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Technical Meeting on the Selection  
of Woodworking Machinery

Vienna, 19 - 23 November 1973

**CENTRAL MAINTENANCE AND REPAIR SHOPS <sup>1/</sup>**

prepared by  
the Secretariat of UNIDO

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SUMMARY

Industrial development in developing countries entails the increasing use of equipment. If such equipment is not looked after adequately so that it will give the required performance and expected span of life, it will become a burden and hindrance to development rather than an asset.

Maintenance is one of the most important industrial activities which contributes to the proper use of equipment and thus to adequate equipment performance, the enterprise output and profitability and the industrial development of the country.

Maintenance, however, requires a series of inter-dependent and mutually supporting activities, the most important of these are planned maintenance (including preventive maintenance), maintenance prevention, predictive maintenance and repair operations. Each of these techniques has its role in the whole maintenance activity.

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## Organización de las Naciones Unidas para el Desarrollo Industrial

Reunión técnica sobre selección de  
maquinaria para trabajar la madera

Viena, 19 - 23 noviembre 1973

### TALLERES CENTRALES DE MANTENIMIENTO Y REPARACION<sup>1/</sup>

preparado por la  
Secretaría de la ONUDI

#### RESUMEN

La industrialización de los países en desarrollo entraña una utilización creciente de equipo. Ese equipo ha de cuidarse debidamente para que dé el rendimiento requerido y alcance la vida útil que de él se espera, puesde lo contrario, en lugar de constituir una ayuda para el desarrollo, supondrá una carga y una rémora.

Una de las actividades industriales más importantes es la del mantenimiento, que contribuye a que se haga del equipo el debido uso y se logre así que sean adecuados su rendimiento y la producción y rentabilidad de la empresa, con lo que se contribuye a la industrialización del país.

Ahora bien: el mantenimiento requiere una serie de actividades interdependientes y mutuamente coadyuvantes entre las que destacan el mantenimiento planeado (incluido el mantenimiento preventivo), la evitación del mantenimiento, el mantenimiento predictivo y las operaciones de reparación. Cada una de estas técnicas tiene su función que cumplir dentro de la actividad general de mantenimiento.

Ahora bien, en los países en desarrollo, además de la falta general de comprensión en cuanto a la índole y a las exigencias propias del mantenimiento, se experimentan dificultades en relación con los aspectos siguientes:

- a) Las empresas de países en desarrollo, a diferencia de las radicadas en países desarrollados, no cuentan con la ventaja que supone el encontrarse cerca de los fabricantes de equipo;
- b) En los países desarrollados existen empresas especializadas en mantenimiento, lo cual es algo casi totalmente desconocido en los países en desarrollo;
- c) Muchas de las operaciones de reparación que han de efectuarse en el equipo actual requieren un equipo de reparación pesado y especializado, así como aptitudes profesionales especiales. Estos recursos son caros y, por lo general, rebasan las posibilidades financieras de la mayoría de las empresas de países en desarrollo;

<sup>1/</sup> La presente versión española es traducción de un texto no revisado.

However, in addition to the general lack of understanding of the nature and requirements of maintenance in developing countries, these countries experience specific difficulties in this field.

- a) Enterprises in developing countries are deprived of the advantages, enjoyed by those in developed countries, of being near the equipment manufacturers.
- b) Specialized maintenance enterprises exist in developed countries but hardly exist in developing countries.
- c) Many repair operations on today's equipment need heavy and specialized repair equipment and special skill. These are expensive and are usually beyond the financial ability of most enterprises in developing countries.
- d) While enterprises in developed countries do not have to keep expensive and slow-moving spare parts in their stores because of their nearness to equipment manufacturers, those in developing countries have to stock such parts.

One of the important steps to overcome these difficulties is the establishment of central maintenance and repair shops which look after the requirements of a group of enterprises. These shops will handle repair work which is beyond the financial and technical ability of the individual enterprises. They will be able to employ special skills and have heavy and specialized equipment and use them economically.

- d) Las empresas de los países en desarrollo tienen que tener en almacén piezas de repuesto de elevado precio, y que no se necesitan con frecuencia, porque, a diferencia de las empresas de países desarrollados, no tienen cerca a los fabricantes de equipo.

