THE UNIVERSITY OF ALBERTA

THE MANAGEMENT OF INDUSTRIAL ARTS EQUIPMENT MAINTENANCE PROGRAM FOR THE COMPREHENSIVE SCHOOLS IN THAILAND

BY

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A THESIS

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DEDICATION

TO

My Parents and Teachers

ABSTRACT

The purpose of this study was to develop a model for the management of industrial arts equipment maintenance in the comprehensive schools of Thailand.

Information concerning: organizational structure of maintenance programs, procedures, finances, and effectiveness of equipment maintenance was considered in this thesis. Among the sources of information were: Thailand Reports*, Terminal Report, and Final Report; interviews with maintenance directors of several educational organizations; interviews with maintenance directors of several non-educational enterprises; review of literature; and the experience of the author who has worked as part of a maintenance team in the Thai Comprehensive Schools.

From the information gathered, a model for the management of industrial arts equipment maintenance was developed. This model was then submitted to a panel of experts who rated each part of the model and submitted opinions as they saw fit. The model was then revised in terms of the advice given by the panel.

The model is based on four major components of a maintenance system, structure, procedure, finance and evaluation. These major components are described in the nine sections of the model. These sections are: (1) Organization, (2) Qualification of Personnel, (3) Work Planning, (4) Kind of Work, (5) Inspection Procedures, (6) Inventory, (7) Budget, (8) Assessment, and (9) Suggestion for Improvement.

It is recommended that the Department of General and Adult Education of Thailand establish a Maintenance Division under a Director of Maintenance to administer a maintenance program for the twenty comprehensive schools established under the Comprehensive School Project. Further, it is recommended that new comprehensive schools also have the services of an organized maintenance division available to them. It is also recommended that the feasibility of establishing maintenance divisions for the other curricular areas be investigated.

* COUTTS, H.T., "Thailand Report". Edmonton, Faculty of Education, University of Alberta, 1969 and 1971.

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

The attempt of any country to formulate a rationale to improve its educational system can be reflected in the statement of its goals. In particular, secondary education in Thailand, as stated by the Ministry of Education in 1960, aims to attain the following objectives: (Ministry of Education 1960, p.1)

> 1. To improve general education appropriate for the maturity of the pupils and the condition of society; and to provide special programs to meet the abilities and interests of each individual.
>
> 2. To inculcate in pupils physical and mental health habits, and concern for the public health program.
>
> 3. To develop desirable citizenship attitudes and abilities in order to live and work effectively with others.
>
> 4. To help pupils acquire knowledge and skills sufficient to earn a living, or for necessary foundations either for vocational training or for higher education.

Objective number four in the 1960 National Scheme for Education in Thailand emphasizes the need for preparing individuals to earn a living after they finish high school. In response to this need, secondary schools in Thailand are obliged to offer vocational training programs. However, since there is uncertainty in the future of the individuals after high school, it is necessary that in all schools emphasis should be placed on industrial arts and vocational

education. This has led to new developments in the Thai secondary education system.

The new developments in the Thai Comprehensive School Project were launched in 1966. The Thai Government had come to an agreement to co-operate in converting twenty selected academic schools into full-fledged comprehensive schools.

The twenty schools assigned to the Comprehensive School Project were located throughout Thailand. They were selected by use of the following criteria: (Department of Secondary Education 1965, p.4)

a) Economic - the occupational demands of the locality
b) Space for expansion
c) Feeder school enrolments
d) Population of the locality
e) Present school enrolments
f) Proximity to vocational schools in which students may further their vocational training
g) Usefulness as a laboratory school . . . in the Supervisory Unit
h) Socio-political consideration

The distance between the Comprehensive School Project office in Bangkok and the twenty comprehensive schools ranges from 60 - 1440 kilometers. The condition of all linking highways is very good all year round. Table 1.1 shows the distance in kilometers, while figure 1.1 shows the location of the schools.

