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THE USE OF DESIGN AND METAL WORKING CENTRES IN
MAINTENANCE AND REPAIR

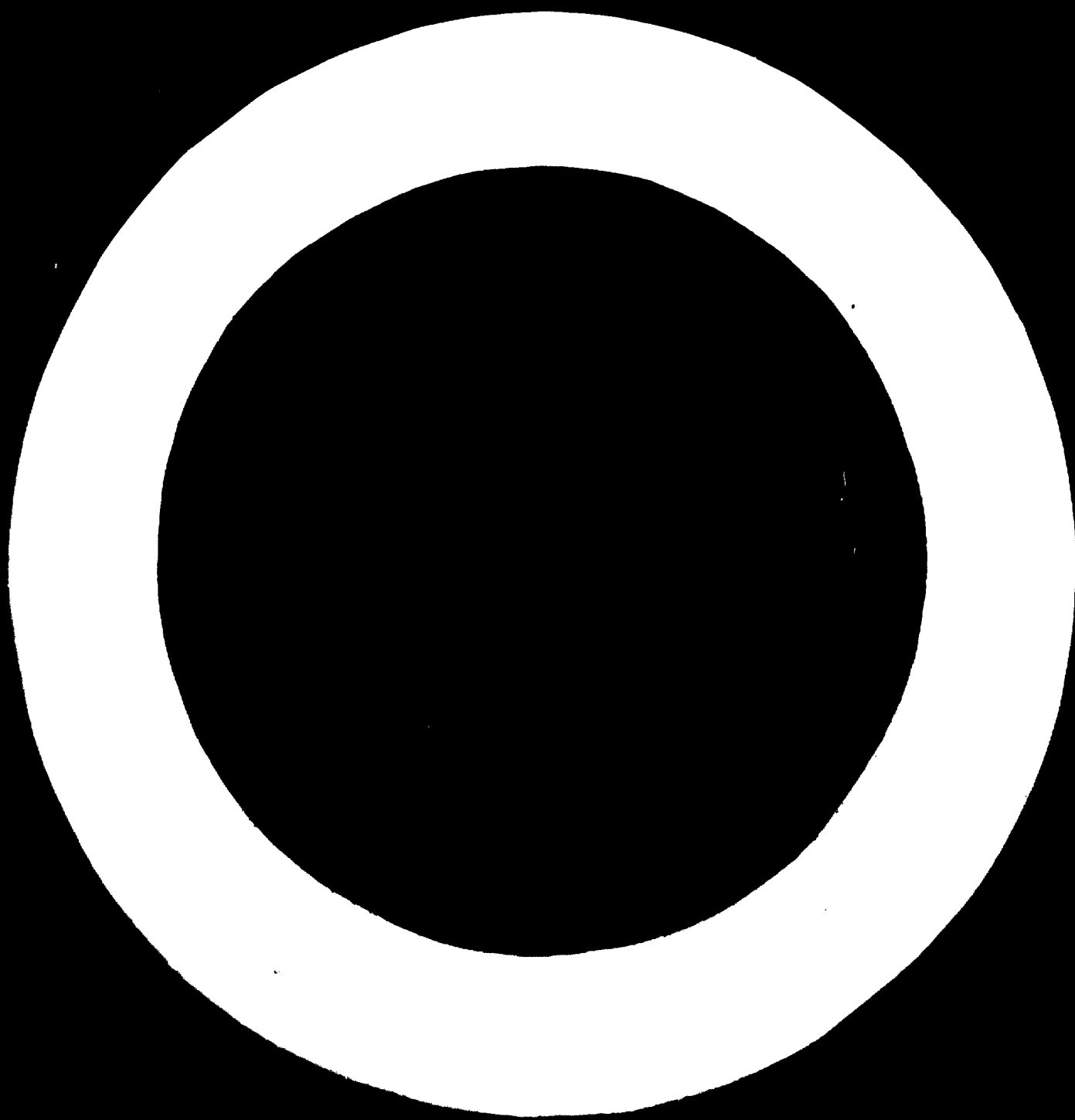
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Organized in co-operation with the German Foundation for
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Introduction.

In the following notes the writer shall endeavour to point out and highlight some of major activities which if carefully adopted as a job of work, by both the Metal Working Centres and the design development centres, over and above their basic plan of operation it would certainly and favourably affect the status of the maintenance problem in their localities. It could in the meantime open the field of correct repair jobs for worn out parts without much fear of damaging the original pieces through the lack of correct understanding of all details.

With a slight extension of their design and drafting abilities and with the help of the workshop facilities that are usually attached to them they could solve many of the problems that are liable to face the local producers of non complicated spare parts and would certainly help them to produce some of the more complicated pieces if the balance between the expenses of their manufacture versus the loss in production plus the cost of downtime proves to be favourable.

Such centres could also encourage the local production of other simple hardware items of the standard and semi standard nature which are generally

very much needed in the developing countries. All such activities could be easily achieved by the preparation of the full working drawings required which would give all the technical data and the specification of the materials involved and give a satisfactory guidance towards the most suitable heat treatment process recommended.

The production of few articles in these centres as proto-types would certainly ensure their usefulness and would ensure the final production of several good spare parts that would satisfactorily replace the original.

As a matter of fact many of the activities that shall be detailed later could be planned, drawn, taught, exercised, organised and initiated by the help of the existing centres wherever they may be with only very slight additions of special purpose equipment and moderate readjustment of the working forces in them.

On the other hand, such activities as will be discussed in this report would undoubtedly have a profound and favourable effect on the life and efficiency of the machine and equipment, not only in the developing countries but also in many old factories that are existing in the developed nations. Although this point could be argued because the majority of the factories in the industrially developed countries are following up some sort of maintenance procedure. Yet still many of them might only be following up ways and means of maintenance which if reconsidered by specialised people could become an

effective tool in increasing the size of production in their establishments and help to improve upon it.

This would not only be the result of better and more efficient utilization of the equipment and minimization of the down-time but it would be through the unquestionable result of longer useful life of the machines and equipments and the lesser quantity of spares the firm has to carry, some of which, after a time, might prove to be a dead capital.

From various incidents that had passed the notice of the writer and due to the old fallacy which is generally rooted in the minds of many responsible people of the industry, where they wrongly feel that maintenance with its tight rulings and expenditures involved therein only means the spending of money without getting sufficient returns and they feel that such capital could be more usefully utilised in direct production jobs, it is not infrequent that one would find factories in the industrially developed countries adopting some old and frail procedures of maintenance. In so doing they are simply lulling themselves as well as the people around them in the false feeling that they are carrying out maintenance work.

Admittedly such an attitude is more pronounced in the developing countries where the managers of the newly constructed industrial concerns are continuously endeavouring to cut down on the costs of production which is usually so high when the industry is in its infancy, but nevertheless, in

our opinion, the subject of developing the maintenance procedures needs consideration in both the developed and developing countries simultaneously but not necessarily to the same degree for many reasons:-

For instance, in the developing countries where the number of real and active consumers is small in spite of the well known fact that they possess large and exploding populations, the volume of production in the industrial concerns is not so high and it is usually kept just around the break-even point and thus there is not enough margin to cover up any extra expenses beyond those needed for direct production purposes.

This fact coupled with many other factors such as the limited experience of the production personnel at this stage, the expenses to cover up the high percentage of rejects, the difficulty of acquiring the correct raw materials, and the high costs involved in getting the technical know-how and in readjusting them to suit the local conditions all these plus the troubles resulting from the newly imposed labour regulations face those responsible for the running of the industrial concerns in the newly developing countries.

