MAINTENANCE IN ENGINEERING LABORATORIES

By

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Introduction

The history of the existence of man has always been characterized by the association of the "needs" to survive, grow and develop and the "means or tools" by which survival, growth and development were possible.

Since then, when he used primitive tools to make machines to carry his loads, to draw him water, to till his land and to fabricate his building materials, he has been faced with the necessity of maintaining those assets until such time that he considered their useful life as ended.

In the nature of things, nothing man-made is indestructible but the useful life can be extended by carrying out repairs at intervals by an activity known as maintenance.

The function of carrying out maintenance is such an obvious necessity that the subject has been taken for granted over the centuries, without much thought being given to its importance in our everyday life or to the constant effort involved.

But during the last thirty years, the impressive advances in engineering and scientific technology had brought into focus the need to extend careful attention to the function of maintaining the complex and costly assets that man is capable of producing.

Engineering laboratories too, with their outlay of training equipment and machineries, has not been spared with this necessity of maintaining their assets.

Issues on Engineering Laboratories

Analyzing the activities recurring in engineering laboratories or any laboratory in general, the existence of a common factor which affects,

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in one way or another, the nature of such activities is noticeable. We choose to identify this common factor as the bio-mechanical interaction.

The "biological" portion of this interaction is composed of people and comprises students, instructors and laboratory personnel, while the "mechanical" part of it, consists of tools, equipment machineries, materials and procedures. The programming of laboratory maintenance is being based on the fundamental needs to:

1. Ensure safety of personnel and students in using the training facilities.

2. Generate activities directed towards the training, upgrading and maintenance of laboratory personnel.

3. Establish and rationalize operational readiness which will comprise.

a) meeting the training objectives

b) meeting laboratory schedule of activities

c) provide equipment reliability

d) increase equipment effectively

e) optimize utilization of equipment.

4. Meet the environmental criteria for laboratories, instruments and personnel which foster the learning process.

Among others:

a) Temperature — often, instruments need to be stored and maintained in air-conditioned rooms, particularly calibrating devices.

b) Humidity — recommendations such as 68% RH for mechanical equipment are commonly accepted as far as humidity is concerned.

c) Dust — almost all equipment for laboratory purposes are affected by dust. This can be prevented by a good physical design of laboratory and excellent housekeeping.

5. Assure, at all times, high level of performance of instruments, in particular, their:

a) Accuracy — the need for an equipment to be fit for precise measurements. Accuracy means keeping the established operational standards, or the systematic activity of adjusting.

b) Calibration — the graduations of laboratory equipment, especially instruments utilizing masters or calibrating apparatuses which are the basis of comparison in measuring or judging quantities, values, etc.

c) Storage — the availability of adequate storage furniture is vital to any laboratory equipment.

d) Mobility — provide properly designed trays or carts for fast moving and slow moving equipment. The fast moving equipment refers to the tools, measuring instruments, power supplies, etc. which the students and professors use very often during a conduct of practical activity in demonstrating or providing an engineering principle.

6. Set out operational and utilization procedures to extend the life of equipment, taking into consideration the life-cycle cost and replacement value of equipment.

The complex task and great responsibility of school administrators and engineering deans to secure the excellent operational readiness of engineering laboratories and to control the effectivity of knowledge and skills transfer in laboratory activities, has always been regarded as one of the most difficult operations to organize and manage. A new concept, encompassing all the activities which take place in engineering laboratories, is therefore here introduced and discussed with the purpose of systematically helping to meet the challenges posed by this complex operation.

Terotechnology Concept of Maintenance

The concept of terotechnology is here introduced for the purpose of providing a comprehensive approach to effective maintenance.

The word "terotechnology" itself stems from the Greek root "terein" — "to look after", "to guard over", "to take care of".

The terotechnology "system" is purely independent of the hierarchy of an organization in which it is intended to be applied and the size and

complexity of the laboratory equipment or installation which it controls. The fundamental principles of terotechnology can be applied, to a greater or lesser extent, to any physical asset in any organization, no matter what size or degree of complexity of either asset or organization.

