized country sellers.

It is for consideration whether some scheme should be devised for encouraging and assisting such co-operation, with UNIDO or other international help. Participants at the Paris meeting who represent industrial interests may have views on this possibility. The underlying principle would be mutual advantage on both sides (as in the somewhat similar case of the training of contract negotiators), since the results could benefit manufacturers - especially the smaller one - in industrialized countries, as well as developing country purchasers.

All such efforts should closely involve national IRSIs, and also national standards organizations, since these should be concerned with design as an aspect of quality, both in the encouragement of higher design and quality standards for locally manufactured products, and also in supervising and promoting higher design and quality standards for imported machinery, equipment, and other technical products.

The Duisburg Symposium of 1970[19/] recommended (paragraphs 53 - 55) the establishment or building up of national design and technical centers. This recommendation still holds good. Where a national IRSI now exists (often with UNIDO help) this is the natural location for design services to local industry and users of imported equipment.

19/ ibid ID/65

STANDARDIZATION

Developing countries are often exhorted to rationalize their mechanical equipment and maintenance situation by adopting a national standardization policy. They would very much like to do so, but cannot because of the miscellany of gifts pressed on them by well meaning donors from all over the world. Consequently "my plant pool is more like a plant manufacturers exhibition and fair than a rationally planned unit" is a typical reaction from a developing country senior engineer to an enquiry about his success with plant standardization.

What can be done to improve this very unsatisfactory situation? Some suggestions are as follows: -

- Attempt to discipline donors, so they agree to provide sufficient spares for the whole life of the vehicles, plant or equipment at the time of the gift, or guarantee to do so in future. (In the latter case it should be without cost, since it is often found that the price charged for spare parts is proportionally much higher than for new equipment).

- If they are unwilling to supply a full quantity of spares for their own equipment then donors should be obliged to agree to provide only makes and models already in standard use in the country. (They should also be encouraged to promote manufacture of spare parts by means of joint ventures etc.)

- Agreement to this policy is clearly in the interest of the developing countries, and should be sought at all conferences of donors for countries receiving aid.

- World Bank, UNDP, and FAO support should be sought to back up this policy, and put an end to the problem of standardization which has existed since countries first became independent, and was also the subject of a recommendation (para. 23) by the Duisburg Symposium of 1970[20/].

Internal Standardization

This is altogether easier to achieve, since it is under the control of the management of each enterprise, and can form an item of an agreed maintenance and spare parts policy for each enterprise. Internal standardization achieves important benefits, among them

- reduced spares holdings
- the possibility of unit exchange, and consequently
- faster repair and re-establishment of production.

20/ ibid ID/65

SPARE PARTS

This subject is absolutely critical and deserves further study - as has previously been recommended (see for instance the Duisburg Symposium of 1970[21/]).

An adequate first supply of spare parts must be built into every contract for sale of equipment. An attempt should also be made to assure continuity of supply - but this may not be possible in practice.

Technical advances in equipment supplying countries result in frequent design changes and new models replacing old. Developing country users tend to want to keep machines and equipment longer than those in developed countries. As these machines age - while remaining fully serviceable - it becomes more difficult to obtain spares.

Some manufacturers in industrialized countries pride themselves on their ability to supply equipment tailor-made to customers exact requirements, and these companies will continue to supply spares, since they themselves work on small batch, rather than continuous flow-line production, and are able to undertake a small order using the drawings and patterns long kept for this purpose.

Other supplying companies will simply regret that they cannot supply any further spares, and if the problem cannot be solved another fleet of useless vehicles or other equipment will join those already too common in many developing countries.

There is perhaps no field in which UNIDO, in co-operation with other UN and international agencies, can confer greater benefit on developing countries, and win their lasting gratitude, than in achieving at least a partial solution to the spare parts problem. (A real use for that much overused word). It is hoped that in their discussions participants will be able to suggest a variety of possible ways in which progress can be made.

The following are some thoughts on the subject: -

21/ ibid ID/65, para. 126(5)

The problem needs to be worked on from both ends, i.e. not only in developing countries but also in the industrialized countries which supply equipment.

In developing countries

- attempt to get Governments to understand and give priority to the problem of spare parts supply for industry

- try to unlock the necessary foreign exchange

- organize the IRSIs (Industrial Research and Service Institutes) to set up spare parts/maintenance support units

- encourage local manufacture of spare parts, to the extent technically possible, and provide training for the necessary skilled staff and management.

In industrialized countries

- encourage companies offering competent maintenance consultancy to work towards the improvement of the spare parts situation in developing countries, through their contacts with equipment manufacturers and suppliers;

- give full attention to the question of spare parts supply in all contracts for sale of equipment (ensuring that all model contracts prepared by UNIDO give adequate guidance on this subject);

- provide developing country purchase with engineering design and production drawings from which they can manufacture their own spare parts;

- raise the question of the supply of spare parts at the Consultation on Training of Industrial Manpower, (assuming the meeting considers it a suitable issue for the Consultation's consideration);

- work together with financing agencies to tackle the foreign exchange aspect of the problem, which at present is sometimes the paramount factor.

Local manufacture of spare parts

In any case, whatever the supply position from the original manufacturers, most developing countries already attempt to manufacture locally at least some spare parts, and all should try to do so.

Local manufacture:-

- saves foreign exchange
- assures supply
- provides employment, to both companies and self-employed people
- advances a country towards "mastery of technology".

But: -

- many spare parts are highly sophisticated and can only be produced by advanced technology;

- even simple parts may be made of special steel, or other material unobtainable locally, or only with difficulty;

- as time goes on "spare parts", as we used to know them, are giving way to complete units, which can not be manufactured locally;

- the ultimate "advance" in design can be a machine which is designed not to be repaired, but to be replaced complete when it ceases to function. This is "planned obsolescence", and is obviously to be avoided (if possible) by developing country purchasers;

- although local manufacture saves foreign exchange the cost of locally made spares tends to be high compared to imported, due to limited market, small volume production, large number of varieties and lack of standardization.

Spare parts within the enterprise

Other aspects of spare parts for industry, which come within the control of enterprises themselves, include: -

- Making a decision whether to maintain or replace a piece of equipment. This involves condition monitoring and engineering technology.

- A unit replacement system, to speed up maintenance in the case of fleet users. This involves maintenance planning and production management.