Pondering on all these factors which appear simultaneously in front of the managers of these concerns, what else could one expect from them when you try and convince them to adopt and introduce another new factor, useful and essential as it may be, which entail further expenditures. Naturally

you expect nothing but reluctance almost to the point of refusal.

All this added to the known fact, which we are all aware of, where the staff of maintenance could at certain instances appear to be without heavy duties particularly if their work would be limited to only maintenance work, especially in a newly constructed factory when extensions and additions which are usually considered the subsidiary duties of the maintenance staff, are not so much needed at this stage.

For all these reasons one is encouraged to stress the undebatable usefulness of earnestly studying the possible utilization of the already existing metal working and design development centres with their existing staff facilities and workshops in helping out those managers by studying on their behalf the various ways and means of maintenance procedures that has been successfully practiced and adopted in the developed nations' industrial concerns, find out the most suitably suited system or combination of systems for the firm they decide to help, work out its economical aspects and prove to the manager in figures the balance of benefits he would expect to have if he introduce stringent maintenance methods.

In our opinion this is the only efficient way in persuading the managers in these countries to consider the matter. Simple talk and oral convincing is a mere waste of time which would not bring satisfactory results, on the contrary it creates a completely different conception of the whole subject and it is advisable not to attempt it.

The help extended by the centres would not stop at that point but it should be continued till maintenance has been well established with the place in hand as will be detailed later in this report.

Unfortunately there can never be one fixed standard procedure to follow in the maintenance field. The one system that might be successful in one concern could prove to be unsuccessful in the other. Because,

the size of the industrial concern, the age of the equipment, the set-up of the place and its layout, even the volume of production, the frequency of the orders received and the nature of the product itself all have been found to have profound influence on the choice of the best procedure for maintenance to be adopted.

Thus in this particular line, one phase of the work and duty of the centres should be the carrying out of a succession of study-cases where one or more cases would be tackled simultaneously according to the number of the staff available on the spot and their capabilities. On the other hand, because the choice of a suitable maintenance system depends largely and in a way essentially on the study and analysis of the accumulated observational results of breakdowns, their nature and their frequency; each case-study will naturally occupy an appreciable duration of time. Thus during the first stages of the work in this field, it is suggested that the number of cases handled to be strictly limited to a minimum, but it is up to the responsible people in the centre to work out a plan for the future increase of the number

handled in the same time. A way of achieving this would be by simultaneously setting up observation points in various firms, in collaboration with the people working there, whose duty would be to record all the necessary information required for the future studies. Such points will only need sporadic visits from the people of the centre and thus many of them could be put to work in the same time. This stage will be known as the exploration stage, prior to the studying and then the practical working stages would follow.

Besides studying the best compromised systems of maintenance just mentioned, the centres could help other firms, as well as those whom they are dealing with, in setting up standard and semi-standard forms needed for the correct flow of maintenance work. Such forms must be prepared in such a way or ways to suit the customs and character of the people in the vicinity where they are to be used. You just cannot possibly copy forms made in an industrially developed country and expect them to be carried out successfully in a developing one. Even a suitable form for one developing country might prove totally inadequate and unsuitable for another developing one.

From all what has been so far mentioned it is clear that there is a lot that could be done by the metal working centres and/or the design development centres in the field of choosing and setting up maintenance

procedures whether these are situated in an industrially developed or developing country.

The experiment which UNIDO is contemplating to embark upon, might and possibly could, give a more successful and gratifying result and in a much shorter duration, if tried out in the industrially developed countries.

This would be due to the fact that these latter centres are situated in an industrial atmosphere where certain stringent discipline generally exist,

This fact alone place them on a more favourable ground for the trial.

The experience gained from these quickly adaptable centres of the developed countries could reflect favourably on the slower responding ones of the developing nations.

Thus the suggestion that is now being put forth could be summarized as follows:

If decision is finally taken by UNIDO to attempt utilizing the metal working and design development centres for the purpose of energising good maintenance policies, a simultaneous programme covering the utilization of a small number of the centres in the industrially developed countries together with a larger number in the less developed ones should be drawn out. This work would only be as an addition to their original plan of operation and

not as a substitute to it.

The experiment could, for example, cover the embodiment of say one centre in a developed country against three in the developing ones.

Again we would advise against carrying out the experiment in one developing country alone because the failure in one place - which may be attributed to some unforeseen natural inclination of that particular spot - would give a false unfavourable re-percussion on the whole scheme. It would be a great pity indeed to expose such an important subject to an unfair deal. As a matter of fact this matter alone i.e. the degree of maintenance of the machines and equipment constitute a very prominent point on the demarkation line existing between industrially developed nations and the developing ones.

At this part of the report I should like to draw the attention of the reader to the report of the expert group on the subject of maintenance and repair which was submitted to UNIDO at the end of November, 1966. In this report it was clearly stated that in the majority of cases equipment and machinery in developing countries last only a fraction of the usual time expected from them. It was also convened that at the same time most of these developing nations are suffering from the shortage of foreign currency in a general way and especially so when such a currency is so much needed

at that particular moment to acquire a replacement for an unexpected damaged or badly worn out part. Unfortunately, the shortage of foreign currency always present an obstacle in the way of many concerns and prevent them from carrying within their stores enough spares to minimise down-times. Thus many of the industrial concerns in such countries find themselves forced to follow the policy of the "Make-do" with the best substitutes available to them in the country and/or improvise what they can as an alternative. A practice which has its mal-repercussions on the quality and the quantity of production.

In my report here, I am not trying to dramatise on the situation that can exist, I am only explaining some of the bitter facts that could, and I dare say have happened. All such facts might appear strange to the eyes and ears of experts or even visitors coming from other and more luckily situated countries. The writer have often heard criticism of having to adopt such practice but found himself unable to give enough convincing explanation of the painful experiences and difficult circumstances that has driven those responsible and able men, that are working in these places, to follow such methods.

From all the explanation that has been given it is conspicuously clear how an efficient maintenance system supported by a.

ample number of well trained personnel could be so valuable in such circumstances, and for this reason we are detailing here-in-under some of the multitude of activities that should be followed up, practiced and continuously develop to enrich the maintenance aptitude in those localities.

Steps and Activities Recommended for Action
by the Centres.

It must be remembered that maintenance is a subject that requires a fair amount of Psychological studies. It does not only call for training but it needs a substantial amount of character reforming no matter where it shall be practiced, be it in the developed or developing nations.

Good successful and effective maintenance systems needs good discipline such as that practiced in the military life and unless such stringent habits are actually implanted within the people and particularly so within those who are responsible for its upkeep success in that direction could not be gratifying. To gain success, it is essential to make sure that maintenance habits are closely knitted within the daily behaviour of those concerned.

Having all these points in the fore front of our vision it becomes so obvious what is the next duty of the centres chosen for that job shall be predominant. It shall be the training of people how to feel for maintenance and how much it means for useful efficient life of the equipment they are handling. Thus in the following we are going to try and give some explanation of the activities that are so much needed to ensure good status of maintenance and repair procedures and which could constitute a programme of work for the centres which are going to be chosen for carrying out this

experiment. Also we have prepared in Appendix I attached to this report

a series of thirty questions which if well considered, the answers would constitute a clear picture of the subject of maintenance and repair and would certainly help those working in these centres to set the programme that they need for successfully overcoming this subject.

