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United Nations Industrial Development Organization

SECOND EXPERT GROUP MEETING
ON COMPUTERIZED MAINTENANCE
SYSTEM IN METALLURGY

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PRECONDITIONS FOR AND INTRODUCTION OF CMMS IN DEVELOPING COUNTRIES

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I MAINTENANCE CONCEPT

Industrial maintenance of production and operational machinery is undergoing rapird and important changes. As facilities are modernised and automated, every possible effort is being made to cut costs and increase production. Because of this, maintenance becomes critical and downtime less tolerable.

The uninterrupted operation of today's plant and often a company's profit depends on the skill, efficiency and procedures of the Maintenance Department.

Because of the increasing automation, the rapid development of production processes, and the increased use of technology in society, we will in the future - to an increasing extent - make ourselves dependent on the function of still more complicated technical systems.

A development which will make these systems still more easy to apply and use is followed by a development which makes it more and more difficult to detect and diagnose failure and to perform maintenance work. It is generally known that after the performance of maintenance work, an upstart and adjustment period follows, most likely causing new failure situations which should preferably be avoided.

Since the mid sixties, computer technology has found wide use for process control. For the first periode, the available computer technology has been used to increase the degree of information for the technical systems through an increased monitoring of vital functions, datalogging of process parameters, and Direct Digital Control, optimal control, etc.

The practical possibilities of using computer technology in process control have increased rapidly after the development of micro electronics which started in the beginning of the seventies. This development has made it possible to decrease the relative costs per performance for control equipment enough to make it possible to increase the reliability of a system through the construction of parallell control systems.

After World War II, the development of the theory within the field of control technology has been converted into control strategies which have proved practically applicable and effective within areas of society.

The development in the eighties within the field of micro electronics and process control will cause a continued development of control equipment, and the more sophisticated part of today's control theory will be used. In consequence, our knowledge of the function of the technical systems under normal and extreme operation conditions will expand more and more.

It is a fact that the maintenance function is becomming more and more in focus, when a factory conciders which efforts that should be taken to increase:

PRODUCTIVITY

PROFITABILITY

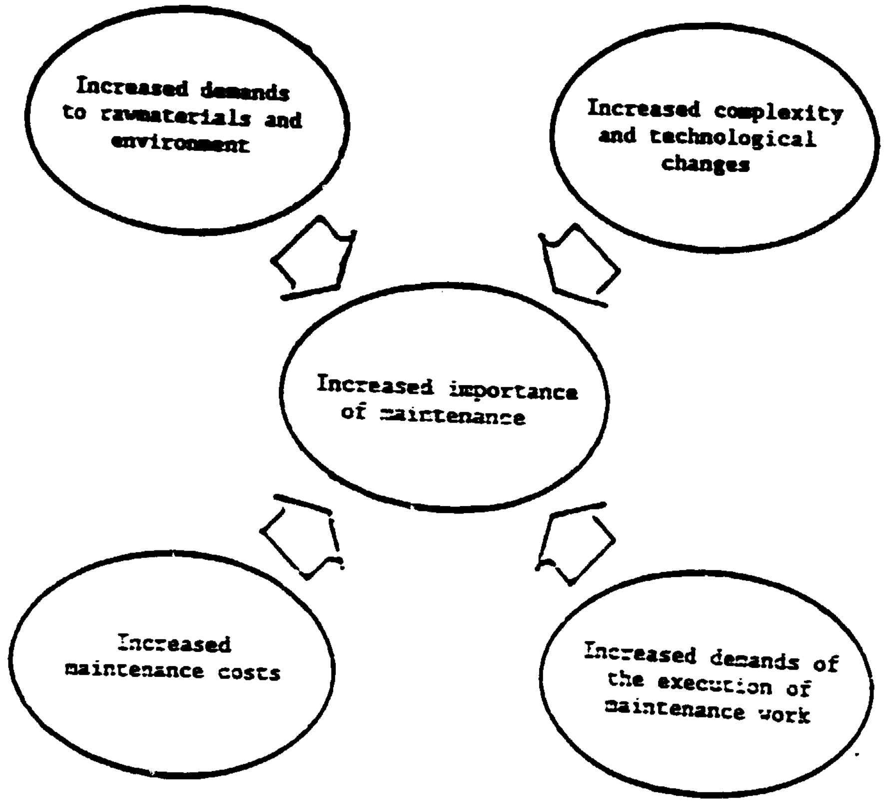
We are today in the situation where access to rawmaterials is decreasing, this, in combination with an increasing population and increased consumption gives us the results of increased rawmaterialprices.

IN MOST CASES ITS THEREFORE MUCH MORE PROFITABLE TO MAINTAIN EXISTING EQUIPMENT THAN PURCHASING NEW PRODUCTION EQUIPMENT.

This is one of the main reasons for the increased interest for modern integrated operations and maintenance techniques.

In Japan some month ago one representative of JIPM said that Japan, after having invested millions of dollars in modern and very complex production machinery, has to use much more in maintaining these equipment, in the years that comes with the result they cant afford to invest in new equipment, something which could give the result that Japan could be in the position of a developing country sometimes in the future.

The figure below gives a summary of the most important reasons for the increased meaning of maintenance:



It is obvious that the demands to the execution of maintenance work is increasing. The question we have to raise is the following:

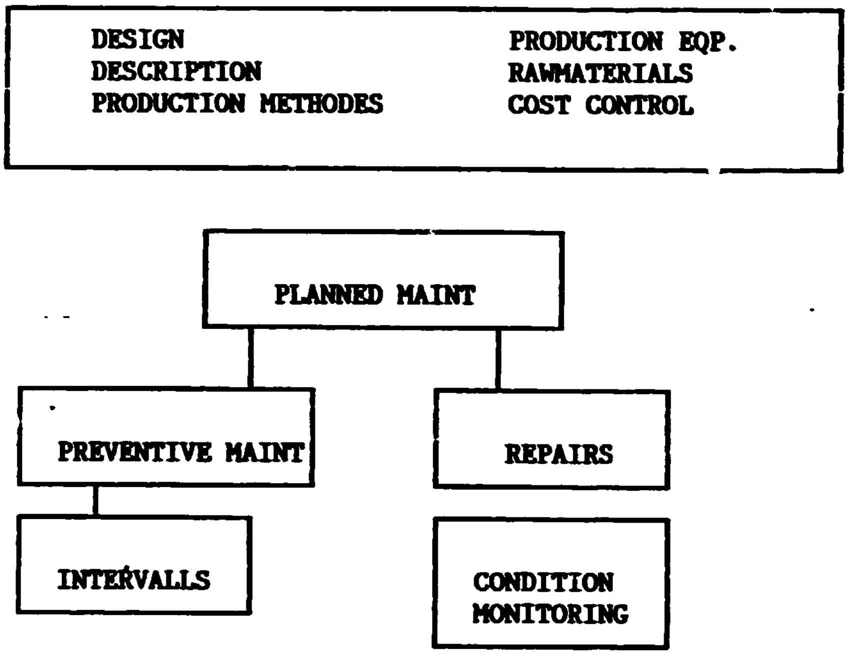
WHICH POSSIBILITIES DO WE HAVE TO
INFLUENCE ON THE TOTAL MAINTENANCE COSTS?

A project executed by EFNMS gave the following result:

When new production equipment is puchased up to 80% of future maintenance costs and problems is already built into the product.

The decisions conserning this is taken by personnel that usually dosent have any interest within maintenance problems and that closes their eyes for the costs and problems their decisions will give the future user of the product.

The figure underneath describes this:



As such a rather huge part of the future maintenance costs is already built into a product, when bought, much more conserns should be made to define our own specific needs, and to create specific and detailed demand specifications.
Today in most cases we are buying the cheapest, whithout making any specifications and without asking the producer to give us an idea of future maintenance costs.

I am now working on a project in another developing country where app. 150 mill. US$ has been invested in a very modern factory. When I asked about their maintenance budget for the next five years, their estimate was about 800.000 US$ a year. Using european keyfigures the maintenance costs will be app. 10 mill US$.

One small example. I have studied the maintenance costs of heavy dump-trucks the last 5 years. The result of this is very interesting.
One of the "cheap" dumptrucks has the same operation and maintenance cost as investmentcost, within two years, while another type, costs 8% more has the same costs within 5 years.

What is done in Norway to solve this problem?

Within all of our offshore industry and most of the proccess industry, a quality assurance manual is demanded from the producer. This manual shows in detail the different administrative procedures the production company is using.

The result of this is quite fantastic, and we have prove for the reduction of maintenance costs with up to 50% for different types of products, after these procedures started.

My self I have been hired from a lot of companies to produce these manuals and also to control that the producer acts in accordance with whats written.

I will therefor as strongly as I can advise you to start creating your own demand specifications when staring a new project, and also;

> ASK THE PRODUCER ABOUT HIS QUALITY ASSURANCE HANDBOOK WHEN COSTLY PRODUCTION EQUIPMENT IS TO BE BOUGHT.
> ALSO START TO CREATE YOUR OWN HANDBOOK THAT SHOWS YOUR OWN DEMANDS AND PROCEDURES.

We have seen that a great deal of the future maintenance costs is already buildt into a product, when bought.

This gives us a need to systemize and coordinate our efforts from all functions within a factory, to achieve optimalization of the

LIFE CYCLE COSTING

This leads us to the expression TEROTECHNOLOGY. And the question is

WHAT HAS HAPPENED TO IT ?

In 1970, the Terotechnology Consept was developed and promoted by The Working Party on Maintenance Engineering of the Ministry of Technology in United Kingdom. The consept did put emphasis on the life cycle approach, feed back of maintenance experience to the various premature stages of a physical asset as:

Specification, design and construction,
manufacturing and commissioning.

It also included the multidisciplinary approach, by putting various specialists or disciplines in the above mentioned stages together, in particular considering the life cycle costs. The terotechnology concept however has not been taken up as expected at that time. To my opinion not because of the validity of the concept. Many maintenance engineers however felt, they were applying the consept already for years. The primary reason for the non-acceptance of the concept is, that we have failed to support the concept with practical methodes and techniques and due to the lack of relevant historical data, required for application of these techniques. Attemps have been made to indicate and classify the available techniques. This techniques have now been further developed and extended and in the mean time gradually more practical data have become available by applying better means for storage and retrieval of maintenance history data. We will see appearing these techniques in the other concepts, which will be discussed below, as well. The terotechnology concept has certainly contributed to the growing awareness for the importance of the maintenance function by nonengineers, emphasizing not only maintenance as a cost, but also as a contribution to manufacturing costs effectiveness.

A short definition of the TEROTECHNOLOGY concept are the following:

> A COMBINATION OF MANAGEMENT, FINANCIAL, ENGINEERING, BUILDING AND OTHER PRACTICES APPLIED TO PHYSICAL ASSETS IN PURSUIT OF ECONOMIC LIFE CYCLE COSTS.

TPM

In Japan they have developed the TPM concept.

TOTAL PRODUCTIVE MAINTENANCE

Total Productive Maintenance is a concept which has been developed in Japan since 1969. It is an abbreviation for "PM with all employees participating through small group activities".

The concept is in fact an extension of the Total Quality Control concept, the quality control circles and zero defect programs into manintenance. Tha primary objective of TPM is to increase the effectiveness levels of plants, by reducing the number of unplanned downtime, rejected products, clients claims and as secundary objectives the reduction of maintenance costs, stock on hand and the increase of labour productivity. The TPM concept consists of the implementation of various elements:

ATTENTION FOR REGISTRATION, REPORTING, EVALUATION AND ANALYSIS OF PLANT EFFECTIVENESS (DOWNTIME, REJECTS, SPEEDREDUCTIONS, REDUCED YIELDS) AND ANALYSIS OF THE CAUSES OF EFFECTIVENESS REDUCTIONS.