- Controlling the stock of spare parts. This depends on efficient supplies management, which is a vital element for any successful industry. Wrong decisions in the purchasing of spare parts (for example too many slow moving - heavy/expensive parts, and too few fast moving replacement items) can both increase expense and waste scarce foreign exchange, and in addition hold up repairs and therefore delay production.

National spare parts policy

The whole subject of spare parts, and maintenance in general, goes so wide and so deep in national industrial life that it deserves to be treated nationally, which is seldom if ever the case. Again the IRSI could be the stimulus and focus for national discussion and action.

There needs to be continuing consultation and co-ordination, not overlooking the necessity for training, and the following parties should be involved: -

- Ministry of Finance: foreign exchange policy
- Ministry of Trade: import licences
- Department of Customs: import clearance system
- Ministry of Industry: responsibility for industry and technology
- National Industrial Training Organisation: training for spare parts manufacture
- National Manufacturers Association: representing private sector industry
- National Small Industry Organization: representing small enterprises
- Ministry of Works: responsible for government vehicle fleets, public buildings, roads etc.
- Major parastatals: railways, power, water etc.
- Ministry of Transport: responsible for railways etc.

This is a large group and meetings need not to be frequent, but bringing them together will indicate that there is a national spare parts policy, and a national industrial maintenance policy generally.

RENOVATION OF MACHINES AND COMPONENTS

In addition to manufacture of replacement parts, much progress could be made in many developing countries with renovation of complete machines, assemblies and individual components. Many components, especially in agro-industries, are subject to wear and abrasion and must be replaced after a certain time. When these components are large, heavy and expensive, and the source of supply is remote, it is very much better not to discard them, but to renovate and replace them.

Well tried technical processes exist for metal deposition by various methods including spraying. These are expensive and must be applied by experts, but are capable of saving very large amounts of money and time. At present the use of such processes depends on the knowledge and initiative of local managements, and many companies which could use these methods do not know of them.

This presents a challenge and an opportunity to the country's IRSI. In some cases the IRSI itself could become a centre for offering this service under contract arrangements (possibly more cheaply than by commercial suppliers). Alternatively the IRSI could reach an agreement with the commercial service, and publicize the service in industry. (The former method would be preferable, since it would be a step towards "mastery of technology").

If the IRSI does not possess physical facilities suitable for a machine or a specialized technical process it can arrange with a suitable enterprise, whether public or private sector, to act as the centre for a national service.

For example regrinding crankshafts of large diesel engines can offer important savings nationally, but the machine needed is expensive, and skilled operators are rare. One major user of large diesel engines is the national Railway. They may already have a crankshaft grinder - in which case, through the help of the IRSI, a regrinding service could be made available to other diesel users. Or they may wish to purchase a crankshaft grinder but find the expense would not be justified for the amount of use they would make of it. In that case the efforts of the IRSI could benefit both the Railway and other users, in both public and private sectors.

Training for renovation

Major mechanical and electrical renovation (e.g. rewinding large electric motors) requires specialized and high level technical skill and knowledge. Special training arrangements must be made and require extra care and effort.

These skills, which used to be common in industrialized countries, are now becoming scarcer due to the new philosophy of unit replacement. However, training can still be obtained in certain firms which specialize in rehabilitation and renovation. In some cases the same specialized companies are also able to organize training courses in developing countries.

5. MAINTENANCE TRAINING

MAINTENANCE AND SAFETY

Maintenance and safety are closely inter-connected. Nearly all maintenance has some effect on safety - even cleaning excess oil from an engine access platform.

In some cases maintenance and safety are one and the same thing. The obvious example is aircraft maintenance. In this case reliability is paramount, and maintenance must seek to be 100% effective. Other industries involving safety must also design for reliability above all else. Elevator manufacturers and coal mining machinery manufacturers are in this category, for example. Maintenance in all these cases is of absolutely critical importance, and is usually entrusted only to specially trained and licenced mechanics, whose competence is assured by independent government or insurance watch-dog agencies.

Maintenance and safety can be equally closely related in process industries. The recent example we all remember is the Bhopal chemical leakage tragedy.

There is a hierarchy of industries in which safety plays a greater to a lesser part. In the most responsible industries (e.g. aircraft and elevators already instanced) safety is all important. However, in the most dangerous industries (steel, shipbuilding, construction) safety is not always sufficiently highly regarded, because it concerns the workers themselves, rather than the users of their products. Here the connection between safety and maintenance is not automatic, and further effort is needed to improve safety by means of better maintenance.

In principle safety considerations should greatly increase both motivation to carry out maintenance, and also motivation to learn to do the work better.

PSYCHOLOGY OF MAINTENANCE

The psychology of people cannot be ignored when considering the total situation of maintenance in any country - developing or industrialized. In fact psychology appears to intrude more into maintenance than perhaps into any other aspect of technology.

In the first place maintenance is a philosophy and way of thought as much as a technology, and is a long-term process requiring continuous attention and effort on the part of both management and trainers, in order to create correct attitudes to maintenance ("sensibilisation").

The 1983 meeting at Yaoundé[22/] in preparation for the Fourth General Conference of UNIDO drew attention in its report to the importance of attitudes for training and human resources development for industry generally. This is no less applicable to training specifically for maintenance.

Indeed the day when maintenance ceases to be a top line priority problem will only come when a worker passing a bearing crying in paid actually does something about it - because it hurts him to hear it! On that day the engineers of the enterprise, and the country concerned, can move a big step forward on the path to industrial self-sufficiency and mastery of technology, because they will be able to cease to worry about keeping things moving at all, and turn their attention to making things run better - for the benefit of the enterprise and the country as a whole.

Furthermore when maintenance is not undertaken the result can be a serious demotivation of workers in an enterprise, which will further increase the bad effect on production already felt because of the inefficient mechanical state of the machines. To be active is psychologically more satisfying than to be passive. Hence preventive maintenance is inherently more motivating to the workforce than "firebrigade"/crisis maintenance.

A contrary effect can however be seen in a plant where production is going well, and production workers are earning a bonus. In this case the intrusion of maintenance team to carry out planned maintenance can be

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22/ ibid ID/WG.394/8

resented, rather than welcomed, since it will lead to a loss of bonus payment. A psychological approach will be needed here too, in order to convince the production workers that a short planned stoppage is better for them (and everybody) than a long crisis breakdown.