The Preliminary and Basic Training Stage.

A big drive should be made to train all the nationals connected with the industry in the zone where these centres are going to limit their basic activities. If the job of training all the nationals that are dealing in industry in that particular zone is considered rather a large task, they at least should aim at training the majority of them. In the meantime they could activate such simple training in the other suitable places within their chosen zone. The drive must be large to have its effectiveness manifested.

During this basic course of training the nationals should be taught the simple straight forward regular rules of cleanliness of equipment walls, floors, buildings and everything around them then to illustrate to them the ways and means of orderliness in their work and to train them in the habit of simple pre-planning and pre-thinking of the daily work before the actual doing of it. Then to impress upon them the necessity of the daily or periodic oiling or greasing of the equipment with which they are

connected in accordance to the manufacturers advice or his manuals.

All of which might look so trivial and simple, yet is so difficult to succeed in creating a regular habit of it within the majority of the nationals of the developing countries.

The reason for such a difficulty, in our opinion could be attributed to a three field cause on which we intend to dwell upon for a moment here as an attempt to help those foreign experts who might be entrusted with such a responsibility or shall have any connections with it during the performance of their tasks.

Unfortunately the whole matter appears so easy and yet it is far from being so in actual life in the developing countries.

The first cause, according to our estimation and summarization, is the internally rooted idea that have, generally speaking, existed when there was a certain class distinction. A situation that have existed in most of these localities in the era before the development of their industrialization drive. During such periods the job of cleaning, in general, whether it is for the equipments, surroundings or whatever it may have been, had the air and distinction of being a job only suitable to be carried out by the very inferior classes, naturally in the best way of their

disposal which generally is limited. This state of things have reached the extent to make the general public look at it with a certain shame if a person of normal standing attempted to carry out such a job.

I feel it is my duty here, hard as it may be, to mention this point clearly in this report so as to ring a bell in the minds of the foreign experts when they go over to these places, and as I have seen them looking so frustrated, all of which comes from the lack of understanding the exact situation and attitude of the nationals and their resentment to carry out such jobs. In fact the nationals understand it wrongly and they think that the expert is trying to humiliate them.

Such a matter must be handled very gradually and with great care. A lot of convincing has got to be done before any serious attempt is taken in that direction. There shall always be a tendency from the side of the slightly advanced nationals to demand the employment of some unskilled hands to perform such jobs as cleaning and clearing. The experts must always guard against giving way to such demands, because the result will be a simple over crowding of employee, more disruption to good order, more difficult administration problems and actually more dirt put on than taken out. Over and above all that in so doing we would be finally overlooking the very important item that comes out of doing the job yourself which is the casual form of visual inspection that is automatically connected with the job of

cleaning.

The second cause is the result of the low standard of living and the smallness of the places of the ordinary national's dwellings which does not call for much cleaning and even then the degree of cleanliness does not matter so much. This is the same reason why we have mentioned before during our discussion of the first cause, "to the best of their abilities which is generally limited".

The third cause would be the hereditary habit that controls the activity of the human being and which is the outcome of the difficult climatic conditions, that are generally existing in the developing country. Such conditions and habits grow with the person from his earliest days. It is a totally different case with the expert who might just be coming from a different climatic condition and have been brought up in a different surrounding and with different habits which he automatically follows without giving it a second thought. It does not matter how long he might have served in foreign countries, he could not be acclimatized to the extent that makes him have the same feeling as the national himself feels.

We candidly believe that patience coupled with strict gradual training administered by the personnel in the centres could have a very great influence in that respect and would lead to a high degree of success if

followed up ardently and with perseverance. If the centres succeed in creating and developing such regular habits in as many nationals as possible, I personally would consider it a substantial stride taken forward towards setting out the correct foundation for more elaborate maintenance procedures, and they could consider themselves well over the halfway mark towards total success.

Our lengthy experience in this field where we were responsible for the maintenance of power stations and other similar establishments have proved to us, without any doubt that those little points which deal with behaviour of the human being are the real important items that actually matters, and that all the other sophisticated rulings, unless well knitted with these key points of human behaviour can just prove to be nothing else but a magnificent array of paper work that bears very little weight towards the actual goal which we are seeking.

For this reason I strongly recommend a thorough discussion of this item by the experts, and I do impress on them that they must put themselves on the level of the working men in the developing country who is going to do the job. It must be remembered that the successful professor is not the one that knows a lot, but he is the one that can bring himself to the level of his student.

Returning back to the complimentary duty of the centres and the preliminary course they should administer or at least activate in any

suitable place in their localities. We have remarked about the regular oiling and we want to mention here that such teaching does not really entail giving out knowledge more than acquainting the trainee and teaching him the simple facts about lubrication, the various lubricants and the when and where each would be considered suitable for use. All to be put in a general broad frame. This would enlighten him sufficiently in that direction and would make him appreciate the advantages of using them correctly.

He should also be made aware of the disadvantages of under-oiling and should be made to appreciate the underlying damage and the devastating effects involved in dry friction, or as it is sometimes termed "Dry Engineering". Manifestation of the damage done to metal surfaces when rubbing against one another without oil could be the best practical example shown to him in that respect.

Strangely enough and through the experience gained by living in a developing country we have found out that a squeaking machine part does not seem to worry the people to the same extent as it would worry a maintenance conscious person.

The disadvantage of over-oiling should also be stressed. Some illustration of the damage that might result from such action, specially when dealing with electrical equipment should be provided. The bad effects oil could have on the insulations and insulating materials must be made manifest.

Oil seals and their uses could be just touched upon - Higher and more detailed studies of this item must be incorporated within the courses of higher grade trainees.

In our estimation the teaching of all the above subjects does not require any complicated or specialised equipment and the centres of metal working and those of the design development could arrange to have them given as short courses prepared for the different grades of working people.

Illustration of the damage through under-oiling could be manifested on locally improvised test equipments to be designed by the centres and manufactured by them or by the proto-type production workshops if available.

Some charts illustrating the various basic grades of commonly used lubricants could also be prepared. Oil producing companies and concerns would only be too pleased to extend all help possible in that direction.

Thus both the centres in question could perform all the requisites of this programme of training in collaboration with the oil producers or dealers in the country concerned without any addition of equipments over and above their usual.

As a matter of fact the actual maintenance of the equipments existing in either centres could form a fertile zone for an actual field training for this class of trainees. Such a practical course could be carried

out under the supervising eyes of the responsible
technician of the centres.

The Advanced Maintenance Training

Course.

The second activity which the centre could successfully and faithfully develop and follow would be the creation and establishment of an advanced training courses for maintenance such courses would deal with the study of "Preventive Maintenance" systems, the advantages of following up such system and its economical aspects. It should also clearly indicate the disadvantages of the wrong introduction of such a system because the utility of such a policy can turn on the structure of the pertinent costs involved.

The course should also deal with the process of planning for it and to draw up the necessary scheduling needed to ensure its economical adaptation.

Later in this report more lengthy consideration shall

be given to this particular system.

The advanced courses will also contain more elaborate studies of the various systems that have been developed and successfully adopted by the various concerns.

All such studies enable the trainee to make the proper choice of the system or combination of systems that is best suited to the environment existing in his vicinity. As we mentioned before this could vary a great deal as it ranges from the introduction of maintenance in a damp atmosphere to a medium or very dry one and from a dusty or smoky to a clear clean surroundings each of which has its own peculiarities and precautionary measures.