- Introduction of preventive maintenance routines, based on;
  - EQUIPMENT
  - PROCESS
  - PRODUCT

  knowledge.

- Transferring the responsibility for routine maintenance to production operators and providing proper training for all the staff, thus involving all conserned parties:
  - OPERATION
  - MAINTENANCE
  - QUALITY CONTROL

  and breaking the barriers between the traditional functional responsibilities, directed to the production of particular products.

- It also includes the creation of a system for quaranteeing rehability and maintainabilty from the stage of design and production of equipment and at persuing ecconomical life cycle costs.

The introduction of TPM is based on a company-wide program and involvement of the whole company staff. It is not considered as just the introduction of a program, but very much directed to change the attitude of the staff, in terms of what is called in Japanese culture, the five S`s:

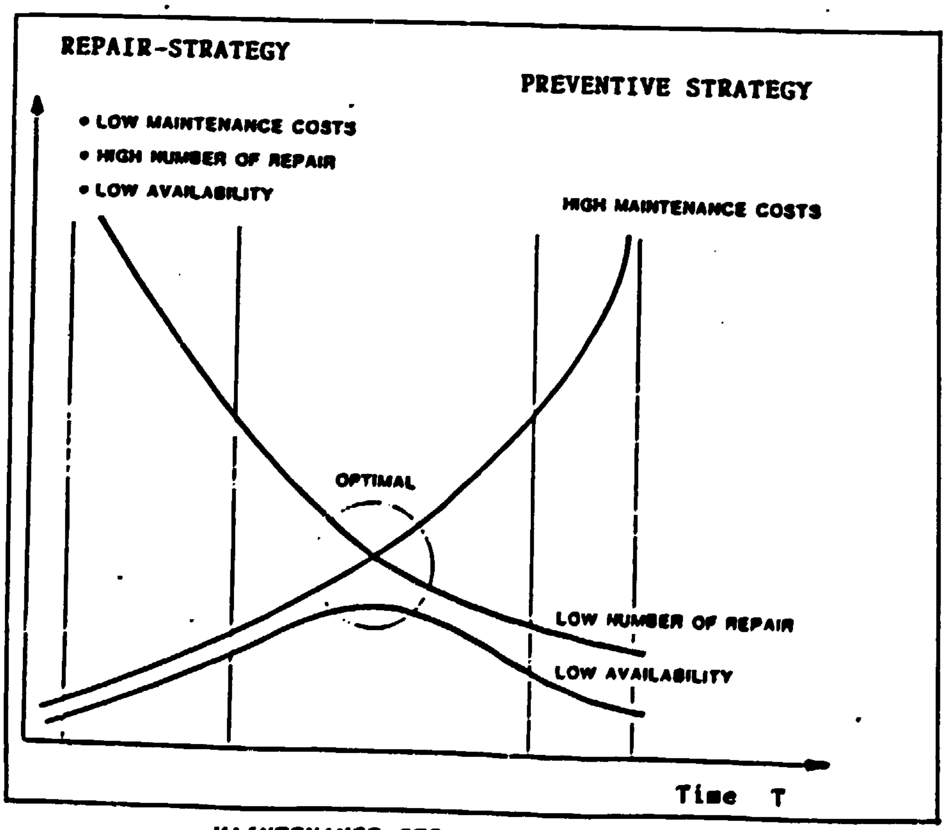
- * SERI : ORDERLINESS
- * SEITON : TIDINESS
- * SEISO : PURITY
- * SEIKETSU : CLEANLINESS
- * SHITSUKE : DICIPLINE

We are now trying to use parts of the TPM-Concept into the project I mentioned earlier, with until now, very good results.

MAINTENANCE STRATEGIES

For about 40 years several Maintenance Strategies have existed. As the figure on this page shows we can have the;

- REPAIR STRATEGY
- PREVENTIVE STRATEGY
- INSPECTION STRATEGY



MAINTENANCE STRATEGIES

WEAK POINTS, FAILURES AND CAUSES

After about 10 years of research work in Europe, during which about 3000 machines production lines and plants was tested, tendencies of what could be called frightening dimensiones were recognized.

Up to 80% of machines and equipment have weak points, this means causes for failure. The availability of these machines in production reaches only between 50 and 70%.

Only in W.Germany between 1977 and 1985, they have been spending about 65 billions of US$ annually for MAINTENANCE.

WHERE IS THE RESULT OF ALL THESE EXPENCES ?

The analysis of different machines in the consumer goods industry, shows that the causes of;

- 30% OF THE WEAK POINTS LIES IN THE PLANNING PHASE
- 30% IN THE OUTLINING
- 10% IN THE DESIGNING PHASE
- 10% IN THE CONSTRUCTION PHASE
- 20% IN THE OPERATION PHASE

The plant operator is forced to produce with these failure prone machines. As time goes by he eliminates many weak points and gets habituated to the remaining.

The question is then:

ARE THESE MAINTENANCE COSTS NECESSARY ?

This is to my opinion where we do our second mistake within the modernization process. First one waits for the failure to occur in order to find the cause, instead of checking for the cause that makes the failures, right from the beginning.

In the industry today, weak points causes up to 20 times more costs annually, than the plan is actually worth.

DEPENDING ON THE CASE IF ONLY 0,1% TO 1% OF THESE COSTS WHERE INVESTED AT THE RIGHT TIME IN A CAUSE ANALYSIS OF WEAK POINTS. UP TO 50% OF THE LOSSES COULD BE AVOIDED

The technogical level of the machines is becoming more and more complex. Because of this the service supervision and maintenance staff is confronted with problems that are becoming increasingly more complicated and they often cannot cope with these problems anymore.

- WE BUY MACHINES AND PRODUCTION LINES WITH WEAK POINTS
- WE MAINTAIN THESE WEAK POINTS BECAUSE WE REPAIR FAILURE, INSTED OF ELIMINATING THE CAUSES
- WITH THESE "WRONG METHOD" WE WANT BOTH A HIGH AVAILABILITY AND LOW COSTS

Based on our experience about Weak-Points, the following facts can be summarized:

Modernizing the construction process by using EDV supported systems causes creativity and innovativeness to be lost. These systems can rationalize, facilitate and complement the construction process but they cannot prevent weak points. When for example a draught has a construction error, the error will be repeated again and again by the CAD duplication. Only by supporting the innovatiness, the creativeness and the combinatory skills of the technical designer the undoubtedly great possibilities of such systems can be fully used.

The gap between the knowledge of top groups which develop machines and plants and the knowledge of the operating staff is widened.

In some fields the methodes for maintenance have taken a wrong course. The maintenance measures taken, help make underdeveloped and faulty constructions work by keeping weak points under control. It would be better to develop a cause analyses. Fewer weak points mean a higher availability, higher productivity, lower maintenance costs, less lost wages and lower production costs.

The idea that weak points in production could be eliminated by changes in the organization structure have often proven to be wrong.

Pure rationalization measures on production lines disregarding the availability and the weak points, lead to new failures.

Based on these facts a new strategy for maintenance has been established within some of the European countries and I would like to use this opportunily to inform you about it, because I have a strong feeling that these ideas is valuable, also to developing countries.

1. THE MAINTENANCE ORGANIZATION SHOULD BE DEVIDED INTO TWO PARTS. ONE PART DEALING WITH MAINTENANCE WORK, AND ONE PART FOR WEAK POINT ANALYSIS.
2. SEPARATION OF MAINTENANCE COSTS AND WEAK POINTS COSTS
3. IMPLEMENTATION OF AN EDP-SYSTEM THAT CAN CREATE WEAK POINTS ANALYSIS AND AVAILABILITY CONTROL.

MAINTENANCE COSTS AND MAINTENANCE PROFIT

The annual maintenance cost in some of the European countries are the following:

-	WEST GERMANY	80 - 110	billion	US$
-	SWEDEN	7 - 9	"	"
-	NORWAY	4 - 5	"	"
-	DENMARK	2 - 3	"	"

Of this app. one third falls within the industrial sector. This enormous sum however represents only the direct costs of maintenance. To this must be added the indirect costs, as well as the income not realised, due to the maintenance being undertaken. A survey has given us the figures, that these costs are at least as high as the maintenance costs itself.

The implementation of maintenance is a prerequisite in sustaining the level of production. More effective maintenance contributes to better results in the firm`s production. This effort however, becomes apparent in other areas of the firm and is this seldom seen to be outcome of the maintenance carried out. An increase in the "profits from maintenance" implies that;

- THE COSTS OF THE FIRM DECREASE
- THE INCOME OF THE FIRM INCRESES

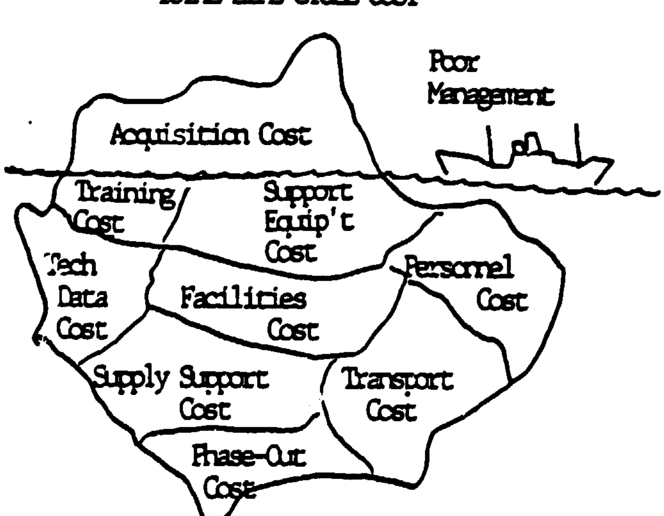
By tradition the cost of maintenance is followed up in the economic system used by the firm, but this follow-up is formulated so as to fit in with the firm`s accounting routines. etc. Therefore, the follow-up seldom fulfills the requirments of maintenance. Parallel with an increase in the cost of maintenance, greater demands are made for a more active follow-up in order better to guide maintenance measures and not only passively to register their costs.

From LCC to LCP

The size of future maintenance costs is to a large extent established at the construction and purchasing stage. A knowledge of the type of costs and the assessment of their size takes on extreme importance as each investment becomes necessary.

A comparison between alternative investments can be based on LCC, Life Cycle Costs. As with an iceberg, it is only a minor part that is visible. At the time of making an investment, it is simple to establish a reasonable purchasing price, while future maintenance costs are "hidden below the surface" and are difficult to assess.

TOTAL LIFE CYCLE COST



The LCC technique is excellent in showing the costs and their distribution over the life cycle. During the operation phase, a simplified assumption can be that the LCC will follow the wellknown "bath tub" curve.

Focussed maintenance costs may be advantageous in those cases where they constitue a considerable proportion of the total costs.
In order to be able to make an economically correct assessment it is, however, necessary to make a study of both what service the firm provides and what resources it requires, a study of both its income and its costs.

LCP, Life Cycle Profit, is a concept which aims at elucidating the fluence of maintenance on the relationship between costs and income. As with LCC, LCP can be applied in the purchasing phase. Moreover, the possibility also exists to be able to utilize LCP during the operation phase to undertake an economic evaluation of the firm's maintenance situation.

By applying LCP, a better understanding is attained for the need to adjust maintenane measures to actual requirements, eg the market situation.

Traditionally mainly the costs of maintenance have been studied and its implementation has been regarded as a necessary evil, which should be done as little as possible.