Observation indicates that attitudes to maintenance are not uniform throughout the world. It appears that in certain regions and countries maintenance is regarded as a normal part of life - and therefore of industry - whereas in others parts of the world this is not so. In some countries indeed there may literally be no understanding of the meaning of maintenance. There may not even be a word in the local language which conveys the idea. Traditionally belongings, even houses, may be left to decay naturally, and are then replaced. This psychology transposed to an industrial situation results in the neglect of equipment, when it requires maintenance. For example, it is a puzzling fact that in some countries it can be seen that people's clothes are never neglected, - yet machines are allowed to fall to pieces quite uncared for!

Probably there is some correlation to be observed between the value a community places on its old possessions (buildings, artifacts, etc.) and the attitude of individual people to the care of equipment and machines, at work as in daily life. (NB however that value placed on old material possessions does not relate to value placed on old social customs, least of all in Africa)

In the long run these differences in attitude to maintenance between regions of the world offer great potential opportunities for TCDC, and this is discussed in "Maintenance and TCDC".

Another aspect of the psychology of maintenance is that in some communities great attention is paid to the external appearance of machines, which may be elaborately painted and well looked after externally, yet internally the working parts are neglected, so that mechanically the machine is unsound! Part of the aim of maintenance training is to seek to give an understanding of what is important and what is not important. This is actually one of the most difficult aspects of teaching maintenance technology. In an extreme case - for example in very dusty conditions, where maintenance cannot be undertaken without allowing dust to get into the

mechanism, it may in fact be better to do no maintenance at all, than to follow the normal routines set out in the manual of instructions. This type of decision can only be learned by someone who has an instinctive understanding of machines, as well as the right psychological attitude to maintenance.

Even technical advances may lead to unexpected problems caused by psychology. For example the provision of an automatic lubricating system for a complicated machine, operated by a single control, may give the maintenance worker the impression that all he has to do is press the button and the oil will flow to every bearing. This is labour saving, but it conceals the serious danger that a worker may not physically observe whether oil is indeed reaching all the bearings, so that if through blockage in one of the lubricating pipes oil cannot reach a bearing, there will be a failure of the bearing despite the technically advanced new lubricating system. This is another example where effective maintenance training has to overcome potential psychological barriers.

A further necessary change of attituted which maintenance training should seek to achieve is to substitute an attitude of preferring to carry out maintenance in time, rather than merely "patching up" when it is already too late.

Finally incentives. These are as important (or more so) for maintenance as they are for production. It is much better to offer rewards for good care and maintenance of machines or vehicles, than merely to punish for causing careless damage (though this may also be necessary).

SOCIAL ASPECTS OF MAINTENANCE

There are a number of "social" aspects of maintenance which must not be overlooked. For example: -

(1) Width of skills. Broad skilled training to cover the maintenance of modern production machines spreads across traditional craft boundaries and may impinge on labour relations - in some countries also on trade union politics. Experience shows that trade unions can be persuaded of the necessity to give their support to changes in training.

(2) Width of skills also impinges on employment policy. The need for increasing width of skill for maintenance workers arises in industrialized countries from new machinery which embodies mechanical, electrical, hydraulic and pneumatic technology. In addition, there is a desire to reduce employment of labour due to its high cost.

In many developing countries the opposite applies. There is a need and desire to employ more people and job fragmentation is common. In that case it may be preferred to employ a team of people each with separate skills, rather than to try to create a combined trade.

To take examples from different countries: -

- multi-skill training is essential in Britain, to save costs
- it is also proposed in Nigeria to meet the demands of industry
- in Singapore it is becoming essential, to economize in the use of scarce labour
- in Pakistan, on the other hand, which has a large surplus of craft skills, there is no desire whatever for multi-skill training.

(3) Modules of employable skill. Some years ago, in an effort to simplify and speed up training, the ILO initiated a system of training for "modules of employable skill". The aim was to give just enough training for a person to be able to get a job, and then to release the training place as soon as possible for another person to be trained. In this way training throughput could be greatly increased.

Experience has led to considerable modification of this concept. Originally conceived to help mainly self-employed people it was found that these people in fact need wider skills rather than narrower.

Whereas in industry a person can do a specialized manual repetitive job requiring little training, a self-employed worker needs broad skills to cover all aspects of the job. For example a self-employed building maintenance worker must be able to carry out plastering, carpentry and plumbing as well as bricklaying.

(4) Road maintenance. Road maintenance workers in rural areas are often not full time workers, and at certain times of the year must give priority to

their farms. This severely constrains the planning of road maintenance, which is also seasonal in character. All the social aspects of development project planning are fully described in the World Bank Staff Working Paper 397 "Human Factors in Project Work"[23/].

WHO NEEDS TRAINING FOR MAINTENANCE?

The following categories of people will need some form of training for maintenance: -

The Operators of the machines, to reduce damage and avoidable maintenance.

Those who actually carry out maintenance, comprising:-

Craftsmen (low technology, where skill exceeds knowledge)

Technicians (high technology, where knowledge exceeds skill)
In addition there will be some multi-skill workers who should combine traditional mechanical and electrical skills, plus also possibly hydraulics and pneumatics.

Engineers: Whenever possible they should be attached to contracts under construction in order to study the methods employed by the foreign contracting companies. An engineer will require at the least a full appreciation and understanding of the need for a system of maintenance. If he is a production specialist he may also require specialized training in maintenance technology.

Managers: To be effective the person responsible for maintenance must have senior management status within the enterprise, and be trained accordingly. Other senior managers require a full appreciation of maintenance, but not of course its technology. Accountants are particularly important in this respect. They rarely understand the details of maintenance, and tend (as discussed in "Recurrent Maintenance Costs") to underestimate the costs, and the necessity for making adequate provision for maintenance.

Planners and decision-makers: These include: -

- Maintenance planners in enterprises. They require to have a full understanding of maintenance systems and costing. Here too the accountants should be involved, in order to form a team with the engineers jointly responsible for efficient maintenance planning.

- National planners should be given a thorough appreciation of the economics, and a certain amount of the technology of maintenance. The evidence leading to this paper, and the present concern for maintenance generally in developing countries, shows that in the past this has not always been the case. In particular national planners who are involved in contract negotiations should receive full instruction in maintenance, in order that project plans take maintenance fully into account throughout.