It is obvious that such courses can only be given to the higher grade personnel who could assimilate the necessary knowledge for correct procedures in collecting information, sampling and tabulating it and finally deducing the best course of action. All such procedures are very necessary with regards

to our subject because we have got to know when and where to carry out the correct operation whether it is a partial maintenance, complete overhaul or simple check-up, all of which depend basically on the historical data and studies of the behaviour of the equipment, the frequency and disposition of breakdown.

Accordingly the subjects of statistical studies, statistical quality control, the knowledge of their economical effects and the counter effects, log-book keeping, preparation of standard forms, the drawing up of schedules for an even flow of paper-work, are all matters that should be well dealt with.

Good lengthy numerous examples must be presented to the trainee and practical attempts should be administered by them during the period of their stay in the centres.

This could only be possible if the centres take active role in studying the maintenance problems as a service rendered to the various industrial concerns in their country

or at least in their locality as we have mentioned before. Such studies should be the prime job of the staff of the centre and the appropriate experts should be chosen as such and they should be able to give their trainees that practical touch so much needed for future good performance.

It is needless to say that unless such a sandwich programme of studies could be drawn a mere series of lectures dealing with the theoretical approach only would not be considered useful and could not expect to bear real fruitful results.

The Repair Technique and its Problems.

So far we have been discussing the procedures and systems of maintenance but we have not touched on the matter of actual repairs. It goes without saying that these two subjects are rather inseparable. When a machine is stopped for maintenance it is not surprising to come across either a slightly worn out part or at least signs of the beginning of wear in certain places. Whether such a state has been anticipated or not, all depending on the system of maintenance adopted, the final outcome of the situation is the same. The maintenance inspector finds himself faced with the necessity to make decision of either repairing the part or replacing it by a new spare part. It is completely left for his judgment to what course of action he is to take. A good sound judgment could eliminate a major breakdown and a poor one might mean a lengthy period of downtime and loss in a future date. Thus it is obvious that an efficient well trained and

experienced maintenance group should always be made available.

They should be well informed about the know how and the technique of good harmless repair beside being capable of anticipating on the spot the best line of procedure to follow.

We must not forget that their judgment shall be based to a great extent in the first place on the status of the equipment available to them and which could justify taking a decision to repair, or even it could depend upon their knowledge with regards the availability of such equipment in any other place or even with regards to the possibility of such a repair. It is well known that the repair should be done without creating many or vital changes in the original structure of the part to be repaired. Admittedly certain changes shall be expected but as long as such changes could be sustained, the idea of repairing that particular item has to be disregarded and then comes the next step of finding the suitable replacement and that again depends a great deal on its avail-

ability in the stores of the firm or in the manufacturers. The time that shall elapse between the ordering of the part and its arrival to the spot and the foreign currency needed to cover the transaction.

Our idea of mentioning all these details here is to point out how a flexible well trained engineer and technician in the line of maintenance could influence the economy of production in any firm. Accordingly the training of these personnel should be considered a job of major importance.

Such a job, is the one we are here proposing for the centres to carry out. Indeed they should be able to give comprehensive technological and technical courses combined with practical training in the ways and means of repairing worn out parts. Also in the correct use of specialised machines and equipments that are built for that purpose together with a course in Welding, Stress relieving and heat treatment techniques. All of which could be carried out by the normal equipment and machine tools that are usually supplied for these centres with

the addition of the special appliances for building worn out parts such as the crank shaft building-up lathe, metal springing equipment, heavy electric plating baths, thermet welding equipment and so on.

On the other hand these courses must be followed by courses in the basic elementary theoretical fundamentals of good design so that the person who is carrying out any repairs should be able to grasp the reasons and necessities that have induced the congenial designer to introduce certain shapes and forms. At least it would make him inclined to respect all what he sees in the original part and try to preserve and renovate it.

He is naturally not anticipated to be a designer but at least he will have some idea about the designers work and to know that the latter would never introduce any shape or detail unless there is a specific reason for it, at least in this his own thinking.

In this respect I would like to mention here a reality which might never pass the mind of an expert as being feasible,

but unfortunately it is a certainty that could be met within a developing country - and I dare say rather frequently.

We all know that halfway knowledge can be more harmful than complete ignorance. This is true here in this case. With the lack of rigid disciplinary training in connection with details shown on the drawings, some of the technicians in these developing countries when they reach the halfway house they are apt to listen to self-formulated opinions. They imagine that certain details are not so absolutely necessary. It then becomes feasible to their thinking that some details could be left out not realising that such a trivial matter can lead to a drastic result. It is not uncommon to see a tyre wheel of a bus fastened to its hub by only four nuts instead of the eight the designer has estimated.

In many instances, after a major maintenance or a repair job only a percentage of the holding bolts and/or fixation means are put back in position but almost never the hundred percent.

The basic knowledge behind design teaching which we are proposing will definitely make these maintenance hands more aware of the dangers in following such practice. The course of design needed in this case should be formed in a suitable way to dramatise points of danger than to indulge in design details that are not necessary for such a speciality.

Collaboration between Metal Working
Centres and Design Developing
Centres.

In our previous discussion of the subject of maintenance and repair, we have anticipated the existence of a certain form of collaboration between the metal working centres and the design development ones if they are both found in the same country or locality.

If it happens that only one of them exist, it should be realised that its duties shall have to cover up for all what is required in this field. This would be more noticeable if the metal working centres are found to be alone. In this case, a drawing office facility must be added and a design capability unit should be created if such offices are lacking. If the creation of a design unit is considered difficult - a state which is very likely to happen - then we would recommend the setting up of closer contacts and co-operation with a suitable or well adopted place of

design in their locality.

Contact with engineering colleges or technical institutes is also recommended. If a specialised engineering design centre or a private design consulting office is available it would naturally be preferred as it would give that practical touch very much needed in our case.

We are stressing here the matter of drawing and design facilities because it is a well known fact that both specialities are usually lacking in most developing countries.

An experienced detailing draughtsman is a rare thing to find in these places. All what might be available are the tracers and the unexperienced draughtsman.

Both would not be in a position to give the correct helping hand in working out alterations and suggestions needed for improving maintenance and repair situation of any machine part which is continuously showing trouble.

Even engineering college graduates lack the length of experience necessary for such work. For this particular case we have advocated the third course stage of training in our report later.

Higher Training Courses.

It is to be noticed however that we have concentrated in this report on the training problem, because, once more we would like to repeat that, in our opinion the flourishing of maintenance, its continuity and its upkeep depends to a large extent on the training of men concerned.

The equipment that are common to both type of centres that we are concerned with are amply suitable for maintenance up-grading. The repair will demand the addition of a limited number of specialised equipment plus those necessary for fine measurements if they do not amply exist. In fact it is the staff and the organisational set up of these centres what needs very careful and thorough re-consideration.

It is absolutely necessary to make sure that they are fit to administer the courses just explained and to follow up the cases of investigations - historical and otherwise - which are so absolutely necessary when deciding on the adoption of a certain system of maintenance.

The general procedures and details connected with the execution of maintenance work shall only be touched upon in this report as we feel that it is more beneficial to build up the base properly at this stage.