Terotechnology is interdisciplinary in nature, i.e. applying it to a typical laboratory, it embraces the aspect of how a particular laboratory equipment can affect the people involved. An example can be shown in the following chart:

People	*Effect of a Lab Equipment*
— Student	— Learning
— Instructor	— Teaching Methodology
— Department Head	— Logistics
— Dean	— Overall effectivity of the learning process
— Director/President	— Cost

The terotechnology concept is a combination of different functions, namely:

— Financial

— Management

— Engineering

and other related practices, which can be applied to physical assets in pursuit of economic life-cycle cost (Figure 1).

Terotechnology therefore, is concerned with:

Specifications	Installations
Designs	Commissioning
Provisions	Maintenance

Modifications Replacements

These activities can be applied to:

Schools/Universities/Colleges Building

Machinery Equipment (In this context, laboratory equipment)

Structure

and with feedback of information on:

Design

Performance

Cost

With the concept of terotechnology and a knowledge of the basic principles of a good maintenance scheme, a means of interrelating these two concepts has to be devised. A sound knowledge and active implementation of maintenance management would then be essential.

Maintenance Management

The term maintenance management can be defined as the "organization of maintenance within an agreed policy." It is the responsibility of the administrator of each university and college to lay down what that agreed policy must be, as clearly as possible, and without ambiguity. A policy must be the acceptable condition of maintenance and the laboratory engineer must be informed of this policy. The maintenance group and other departments (Figure 2) should know their respective responsibility based on this policy.

Essentially, maintenance management must include:

1. Setting objectives
2. Planning
3. Directing
4. Controlling
5. Appraising

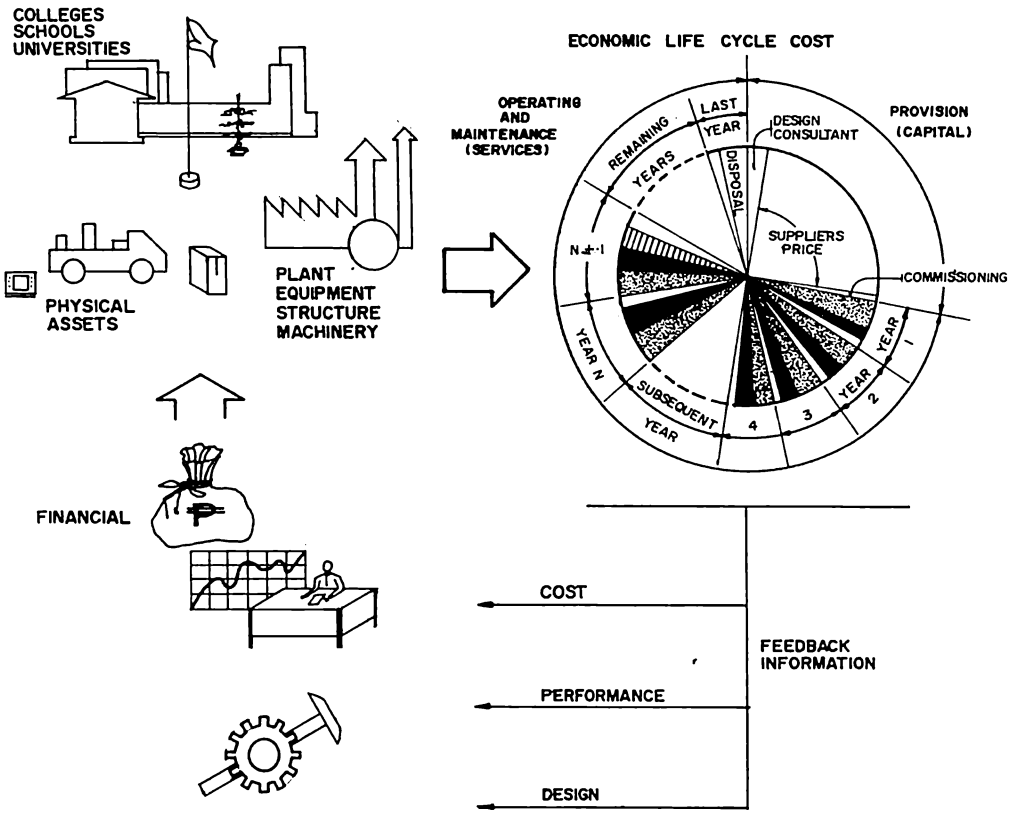

FIG. I TEROTECHNOLOGY CONCEPT ILLUSTRATED

1. *Setting Objectives*

The principal objectives of maintenance can be set as follows:

a) Extension of the useful life of the laboratory equipment and facilities. A particular importance is considered for developing countries like the Philippines, in view of the lack of capital resources for instrument replacement. In developed countries, it is sometimes feasible to "replace" rather than to "maintain".

b) Assurance of the optimum availability of installed equipment and machinery.

c) Assurance of the operational readiness of all laboratory equipment and/or facilities at all times.

d) Assurance of the safety of students, professors and other personnel using the facilities.

2. *Planning*

The most successful maintenance management plans are invariably those which are kept as simple as possible to administer, involving the laboratory maintenance personnel in the minimum amount of paperwork.

The planning of maintenance embodies such items as advanced decision-making with regards to jobs to be done, methods to be carried out, preparation of materials, acquiring of proper tools, scheduling of laboratory equipment to be maintained, labour, timing, and time requirements.

a) *Preparation of Maintenance Schedule.* A maintenance schedule (Figure 3) must be prepared for every item of the laboratory equipment and machinery which, if decided, shall require the application of planned preventive maintenance.

b) *Job Planning.* This is the establishment of what is to be maintained in a certain laboratory. This will involve the preparation of a facility register. The facility register will indicate all laboratory equipment and facilities to be maintained.

c) *Job Specification.* Job specification are the means — of communicating laboratory engineers' requirements to laboratory technicians and tradesmen.