23/ World Bank Staff Working Paper No. 397, June 1980

Designers should be made aware of maintenance considerations (as discussed in "Effect of Design on Maintenance"). For the most part designers will be attached to national IRSIs.

(There is in addition a real need to associate designers in developed countries with the special considerations relating to maintenance of their equipment in developing countries. See "Improvements of Design".)

Consultants in developing countries should acquire specialist knowledge and experience of maintenance as a special subject. There is a great need for their services in industry. To some extent this knowledge and experience may be gained by attachment to the national IRSI (when it has itself acquired full competence in maintenance) but there will also be advantage in obtaining outside training from maintenance specialist firms in industrialized countries.

Small enterprises: In a small enterprise one man may perform several or all of the foregoing functions. He will therefore need a very special form of training, which should be offered by the national organization responsible for the encouragement of small enterprises. To be able to give this specialized training the staff of the national small enterprise organization itself should also receive training in maintenance, suitable for passing on to small scale industrialists.

Operator/Maintenance fitter responsibility frontier

Practice varies between enterprises and between industries concerning the responsibilities for routine maintenance of production machinery, vehicles or equipment by the operator himself and by the specialist maintenance worker. There are matters of custom, trades union politics, psychology (the incentive of variety), cost, staff availability, etc. involved. The effect for purposes of training for maintenance is that training of the operators of machines and equipment must never be overlooked. It is with the operator that all maintenance must start, and if in addition the operator is himself expected to carry out some maintenance his need for correct maintenance skills, knowledge and attitudes becomes even greater.

ORGANIZATION OF MAINTENANCE TRAINING

Need for a recognized occupation category of "Maintenance Mechanic"

In many developing countries (as in industrialized countries) there is a long established list of nationally accepted skilled "trades", which are defined in connection with national apprenticeship schemes and/or trade

testing schemes. For an excellent and comprehensive description of these in the Asian and Pacific countries see the APSDEP Study on Apprenticeship in Asia and the Pacific, ILO Islamabad, 1981[24/].

Often these schemes were established, codified or reformed with the help of the ILO, in some cases 20 or more years ago. This was before the recognition of the growing importance of maintenance and the recent developments of maintenance technology. Consequently there are not in all cases nationally recognized trades of "Maintenance Mechanic".

The creation of such trades has now become a pressing need, and the help of the ILO is invited to assist in the acceptance and establishment in developing countries of the new skill of Maintenance Mechanic, or equivalent, where it does not already exist. For example work is now being carried out in Nigeria by the national Industrial Training Fund (ITF) towards this end, In other countries like Algeria and Morocco action has already been taken on a national scale to establish maintenance as a recognised separate industrial occupation, and to include maintenance skills in most technical training syllabuses.

Concerning the national system of vocational and industrial training generally the fact is that maintenance is not at present seen as a distinct unit or subject. Now that maintenance is coming to assume a greater importance in industry a corresponding effort will need to be made to establish "Maintenance" as a recognized important objective within national industrial training systems.

Co-operation of Professional Engineers Associations etc.

There is valuable help for maintenance training potentially available from the national associations of engineers, and other professional and technical associations. Many of their members are closely involved with maintenance activities in industry, and will be very willing to co-operate with the national training organisation in providing training and setting national standards for training of maintenance managers and engineers.

24/ "A Study of Appraisal in Asia and the Pacific", ILO, Islamabad 1981

In the organisation of maintenance training on a national basis there are thus three separate elements to consider, each closely interested in better maintenance and potentially ready and able to participate in training. These are private sector industry - through manufacturers' associations, etc.; public sector industry - through ministries and parastatal corporations; and professional associations.

NUMBERS REQUIRING MAINTENANCE TRAINING

Proportions of maintenance to production staff vary from industry to industry. In a traditional labour intensive industry they are a small proportion (though key staff). In the extreme opposite case of the modern fully automated factory every worker may be a maintenance worker!

An actual example showing the astonishing rate of change in industrialized countries is: -

1965: one maintenance worker for 44 production workers
1971: two maintenance workers for every one production worker
This was an automotive plant, but comparable examples exist in other industries.

Therefore both the numbers of maintenance workers and their relative importance have already increased greatly. This tendency will inevitably be found increasingly in developing countries also.

SKILL CONTENT OF MAINTENANCE

Maintenance as a subject for training has a number of special features.

1. It is a philosophy and way of thought as much as a technology, and is a long-term process requiring continuous attention and effort on the part of management and trainers in order to create correct attitudes to maintenance.

2. The skill content of maintenance is industry specific. A man competent to maintain a traditional sugar factory cannot look after a modern textile mill.

Industry is a factor of technology, and maintenance training must therefore keep up with new technology. But at the same time the need for traditional maintenance and rehabilitation skills (i.e. mainly mechanical) still persists - indeed it is increasing in volume as the need to look after old machinery is more widely appreciated. So training for maintenance must be capable of spanning a wide range of user needs.

The balance of knowledge against skill in maintenance is changing rapidly. Traditionally it was nine tenths skill and one tenth knowledge gained from experience, not from books.

Nearly all average maintenance now necessitates studying instruction manuals which demand a fair standard of literacy , and also knowledge of the language used.

In the extreme case (for example advanced telecommunications) the instruction manuals may actually be bigger than the equipment itself! At this end of the scale the traditional situation is reversed, and the requirement for maintenance is nine tenths knowledge (mostly from books, not experience) and only one tenth skill (to remove and replace unit components).

Three main categories of maintenance workers can be distinguished for developing country needs: -

1. traditional simple mechanical industries
   - training requires to impart basic mechanical skills

2. automated (but mainly mechanical) industries
   - training requires to impart advanced mechanical skills (including hydraulic and pneumatics), and some electrical knowledge

3. electronic based advanced technology industries
   - some mechanical skills are still required, but there is a great preponderance of electrical and also electronic skills.

All of these are needed for national development. Their training is radically different. The main difference between them, as has been pointed out, is the proportion of knowledge to skill required:-

- Category 1 needs virtually all manual skills (plus experience) and can even be illiterate.
- Category 2 must be able to read engineering drawings and instruction manuals, and should have basic mathematics and science knowledge.
- Category 3 requires a great deal of understanding of electrical and electronic theory, and is essentially an intellectual. Above all he must have diagnostic ability by the use of abstract logic.