Many firms have thus not taken advantage of the very considerable possibilities for the improvement of the firm's results by optimising rather than minimising its maintenance.

KEYFIGURES

MAINTENANCE COSTS IN % OF INVESTMENT VALUE

- AVIATION 15%
- SPACE TRAVEL 30%
- MECHNICAL INDUSTRY 3-5%
  - Machinetools 7%
  - Cranes 6%

- Valves 10%
- BUILDING AND CONSTRUCTION 5%
- OFFSHORE INDUSTRY 35%

Another interesting keyfigure are:

MAINTENANCECOSTS IN % OF OPERATIONS COSTS

- AVIATION 45%
- OFFSHORE INDUSTRY 35%
- MECHANICAL INDUSTRY 15%

ORGANIZATION OF MAINTENANCE WORK

Our goal for an effective Maintenance Function can vary from factory to factory, but generally they can be expressed in the following way:

- INCREASE AVAILABILITY OF ALL PRODUCTION EQUIPMENT
- OPTIMIZE OPERATION AND MAINTENANCE COSTS
- REDUCE LOCKED UP CAPITAL OF STOCKED SPAREPARTS
- INCREASE EFFECTIVITY
- TRANSFER FROM PREVENTIVE TO CONDITION BASED MAINTENANCE
- ACCUMULATE STATISTICAL DATA TO CREATE A BASIC PLATFORM, TO DECIDE MAINTENANCE INTERVALS

To reach these goals we have to create some guidlines for the following functions within the factory:

- ORGANIZATION
- ADMINISTRATIVE ROUTINES
- TECHNICAL DOCUMENTATION
- LOGISTICS
- HUMAN RESOURCES

All these functions are influencing on our maintenance organization and has to bee seen as a part of the maintenance function.

The organization of the Maintenance function within a factory is depending on the human resources and their motivation to create an effective job.

When deciding for a future maintenance organization we have to make strategic dicussions within the following areas:

* <u>Location.</u> In some areas, external maintenance crews may be used during peak loads, or they may take over entire specialized maintenance tasks. Neighbouring plants also commonly loan spare parts to each other in an emergency.

* <u>Technological standards.</u> In some plants, advanced technology means that full-time maintenance specialists are required, making it possible to rely on outside help.

* <u>Plant size.</u> Small plants cannot fully emply the specialists they need. This leads them to build up large reserves, for example, of spare parts, and, in emergencies, to have to call in outside specialists under contract.

* <u>Manpower.</u> If work loads fluctuate, and if there are no stabilizing factors, external craftsmen can be called in during operating peaks. In this way, maintenance costs can be kept low during normal operating periods.

* <u>Risks of breakdown.</u> Equipment with a high risk of breakdown requires substantial backup services, in the form of standby facilities and a much larger maintenance work force.

Based on these factors its obvious that the organizational chart of the maintenance function can differ from factory to factory. It is however of great importance that the maintenance is organized as a dynamic function, i.e. ADAPTIV. This means an organization that adapt itself to the specific needs, depending on differenet market situations that the company will meet.
Maintenance work can be defined as;

- SERVICE
- INSPECTION
- REPAIR

All these three functions needs preparation and planning to get the maintenance work done as effective as possible.

Appendix 1.a, b, shows an organization implemented within a company in Iraq.

As you can see I have split the organization in two parts;

- SERIVCE AND INSPECTION
- REPAIR

The Service group is responsible for;

- OILING OF ALL EQUIPMENT
- GREASING OF ALL EQUIPMENT
- CHANGING OF SMALLER PARTS

The Inspection group is responsible for;

- INSPECTION WORK
    - USING DIFFERENT TYPES OF CONDITION MONITORING METHODES
    - JUST
        - LOOKING
        - LISTENING
        - SMELLING
- SMALLER REPAIRS

If we had had the possibility we should have had one group of persons specialized as Inspectors doing both Inspection and greasing-oiling.

As all of you know the oiling and greasing work usually are done by people not able to do other types of work.
To use this type of personnel at a job of such importance is a great misunderstanding.

> PEOPLE DOING INSPECTION AND SERVICE WORK (OILING AND GREASING) SHOULD BE HIGHLY QUALIFIED MECHANCIS THAT ARE GIVEN SPECIFIC TRAINING WITHIN CONDITION MONITORING METHODS AND TRIBOLOGY.

To my opinion most of the inspection and service work should be executed by specialists from the company, whilst repair work can be done by personnel from outside if we have a lack of personnel.

Within a lot of companies we can find thick walls between operation and maintenance. I hope we can agree that both functions is an integrated part of the production, and that they should be organized as such.

To my opinion the;

OPERATORS SHOULD BE GIVEN
MAINTENANCE TRAINING

and the

MAINTENANCE PERSONNEL SHOULD
BE GIVEN TRAINING TO OPERATE
THE PRODUCTION MACHINERY

In addition to this we have the engineering department.

It is evident that a central engineering department favours the successfull introduction of wide range engineering initiatives. Why then are engineering departments being split-up at least at the frontline maintenance level? There are three main drivers encouraging, and in some cases forcing production and engineering together; costs technological and organizational factors.

a) Cost: In the drive to reduce unit costs, some companies are combining engineering, maintenance and production to reduce manning and maximise the use of currently unproductive time.

b) Technological: With the introduction of new plant and equipment the nature of the inter dependence between engineering, maintenance and production has shifted to becoming a reciprocal, if not a team interdependence. The need to improve organizational co-operation at the expence of specialization is resulting in a combined maintenance and production structure.

c) Organizational: A more diffuse factor found in very few companies is the drive to develop a more efficient and effective organization via a thorough examination of its "beliefs". This drive is resulting in a more integrated structure which is bringing maintenance and production together.

Irrespective of the factor, the result is a redefinition of the boundary between production and maintenance thus raising the technical selfsufficiency of production. The degree of selfsufficiency will depend upon the rate of technical development of the plant and capital investment changing the skills required to operate and maintain the plant.

As an end of my short presentation of maintenance organization I would like to, based on experience, to give some headlines conserning changing of organizations.

a) Allow sufficent time - it takes years to change a culture and an organization

b) Involve foremen/supervisores at the earliest design stages

c) Base the need for changes on the drive for business/manufacturing excellence, and not just cost reduction

d) People reductions should be achieved through attrition/natural wastage, and not compulsory redundancies

e) Neither top-down, nor bottom-up have been shown to be successful strategies, hence do both

f) Monitoring and enforcement of safety standards must be heightened during the changes as the focus on safety can be easily diluted through the changes

g) The preparation of key actors on the site management team both individually and collectively is vital before launching any major change initiative

h) Developing joint agreement of how to monitor the changes as they occur and so help realise the objectives for introducing the changes

i) Establish clear guidelines/principles upon which the joint engineering - production is designed

j) Consider the use of internal enablers/facilitators to progress the development of the organization at a local/departmental level

k) Create a specific change programme budget to cover training costs, training material development costs, etc.

l) Both maintenance system and support services must be developed to encourage and endore the organization charges desired

m) Treat the design and development of a new organization as an engineering project with a distinct series of phases running from feasability through to commissioning and operation

PROCESS CONTROL, CONDITION MONITORING, AND CONTROL

The starting point for modern maintenance planning is condition monitoring which forms the basis for the information necessary for a more cost optimized operation of technical systems, seen from the terotechnical point of view, where construction, operation, and maintenance should be seen as a whole for the period of time considered for the actual technical system.

The very fact that condition monitoring uses the actual technical systems as starting point makes it realistic to expect that future maintenance will be based on this, and the casual and uncertain basis used today, where statistical results prove uncertain and insufficient, will be eliminated.

When condition monitoring is introduced in connection with maintenance, no basic need exists for development of new control strategies; several of these are described by Pau and others, but to a great extent examples of use are needed which have been described in such a way that it is possible to build on practical experience, regardless of the field where it has been obtained.

The next figure (2) illustrates the functions of maintenance department when centered on a Work Control and Planning system. This may be a manual system but is often computerized. Programmes for maintenance work are issued (1) and feedback reports are generated (2). Lines (3) and (4) show liaison with the maintenance stores. The performance of the maintenance department is recorded and costed (5), (6), (7), (8), and liaison with the user (or operations management) is established through (9). The monitoring of performance (technical and financial) is not always possible in simple maintenance systems but should be the goal for the manager when work planning and control is well established. Not only will costs control be possible but more of the work can be condition-based; that is, more of the work issued in direct responses to the physical condition of the assets.

The systems and pratices in the existing maintenance department often require inspection and updating before a maintenance improvement programme can be started. The first step is the Maintenance Audit, by a consultant who visits the site or sites and interviews the manager and selected members of the staff. A report is then generated, with proposals and actions plan, from which suitable changes can be introduced. The audit will outline systems for the relevant types of maintenance and for a functional management structure. Preventive maintenance will be planned but should be related to:

a) A condition-based work programme
b An acceptable level of maintenance activity to maintain cost-effectiveness in operation

MAINTENANCE PLANNING AND CONTROL

The basic requirements for a planned Maintenance system are:

- REGISTER OF ALL ASSETS TO BE MAINTAINED
- A SCHEDULE OF PREVENTIVE MAINTENANCE WORK, FOR THE BUILDING, UTILITY AND PRODUCTION EQUIPMENT
- A METHOD OF ENSURING THAT THE SCHEDULED WORK IS REQUISITIONED
- A METHOD OF PLANNING OTHER TYPES OF REQUISITIONED WORK (CORRECTIVE, EMERGENCY)
- A SYSTEM OF RECORDS AND ANALYSIS OF PERFORMANCE

A very simple basic system is shown on this page.

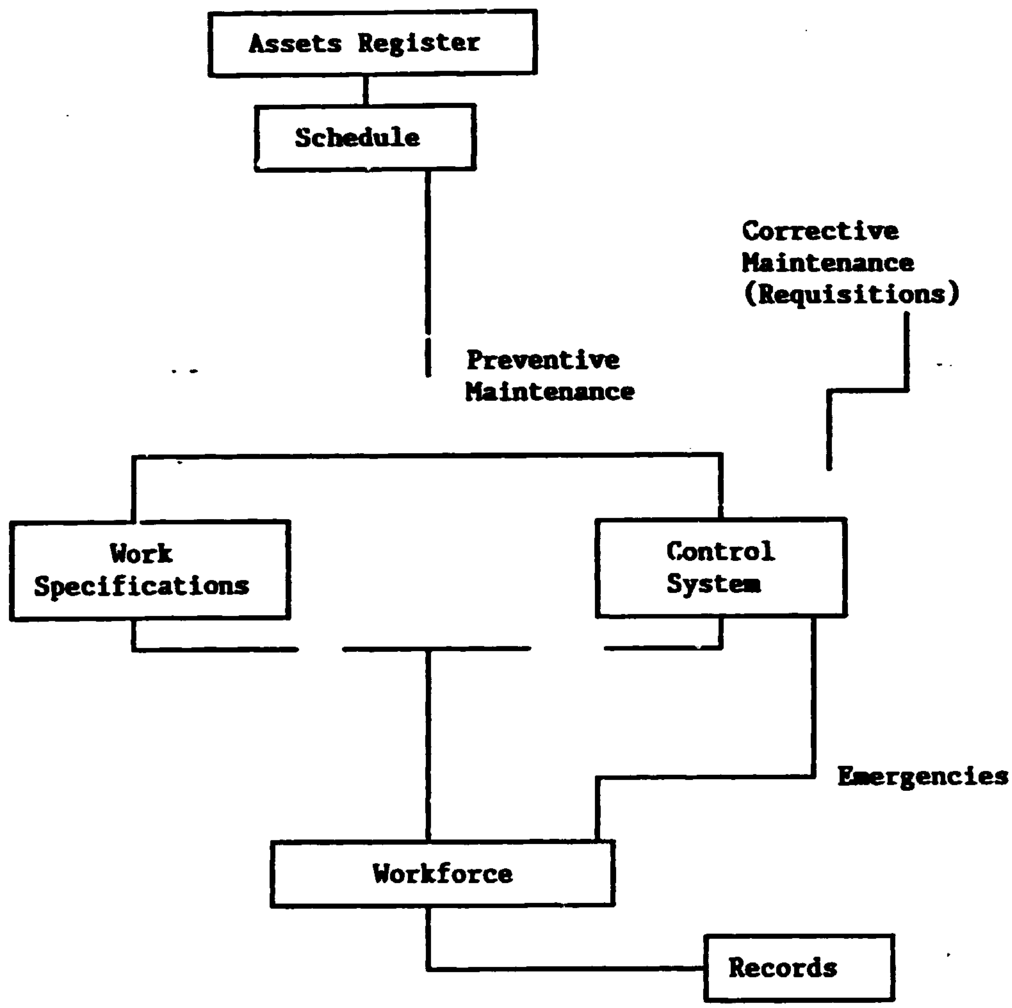


Figure 3 - Basic System

MODULES WITHIN A MODERN MAINTENANCE MANAGEMENT SYSTEM FOR THE STEEL INDUSTRY

Based on my experience it should be no basic difference in the structure of a Maintenance Management system used in so called developed or undeveloped countries.