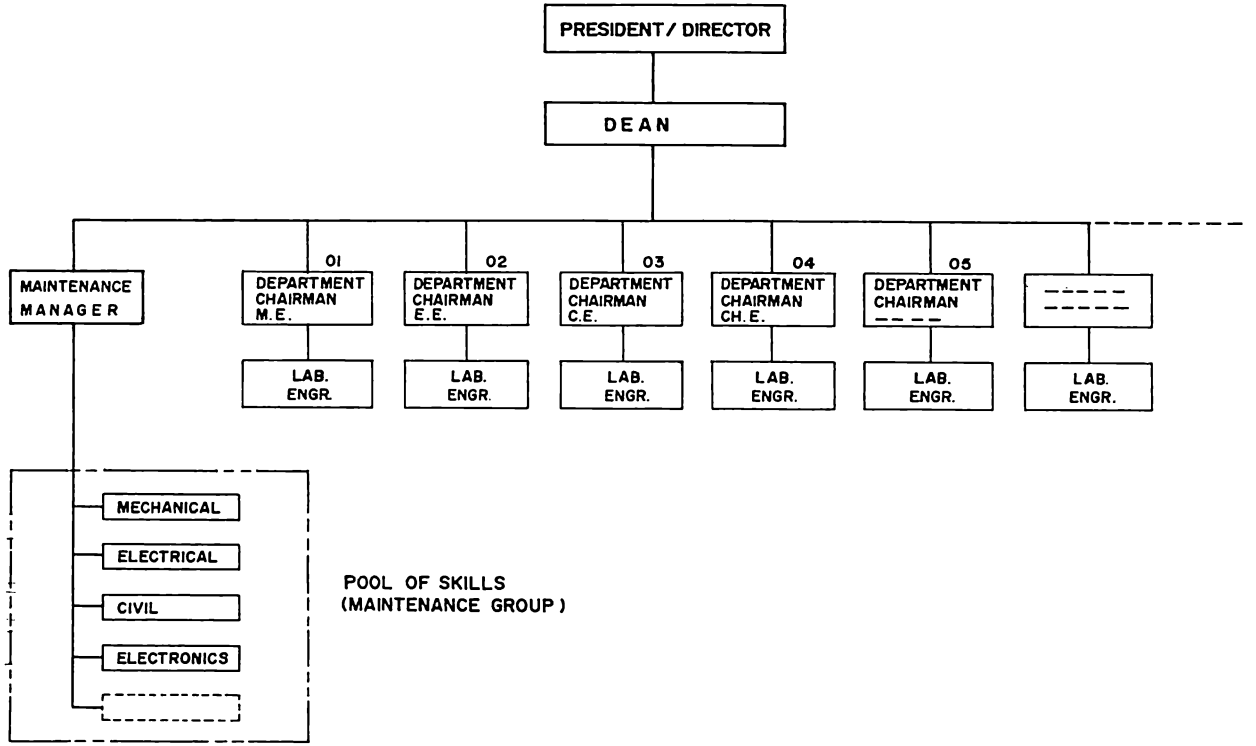

FIG. 2 MAINTENANCE GROUP IN A SCHOOL ORGANIZATION

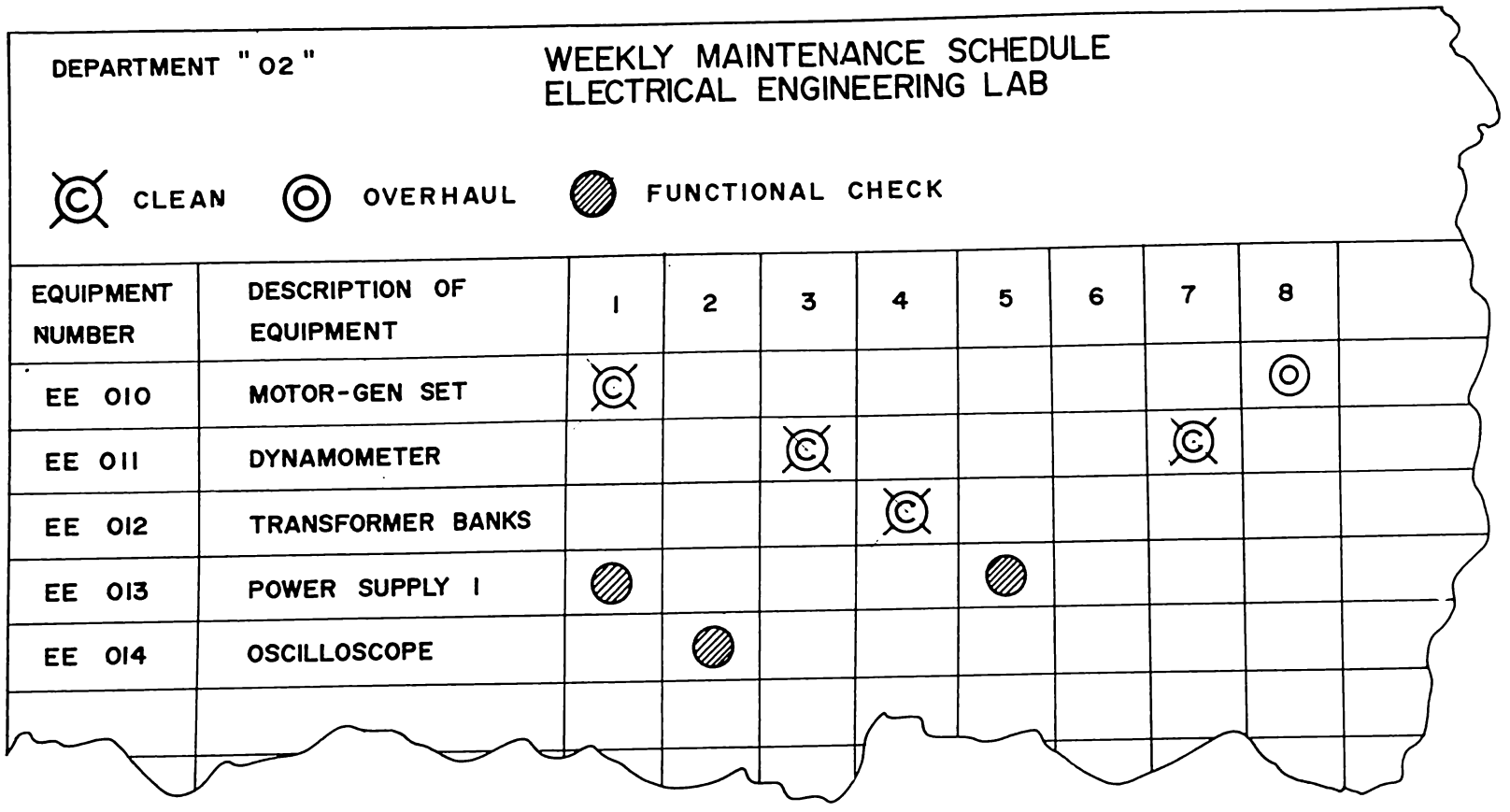

FIG. 3 WEEKLY MAINTENANCE SCHEDULE USED IN JOB PLANNING

Job specifications can be applied by drawing up a maintenance programme and scheduling laboratory equipment and facilities to be checked or inspected.

d) *Maintenance Specifications.* Maintenance work can be classified as:

(i) Unplanned Maintenance — A form of unplanned maintenance is emergency maintenance, which is necessary to put in hand immediately to avoid serious consequences, for instance: hazards to students and professors in a laboratory.

(ii) Planned Maintenance — this type of maintenance can be split up into two main activities (Figure 4):

- Preventive — the major part of preventive maintenance involves inspections on the basis of "look, feel, and listen." This should be supplemented by minor adjustments at predetermined intervals and the replacement of minor components found necessary as the results of such inspections.

- Corrective — maintenance involves repairs, usually of short-term planning that may crop up between inspections, including planned overhauls, the extent of which will have been planned on a long-term basis as a result of preventive inspections.

A weekly-planned preventive maintenance becomes necessary, with a close collaboration among instructors and professors of every department. A proper coordination between the laboratory engineer, laboratory technicians and department heads for planned preventive inspections and repairs is an absolute and essential basic requirement.

3. *Directing Operations*

One of the problems confronting our laboratory engineer and the maintenance manager is that of communication. Effective management relies on two-way communication, in our case between the laboratory engineer, the instructors, department head, deans,