TABLE 1.1

School, province and Distance from Bangkok in Kilometers

School and location	K.M.
Samsen Wittayalai, Bangkok	-
Piboon Wittayalai, Lopburi	153
Nakorn Sawan, Nakorn Sawan	264
Rajaseema Wittayalai, Korat	255
Kaen Nakorn, Khon Kaen	444
Roi-ed Wittayalai, Roi-ed	510
Benjama Rajarangsarit, Cha Cheong Sao	60
Yuparaj Wittayalai, Chieng Mai	756
Udorn Pittayanukoon, Udorn	561
Piyamaha Rajalai, Nakorn Panom	730
Kanarasadorn Bamroong, Yala	1440
Samakkee Wittayakom, Chieng Rai	875
Haad Yai, Haad Yai	1300
Cholaras Umroong, Cholburi	83
Saraburi, Saraburi	108
Boonyawat Wittayalai, Lampang	647
Benjama Maharaj, Ubon	680
Chalerm Khuan, Pitsanuloke	492
Ayuthya Wittayalai, Ayuthya	87
Benjama Rajuthid, Nakornsrithamarat	1188

Bangkok

The Communication between these schools is convenient both by mail and long distance telephone. The farthest school is not more than three days by mail.

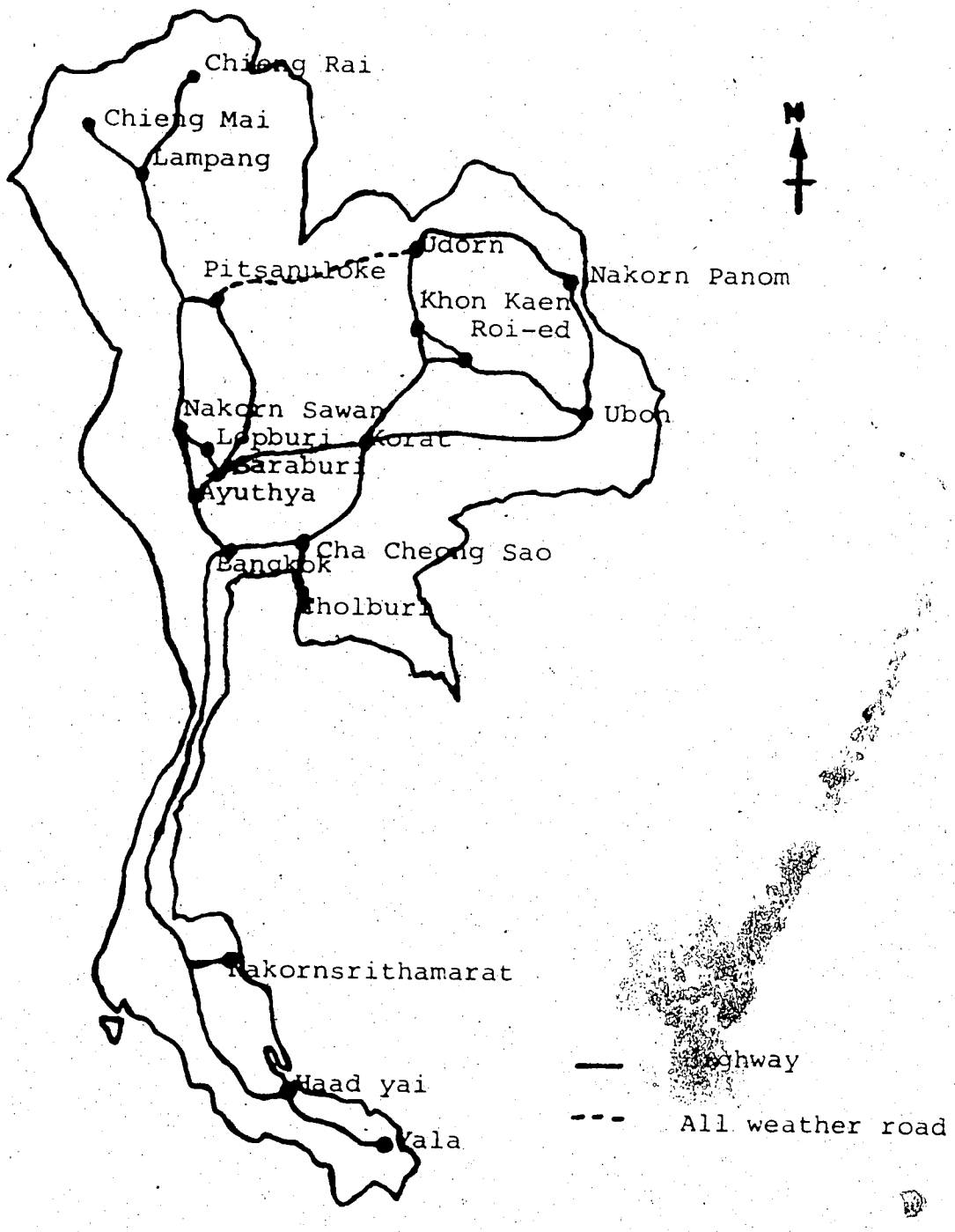


FIGURE I.I

Map of Thailand showing location of the twenty schools in the Comprehensive School Project.