Returning back to the point aimed at in this chapter we would like to state that a high level of capabilities, flexibility in design matters are needed here. Thus these centres, especially the design developing ones should concentrate more deeply on training the engineer designers in finding out the ways, means and procedures that would make them able to deduct the reasons that lead to the wear, especially if it is found to be rather excessive and they must be trained in the way of preparing the detail reports which would highlight all the circumstances connected with the problem and to suggest, what in their opinion to be the best remedy. The mere mention

of the remedies alone is far from being the answer required because their deductions and opinions should only be considered as light sources for higher persons connected with the problem.

This kind of study needs a fair amount of technical and scientific knowledge together with a mastery in analysing power beside a keen sense of observation. Each of which in itself constitute a subject that needs special coaxing and training, different to what is given in the colleges to bring out the best results. For this reason we have stated above the expression of training "Engineer Designers."

Thus the centres are required to develop within their compass a source or a group to follow up the activity mentioned before and if they feel that it is too advanced to develop it themselves they could co-operate with other suitable concerns in the country to develop such teaching. A warning here is given - this course should never be a purely academic course or it would completely miss the mark.

Great care must be exercised in choosing the candidates that are going to sit for this course and who shall be the maintenance engineers at a later stage.

The eligible candidate could be either an engineer or a highly trained qualified technician with 10 or more years of practice. Both should possess the necessary talent needed for creative thinking. Over and above that, should be put through a special training course in that direction and at present courses of this type are being administered by the large manufacturing firms in the industrially developed countries such as the Motor Car Industry in the States and the large electrical concerns in England.

The training of these candidates should be designed to make them capable of facing the task of working out alternative designs for the defective parts with a very limited margin of freedom for action or simply suggesting alterations and/or modifications and additions, all of which would have the ultimate effect of minimizing the frequency of breakdowns.

and in the best of cases eliminate the major ones which could result in lengthy down-times and financial losses.

In many incidents such engineer-designers might have to work in close co-operation with the engineers and designers of the original manufacturers of the machines. Thus they must be of the high calibre in knowledge which would make them equal for such a task.

In the meantime they should be capable of giving a helpful and supporting hand to the group of technicians or engineers who are working in the various concerns in the country whether it is industrial, public service or agricultural etc. and who are engaged in setting up and preparing the technical specifications required when tendering for machines and equipment..

In that respect they would be acting as consultants to them in matters concerning good maintenance requisites.

Such help could be so given so ensure that the supplied articles are those most suited to the environmental require-

ments of the place while being in the same time easy to maintain and would not be subject to frequent breakdowns.

In many instances the ease of maintenance procedures has been demanded even if it meant slight increase in the first capital outlay. Again it is expected that this class of engineers would have to discuss the technical details involved in the issued tender specification with their opposite number on the maker's or supplier's side on behalf of these industrial establishment.

In other words we are seeking here to administer that kind of training - whether it is to be carried out within the centre or merely energised by the centre - which would produce a form of specialised, practically minded engineer with sufficient qualifications and flexibility of thought in design matters beside being a good maintenance person.

Local Production of the Spare Part. in
the Developing Countries.

The sound of the title given to this chapter, as it stands has many alluring qualities which makes it a subject of frequent discussions among the responsible people of the developing countries. In fact it has been looked upon by the industrialists in these nations as a problem of great importance which should be given every attention and they feel that it ought to be considered in great detail.

For this reason and due to the fact of being personally involved, in the past, with such a job for a length of time that ran into years I feel it is my duty to detail here the results of my experience in this respect.

Though I am giving an opinion which I have personally formed through the studies that has been made, I hope that this opinion would not greatly affect or discourage those who shall find themselves confronted with similar matter or situation.

On the contrary, I give this opinion here to be in accordance with the saying "forewarned Fore-armed."

It is a very complex subject and if the difficulties and experience are brought out at the start it will throw some lights on that difficult path and make the person treading through it avoid the pit falls that might be encountered. He would thus be in a better position to reach a more successful result.

Perhaps, through the preliminary glances and thoughts that might fly across the minds of the responsible people, the production of those innocent looking spares can appear to be an easy problem to tackle locally, as it would certainly save for the country much of the foreign capital which is so much needed for other demands and requirements.

This thought could again be strengthened by the fact that the number of machine tools that is usually acquired by the various newly established industrial plants for their maintenance shops form in itself a strong production

unit with a big machining capabilities that are not fully utilized.

On hearing about such a situation it is only natural that those responsible for the economy of the country would demand a thorough investigation of the problem and with the aim of fruitfully utilising that free manufacturing capacity which to their thinking appears to be a semi-dead capital left un-utilised.

In the country of the writer such a situation was acutely felt soon after erecting the numerous factories and equipping each with a fairly large maintenance shop and which was a natural procedure with each factory due to the fact that they know that the supplier of the original equipments in the factory is far and in the case of breakdowns there is always an urge to minimise down-time and a good strong maintenance shop is about the best insurance against that.

It became an important task to look into the subject of producing the spares locally by utilizing the capacities available in these shops which was looked upon as being an excess unutilised machining power.

Several suggestions were made and elaborate statistical studies were carried out, but alas the execution of all proposals has not been successfully achieved.

There were more than one reason for the failure of such a plan. Although this excess machining capability was actually existing and it did represent a substantial capacity of production - if considered as a unity, yet it was so scattered and distributed that no real good use could be made out of it but what it was bought for. Only and in limited incidents and in a narrow scope that such a capacity was fairly made use of in production purposes.

Through a vast and comprehensive study made it was proved that the problem of the local production of spare parts in developing countries demands the setting up of a very strong governmental body with immense powers to concentrate on it alone.

A good example of such a situation is the case of the U.S.S.R. where - as the writer was informed during the joint studies that he had carried out with the Russian Experts in that respect - the spare part problem is administered there

by a specialised ministry and they have suggested the creation of an individual ministry in the U.A.R. for this task alone.

In this respect, I would like to refer the reader to the report concerning the local manufacture of the spare parts in the U.A.R. prepared jointly by Russian and Egyptian experts which has given details of the studies performed so as the reader could then grasp the magnitude of the operation.

For this reason, it is our advice that the centres should not scatter their activities by indulging into the matter of local production of the spare parts because it is such a complex problem that all the efforts which any centre could extend will only resemble a scratch on the surface and it would certainly distract it from its basic aim, which we are here seeking.

Nevertheless from the studies referred to above it was convened that certain amount of the spare parts are actually being produced by the individual entrepreneur. and small concerns

within the country - this is a case that is apt to be existing in most of the developing countries.

In the case of the U.A.R. it was found that these privately owned small firms are actually producing twenty to twenty five percent of the total quantity of spares consumed in the country. This percentage, as expected, represented that type of spares which are demanded in large quantities and which could be thus produced economically.

It was also noted that the quality of the spares produced locally are appreciably below the high standard of production needed for such items. This was found to be so because they were the outcome of the individual efforts which was limited in resources and technical knowledge. The majority were produced by simply mimicking the original parts with no drawings or technical specifications to help them. In fact they have been largely produced by what we have called before the "Make-do Policy" where inferior materials and finishes were generally adopted.

The centres could, in this respect, play a very pronounced role where they could come to the aid of these small concerns and help them by:-

- a. Studying the original spare, analysing the material chemically or electrically as the case may demand and scrutinize the process utilised in its heat-treatment and estimate its surface finish, hardness, etc.
- b. Prepare a detailed working drawing of the part indicating on it all the technical data required for its production. Propose the use of the locally available raw material as an alternative if the exact original material is not available in the local market.
- c. Design the special tools that would produce a high class product.

Naturally all such technical study could mean a lengthy and costly investigation, but it could be carried out as a service to the industry of the country.