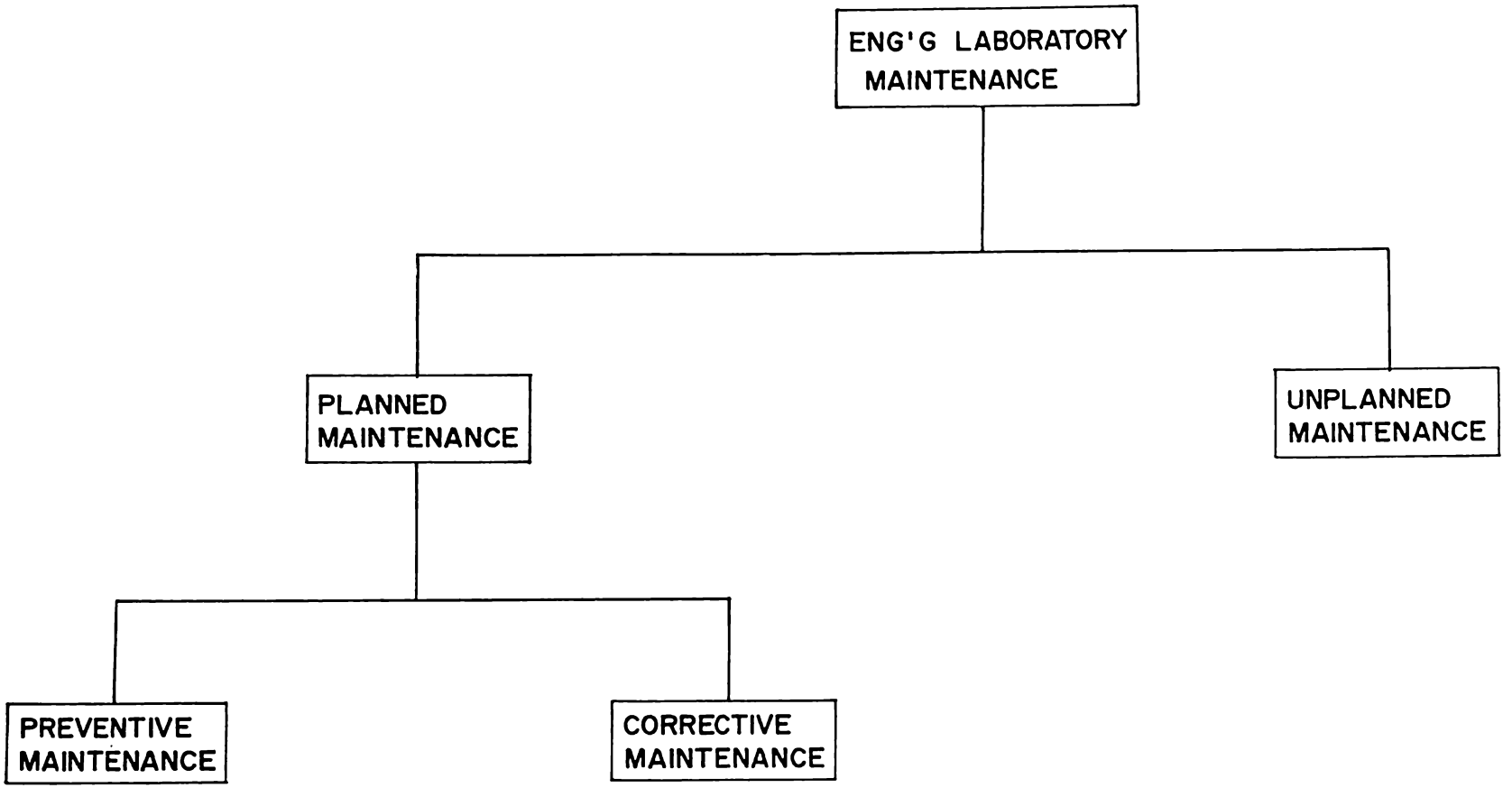

FIG. 4 TYPES OF ENGINEERING LABORATORY MAINTENANCE

his technical staff and the maintenance shop-floor supervisor (Figure 5).

In laboratory equipment maintenance, the success is dependent upon people, their cooperation, and their enthusiasm for a methodical approach to their work.

Work methods and patterns should be designed by the laboratory engineer. Some forms are to be printed to release the tradesmen from heavy write-ups and to have a uniform data gathering and reporting (Figure 6).

The job instructions given by supervisors, whether verbally or in writing, can so easily be interpreted differently by technicians or tradesmen (Figure 7).

The feedback of information from a technician's report of what work he has done, for example, what defect was the cause of the failure or breakdown, should be properly done by the person who did the maintenance.

A clear explanation of the nature of job of the repair carried out is essential information for management and supervision, to enable them to retain control over maintenance operations.

Ensure always a feedback of meaningful information that will enable management decisions to improve maintenance.

4. *Controlling Maintenance*

A successful control scheme for maintenance operations lies in retaining simplicity. Only essential information are to be analyze in retaining on a routinary basis. A properly devised system or control, can reap the full benefits which are envisaged during the setting-up stage.

Essentials for controlling the maintenance operations are:

1) Establishment of systematic operational procedures for routine inspections and analyses of maintenance work.

2) Good consideration of specific techniques (Figure 8).