The Thailand Comprehensive School Project has resulted in large amounts of money being invested in education. In terms of American dollars this amounted to $26.6 million (Coutts, 1969) for the period of 1966-1971. The industrial arts program alone amounted to $8.4 million (Coutts, 1969). This portion was applied to the construction of school shops, equipment, machines and tools necessary for the industrial arts training program. As time passes, machines, equipment and tools depreciate and sometimes go out of order. This calls for maintenance to keep them functional as long as possible so that the initial investment will give a maximum return.

TEMPORARY MAINTENANCE TEAM

The education officials responsible for this project have realized the importance of equipment maintenance since the very beginning. As a result, a temporary team was established to solve maintanence problems in the project schools as well as to help install new equipment. Founded for this dual purpose, the team consists of three Thais working with the assistance of a Canadian advisor. The temporary maintenance team was organized as an educational task force for the Comprehensive School Project. The personnel were drawn from the schools and the Supervisory

Unit of the Department of General and Adult Education. The researcher was a member of the team and has had three years' experience in performing the duties assigned to the team. These duties involved installation of equipment, checking the operation of new equipment, and repairing existing equipment.

The Comprehensive School Project was terminated at the end of August 1973, resulting in the disbanding of the temporary maintenance team. However, it is necessary that maintenance continue for comprehensive as well as for other schools (such as those in the UNICEF School Project and the newly developed schools under the Diversified School Project). With the inclusion of other schools, the organization of maintenance is likely to be on a broader scale. The aspects of maintenance related to the existing comprehensive schools is the scope of this study.

BACKGROUND OF THE PROBLEM

According to the loan agreement between the Thai and the Canadian Governments on the establishment of comprehensive schools in Thailand, Thailand agreed to purchase the equipment from Canada. The Canadian Commercial Corporation (C.C.C.) represented the Canadian Government in the purchase

of equipment and tools for the Thai comprehensive schools. Since inception of the Project, the following problems have arisen:

1. Unavailability of the spare parts.

The companies which sold the equipment and tools to the C.C.C. have no local representatives in Thailand. When the equipment was in need of repair, spare parts of the same kind were not available. It became necessary to order spare parts from overseas. This meant several months delay in their arrival for use in the Thai comprehensive schools.

2. Shortage of qualified technicians.

As there were no technicians involved in the Comprehensive School Project, it was very difficult to install the new equipment in the shops. The Canadian advisers and some industrial arts supervisors of the Department of General and Adult Education made the installations. Since these people were chiefly theoreticians and not highly skilled as technicians, some difficulties were experienced in the task of installation of equipment. For example, most of the metal lathes were not accurately levelled because precision instruments were not used. When the lathes were used, they were not capable of precision work and tended to wear faster than is normal.

3. The problem of electrical power supply.

In Thailand the electrical power supply is normally

220 volts at 50 hertz single phase while in Canada the normal electrical power supply is 110 volts at 60 hertz. Machinery shipped from Canada was designed for Canadian rather than Thailand power requirements. In most cases the electric motors on machines did not perform satisfactorily because the power supply in Thailand was not that for which the motors had been designed. The problem was further complicated as ambient temperature and humidity in Thailand are markedly different from conditions in Canada.

4. Machines received without required accessories.

Some machines were supplied without the accessories which would make their use efficient. Thirteen milling machines and thirteen shapers had no cooling pumps, cutter blades or tool holders. When they were installed, they could not be used in teaching students. At this moment, the Project must provide the accessories.

5. The problem of translating equipment manuals.

Equipment manuals were all in English. No complete translated copies in the Thai language were available. When the industrial arts teachers taught, they had to translate the manuals by themselves, sometimes word by word.

6. Lack of formal training on installation and maintenance of equipment.

Teachers had not received instruction on installation and maintenance of machines. Most of the Thai industrial arts teachers were trained on how to use the machines but

very little was done concerning instruction in stallation and maintenance. This lack of knowledge on the part of the teachers may have led to the damaging of some machines.

7. Complicated process of purchasing.

Owing to the highly bureaucratic administration of the Department of General and Adult Education, the process of purchasing spare parts or other supplies is very complicated. The purchases have to be approved at various levels up to the Director General of the Department of General and Adult Education. When a purchase is authorized, the head of purchasing section issues a purchase order. Problems arise when the purchaser does not understand the precise needs of the maintenance team and orders items not suited to the particular maintenance job. For example, when 250-300 MFD., 220-280 volts condensers were required for repairing motors, 250-300 MFD., 220-280 volts condensers which are used with electronics were supplied.