In our opinion this would not mean any material loss to the nation because this particular percentage of the spares represent those that are demanded in large quantity, otherwise they would not have been attempted by the small private industrialist.

The production of few proto-type pieces in the proto-type production centres which mean the manufacture of the dies and the special tools required would certainly constitute a big contribution towards the availability of very good spares produced in the country. On the other hand such action will enrich and help towards the perfection of work of the various maintenance groups.

These special tools and dies could be produced fairly cheaply and easily by the utilization of the new epoxy resins that have been recently developed and are still being developed.

The centres should make sure that they are up-to-date in that speciality, otherwise they would not be able to help in this direction because the production of dies by the old methods would be too costly to attempt.

Over and above what had been already mentioned, the centres could go forward to help any industrial concern in getting over any difficulty in the spare part problem, where they could use all their knowledge and all the facility available to them to manufacture or repair a complicated or defective spare part if such a spare is causing appreciably harmful delays to the production of that concern.

Example of such cases could be met with in the industrial life when dealing with an exceptionally large sized part such as a turbine shaft or a heavy bed plate which are amongst the family of slow moving spares that are not normally stocked.

In this capacity the centres would then be acting as an executive consultant but they should never involve themselves actively in that vast complex field of spares because it contains a tremendous variety of specialities plus a multitude

of administrative responsibility far beyond the capacities of such centres.

Finally we are very sceptical about the possibility of production of large series of spare parts in the maintenance shops of the various industrial concerns. It is customary that such shops are scantily manned in spite of the fact that they might have within their layout a fair amount of machine tools. Again those engaged in the maintenance jobs, whom we have called the maintenance groups, are usually found where maintenance work is demanded i.e. within the production floors.

The series production of any part will certainly interfere with the normal flow and run of things in these shops and if preventive maintenance system is adopted which is mostly adopted by big concerns who could afford the big maintenance shops - there will be enough paper work to keep all maintenance personnel pretty well occupied, because we must remember that it will entail -

1. Scheduling and Designing.
2. Work Requests.

3. Work Assignment.
4. Co-ordination and Dispatch.
5. Inspection whether running or shut down.
6. Feed back procedures.
7. Work measurement.
8. Budgetting, storing, etc.

and above all that, the continuous training to fill up positions of the dropping-outs.

For this reason and as a result of lengthy thinking in the recommendation given to the U.A.R. it has been proposed as being advisable to sectionalise the production of the spares and suggested sectorial procedures to be entrusted to specialised shops, which should be built and equipped for that purpose.

Through such a division the diversifying element - which is a well known feature of the spare parts - could then be reduced to a minimum. This would be attributed to the faint similarities existing within the one sector.

When we talk here about sectors we mean a sector engulfing one type of industry, say the sector for the textile industry,

another for transport equipment and their concerns, a sector for mining, a sector for food industries and their machinery and so on.

It was also proposed that groups of the specialised people of each sector would be put in charge of the specialised central spare part production shops. Such groups, in the opinion of all experts would be more acquainted with the actual nature and requisites of the spares concerned and would indeed be more conversant in suggesting amendments and alterations.

For example the centralised spare producing shop for the textile sector would be administered by mechanical engineers who had a fairly long background experience in maintaining textile factories.

In our opinion a clear line of demarcation must be drawn between dabbling about in the spare part production and maintenance work.

Admittedly if a huge complex of manufacturing establishments would find it worth their while to set up their own

spare producing shop, there is no harm of doing so if this procedure would prove economical and this could only be the case if the size of the complex is large enough to warrant that; but in any case this procedure in itself would not solve the country's problem of shortage in the spares and the trouble of maintenance work as a whole.

Realising that the centres with which we are concerned are meant for helping the nation in a wide way, so, we cannot see that they would be suited to tie themselves up to one complex.

If the proposal of sectorial divisions is adopted, then the centres could find the very suitable national field, where they could effectively help by advising and helping in the research and investigations needed for the production of the proto-types of the spares that are commonly asked for.

We must always remember that their work will be far more effective if concentrated on training for maintenance and on implementing the training in all stages as proposed previously.

Adoption of Preventive Maintenance as a
Means for Upgrading Maintenance
and Repair.

In the preceding discussions we touched briefly on the complicated procedure of paper work connected with preventive maintenance. To avoid any misunderstanding of our aim we feel it fit to mention just a little more about this system because its application is in fact one of the ways for up-grading maintenance procedures. Both design development and metal working centres must introduce the teaching of this system in detail; and give a practical demonstration of the forms, scheduling and other paper work attached to it.

Preventive maintenance which we shall refer to as P.M. - has been recognised as an extremely important item in reducing maintenance costs and improving reliability. In practice P.M. takes many forms and has varied scopes.

Sometimes the P.M. programme can cover every piece of equipment with periodic inspections which include recording of wear or other deterioration of parts.

These records are a basis for maintaining the equipment in good condition while operating and will point to the need of major overhauls and replacements before breakdowns.

In other cases P.M. programme may consist simply of a good lubrication programme accompanied by superficial examination of major defects. Two major factors should control the extent of P.M.

1. The cost of the programme compared with the carefully measured reduction in total repair costs and improved equipment performance.
2. The percentage utilization of the equipment maintained.

Establishing of a comprehensive P.M. programme for its own sake should be approached with Caution. It is possible

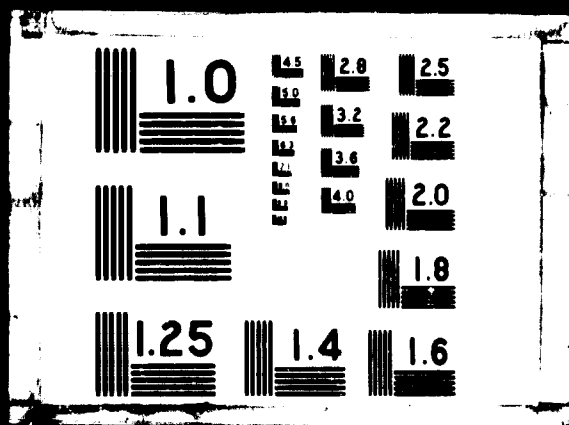


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that the cost of the programme would exceed the total maintenance cost if we use the breakdown maintenance approach. A shut down of some equipment for no other reason than periodic inspection and adjustment could prove to be intolerable from the production view point.

If on the other hand breakdown could result in severe damage to the equipment and a far more costly repair, the scheduled inspection time should be considered.

Again a programme of unit replacement could result in considerably lower maintenance cost where complete P.M. is impractical. For example in a plant using many pumps; a programme of standardization coupled with an inventory of complete units of pumps most widely used may provide a very satisfactory programme, for this equipment.

The spare-tyre philosophy can be extended to many other components or sub-assemblies with gratifying results.

In spite of the undisputed advantages of a sound P.M. programme, the plant engineer must face the fact that it is sometimes more profitable to the company as a whole to run a

piece of equipment until it breaks down rather than take a deliberate shut down during a crowded production schedule.

While this may be hard to accept but it is something to be included in consideration of any P.M. programs so long as there is no threat to the safety of personnel or adjacent equipment is implied in the unexpected failure.

Strange enough if you ask five plant operating executives to define P.M. you will probably get five different meanings. This is due in our opinion to the scope to which the intensity of application of this method is considered.

Good P.M. begins with proper design. For instance instead of setting up routines to keep electric motors clean in dusty areas you could specify totally enclosed fan-cooled motors.