Uno de los pasos más importantes para salvar esas dificultades es el establecimiento de talleres centrales de mantenimiento y reparación que atiendan a las necesidades de un grupo de empresas. Estos talleres se ocuparán de aquellos trabajos de reparación que rebasen las posibilidades financieras y técnicas de cada empresa por separado. Podrán emplear aptitudes profesionales especiales y contarán con equipo pesado y especializado cuyo empleo resultará así económico.

## INTRODUCTION

1. Maintenance is becoming one of the most important industrial activity in both developing and developed countries. In developed countries, the spectacular advance in science and technology is accompanied by the use of more sophisticated and complicated equipment: transfer machines and the increasing use of electronics are just two examples. Thus, the rising capital investment per labourer and the market competition have forced enterprises to pay great attention to "downtime of equipment" due to its enormous cost to the enterprises.

2. In developing countries, industrial development is associated with transfer of technology from the advanced countries and increasing use of equipment. Such equipment is acquired mostly through loans and purchases, and this is a very big strain on one of the most scarce resources in developing countries, i.e. capital. Even if the equipment is donated, local working capital would be required. If such equipment is not looked after adequately so that it will give the planned performance and output and last a reasonable life, it will become a burden and hindrance to development rather than an asset.

3. Maintenance, in both cases, is one of the most important activities, affecting the enterprise's profitability and the industrial development of the country. Adequate maintenance, however, requires a series of interdependent and mutually-supporting activities. The most important of these is called "Maintenance Prevention", i.e. eliminating as much maintenance and repair work as possible. This takes place in two stages. The first is at the equipment ordering stage; particular attention should be paid to equipment design and specification from the maintenance point of view, taking into consideration local conditions, accessibility of parts for dismantling and ease of repair. The second stage is when equipment is actually installed and producing. Failures should be studied carefully in order either to avoid them in future or to prolong periods between failures. Maintenance work which cannot be eliminated should be carefully planned and scheduled. Preventative maintenance techniques should be adopted to avoid emergencies and unexpected stoppages. Predictive maintenance procedures should be used to follow up any physical changes in equipment in order to avoid further deterioration or to be ready for its repair beforehand. Many pieces of monitoring equipment are used in predictive maintenance, such as noise and vibration analysers, crack detection and ultrasonic testing.

4. Adequate repair of equipment is of utmost importance in order to implement planned maintenance work, to avoid excessive downtime and to enable equipment to give its designed performance continuously. No planned maintenance work can be carried out with equipment badly repaired or adjusted. A planner must have as accurate an idea as possible of the expected times between failures. Badly repaired equipment may stop unexpectedly any time and put all plans out of gear. With bad repairs, a well planned maintenance programme will gradually turn into a series of emergencies, resulting in excessive downtime and inability to continue production. Products today are produced to close tolerances and unless equipment is properly repaired and adjusted, the percentage of rejections will be enormous.



I THE SPECIFIC CONDITIONS IN DEVELOPING COUNTRIES

5. In addition to the general lack of understanding of maintenance in developing countries and improper care of equipment, these countries experience the following difficulties in the field of maintenance and repair:
6. a) Enterprises in developing countries are deprived of the advantage enjoyed by the industrialized countries of being near to equipment manufacturers and suppliers. In developed countries when certain troubles specific to certain equipment occur, a telephone call will bring specialist services within days and perhaps hours. This is, of course, not the case when the distance between supplier and customer is hundreds of kilometers; only in rare instances do local agencies supply such services. In addition to the cost of sending a specialist from a manufacturer to a customer in a developing country, manufacturers may afford to release their specialists for a very short trip, but in many cases they cannot afford to release them for longer periods. Thus enterprises in developing countries have to build up within their organization the special skill to cope by themselves. This is very costly since personnel with such special skills are usually highly paid and underemployed most of the time.
7. b) Many specialized maintenance enterprises exist in developed countries. These can carry out certain types of seasonal and specialized repairs in a more proficient and cheaper way than when carried out by the enterprise itself. Such specialized firms hardly exist in developing countries, with the result that they have to build up a maintenance work force of trained personnel to cope with seasonal and emergency repairs and peak loads. Even if such skills could be made available to the enterprise, which is rarely the case, it would be a costly procedure. With the availability of such specialized maintenance firms, enterprises could build up their own maintenance forces to cope with average loads, leaving the peaks for specialized firms.
8. c) Many repair operations on the production machinery of today need special, and often heavy and expensive, machinery. Most of the enterprises in developing countries are small and can hardly afford to buy such equipment; even if the equipment were bought, it would be idle most of the time and create a financial burden and increase cost of production.
9. d) Spare parts are one of the very crucial problems facing developing countries. Enterprises in developed countries do not have to stock expensive and slow-moving spare parts. Foreign currency is not readily available and in most countries a long time is required to obtain an import permit. Equipment may stay idle for months before the required spare part is obtained. In most cases this is much more expensive than keeping the part in stock; thus developing countries usually carry a bigger stock of spare parts than developed countries. At the same time very few enterprises in developing countries can afford the establishment of machining capacity able to manufacture parts in emergencies.