In job-grading terms category 1 can be a semi-skilled worker, category 2 must be fully skilled, while category 3 is a technician, or even a higher technician. It is self-evident that they are not interchangeable, and their training will take place in different institutions of different types. To provide the nation with the maintenance workers it needs, the national training system must undertake all these types of training in sufficient numbers.

There is a similar variety in the range of specialization needed by maintenance workers, with opposite tendencies operating simultaneously.

At high technology levels there is a tendency to greater specialization - as machines get more and more complicated. A copying machine technician may work only on one make or even model.

Conversely at middle technology levels there is a need for less specialization - broad skill training to cover the maintenance of modern production machines has to include not only basic mechanical and electrical skills, but also hydraulics, pneumatics and electronics.

Traditional apprenticeships do not meet these requirements. The solution is a new multi-skilled trade of maintenance mechanic, based on a modular syllabus from which all the necessary elements can be selected. This need for broad skill ability exists also in the case of self-employed maintenance workers (further discussed in "Maintenance and small industries").

Maintenance training implications of new technology

New technology, if it paid proper attention to maintainability, can reduce the amount and frequency of maintenance. However, it may have the opposite effect on the complexity of maintenance, making it technically more

difficult to carry out. And at the same time it becomes more important to perform this maintenance exactly as specified, both in technical method and time intervals.

This may demand a much higher level of both education and training on the part of some maintenance personnel, since complicated written instructions must be precisely understood and followed to the letter. So the conclusions must be that modern technology is tending to reduce the amount of maintenance, but is increasing its importance and its complexity.

TEACHING METHODS AND TRAINING TECHNOLOGY

Teaching methods suitable for teaching all types and levels of maintenance staff in developing countries, as listed above, have been devised and are in general use.

Valuable help has recently been given by the method of the "analysis of technological complexity" evolved by UNIDO Consultant Mr. F. Vidossich[25/], and by COFRANSID of France[26/] in the case of training for the steel industry. Both of these methods enable trainers to identify the key skills needed by individual workers and managers, including those associated with maintenance.

It is universally agreed that once the necessary knowledge and skills have been correctly identified actual teaching presents no special difficulty, because well researched methods and much experience have been gained over the last 20 years of systematic industrial training.

Obviously new training technology must not be ignored where suitable. But it must always be remembered that methods based on technology which may work very well in industrialized countries are not necessarily transferable to developing countries. Overhead projectors and tape-slide co-ordinated programmes are approaching the technical limit for some countries. While video recorders are undoubtedly an effective teaching tool they cannot always be maintained, and ideal but unused audio-visual studios are a feature of many large and expensive third world training centres.

25/ Human Resources and the Technological Complexity of Capital Goods
26/ Groupement Francais pour la Construction d'Usines Sidérurgiques

One aspect of maintenance training requires special treatment, and progress now being made in industrialized countries in "distance learning" is potentially important and valuable for training of maintenance technicians and supervisors in developing countries - especially for industries which are located away from training resources in main cities, and for national utility companies (power generation, water supply) which must operate a number of units in locations all over the country.

In every country it is well known that one of the national organisations which is best prepared and informed in all matters of practical maintenance is the Army. In particular it has developed methods of teaching both practice and theory to people of all levels of education very fast. This special experience should be drawn on and used if possible by the national industrial training organisation for the benefit of industrial maintenance training.

Language problems: In all technical training language problems can intervene, and in maintenance training this is more than usually the case. A clear understanding of instruction and maintenance manuals is indispensable, and these are often in a language foreign to the machine operator and maintenance workers. This further barrier to understanding must be overcome, either by translating all the written material into the local language, or by providing additional language training/assistance for maintenance staff. New machines introduce new technology and new technical words. It must not be assumed that normal school learnt will be sufficient for the needs of maintenance staff, whether engineers or mechanics.

6. MAINTENANCE: SECTOR DIFFERENCES AND SPECIAL CASES

KEY MAINTENANCE: CONTROL AND INSTRUMENTATION

When a major component of a large machine has to be repaired or replaced this is usually a predictable major event, so that the loss of use of the machine although undesirable can at least be planned for. However, when the control and instrumentation system of the machine suffers a fault this is unexpected, and the stopping of the machine is always unwelcome - sometimes dangerous.

Furthermore, control and instrumentation equipment is usually small in bulk and capable of unit exchange, so that if spare parts and someone with the necessary knowledge and skill is available a replacement can be made relatively quickly, and a breakdown need not last long.

All this means that training for maintenance of control and instrumentation is a priority need; indeed a key need in modern industry, and becoming more so all the time.

Co-operation should take place between industry and other users of similar control and instrumentation equipment, including health, research, education and agriculture. Based on the need of academic and scientific institutions UNESCO has for a number of years been carrying out training workshops and seminars, both regionally and nationally, and has given the training of control and instrumentation technicians much importance in its regular programme activities.

UNIDO should consult with UNESCO on this key subject, to ensure that industry is able to share the benefits of the training already available. As the need increases ways should be sought to augment the volume of such training for industry. Often it will be found possible to come to an agreement with a local university or polytechnic to train a group of control and instrumentation technicians from one or more enterprises, locating the practical part of the training in the enterprises themselves.

MAINTENANCE AND SMALL INDUSTRIES

"The training system in most countries virtually bypasses the informal sector and most attempts to provide training for it have not proved successful. Small enterprises and artisans in the "informal sector" contribute substantially to the economies in many countries. In view of the limited growth of employment opportunities in large and medium sized industry, more attention will have to be paid to small and artisan industries in the future."

"Projects designed to assist small enterprises through training and consultancy are rarely fully effective, except in a few cases where the services are confined to a single sector. This is, in fact, the area which in the future will require the greatest attention both in the technical and managerial training fields."

These quotations are from the report of the Administrator of the UNDP to the Governing Council of the UNDP, entitled "Programme Implementation Evaluation", dated 14 March 1984[27/].

Everyone knows the basic facts and they are frequently quoted. Small businesses and industries employ between 40% - 80% of the total working population in many countries, both developing and industrialized. They produce anything up to 40% of total national manufactures. In some countries they contribute substantially to exports, through sub-contracting to larger companies.