Some people in their talk about P.M. and its philosophy they consider it as vital because it does not only prevent breakdowns or cut operating cost but also it will improve output and quality of production both of which are inferior in the

developing countries specially at the early stages of their industrialization.

No matter to what degree of refinement a P.M. programme is made it should contain the following basic activity.

1. The periodic inspection of plant assets and equipment to uncover conditions leading to production breakdowns or harmful depreciation.

2. The upkeep of the plant in such a condition so as to be able to adjust or repair the equipment while such requirements are still in a minor stage.

"A stitch in time saves nine."

It often happens that P.M. is misused and considered as a synonym for Planned, Scheduled, Controlled and Productive Maintenance.

The fact is the P.M. is an important part of all these functions and not the only constituent.

Again the more highly mechanised the industry is the more it needs P.M. and its advantages.

The cost of maintenance of modern equipments are high

and the cost of downtime too is higher.

We could go on enumerating benefits and advantages, but we feel it fit to close up the subject by re-stating that an efficient plant maintenance programme needs:-

Good paper-work system, Work Planning, Scheduling, Training, Work Measurement, Control reports, Good shop and tool establishments.

We must not stop at that point as it would not be fair but we should name here at least 1) benefits that could be rewarding for a good balanced P.M. programme to prove that as much as you put in it you could get back from it.

These benefits are:-

1. Less down-time, fewer breakdowns.
2. Less overtime pay for maintenance men.
3. Fewer large scale repairs.
4. Low repair cost for simple repairs made before the breakdown because of less manpower, fewer skills, fewer parts.

5. Fewer product rejects and less spoilage.
6. Elimination of cash outlay for premature replacement of plant or equipment because of better conservation of assets and increased life expectancy.
7. Less standby equipment thus reducing capital investment.
8. Identification of items with high maintenance, cost leading to investigation, correction of causes such as misapplication, operator abuse and obsolescence.
9. Better work control.
10. Better spare part control.
11. Better industrial relations because production workers don't suffer involuntary lay offs or loss of incentive bonus from breakdowns.
12. Greater safety for workers and protection for plant; less compensations and insurance cost.
13. Lower unit cost of manufacture.

Lastly P.M. has been applied successfully to large and small operations. It works well in job shops as in production line or continuous-flow operations. There is an upper capacity limit as it has been tried with as low as 3

maintenance men as well as in large plants of 250 men.

To get the full benefit of the P.M. system it must be sold well to higher management production executives and supervisors and it is up to both centres to carry out such a job and follow it up well. They could start with the management and check over records for the past year or more for all machine breakdowns. List the total cost of breakdown repairs, labour, material, overtime and other charges. List what each breakdown cost in idle time of operators, spoilage and the like. Add cost of operating heads and other expenses as injuries etc. Next estimate what the repairs would have cost if made before breakdown and if there had been time for planning, getting material, and making productive use of operators etc.

A point of warning is given here. It should be noted that programming for the preventive maintenance system takes time and anybody who expects the full benefit of this system quickly will be disappointed. All experts agree that it takes several years to get it rolling high.

Conclusions and Recommendations.

This report has been basically prepared in two separate sections; the first dealt with the idea of utilising the existing centres with their present existing facilities in the up-grading of maintenance and repair procedures - while the second constitutes an abbreviated version of some of the detail work connected with the preventive maintenance system being one of the most effective tools used for up-grading maintenance procedures, improving quality of production and increasing the life expectancy of the equipment all of which are matters of great importance to the developing nations. Thus it is well recommended to be administered theoretically and practically by both the centres of design development and metal working.

Our conclusions and recommendations with regards the first part are:-

1. It has been made clear that both the Design development centres and the Metal working centres are suitable places for carrying out the up-grading services required for both maintenance and repair work.

2. Wherever these two types of centres exist in the same country, or locality, they must have a close collaboration and co-operation in this field. It is essential to have a certain amount of design activities, especially in matters dealing with repair procedures and the higher grade maintenance problems.

If only one of these centres exist, particularly if it is a metal working centre, it would be its duty to create and establish contact with a good design concern in his locality to cover up that corner of activity necessary for performing the job correctly.

3. The common equipments that exist in the workshop of either centre - details of which are clearly illustrated in the plan of operation of similar centres as drawn by W.M.I.D.O. - is considered ample for the general purpose of up-grading maintenance work.

The addition of some specialised equipment would be necessary to both or either of them to facilitate making of the repair jobs.

Adequate facilities for all welding systems with all the subsidiary appliances should also be made available.

4. Allocation and qualifications of the existing experts and staff must be reconsidered and altered to suit.
5. Extension of accommodation should be considered to cater for the extra classroom work required.
6. The addition of the new responsibilities of up-grading maintenance and repair to the centres in question does not necessitate discarding of their basic plan of operation. The new duties could be introduced as an additional task. In fact it will be a sort of complementary job to their present responsibilities.

The additional new three grade courses must be scheduled to suit the environment of the place where this experiment is to be carried out.

7. It is strongly recommended that this project which U.N.I.D.O. is now contemplating, should involve

more than one locality at the same time for reason detailed in report.

8. It is also suggested to carry out similar experiment in a developed country in any of the metal working training centres which might be there.

The quick response expected in such a centre would have very favourable influence on the other part of the experiment mentioned under 7 above.

9. Both design developing centres and metal working centres are strongly advised to keep out of the local production of the spare parts.

The complicated nature of this problem is far beyond the capacities of such centres. Besides it will definitely drive them away from the basic aim that we are seeking in respect of developing and up-grading of maintenance and repair work.

10. These centres could act as consultants and could render help in the field of spare parts in very limited and special circumstances as we have detailed in our report.

APPENDIX I.

The Thirty Questions.

The following are a collection of questions compiled to form with their answers a broad frame for the subject of maintenance and repair.

They are given here to act as a reminder of the various points connected with maintenance to the person who is contemplating the formation of a programme for its development.

The majority of the answers required here have either been stated within the text of the report or are included within the wording of the question itself.

1. What is maintenance, is it a habit to acquire or a new job to do or both?
2. How can one develop the maintenance conscious?
3. Is there any distinction in: a) between maintenance and repair. Does maintenance always demand repair?
4. How can one distinguish the different categories to be suggested in the various types of maintenance. Can it be divided

consider the job of cleaning and the casual inspection connected with it as the electronic eye for the detection of the first signs of wear and necessity of consideration for repair?

5. Describe what is meant by Preventive Maintenance? How can it be considered as an effective tool for the up-grading of maintenance responsibility and why? Give reasons.

6. What is the difference between:-

Daily Maintenance duties.

Periodic " "

Overhauls (the majors and the minors)

and what sort of a yard-stick would you consider suitable to use in defining the period of i.e. cycle is it - hours, days, months, metres, kilometers, mileage frequency or turns.

7. Is there any difference between

Maintenance and overhaul

equipment, and countries.

8. Consider the role of design in affecting,

- a. Maintenance function
- b. Overhaul procedure.
- c. Repair work.
- d. Replacement of defective parts.

9. What is a spare part; define the type called quick moving and that called slow moving and state your opinion.

- a. Would you repair used parts properly stock them ready for future use as spares, or,
- b. Would you only stock new spare parts?
- c. How much should a firm carry in its stores from the spare parts needed? Should it be the quantity required for one, two or three years or less.
- d. Is it worthwhile indulging in the local production of the spare parts and to what extent; when and why would you do that.