10. e) Skilled maintenance personnel are very scarce. The lack of adequate maintenance facilities makes the situation still worse. Most of today's maintenance, repair and adjustment operations cannot be carried out by all-round mechanics, but require specially skilled technicians. Today's equipment design is so developed that it needs much more skilled maintenance crews rather than actual machine operators. The need for maintenance skill is particularly important in developing countries, where enterprises do not have at hand the technical help of the manufacturers or specialized maintenance firms. They must depend completely on their own staff.
11. f) Almost all equipment utilized in developing countries is imported from the most advanced countries. Such equipment is designed to cope with the economic, cultural, technical and physical conditions of the developed countries and thus many modifications are required, especially for working with dense tropical species. The manufacturers are usually not in a position to study local conditions and carry out the necessary modifications. Even if they become aware of the necessary modifications, since the equipment supplied to any one of the developing countries is usually a very small percentage of their total mass production, they can only afford to introduce minor changes.
12. It would be a very great advantage if developing countries could build up their ability to study behaviour of equipment under local conditions and carry out or include such modifications in the specifications of equipment to be ordered. Although the savings in cost and reduction in downtime gained by building up such ability is considerable, most of the enterprises in developing countries are too small in size to be able to afford building up of such capacity within the enterprise.

## II ROLE OF CENTRAL MAINTENANCE AND REPAIR SHOPS IN SOLVING THESE PROBLEMS

13. The biggest obstacle to building up the technical capacity to tackle such problems is the fact that most of the enterprises in developing countries are too small and have limited financial resources. They cannot afford to establish their own training facilities or send their staff to industrialized countries for training, and as a result have to depend to a great extent on local training facilities. In many cases training is required to upgrade personnel to a level higher than that obtained in standard technical trade or vocational schools which are practically the only training facilities in developing countries.
14. While the demand and potential use of highly skilled personnel and special and expensive equipment may be limited in any one enterprise, the total demand from a group of enterprises may make this economically justifiable. This provides the main rationale behind central maintenance and repair shops.

15. The establishment of a central maintenance and repair shop would have the following advantages:
16. 1. Since it will cope with the demand of heavy work and specialized operations from many enterprises, it will be able to afford the purchase of heavy and specialized equipment. Such equipment would be utilized economically and the costs of repair to the individual enterprises would be reduced to reasonable levels. It will cope with all operations which are beyond the ability of the individual enterprises, such as:
- a) General maintenance of machines.
  - b) Turning of large diameter parts (0.5 - 3 and more meters), an operation which requires a big lathe which cannot be utilized economically by individual enterprises.
  - c) Surfacing and grinding large surfaces, an operation which requires planing, surfacing and grinders of big capacities.
  - d) Specialized operations such as gear cutting and balancing of parts.
  - e) Accurate and high quality forging and casting.
  - f) High standard welding operations.
  - g) Specialized equipment for servicing of:
    - Special tools (carbide and stellite tipped saws, knives and cutters)
    - High pressure hydraulic systems
    - Electric motors and relays
    - Electronic controls.
17. 2. Central shops will afford to hire and train highly specialized maintenance technicians, machine operators, welders, etc. and pay them adequately while using them economically. The work done will give their personnel a chance to continually improve their proficiency and gain experience by dealing with a variety of jobs. The availability of such experienced personnel is an asset to the enterprises, and also to the country. It will save calling on experts from the developed countries, thus saving the enormous expense, particularly in foreign currency, such help would involve. In addition, in the long run, local maintenance experts will be better acquainted with local conditions; foreign experts will perhaps be coming to the country for the first time and they will require a certain amount of time to become acquainted with local conditions and problems, which may be different from those in their own country. Thus experienced personnel in the central shops will save time as well as money.
18. 3. A central workshop with experienced personnel and adequate machinery, casting, forging and welding capacity would be able to make individual parts in an emergency so that equipment can be kept running when such parts are not available in the stores, even if such a part will not be of the same accuracy and specification of that supplied by the manufacturer. The saving resulting from cutting down downtime of equipment makes it really worthwhile for the individual enterprises to encourage and help the establishment of such centres.