Such a system could, based on the specific needs, have the following modules:

TECHNICAL FOLLOW UP MAIN MENUE 1.

- PLANT REGISTER
- INSPECTION PLANNING
- PREVENTIVE MAINTENANCE PLANNING
- WORK ORDER MODULE
- LOG BOOK
- TECHNICAL DOCUMENTATION
- TECHNICAL MONITORING
- OTHER MAINTENANCE REGISTERS

ECCONOMICAL FOLLOW UP MAIN MENUE 2.

- STOCK KEEPING/PURCHASING REGISTERS
- TIME ACCOUNTING
- TECHNICAL ECCONIMICAL ANALYSIS
- MAINTENANCE ROUTINES
- INTERACTIVE TRAINING

The next three pages gives an overview of the Sub Menues within the Main Menues and also a flowchart.

IMPLEMENTATION OF A COMPUTER ASSISTED MAINTENANCE MANAGEMENT SYSTEM
Before purchasing, even looking at a Computer Assisted Maintenance Management System, the factory should go thru some procedures to create their own demand specification.

Within developed countries today we can see a lot of mistakes done. Somebody has heared that, that and that system is very good and without checking if the system really fits the specific needs of the factory, they purchases it.
When they are starting the implementation within their own factory, the big problems often starts. Most of the about 40 computerized Maintenance Management Systems today are very little flexible as they are written in either Fortran Ccbol or even Pascal.

The result is that the factory has to change their own organization and administrative routines to fit the specific needs from the system, instead of getting a system that fits the specific needs of the factory.

What kind of a procedure should be followed then, to get a system that fits our specific needs and how to implement it?

To secure an optimum result, when implementing an EDP-system within a factory, a detailed plan should be developed. These plan should reflect both the todays and tomorrows needs. At the same time the borderlines to other systems within the factory should be considered. This means systems that should communicate with the maintenance system.

I would like to mention one specific example.
Some months ago I was asked as consultant to find a Maintenance Management system for a company within a developing country, and to implement this system.

When I asked about the specific needs within the factory, I did`nt get any answeers.

They would only like to have a computer system to solve their maintenance problems.

I tried to discuss the problem from my point of view, advising them to define their maintenance problems and then look for a specific system, but this they refused, and my self, I had to say now to the project.

I have mentioned my project in Iraq several times now and I would like to use these project as a guide to discuss how to implement a Maintenance Management system within a company. I would also like to stress the fact that the same prescription also should be used within the developing countries.

IMPLEMENTATION OF COMPUTER ASSISTED MAINTENANCE MANAGEMENT SYSTEMS WITHIN A FACTORY

Implementation of a computer system within a factory should be treated as an engineering project, devided into the following phases:

PHASE I	ORGANIZATION OF THE PROJECT
PHASE II	RESOURCE ANALYSIS
PHASE III	DEMAND SPECIFICATION
	SYSTEM SELECTION
PHASE IV	SYSTEM DEVELOPMENT
PHASE V	TRAINING OF PERSONNEL
PHASE VI	CREATION OF DATA INPUT TO THE SYSTEM
PHASE VII	IMPLEMENTATION OF THE SYSTEM
PHASE VIII	FOLLOW UP

PHASE I DEFINING AND ORGANIZATION OF THE PROJECT (PILOT PROJECT)

This first phase has the goal of defining, structuring and organizing of the project, including creation of a timeschedule.

1. REQUIREMENT PROFILE
   DEFINING AREAS WITHIN THE FACTORY
   WHERE NEW SOLUTIONS IS DESIRABLE

2. CREATE A GOAL AND STRATEGY FOR THE PROJECT

3. ORGANIZATION OF THE PROJECT

4. PROJECT PLAN

PHASE II RESOURCE ANALYSIS

The Resource analysis is devided into the following steps:

1. SURVEY OF THE TODAYS SITUATION
2. COMMENTS TO THE TODAYS SITUATION
3. ADJUSTING OF THE TODAYS ORGANIZATION AND ADMINISTRATIVE ROUTINES TO FIT FUTURE NEEDS

1. SURVEY OF THE TODAYS SITUATION

This survey is tha platform for our future work. The result of it will give us the possibility of studying what to do and how to do it, to adjust our internal existing conditions, before the selection and implementation of an EDP-System.

Based on my experience I would stress the fact that this part of the project is of great importance. Usually it is neglected by most projects where implementation of computer assisted Maintenance Management Systems is the goal.

The survey should cover the following areas:

- ORGANIZATION
- ADMINISTRATIVE ROUTINES
- OPERATION
- MAINTENANCE
- LOGISTICS
- TECHNICAL DOCUMENTATION
- TECHNICAL CONDITION OF PROD.EQP.
- HUMAN RESOURCES

The goal of this part of the project is to clearify the status within all functions and the link between different functions.

2. COMMENTS TO THE TODAYS SITUATION

Based on the results of the survey, a report should be created, giving proposals and comments to items or routines to be changed, to fit the specific needs from a productive point of view.

3. ADJUSTMENTS OF THE TODAYS ORGANIZATION AND ADMINISTRATIVE ROUTINES

Using the report as a guideline, the Organizational and Administrative routines should be changes, according to the proposals.

This could mean:

- RESTRUCTURING OF THE ORGANIZATION PLAN
- CREATION OF SPECIFIC JOB INSTRUCTIONS
- CREATION OF NEW ADMINISTRATIVE ROUTINES
- CREATION OF AS BUILT DRAWINGS

- TRAINING OF PERSONNEL TO MAKE THEM ABLE TO MEET THE NEEDS FROM MODERN OPERATION AND MAINTENANCE OF PRODUCTION EQUIPMENT
- UPGRADING OF THE TECHNICAL CONDITION OF PRODUCTION EQUIPMENT

PHASE III CREATION OF A DEMAND SPECIFICATION INCLUSIVE SYSTEM SELECTION

Before going into the question of the creation of a demand specification I would like to start with the question:

WHAT IS A DEMAND SPECIFICATION ?

The anweer is the following:

A SUMMARY OF ALL DEMANDS GIVEN TO FUTURE SOLUTIONS WITHIN MANUALLY OR COMPUTER ASSISTED SYSTEMS.

WHY IS IT NECESSARY TO CREATE A DEMAND SPECIFICATION ?

- GIVES US THE POSSIBLITY OF A SAFE AND SECURE ADAPTING AND DESCRIPTION OF FUTURE DEMANDS AND SOLUTIONS
- GIVES THE DESCRIPTION OF OUR PROPOSAL OF A SOLUTION IN A WAY THAT THE USER UNDERSTAND AND EVALUATE;

  - SYSTEM STRUCTURE
  - SOLUTION ITSELF
  - WHAT IT INVOLVES
  - WHICH POSSIBILTIES IT GIVES
  - WHICH SITUATION IT WILL GIVE

THIS MEANS BASIS FOR THE JUDGEMENT OF CONSEQUENCES AS A RESULT OF OUR DECISIONS BASED ON OUR SELECTION OF:

- SOFTWARE
- HARDWARE

WHAT IS OUR CRITERIA TO A DEMAND SPECIFICATION:

- HAS TO GIVE THE NECESSARY OVERVIEW
- HAS TO GIVE THE NECESSARY DETAILS
- HAS TO BE USER ORIENTED

- HAS TO PROMOTE THE BEST EDP-LANGUAGE FOR THE SYSTEM
- DESCRIPTIONS THAT IS EASY TO UNDERSTAND
- HAS TO COVER THE WORKINGROUTINES WITHIN THE USER FUNCTIONS AND FUTURE SOLUTIONS
- FRAMEWORK AGREEMENTS

PHASE IV SYSTEM DEVELOPMENT

ESTIMATION OF THE MARKET POSSIBILITIES:

- SOFTWARE
  - SHOULD MEET THE DEMANDS FROM OUR SPECIFICATION
  - IF WE DONT FIND ANY TAILORMADE SYSTEMS IT SHOULD BE EASY TO CHANGE THE SYSTEM TO A TAILORMADE ONE
  - IF THIS IS'NT POSSIBLE A TAILORMADE SYSTEM SHOULD BE CREATED
  - WHICH PROGRAMMING LANGUAGE WOULD BE THE MOST SUITABLE?
  - IS IT POSSIBLE TO USE THE SOFTWARE ON DIFFERENT HARDWARE?
- HARDWARE:
  - BUYING A MACHINE:
    - PC, (STAND ALONE OR NETWORK SOLUTION)
    - MINI
    - MANEFRAME
  - TIMECHARING BY A CONTRACTING COMPANY

- CONTRACTING COMPANY:
  - HE HAS TO KNOW YOUR BRANCH IN DETAIL
  - MUST GIVE YOU THE SUPPORT TO DEVELOP SPECIAL SOLUTIONS TO FIT YOUR SPECIFIC DEMANDS
  - HAS TO HAVE GOOD REFERENCES
  - HAS TO HAVE AN ORGANIZATION AND RESOURCES TO MEET YOUR SPECIFIC NEEDS
  - HAS TO TAKE THE TOTAL RESPONSIBILITY FOR:
    - SOFTWARE
    - MAINTENANCE
    - DEVELOPMENT
    - TRAINING
    - COMPETETIVE PRICES

TEST OPERATION

- BY TESTING OF SOFTWARE, CONTROL IF IT SATISFIES ALL NEEDS DESCRIBED WITHIN THE DEMAND SPECIFICATION
- IF THE COMPANY HAS A HARDWARE OF THE TYPE DESCRIBED AS NECESSARY, MAKE A TEST INSTALLATION, TO SEE HOW THE SYSTEM FUNCTIONS WITHIN THE FACTORY ENVIRONMENT.

This should be done much more than done today. Will need some resources.

PHASE V TRAINING OF PERSONNEL

TRAINING

- SELECT KEYPERSONNEL TO THE DIFFERENT AREAS OF RESPONSIBILITY AND GIVE THEM A VERY SINCERE TRAINING WITHIN THE FUNCTION AND OPERATION OF THE SYSTEM
- TRAINING OF OTHER USERS

STATEMENT:

TRAINING OF PERSONNEL IS THE MOST UNDERESTIMATED AREA WHEN IMPLEMENTING OF COMPUTER ASSISTED MAINTENANCE MANAGEMENT SYSTEMS.