It is also known that conventional formal sector industries are coming to employ relatively fewer people, due to "advances" in technology, which mean that each new work place can now cost an enormous sum of capital investment. Consequently the vast majority of the rapidly increasing population of most developing countries will never be able to find employment in the formal sector of industry. But at the same time there are opportunities for manufacture and sale of traditionally produced consumer goods which increase as the population grows, and there are also great needs for people to maintain

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27/ see (DP/1984/18 paragraphs 18 and 29)

modern machines and equipment, with trucks and cars the most obvious example. So the employment hopes of most countries for the future (developed as well as developing) will have to rest firmly on the small business/small industry/ informal sector, right down to single self-employed people providing some service the community needs.

The two arguments together - to help the individual and at the same time to help the nation - add up to an unanswerable case for taking action to help small "industrialists" (including self-employed craft workers). See also for example the very clearly expressed comments on the role of small business and industry in the ILO's World Labour Report for 1985:28/ -

"A few sectors urgently need training facilities, such as small enterprises, handcrafts and the informal sector. These sectors have benefitted little from existing training programmes. However, it is precisely these sectors that produce many consumer goods and services, provide jobs for a large part of the active population and still offer considerable potential for expanding employment".

"Similarly, while entrepreneurship and management development programmes for small enterprises have been introduced in many countries, vocational training for that sector has been overlooked."29/

Why then does relatively little appear to be happening in this field? The first difficulty seems to be to identify the people concerned. By definition they are mostly "informal", i.e. not organized, and therefore not easy to make contact with.

They can be divided into three main groups: -

1. Small employers, with a few paid workers (each country's definition varies. The range could be from 5 to 50).

2. Self-employed people, with some degree of conventional industrial skill, offering a service to the public - e.g. building, motor-mechanic, etc. Many of this group are engaged principally in some form of maintenance activity.

3. Self-employed traditional craft-workers, often illiterate. This group is outside the scope of our present study.

28/ See "World Labour Report 1985: Volume II", ILO Geneva, page 111
29/ ibid page 130

Groups 1 and 2 are relevant to consideration of maintenance and training for maintenance. In fact, they represent both a need and an opportunity.

Their needs are: -

- Training to give them a stronger technical base
- Support to help them to maintain the machines on which they depend.

The opportunity is to make greater and more efficient use of their potential contribution to the national economy. Small industries need more business, and large industries need reliable suppliers of components etc. under sub-contract arrangements. This relationship is found in most industrialized countries and benefits both sides.

The essential condition for success is that the quality of the small firm's product must be up to international industrial standards. If not it cannot be used by larger companies, whose products are sold either at home in competition with imports, or abroad in competition with other products of international standard. The national standards organization should establish standards for small industries to work towards, and the national small industries organization should assist and encourage them. Training help from the national industrial training organization will also be required.

In order to reach an internationally saleable standard of product small industries may have to make use of quite sophisticated machinery, and they need maintenance support to keep this in good operational condition. Such a maintenance service can be provided centrally by the national small industries organization.

Small industries represent potentially a further benefit for national industrial maintenance efforts. Many small companies can find useful employment by providing a maintenance service to larger companies, and this should be encouraged. Again the essential condition is that their work must be of a high technical standard, and this too will probably need training, as well as supervision and support by the national small industries and national standards organizations.

When the owner of a private car wants to have his car repaired or maintained he invariably goes to a self-employed small mechanic. How often one hears stories of damage caused by lack of proper technical knowledge! Even in Nigeria, where there is a long historical tradition of craftsmanship, the standard of skill of the "roadside mechanics", for lack of any proper training, is universally condemned.

So a real effort on the part of national industrial training organizations to provide skill improvement training up to recognized standards, for small industries and self-employed workers, could pay very large dividends in national development terms.

Training for small industries and the informal sector

This is not an easy matter, since formal training courses and methods suitable for employees in formal sector companies may not be suitable for trainees from the informal sector. For example the trainees may be illiterate or semi-literate, and lack scientific and technical schooling. A basic requirement of a skilled machinist is to be able to work from an engineering drawing. To read a technical drawing usually takes several years of study at a technical college. Even an accelerated course needs a good standard of literacy and some technical knowledge.

One method now being explored to overcome this difficulty for informal sector craftsmen is to teach them to work from actual samples, or scale models. This practical method was successfully used in historical times, and is still used today by self-employed craftsmen in for example Pakistan, who produce skilled work by copying identically the actual samples given to them.

Other such innovative methods will need to be devised to make conventional industrial training methods suitable for the different needs and circumstances of traditional/informal sector workers.

Much practical trial and research is still needed, and it is hoped that participants will give time and thought to the question of how to make use of the potential national resource, especially for maintenance, represented by small industries and the informal sector.

No one has yet found an effective means of providing training for the informal sector, and many countries have put the question on one side until later, due to their understandable preoccupation with developing the formal modern sector of industry. Some countries, however, have done work which should be carefully studied. Examples are SENAI in Brazil; India, which has the Small Industry Extension Training Institute (SIET) at Hyderabad, a project to support the manufacture of sewing machines on a cottage industry basis and many other relevant activities; and Kenya, where "Village Polytechnics" have been established and experimental work for the informal sector carried out by the Directorate of Industrial Training. The ILO has been working in this field for many years, and would be best placed to coordinate all these efforts.

That village enterprises can succeed even in high technology fields is demonstrated by the arms makers of the Philippines and the North West Frontier, and by the surgical instrument makers of Sialkot, also in Pakistan. Valuable lessons could be learnt by studying how training is acquired and passed on in these exceptional cases.

Training of entrepreneurs Training in entrepreneurial skills is often discussed in relation to small industries. This subject is not dealt with here because it relates to employment rather than technology. Regardless of how many new people can be found employment in the small scale sector they cannot successfully remain in the sector unless their products and services are of an acceptable technical standard.

Note on terminology Various names are used to describe small enterprises (that is to say small businesses and small industries). These names include "informal sector", "traditional sector", "cottage industry", "roadside mechanic", "traditional craftsman" etc. .

Broadly speaking they can be divided into (1) modern sector and (2) traditional sector

These produce: -

(1) Products and services for or connected with modern sector technology, which includes everything to do with industrial maintenance, and sub-contracting for larger manufacturers.

(2) Traditional products, for local consumption or export as handcrafts. We are not concerned with this aspect in the present study, but the ILO gives much support to it, for the purpose of employment creation.

Possible Consultation on small and medium-scale enterprises

The Industrial Development Board of UNIDO at its meeting in May 1985[30/] directed that the possibility should be considered of holding a Consultation on Small and Medium-Scale Enterprises (including co-operatives) in 1988 or 1989. It will be important therefore to try to make some progress before and at the Consultation on Training of Industrial Manpower concerning the difficult subject of how best to set about the task of training for small enterprises.