- 6 -
19. 4. With the accumulation of experience in the central shop, the quality of locally manufactured spare parts will improve and parts that are not too complicated and do not require very specialized techniques, machinery and equipment would be manufactured locally to the same standard as the imported ones. Thus large stocks of such parts, in particular slow moving and emergency items, could be reduced, and the reduction, without the risk of prolonged downtime, will benefit enterprises materially and improve their productivity and profitability.
  20. 5. The existence of central shops would also encourage the local production of other simple hardware items of the standard and semi-standard nature that are generally very much needed in developing countries. They could become the nucleus and initiators of local manufacture of such items. These shops would manufacture prototype series for local enterprises and then guide them in the proper technique, machining process, heat treatment, etc. They could also produce on a non-serial basis simple pieces of production equipment.
  21. 6. Central shops, with their accumulated experience of local conditions and problems, could act as advisers to local enterprises in handling their problems and improving their techniques, resulting in reduction of failures and better use of equipment. In time, central shops would not only help with repair operations and the manufacture of some parts, but would also study failures, advise on changes in working conditions or materials to avoid them, and redesign parts to suit local conditions. This would help build up local design ability and would be a vital asset to enterprises in the modification of equipment to suit local conditions and in formulating the right specifications for new equipment from the point of view of maintenance. The central shops could be able to design (and subsequently produce) complementary equipment, e.g. transfer lines, dust extraction, etc.
  22. 7. A well established central shop can act as a maintenance subcontractor, taking over from enterprises seasonal overhauls, peak loads and emergency heavy repair. In such a case the individual enterprises have only to employ sufficient manpower to cope with routine maintenance and repair operations, thus reducing the cost and burden of maintenance staff who would otherwise not be fully utilized. The obvious advantages of this are appreciated.
  23. 8. Central shops can also act as a training centre in which maintenance personnel from different enterprises can be upgraded to a high level of proficiency. This would spare enterprises the necessity of establishing their own training facilities and sending personnel abroad for training, which most enterprises would anyway be unable to do because of limited means.

### III THE FINANCIAL ADVANTAGES OF CENTRAL SHOPS

24. Taking into consideration the various useful activities that a central maintenance and repair shop can render, as previously outlined, the financial advantages to the enterprises can be summarised as follows:

a) Repair operations carried out by skilled and competent personnel and the availability of specialized machinery result in better, quicker and cheaper repairs.

b) As a result of (a), downtime of equipment will be reduced substantially. Time of repair will be shorter and, because of the high standard of repair, time between failures will be longer. The effect of increasing equipment availability on the success of the enterprise cannot be over-estimated.

c) When peak loads, seasonal repairs and overhauls and emergency repair are taken over by the central shops, enterprises will be able to reduce their maintenance staff and avoid idle time of maintenance personnel. The resultant reduced payroll of maintenance personnel will contribute greatly to the lowering of overall costs of production. (To give an idea of the magnitude of this saving, in many companies the direct maintenance labour cost exceeds the profit).

d) Repair and adjustment work carried out by specialist and proper equipment would result in that equipment continuing to perform to design over long periods. The percentage of rejections in production will be reduced and this will contribute to the lowering of production costs and increased profitability.

25. It is, however, difficult to give quantitative figures for such financial savings. Conditions vary greatly from country to country, as do those in enterprises in the same country and even in enterprises within the same industrial sector of the same country. Such financial benefits, however, depend on:

a) The average size of the enterprises; the smaller the size, the bigger the saving will be.

b) The degree of mechanisation of the techniques adopted.

c) The level of industrial development of the country.

d) The rate of progress of industrialisation. Usually if industrial enterprises are established at a high rate, management of such enterprises face the problem of shortage of competent personnel to cope with the various duties. When this occurs, maintenance is usually one of the activities that is given low priority. In such cases, central workshops could be of immense help.