HOW CAN WE BELIEVE IN REACHING OUR GOALS THEN?

PHASE VI CREATION OF DATA INPUT TO THE SYSTEM

SAMPLING OF TECHNICAL DATA

- DATA FOR
  - ASSETS REGISTER
  - PREVENTIVE MAINTENANCE/INSPECTIONS
  - REPAIR
  - SPAREPARTS

CREATION OF TECHNICAL DOCUMENTATION

- ANALYSING OF AVAILABLE DOCUMENTATION
- CREATING OF NEW DOCUMENTATION
  - MANUALS
  - AS BUILD DRAWINGS
  - PICTURES

- TAPES
- LASER DISCS

PHASE VII IMPLEMENTATION

<u>IMPLEMENTAION OF TECHNICAL DATA</u>

DONE BY PERSONNEL FROM THE FACTORY ITSELF, OR CONSULTANTS

PHASE VIII START UP

<u>START UP PERIOD</u>

- STEPVISE START-UP AND USE OF THE SYSTEM
- TEST OF ALL FUNCTIONS, INCLUSIVE:
    - USERFRIENDLINESS
    - EFFECTIVITY
    - RELIABILITY
    - FLEXIBILITY
    - MAINTAINABILITY
    - SAFETY
    - <u>ETC.</u>

Giving this paper I hope I have given an overview of problems and possibilities by implementing Computer Assisted Maintenance Management Systems.

To reach a positive result you have to;

MOTIVATE AND RELY ON YOUR OWN PERSONNEL

REMEMBER

THEY ARE YOUR MOST VALUABLE RESOURCE

IMPLEMENTATION OF COMPUTER ASSISTED MAINTENANCE MANAGEMENT SYSTEM:

PHASE I ORGANIZATION OF THE PROJECT.

PHASE II RESOURCE ANALYSIS.

PHASE III REQUIREMENT SPECIFICATION.

PHASE IV DECISION OF WHICH SOFT/HARDWARE TO CHOOSE, ACCORDING TO REQUIREMENT SPECIFICATION

- USE OF STANDARD SYSTEM
- CHANGING OF STANDARD SYSTEM.
- CREATION OF A TAILORMADE SYSTEM FROM SCRATCH.

PHASE V TRAINING OF PERSONNEL

PHASE VI CREATION OF TECHNICAL DATA AS INPUT TO THE SYSTEM.

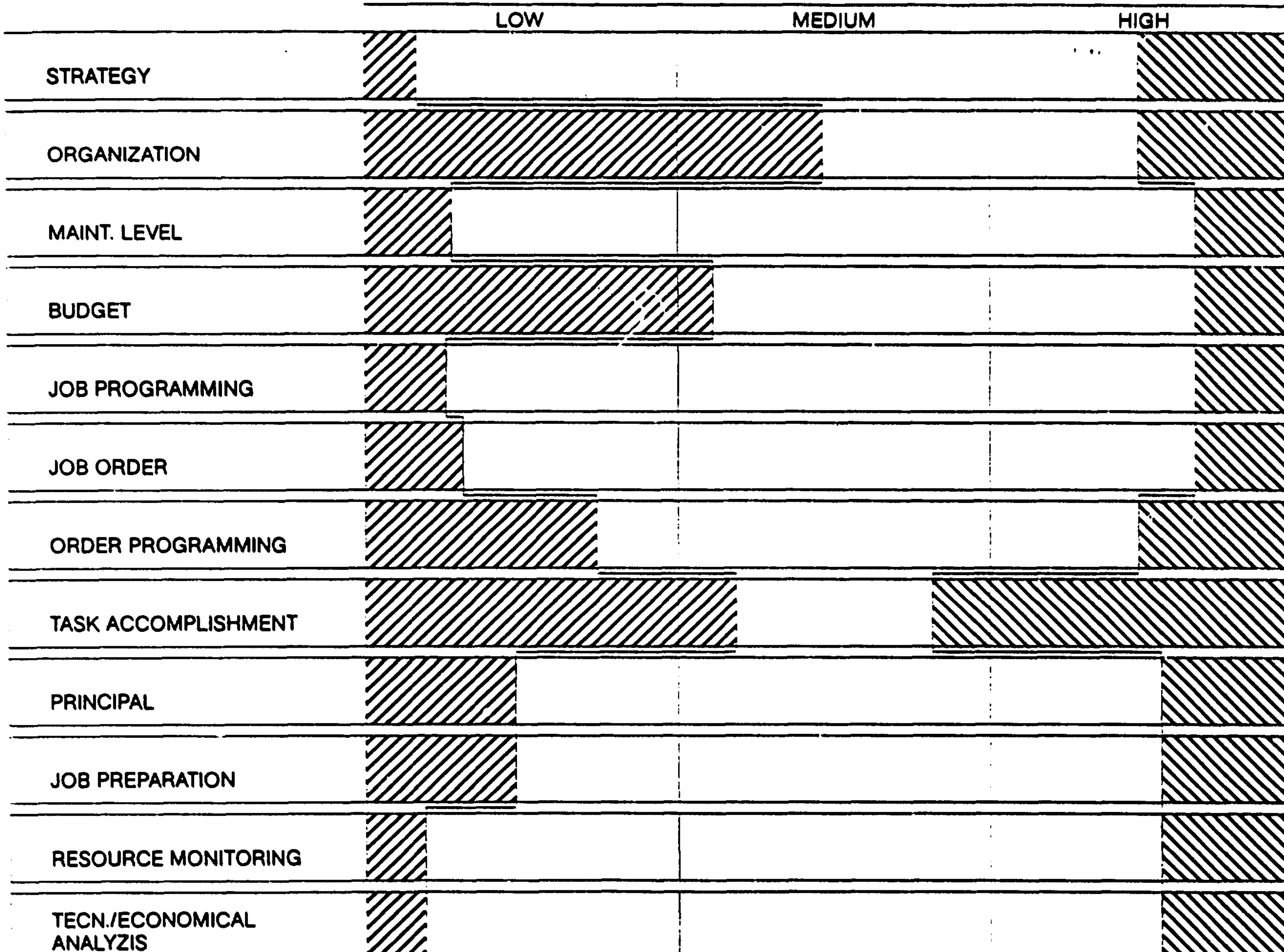
PHASE VII IMPLEMENTATION OF THE SYSTEM.

PHASE VIII FOLLOW UP.

PHASE I ORGANIZATION OF THE PROJECT.

- DEFINITION OF AREAS WITHIN THE FACTORY, WHERE NEW SOLUTIONS ARE DESIRABLE.
- CREATION OF GOAL AND STRATEGY FOR THE PROJECT.
- ORGANIZING OF THE PROJECT.
- PROJECT PLAN.