ROAD MAINTENANCE

Industry must have roads for its supplies and products, so maintenance of roads is a subject of indirect but real interest to UNIDO.

Technology of road maintenance is a separate subject, but maintenance of the plant, equipment and vehicles which are the means by which roads are maintained resembles maintenance of any other fleet of transport or construction equipment. The economic significance of inefficient use of expensive road maintenance equipment is dramatically expressed by the World Bank in a recent report on road maintenance in Africa[31/]:

"Equipment is the single most costly resource employed in road maintenance. Economic losses entailed in such inefficiencies are of a large order of magnitude. The importance of improving utilization of existing fleets can be appreciated when it is recognized that annual economic losses from inefficient utilisation will often equal or exceed entire World Bank lending in the Roads Sector to the countries concerned."

The technology and management of maintenance of construction and transport equipment is very well researched in industrialized countries, and much training has been done in developing countries over the years. The World Bank report comments, however: -

30/ UNIDO/ID/B/350 para 89.4

31/ "The road maintenance crises in Africa: an Agenda for action", World Bank, Washington, May 1985, not published

"Shortages of skilled and experienced road maintenance staff still persist after two decades or more of efforts with training and technical assistance. Salaries and conditions inferior to those in the private sector, and frequent changes in personnel due to administrative or political changes accentuate the staff problem. Apart from staff not being given the resources they need to undertake the work, they often do not have clearly defined responsibilities and are not accountable in any meaningful way for either the quantity or quality of their output. Incentives for good work, and disincentives for poor work virtually do not exist. It is not surprising that low outputs and inefficiency are general. What is surprising is that some staff concerned with road maintenance manage to perform as well as they do. Attitudes towards maintenance are frequently negative in government. Planners and engineers, as well as politicians, often prefer to be associated with new construction rather than face the continuing worries of maintenance management."

These problems are managerial, not technical, but unless ways and means are found to overcome them roads will continue to deteriorate, and industries' transport links will become unreliable and expensive.

It is pleasant to be able to end on a more encouraging note. A road maintenance handbook[32/] is in wide use by road maintenance supervisors in African countries. This book is extremely well produced, with excellent pictures which immediately capture attention and interest. The handbook is produced by the UN Economic Commission for Africa, and has been financed jointly by the Governments of France, the Federal Republic of Germany and the United Kingdom. It is an excellent training aid and reference for the technical side of the work of road maintenance, but of course it can have no effect on the managerial problems described above.

32/ UNECA Addis Abeba, published 1982 by Ministère de la coopération et du développement, Paris.

PART Iv: MAINTENANCE AND MAINTENANCE TRAINING: PROJECTS AND PROGRAMMES

MAINTENANCE ACTIVITIES OF UNIDO

The following extract from a UNIDO paper of October 1979 entitled "Maintenance and repair: the role of international organizations, as illustrated by UNIDO experience"[33/] shows the importance which has generally been placed on maintenance by UNIDO since the earliest days of the organization: -

"A. UNIDO activities

2. The first major printed publication of UNIDO after its inception was the Report of a Group of Experts on Maintenance and Repair of Industrial Equipment in Developing Countries[34/]. Realizing that in many developing countries the lack of attention to maintenance and repair has been a major cause of underutilization of capital, UNIDO has from the beginning given particular attention to the problems of maintenance and repair in developing countries, both at a general level and at sectoral levels. It has also assisted something like 20 developing countries and also organized in-plant training programmes on maintenance.

3. At a general level, UNIDO organized a Symposium on Maintenance and Repair in Developing Countries in 1970[35/] and a Symposium on Maintenance Planning and Organization in Developing Countries in 1973[36/]. It has also brought out a publication on "Introduction to maintenance planning in manufacturing establishments"[37/].

4. At a sectoral level maintenance and repair problems in sugar industry, wood working, fertilizer plants, chemical plants, machine tools, agricultural machinery, automotive equipment and ship building have received attention.

5. At the country level, UNIDO organized 'maintenance weeks' and conducted surveys in several countries. Originally, its experience of country requests for assistance was that requests were more for trouble-shooting and not for making systematic arrangements for maintenance of equipment. Later, however, a number of projects for assistance in this field have been implemented in countries including Afghanistan, Cuba, Cameroon, Colombia, Central African Republic, Jamaica, Madagascar, Mongolia, Pakistan, Republic of Congo, Saudi Arabia, Turkey, Morocco, Tanzania, Uganda and Indonesia.

33/ See Id. 79-7723
34/ See ID/1, April 1967
35/ See ibid ID/65
36/ See ID/WG.145/3 etc., February 1973
37/ See ID/156

6. Since 1970 UNIDO has been organizing annually in-plant group training prog.ammes in maintenance and maintenance management for personnel from developing countries. In 1978 an in-plant training programme in industrial maintenance was held in a developing country viz., Tanzania. Special programmes have also been held for maintenance of railways, buses and trucks, instrumentation, etc."

The paper from which this extract is quoted was prepared for the International Plant Engineering Conference, co-sponsored by UNIDO and held at Hyderabad, India, from 24 to 27 October 1979[38/].

Since then UNIDO's activities for maintenance have continued, including a substantial number of in-plant group training programmes each year. In the 13th issue of the UNIDO Guide to Training Opportunities for Industrial Development there are eight group training programmes sponsored by UNIDO which are directly concerned with maintenance, and 10 more in which maintenance is a significant element, out of a total of 51. This is a considerable proportion, and shows the continuing desire of UNIDO to increase the level of attention to industrial maintenance in developing countries.

MAINTENANCE AND TECHNICAL CO-OPERATION AMONG DEVELOPING COUNTRIES (TCDC)

Since the enthusiastic adoption of the Buenos Aires' Plan of Action for Promoting and Implementing Technical Co-operation among Developing Countries (TCDC) in 1978[39/], it has proved easier to support the idea of TCDC in principle than to find actual ways in which it can be implemented. Support for national efforts to improve industrial maintenance would appear to offer excellent prospects of real co-operation leading to practical results, and the views of participants from all the geographical regions will be welcomed.

Certain regions and countries appear to have no problems with maintenance. In some of these developing countries it is a matter for constant wonder how ancient machines are kept going to an incredible age. In other regions maintenance just does not happen.