#### IV ORGANIZATION AND EQUIPMENT OF CENTRAL SHOPS

25. It must be remembered that establishing a central maintenance and repair shop and bringing it up to the standard necessary to fulfil its duties as outlined above is a long term process, requiring years not months. The crucial part is not the purchase and installation of equipment or the building of offices and sheds, but rather the training of personnel. This will pass through two phases: the building up of their basic technical knowledge and then the building up of their experience and knowledge of local conditions and problems. During this second phase, their technical ability will gradually improve as they see and handle more cases.

26. It is not expected that such a centre will start being useful and giving a good return for the money invested before, say, the first couple of years. In the long run, however, such an investment will give more than adequate returns. These facts should be kept in mind so that the sponsors of such centres do not expect results quickly and become frustrated.

27. It is better to start small and enlarge the centre gradually as more and more market experience is acquired. This is due not only to the time required to build up staff experience, but also to the time it takes to become aware of and acquainted with local demand. The central shop is not a production factory where the different machining operations are known in advance and the type and capacity of machines and layout of the shop can be determined beforehand; it is a jobbing factory dealing with a variety of operations which may change from season to season and even from day to day. Thus it is difficult to determine from the start what equipment is required.

28. It is recommended to start by studying carefully the enterprises which are potential customers and the type of production and maintenance equipment they have. This will give a good general guide. The machine shop of the centre would then be equipped with basic equipment with a capacity larger than those available in the different enterprises and some special machinery for which the preliminary study indicates demand. Gradually more equipment would be added to the shop as more experience is gained. As a general guide, the following equipment may be installed for a start:

- a) A horizontal lathe which handles jobs of up to one meter in diameter.
- b) If preliminary studies indicate that bigger sizes are to be machined, a vertical lathe is recommended with a capacity of 2 - 3 meters machining diameter.
- c) If the shop is to serve mainly sectors that need spares or parts which are small but very accurately made, a small sensitive lathe is to be added. This should be supported by accurate measuring equipment like dial gauges and projection profile measuring equipment.
- d) A universal milling machine.
- e) If the preliminary studies justify it, a cylindrical grinding and surface grinding machine could be added.

- f) A surfacing machine.
- g) Welding equipment .
- h) Forging equipment.
- i) Casting capacity, if indicated by preliminary studies .
- j) Facilities for repair of electric equipment including motor rewinding .

28. The above indicates that there is no such thing as a standard layout for a central shop; as mentioned before, this will depend entirely on local conditions and the ability of the individual enterprises to cope with their work. Many enterprises in developing countries prefer to be self-sufficient, even if that is uneconomical.

29. In addition to the workshop, the centre should have the following departments:


30. a) A technical office to study maintenance problems and equipment failure. When fully developed, such an office will be of great help in reducing maintenance work and cost and help enterprises in ordering new equipment. The time would come when such an office would be able to modify the design of parts to make them more suitable to local conditions and reduce the number of failures. It would help enterprises in routine inspection, mainly by monitoring equipment such as crack detectors, ultrasonic testing equipment, noise and vibration analysers, etc. Such equipment is not expensive and, in experienced hands, can be very useful in detecting changing conditions in equipment so that failures may be avoided or anticipated and measures taken to minimize their effect. This would also help to establish realistic maintenance programmes. Instead of enterprises being faced with sudden failures, proper inspection programmes carried out by monitoring equipment will enable enterprises to know well in advance of the possibility of failure and thus prepare for the importation, or inform the local manufacturer, of the part required so that it is available in time and no unnecessary downtime will occur. Inspection operations and programmes can be carried out by the centre according to a yearly contract.

31. The technical office would also be of great support to the machine shop by giving the required specifications and drawings. Parts manufacture needs proper choice of material and accurate determination of tolerances and clearances.