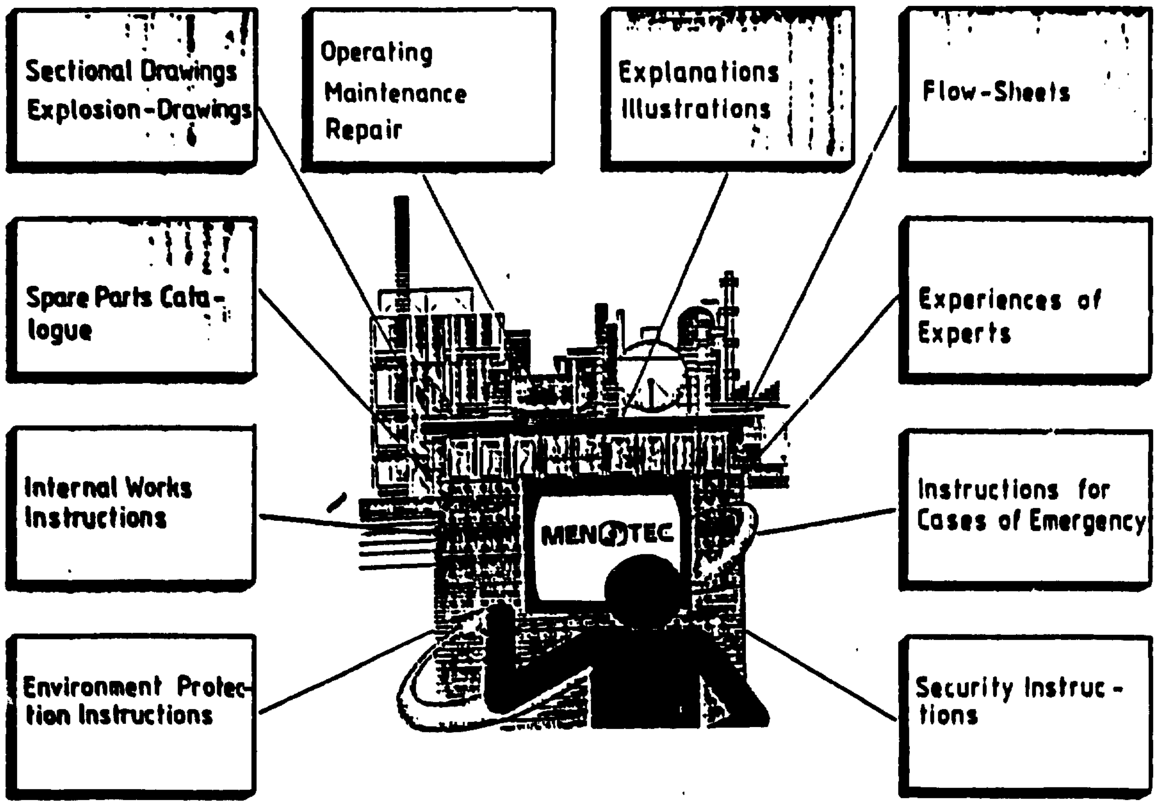
MAINTENANCE PROFILE



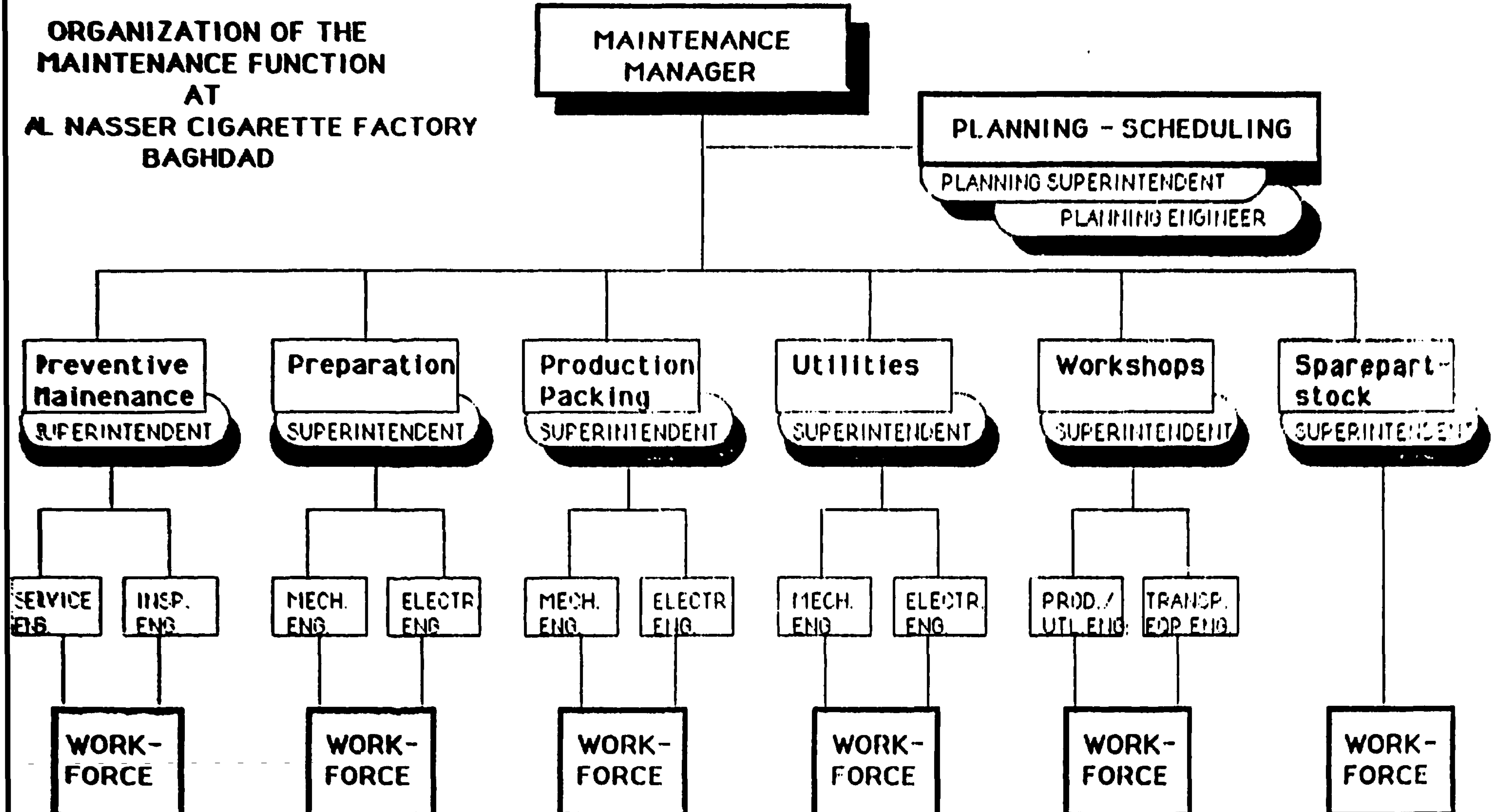
Bilag 2

The MEN-O-TEC System:

Elements of Information At The Working Place



ORGANIZATION OF THE MAINTENANCE FUNCTION AT AL NASSER CIGARETTE FACTORY BAGHDAD



THE ORGANIZATION IS SPLIT INTO
- Service and Inspection
- Repair

SERVICE GROUP RESPONSIBLE FOR:
- OILING.
- GREASING
. CHANGING OF SMALLER PARTS

INSPECTION GROUP RESPONSIBLE FOR:
- INSPECTION WORK
- SMALLER REPAIRS.

PEOPLE DOING INSPECTION AND SERVICE WORK (OILING AND GREASING) SHOULD BE HIGHLY QUALIFIED MECHANCIS THAT ARE GIVEN SPECIFIC TRAINING WITHIN CONDITION MONITORING METHODS ANL TRIBOLOGY.

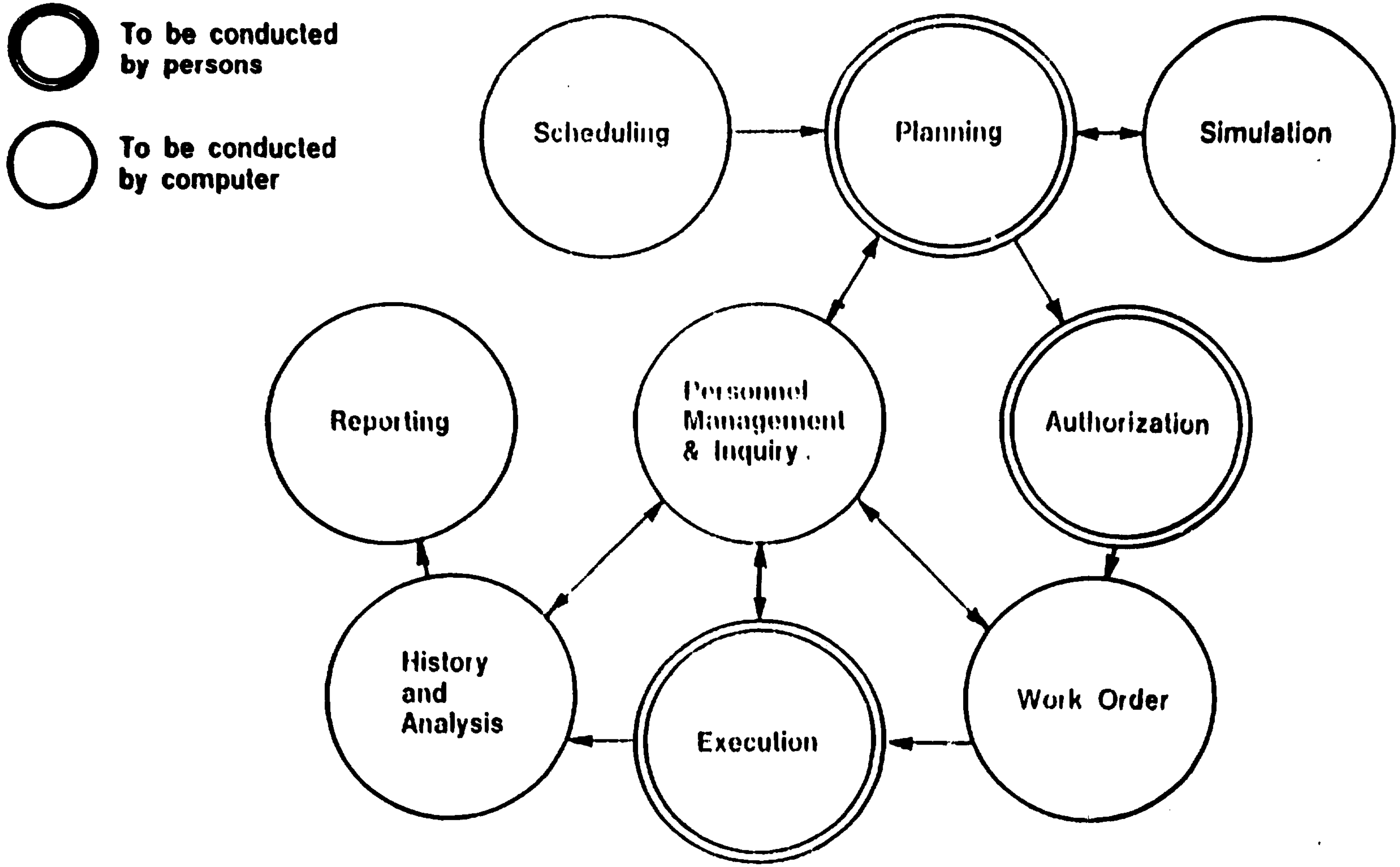


Fig.2 Function of Computerized Maintenance Control

- **MCS**
  - **PREVENTIVE MAINTENANCE SYSTEM**
    - Preventive maintenance scheduling
    - Equipment status data input
    - Maintenance Scheule lists issure
  - **WORK ORDER SYSTEM**
    - Work selection, • Work authorization
    - Work order sheet issur
    - Assignment of maintenance crew
    - Work result input
    - Inquiry of work order status
  - **INQUIRY SYSTEM**
    - Maintenance data, Equipment data, Spare parts and Equipment history Inquiry
  - **MAINTENANCE CREW MOBILIZATION SYSTEM**
    - Work assignment inquiry
    - Personnel status inquiry
    - Maintenance crew holiday scheduling
  - **OPTIMUM OPERATION SCHEDULING SYSTEM**
    - Simulation for maintenance/operation long term scheduling
      - Operation and Maintenance scheduling
      - Maintenance crew assignment scheduling
  - **REPORTING SYSTEM**
    - Work order status, Cost analysis, Personnel management, Maintenance history and Equipment status report
  - **FILE UPDATING SYSTEM**
  - **HELP SYSTEM**
    - Manual of MCS for systems engineers and programmers
  - **AIDE SYSTEM**
    - Manual of MCS for operators

Fig.3 System configuration of MCS

MAIN MENU

1. Plant register
2. Inspection planning
3. Preventive maintenance (PM) planning
4. Work order module
5. Log book
6. Documentation
7. Technical monitoring
8. Other maintenance registers
9. Stock keeping/purchasing registers

PLANT REGISTER

1. Machine register
2. Discarding of machines
3. Items register
4. Items grouping
5. Component belonging
6. Reports

PREPARATORY MAINTENANCE

1. Instruction register
2. PM plans
3. Automatic generation of PM–WO
4. PM list

LOGBOOK

1. Registration log
2. Print of logbook
3. Print of stoplog

TECHNICAL MONITORING

1. Operational reliability v.s. requirements
2. Total list
3. Summary – operational reliability
4. Functional reliability – MTBF
5. Servicefriendliness – mean repair time
6. Service reliability
7. Error log

INSPECTION PLANNING

1. Inspection plan
2. Instructions selfcontrol
3. Reporting
4. Action list
5. List of internal ingrediens
6. Inspection list self control
7. Print selfcontrol instructions
8. Print action list
9. Print total list of authorities inspections

WORK ORDER MODULE

1. Corrective W.O.
2. PM – W.O.
3. Project W.O.
4. Other W.O.
5. Standing W.O.
6. Work reporting
7. Error reporting
8. Ready-reports
9. Closing of W.O.
10. Print W.O.
11. Other reports

DOCUMENTATION

1. Register reports/documents
2. Register drawings
3. Inquiry: In what document is a specific item
4. Inquiry: In which drawing is a specific item

OTHER MAINTENANCE REGISTERS

1. Cost center
2. Component register
3. Error codes
4. Plants
5. Planned stop
6. Non significant time
7. Safety regulations
8. Category register

PLANT REGISTER REPORTS

1. Registers
2. Machine lay-out

PRINT WORK ORDERS

1. Corrective W.O.
2. Preventive W.O.
3. Project W.O.
4. Other W.O.

OTHER REPORTS W.O. MODULE

1. W.O./cost center
2. W.O./item
3. W.O./coordination departement
4. Stop order overview

MAIN MENU

1. Purchasing
2. Stores
3. Time reporting
4. Technical/economical monitoring
5. Register
6. Maintenance routines

PURCHASING

1. Purchase request
2. Purchase order
3. Direct purchasing
4. Invoice control
   Store costcenter
5. Generate purchase request
6. Print purchase order