Systematic operational procedures that are laid down from a well-planned maintenance program shall depend on the routinary

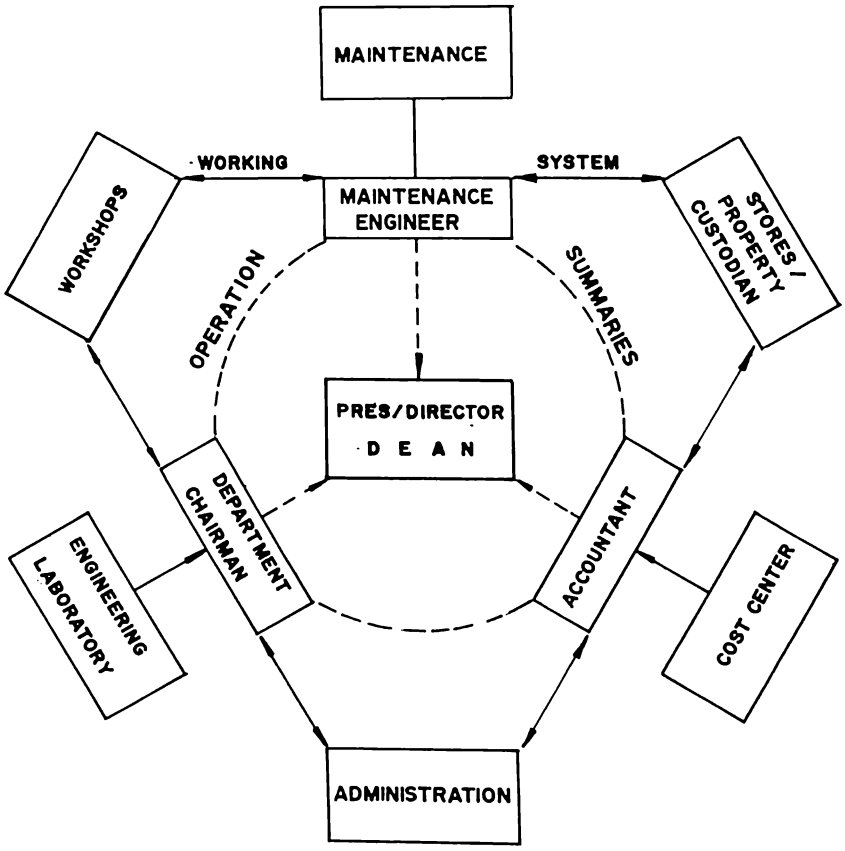

FIG. 5 ORGANIZATION COMMUNICATION NETWORK

JOB REPORT

Maintenance Dept.	
Equipment	Location
Motor-General Set	Electrical Power Lab

WORK DONE

Coupling

1. Tightened set-screw
2. Inspection of coupling
3. Cleaning

Motor

1. Cleaning of commutator
2. Adjustment of brush contacts
3. Conducted test for grounds, shorts, open.

Generator

1. Inspection of connections
2. Cleaning
3. Conducted test for grounds, shorts, open.

COST CENTER	DATE OF REPAIR	NAME & NO.
043	09/26/82	F.P. FERIDO 085

Fig. 6. Job Report Format

JOB SPECIFICATION

WEEK NUMBERS			
10	26	39	

EQUIPMENT DESCRIPTION : Motor Generator Set		EQUIP. No.	EEO10
		SPECS. No.	MG/003
LOCATION : Electrical Power Lab		MAINTENANCE CODE	11
		COST CENTER	043
SPECIAL TOOLS : SET OA		ACCOUNT No.	274