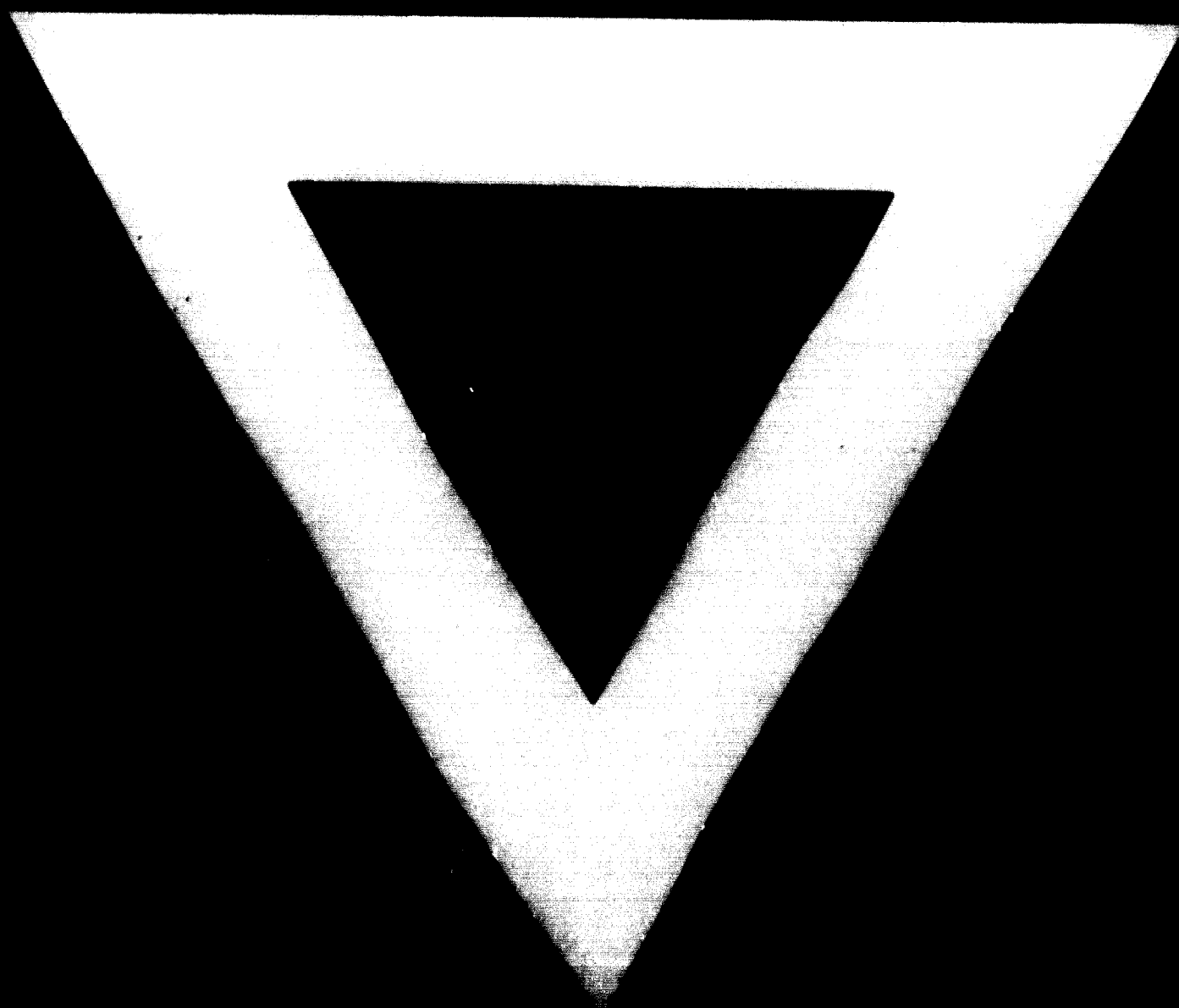
32. b) A drawing office to support the machine shop, the enterprises and the technical office. The value of good draughtsmen producing good drawings is generally much underestimated. In most cases the drawing office will be part of the technical office.

33. c) A maintenance management department to carry out planning and organization, which though a different aspect than technical maintenance activity, should be given its due importance. Many maintenance problems can only be solved by planners and organizers and not by technicians. The centre should establish within its organization the capacity to handle such problems and render the proper service to enterprises in so doing.

### CONCLUSION

34. Central maintenance and repair shops play an important rôle in improving the productivity of enterprises, reducing the production costs through better maintenance and utilization of equipment and accordingly helping in the industrial development of a country. They not only help enterprises to carry out operations which are beyond their means, but also carry them out in a more economical way.
35. Such shops would create a nucleus for building up the country's ability to handle equipment in a better way under local conditions and for the technical ability to redesign parts to suit working conditions and suggest necessary modifications to new equipment.
36. Such shops would be of great assistance to newly formed enterprises manufacturing hardware and other commodities usually needed in developing countries. In addition to helping in the design of products and technique of manufacture, they can build up and test prototype series.
37. Central shops are of particular use to countries where the average size of enterprises is small and where the country is at the early stages of industrialisation. Investment in such shops will give enormous returns in the long run.
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