STORES

1. Material out
2. Material in
3. Return to supplier
4. Stock-taking
5. Stock catalogue
6. Stock value
7. Rest order

STOCK TAKING

1. Counting lists
2. Continuous counting
3. List of differences
4. Counting of differences
5. Manual counting

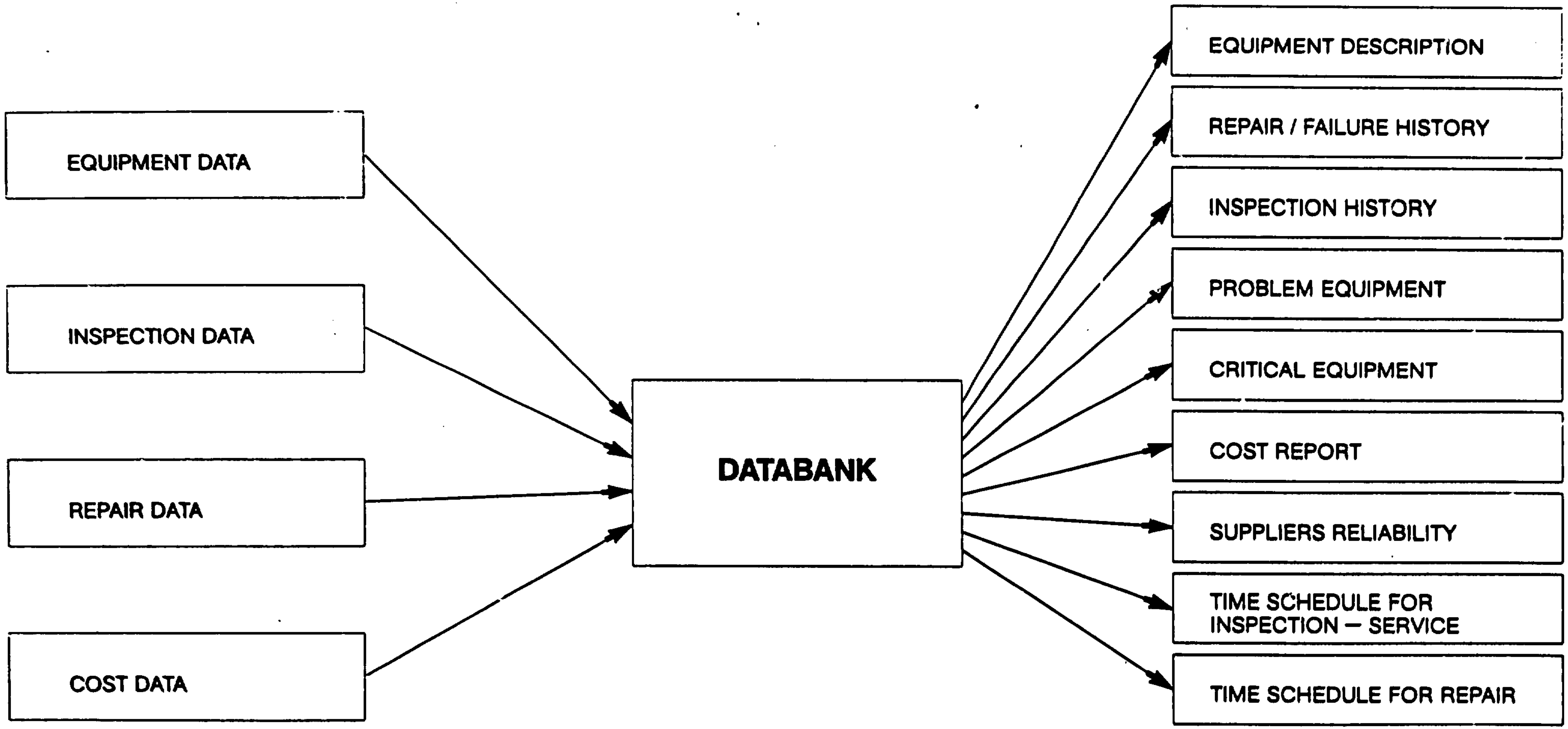
TECHN./ECONOMICAL MONITORING

1. Cost monitoring of work orders and maintenance responsible in operations
2. Debited amount cost center/ work order/maintenance/operations
3. Cost monitoring W.O. maintenance/technical service
4. Debited amount/cost center and W.O. maintenance/technical service
5. Technical/economical monitoring

MAINTENANCE REGISTERS

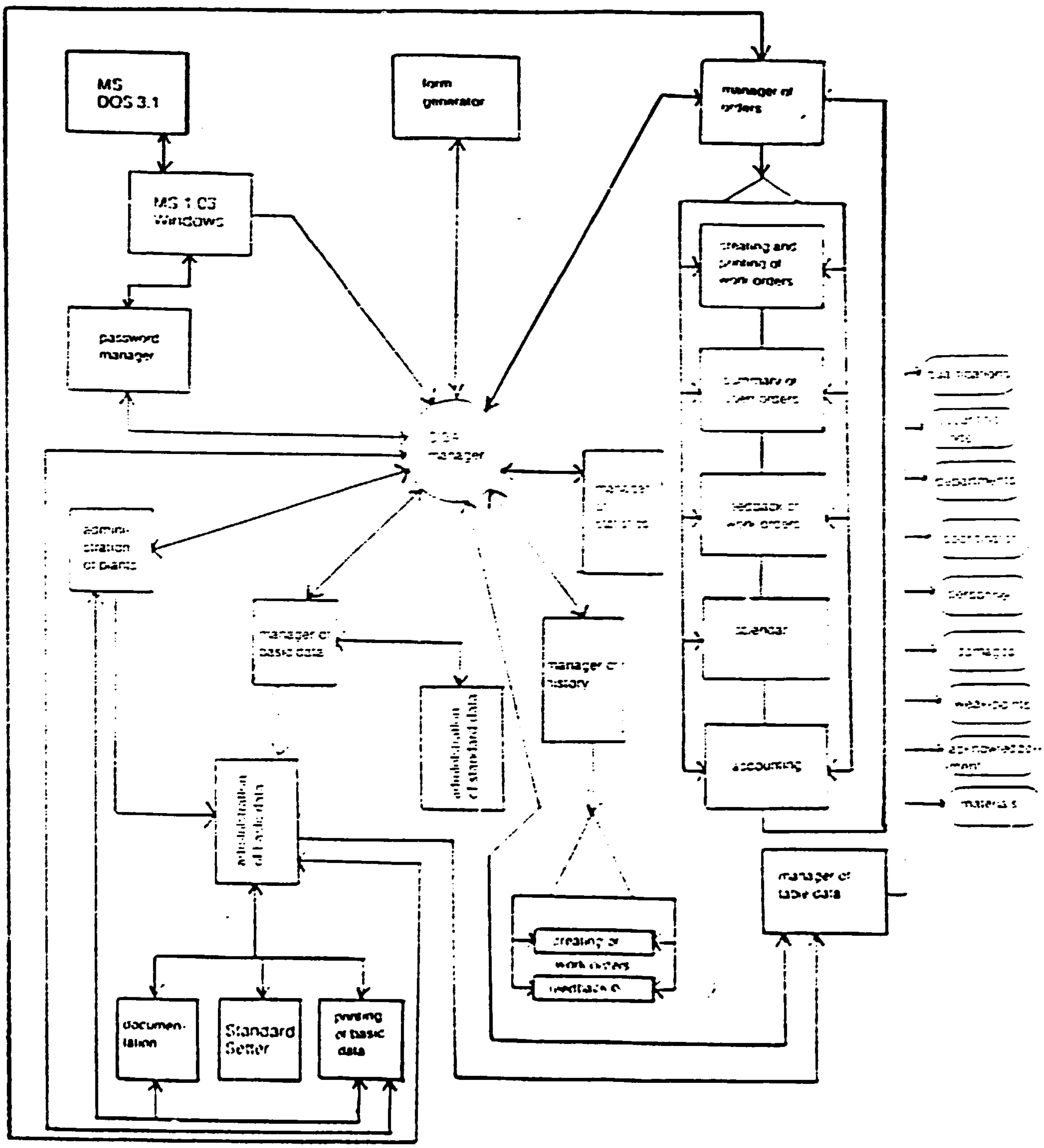
1. Supplies register
2. Component register
3. Hourly rates
4. Category register
5. Cost classes
6. Cost centers
7. Component groups
8. Lists of register contents