10. How could "good design" strike the balance between over simplification of the commodity to ease

maintenance and the good economical performance of the article?

11. Discuss and compare between the two systems that are known,
 - a. Repairing of defective parts as much as possible.
 - b. Simple removal of part and replacement by a new part regardless of the degree of defect?

12. Do you consider the go-between system is the most ideal for developing countries, or is it preferable to adopt the "b" system above to make up for the limited experience existing there; not forgetting the shortage of foreign currency, and the frequent in-accessibility of the parts when needed.

13. What are the techniques required for the re-chasing and re-building of worn out parts: Is it the welding or metal spraying, or the casting of new pieces in place of worn parts?

Describe some of the specialized equipments used for these purposes.

14. What are the heat-treatment equipments that should be required to facilitate repair operation?
15. How could radio-graphy and non-destructive testing appliances help in this field?
16. What is the technical background knowledge needed to ensure the capability of carrying out such repairs successfully?
17. Do you feel that the lack of mastering the languages in which instructions of makers are given could form a barrier in the developing countries against good maintenance procedures?
18. When and where should the repair of damaged or worn out parts be made?
 - a. During the overhaul periods, before or after it.
 - b. In the main production shop.
 - c. Or in a specially prepared shop.

19. How could downtime be minimized?
20. Is it preferable to tender for maintenance jobs or to keep a permanently employed maintenance group within the firm?
21. How big the maintenance group could be in relation to the number of men employed or is it better to have its strength considered in relation to the number and variety of equipment involved?
22. Give a general chart for the basic organization for the maintenance group and to what authority they should report to, is it to the production manager or to the general manager?
23. What form of incentives could you improve for the maintenance group. How could the bonus be given to them?
24. Does the work of the maintenance group only deal with machines and equipments or should it extend to cover maintenance of buildings including roofs

and floors and all painting work,

illumination, piping, etc.?

25. How would you place the matters concerning the maintenance of electrical and power distribution grid, the general services, the transport equipment and the air conditioning system?

26. Would you consider stores and storerooms, sanitation, housekeeping and corrosion control as part of the work to be entrusted to the maintenance group and what are the advantages that could be gained from such action?

27. What are the basic provision to be introduced in the programme of training for maintenance, is it one or more of the following or all of them?

- a. The selection of the qualified men for training.
- b. The determination of standards of performance of trainees.
- c. The way of measuring the performance of trainees against standard of performance.
- d. The job progression schedule, wages and all other elements relating to it.

- e. The job description for each stage of training.
- f. The quantity of men required.
- g. How, when and where training is to be given.
- h. How to delegate responsibilities for carrying out the training programme.
- i. The procedure in settling individual trainee problems and how to consider their failure points.

28. What do you understand from the expression of "Improvisation Technique" or what you may call "make-do-Policy"? Is this a good practice and what are the motives that have created such a system in the developing nations. Does this system encourage cannibalism?

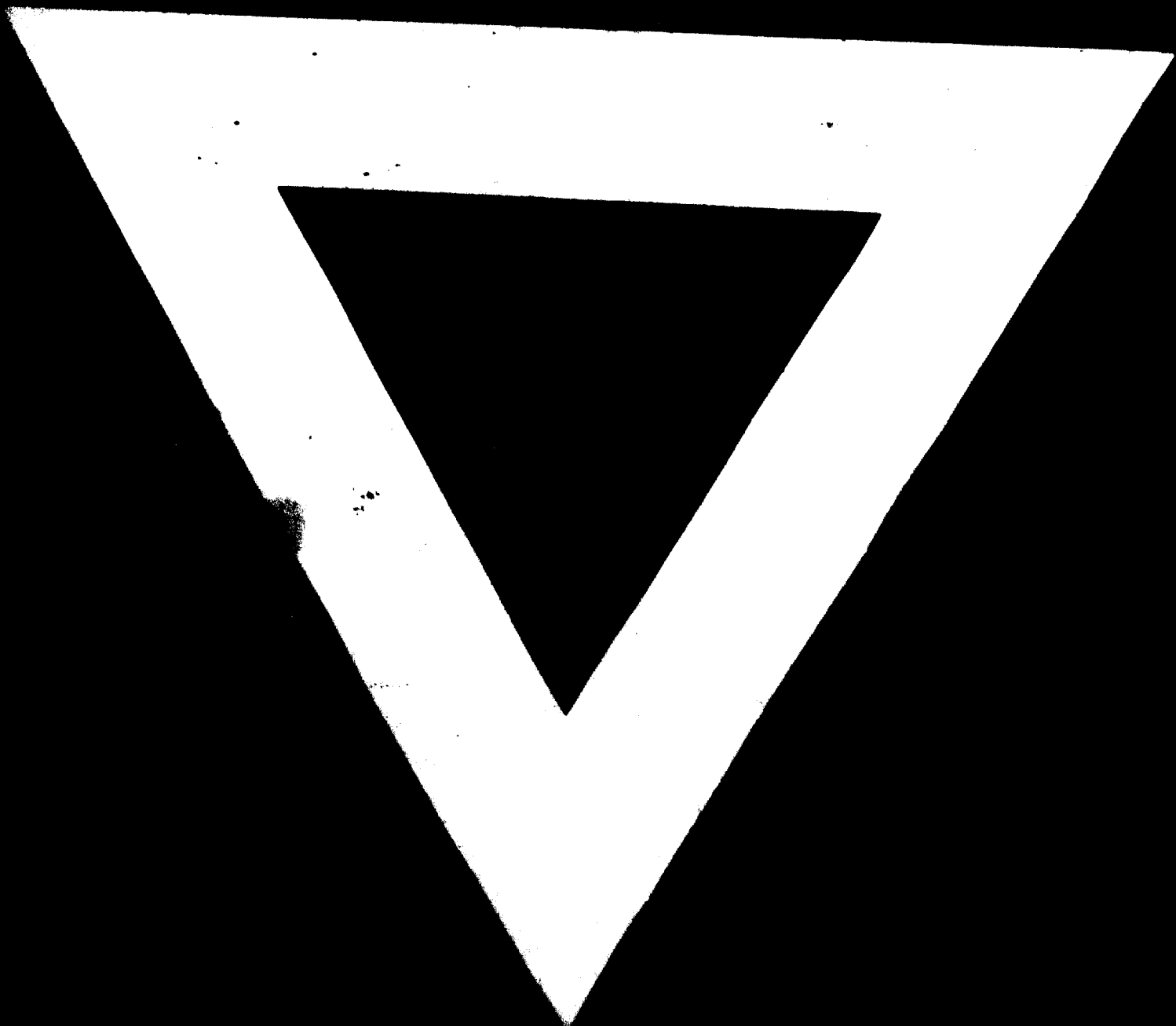
29. What are the referatory steps and recommendations that could be given by -

- a. The experts discussing this subject.
- b. I.L.O.
- c. The metal working and design development centres.

30. How can design and design capabilities lend a good and effective hand in the field of maintenance and repair?

- a. Is it by introducing alternative designs for the parts that frequently break or cause breakdowns.
- b. Is it by coming to the help of the people concerned with the repair operations and/or the manufacture of replacement parts and the simple spare parts, or to prepare for them the completely detailed working (shop) drawings, giving them all the technical specifications that makes the job of manufacture or repair an easy one.
- c. Is this the only way to ensure good results? Could you propose another way?





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