Coupling

1. Check set screws
2. Inspect keys for wear
3. Test coupling alignment
4. Check lubrication
5. Test set screw tightness

Motor

1. Check brush position
2. Check smoothness of brush surface
3. Test for grounds, shorts, open

Generator

1. Inspect external circuit
2. Inspect for loose connections
3. Test for grounds, shorts, open

Fig. 7. Example of Job Specification

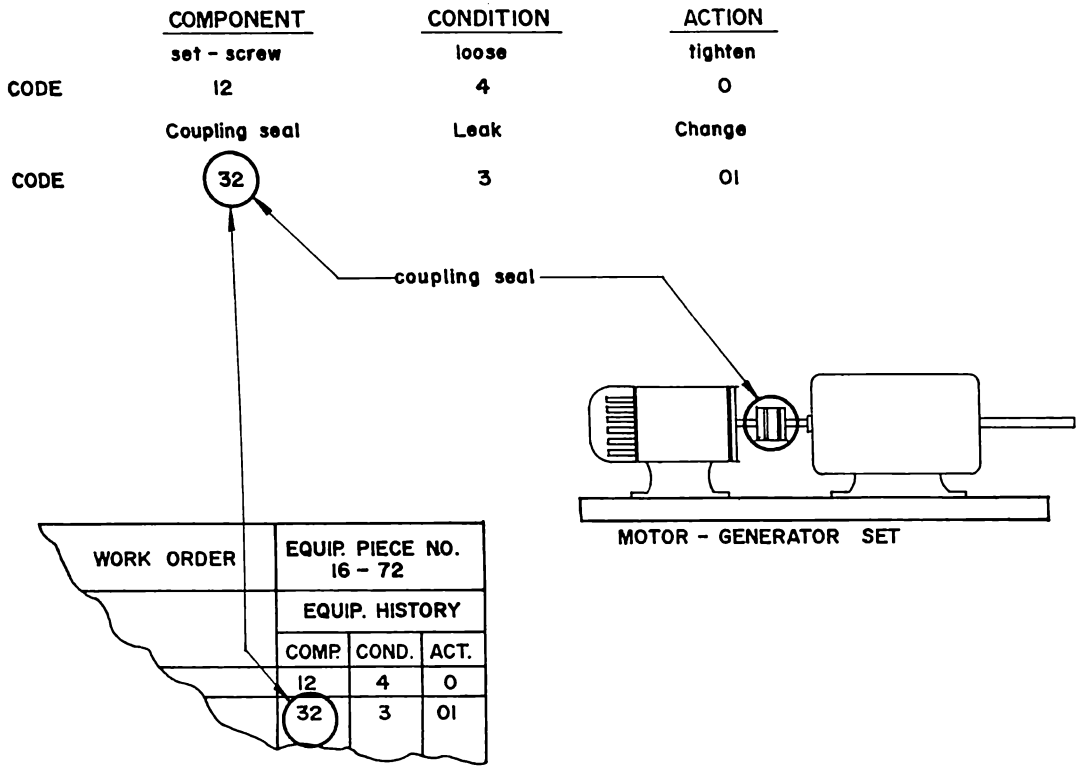

FIG. 8 SPECIFIC TECHNIQUES IN MAINTENANCE CONTROL

activities of the maintenance functions. On the part of the managers/laboratory engineers, there should be systematic and easily workable schemes of doing the maintenance task. Data entry and reporting habits shall be emphasized.

5. *Appraising Maintenance Operations*

Regular appraisal and evaluation of maintenance operations should be conducted by the maintenance manager in order to determine the effective performance. The major areas subject to appraisal are:

a) Personnel Performance — to determine efficiency rating based on qualitative and quantitative values.

b) Operations Performance — to determine the viability of the projected maintenance operations as against actual undertakings.

c) Quality Assurance — to ascertain the accuracy and reliability of the status of instruments.

d) Cost Control — to evaluate the validity of decision-making on cost of repairs as against cost of replacement.

e) Data Retrieval — to establish the usefulness and validity of the maintenance reports.

f) Development Plan — monitor the activities intended for the manufacture and production of local training equipment and modules.

Conclusion

The relevance of establishing and organizing an efficient maintenance program for the upkeeping, improving and updating of training equipment and laboratory personnel has become today a matter of survival for an engineering school. The replacement costs of outmoded lab equipment has become a very expensive exercise. It is high time that engineering schools should be more realistic in organizing a small and efficient R & D Center to design and manufacture training modules and other type of technology software.

The validity of a good maintenance program is not proven only in maintenance operations but particularly in the creativity and productivity output of the maintenance management team.

References

1. Corder, A.S., Maintenance Management Techniques, McGraw-hill, 1976.

2. White, E.N., Maintenance Planning, Control and Documentation, Gower Press, 1973.