SCHEMATIC DRAWING OF A DATA SYSTEM



CIBA OPERATING SYSTEM

InsTA maintenance of technical equipment



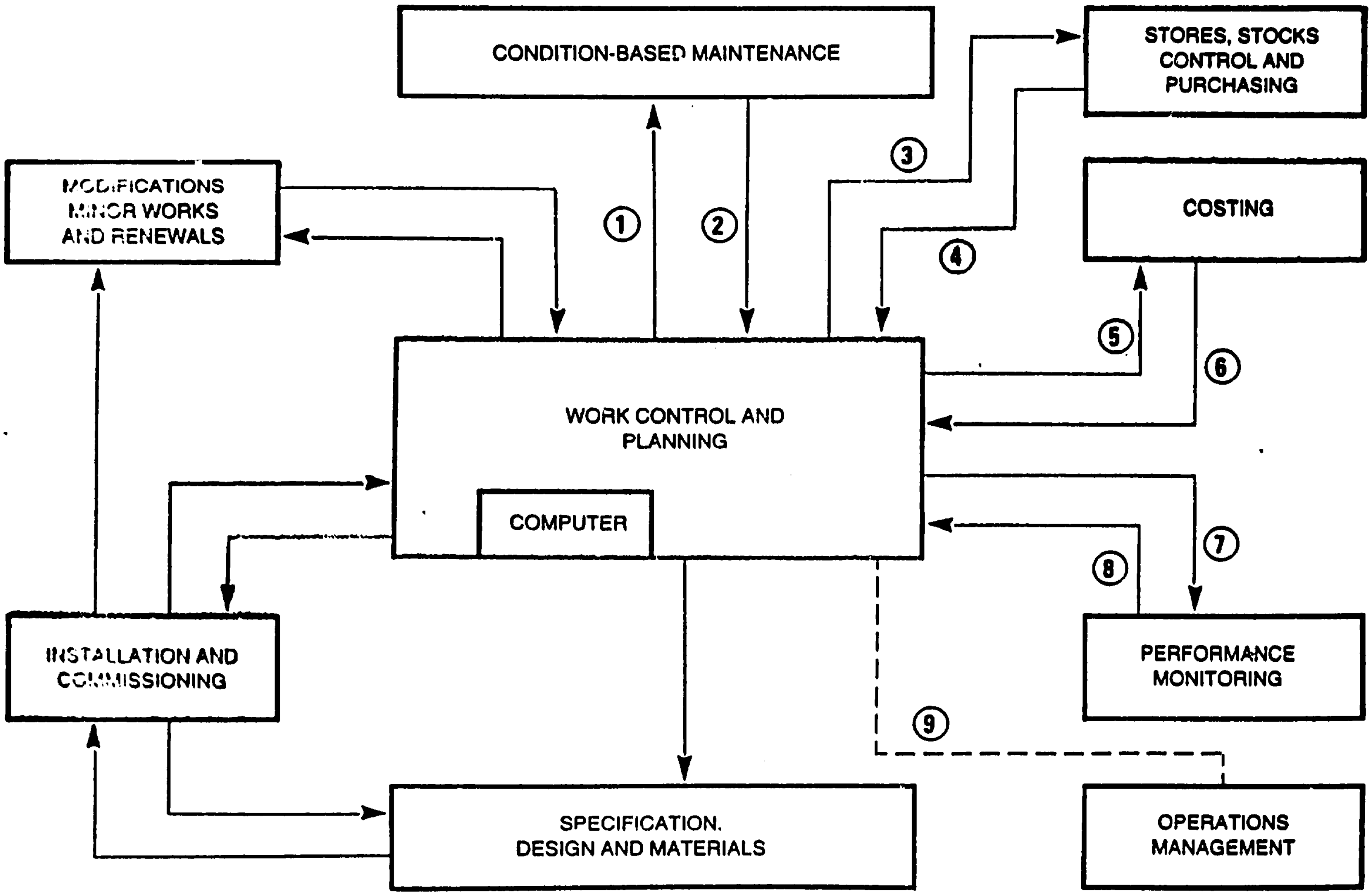
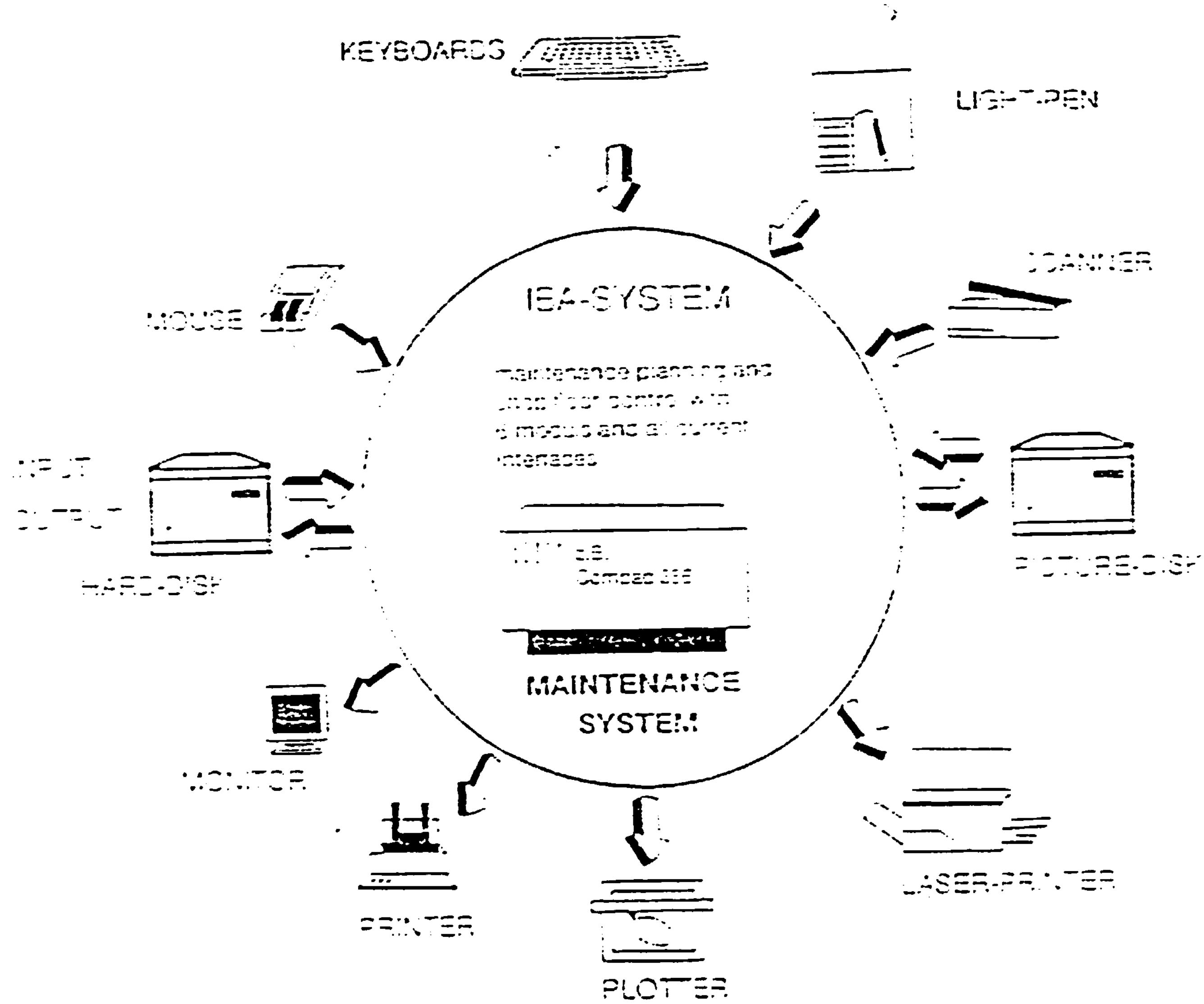
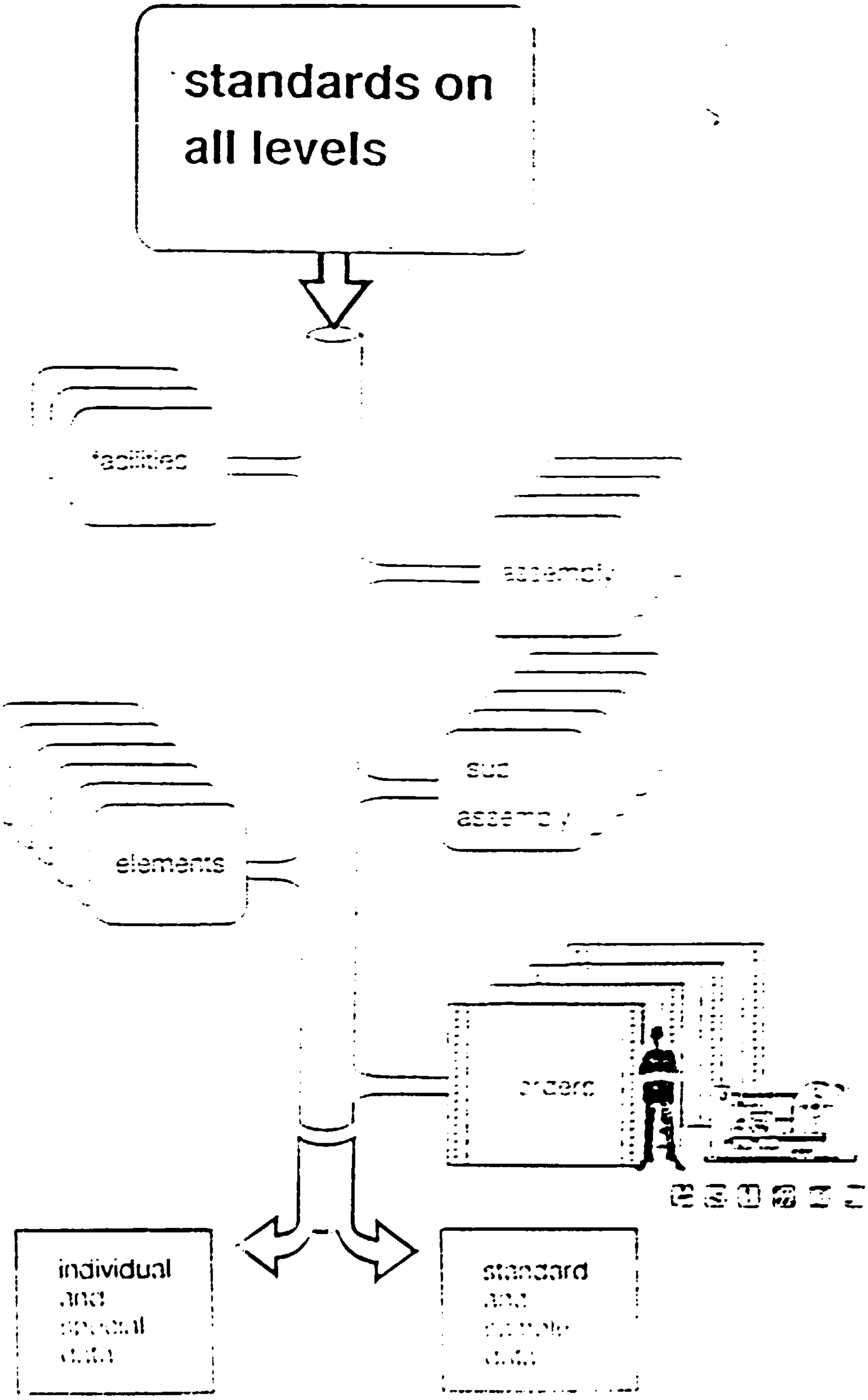


Figure 2 — Functional Management.

CONFIGURATION

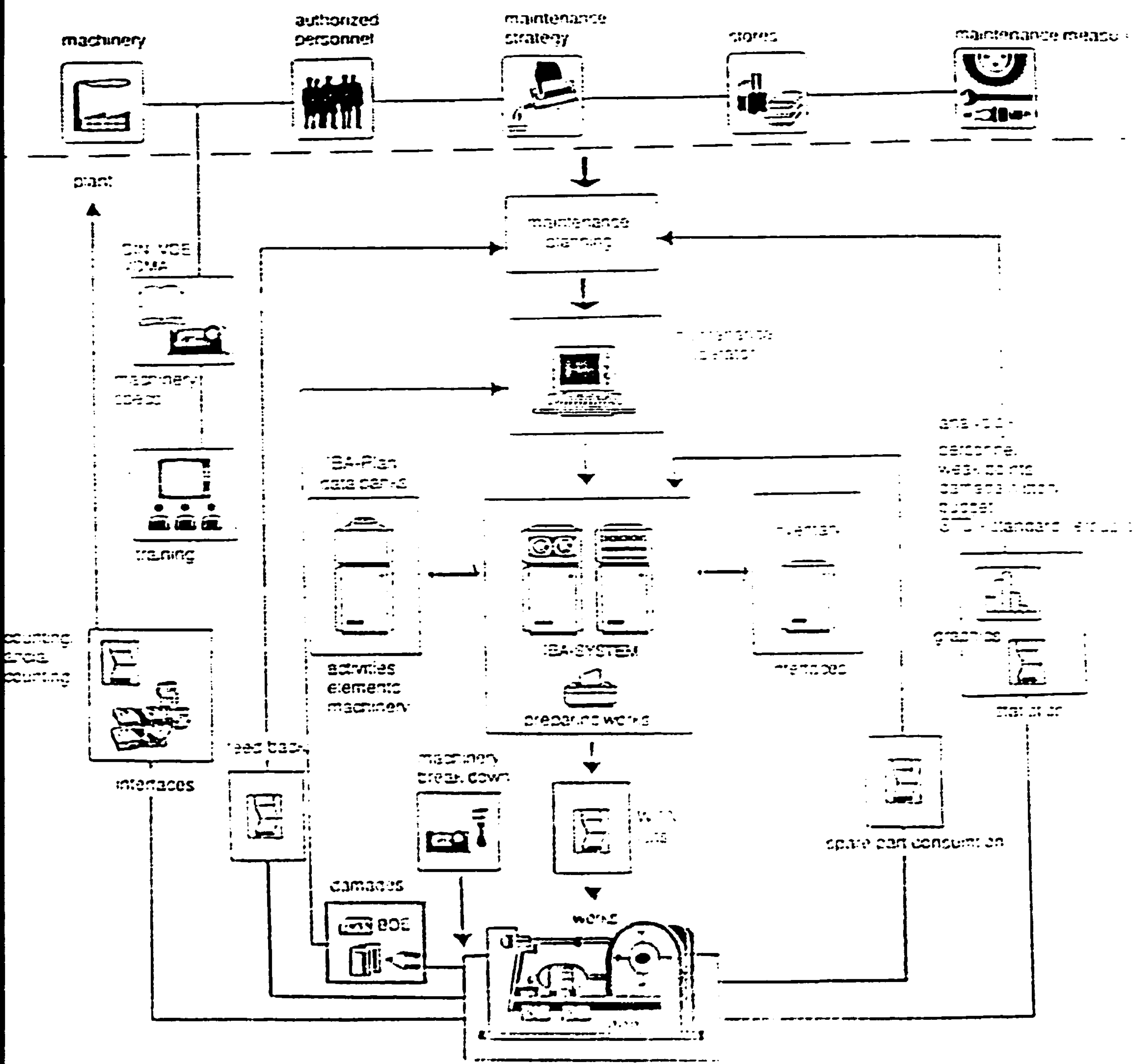


DATA STRUCTURES



SYSTEM DIAGRAM

InsTA maintenance of technical equipment



To my opinion the;

OPERATORS SHOULD BE GIVEN
MAINTENANCE TRAINING

and the

MAINTENANCE PERSONNEL SHOULD
BE GIVEN TRAINING TO OPERATE
THE PRODUCTION MACHINERY

PHASE V TRAINING OF PERSONNEL

TRAINING

SELECT KEYPERSONNEL TO THE DIFFERENT AREAS OF RESPONSIBILITY AN
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