38/ PI/93, August 1984

39/ For Report of Conference see UN Publication's Sales No. E. 78.II.A.11

The reasons for these differences are psychological and historical, and are a little further explored in "Psychology of Maintenance".

In the broadest terms Asia is a maintenance skill surplus area, and Africa is a maintenance deficit area. Two qualifications to this general statement are: -

- Maintenance comprises procedures (management of maintenance), and skills. Asian countries possess skill in abundance, but sometimes are deficient in management of maintenance.

- Africa is not uniform. Those who know Nairobi and Lagos airports, both new, both prestigious, will puzzle to understand why one is as good as new, while the other appears to be suffering from neglected maintenance.

In principle, however, the general flow of TCDC should move from Asia to Africa, and the concern of the international agencies is to enable it to do so.

TCDC comprises
- exchange of information
- practical help, including consultancy and training.

Exchange of information

National focal points are required in each country, and many already exist. The majority are listed in the Directory of Industrial Information Services and Systems in Developing Countries[40/] produced by UNIDO. It would be desirable to designate in each country a single contact point for information on industrial maintenance, and to circulate the information to other developing countries. For example in Pakistan this single point could be the Pakistan Industrial Technical Assistance Centre (PITAC), or possibly the Pakistan Standards Institution (PSI).

In the UNIDO Guide to Information Sources[41/] on Industrial Maintenance and Repair there is also a country-by-country list of information sources. In this case the entry for Pakistan is the Pakistan Institute of Management (PIM). It would be necessary to consider which of these three possibilities - PITAC, PSI or PIM - would be the most appropriate central point for exchange of information on maintenance.

40/ See UNIDO/IS.205/Rev.1
41/ See ID/36

Exchange of information is specifically mentioned in the Fourth General Conference of UNIDO resolution on TCDC (paragraph 4c). For UNIDO's help to be effective there would have to be a change from a passive to an active role. At present the Directory of Industrial Information Services is based solely on responses to a questionnaire. People who did not respond are not included - for example Tanzania. If it is agreed that maintenance should be a priority subject for exchange of information it would be necessary to instruct each country what is required, and to designate by agreement one main contact for maintenance matters in each country. This more active role is still consistent with UNIDO's function of co-ordinator and catalyst. For example INTIB (Industrial and Technological Information Bank) already provides a valued service to developing countries. It would be for consideration whether a special unit might be found within INTIB to concentrate on maintenance issues.

Training and consultancy help

Training co-operation between developing countries (which can include training in maintenance) is referred to in the resolution of the Fourth General Conference of UNIDO about human resources development (paragraph 7), where assistance is urged for the cost of international travel for trainees under TCDC arrangements. Consultancy help from one developing country to another on maintenance subjects is equally important, and is included in the scope of paragraph 5(g) of the Fourth General Conference resolution on TCDC.

If the meeting supports these objectives of increasing exchange of information and training and consultancy help between developing countries it may wish to draw attention to the UNIDO IV resolutions.

Existing TCDC

There is already in existence a very considerable amount of TCDC within Regions, some created by the Regions themselves, and some by United Nations or other international agencies. Co-operation between the Regions, however, is not so well developed, and in the case of industrial maintenance and training for maintenance this appears to be an aspect requiring further attention.

Within ESCAP countries resources are available, and within ECA countries needs exist. It is necessary to facilitate the flow of help from one Region to the other, and the comments of international agency representatives at the meeting will be welcomed.

Organizations which constitute existing examples of TCDC include: -

- the UN Regional organizations: ECLAC, ECA, ESCAP etc.
- the ILO Regional organizations: CINTERFOR, CIADFOR, APSDEP
- Regional economic groups, Andean Pact, ECOWAS, SADDC, ASEAN etc.
- the Colombo Plan countries
- the ACP countries and their Center for the Development of Industry (CDI)
- technical organizations within Regions, e.g. in Africa ARCEDEM (African Regional Centre for Engineering Design and Mechanization)
- Union of African Railways, etc.

All these organizations in their different ways have the potential to support industrial maintenance and/or training for maintenance. Some of them appear to be particularly suitable for increased co-operation with UNIDO in the field of maintenance, for example the CDI for the ACP countries, and ARCEDEM (which is already supported by UNIDO) for Africa.

Ways and means have to be found. Practical research is needed to determine

- which developing nations have special aptitude for maintenance (for example Pakistan, Sri Lanka, India, Burma)
- how to encapsulate and transfer this knowledge and skill to other developing nations which lack it?

The advice of participants is greatly needed.

15149

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FRANCAIS
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Réunion d'experts de haut niveau préparatoire
à la deuxième Consultation sur la formation
de la main-d'oeuvre industrielle

Paris (France), 13-16 janvier 1986

IMPORTANCE DE LA MISE EN VALEUR DES RESSOURCES HUMAINES POUR LA MAINTENANCE DANS L'INDUSTRIE

Rectificatif

Page 5

Lire comme suit les entrées concernant APSDEP et CIADFOR

APSDEP Programme de développement des qualifications pour l'Asie et le Pacifique (OIT, Islamabad)
CIADFOR Centre interafricain pour le développement de la formation (OIT, Abidjan)

Page 9, note de bas de page 6

Ajouter "(PNUD)" après "post investissement"

Page 14

Remplacer "Organismes bilatéraux" par "Organismes donateurs"

Page 24, ligne 6

Supprimer "industrielle"

Page 25, ligne 5

Remplacer "disposent d'aptitudes spéciales" par "ont formé de bonnes compétences"

Page 31, ligne 6 avant la fin

Supprimer "industrielle"

Page 32, lignes 5 et 12

Supprimer "industrielle"

252

V.86-62708 4963A

Page 33, ligne 13

Supprimer "industrielle"

Page 70, dernier paragraphe et page 71 premier paragraphe

Remplacer le texte actuel par le texte suivant :

3) Unités de compétences utilisables. Il y a quelques années, souhaitant simplifier et accélérer la formation, l'OIT a lancé un système de formation sous forme d'unités de compétence utilisables. Il s'agissait de donner à l'intéressé(e) une formation qui lui permettrait d'avoir accès à un emploi rémunéré. Ce système permet aussi de manière souple aux stagiaires d'améliorer et d'élargir leurs aptitudes en absorbant des unités supplémentaires de compétences employables.