STATEMENT OF THE PROBLEM

The major problem of this study was that there is no formal organization of equipment maintenance in the Thai comprehensive schools.

PURPOSE OF STUDY

The purpose of this study was to develop an appropriate model for an equipment maintenance system for the comprehensive schools in Thailand. In line with the problems described in the preceding section, the purpose of the study may be stated in the form of several sub-purposes.

Sub-purposes:

1. to study maintenance organizational structures which include the chain of command, personnel and work planning.

2. to study the maintenance operation system: area of work, inspections and inventory system for industrial arts equipment.

3. to study the financial budget system.

4. to study evaluation of maintenance work.

5. to use the information gathered in sub-purposes 1, 2, 3, 4 to develop a model for the administration of a maintenance system for industrial arts laboratories of the Thai comprehensive schools.

SOURCES OF DATA

Some guidelines may be extracted from the information which the researcher gathers from Alberta school systems,

specialized organizations and experiences of returned Canadian International Development Agency (CIDA) personnel.

In addition, some data relevant to the Thai comprehensive schools will provide further information to be considered in developing a model for the proposed new Thai equipment maintenance system. The final outcome of this study will be a proposal for the management of equipment maintenance in the Thai comprehensive schools.

NEED FOR STUDY

As stated in the introduction, the disbanding of the temporary maintenance team creates an urgent need for study of a permanent structure whereby maintenance of the existing equipment can be organized and administered. This need applies to the current situation in the Thai comprehensive schools.

We cannot overlook the importance of maintenance in its own right when it applies to school systems in general. The significance of equipment maintenance is pointed out by G.E. Petes (Petes, 1970, p.3) as a necessity in industry. He has this to say:

> The utilization of fixed assets greatly depends upon their good working

> order. Therefore it is necessary to establish and uphold the balance between production and maintenance and to plan development harmoniously. This is the only way to ensure maintenance service at low costs, to keep machines, equipment, buildings and job sites in a condition suitable for the best utilization of the fixed assets. If the right equilibrium is established considerable reserves may come to light.

As we must utilize the schools' equipment to its fullest potential, it is necessary that the right equilibrium be established between the use of this equipment and its maintenance in good working order. In all schools where there are shops and equipment these must be well organized and managed so that a balance is very crucial for the success of the entire program of the school.

LIMITATIONS

The following are limitations of this study:

1. The interview schedules may not be sufficiently comprehensive or clear.

2. Some factors may not be the same in Alberta and Thailand. For example, the philosophy of society, economic factors and general physical conditions may well lead to different decisions being made.

DELIMITATIONS

This study was delimited to the management of equipment maintenance. The researcher gathered information from public schools, technical institutions, The University of Alberta and industrial organizations, all of these sources being located in Alberta. The industrial arts equipment data are delimited to the equipment in the twenty comprehensive s h ols in Thailand.

DEFINITIONS

Center - the head office of the Comprehensive School Project, Ministry of Education, in Bangkok from which the present maintenance equipment program operates.

Department of General and Adult Education - in the reorganized Ministry of Education in Thailand. This department is the combination of the former Department of Secondary Schools and Department of Elementary Schools. This reorganization was officially announced at the beginning of 1973.

Equipment - machine tools and hand tools which are used in the Industrial Arts Departments of the schools.

Inventory cards - cards used to record the history and maintenance of each piece of equipment.

Maintenance - to care for and to keep equipment in good

working condition so that it can be used as long as possible.

Management - the control, handling, administration, guidance and organization of the center.

Technician - a person who has experience and skill in technology, especially in electrical and electronic equipment, machinery and power mechanics.

CHAPTER II

REVIEW OF THE LITERATURE

In searching the literature it became evident that little research has been conducted relative to the area investigated in this study. The search was made at the University of Alberta as well as through personal visits to certain universities in the United States. No studies were found on the management of industrial arts equipment maintenance systems in comprehensive schools. Existing literature is chiefly concerned with the general management of maintenance work in industry and business.

Importance of Maintenance.

Maintenance is vitally important for any kind of industry. What makes maintenance an important function is depreciation of the quipment used in the production of goods and services. Cornell (1958: 7) points out the alarming effects of depreciation and the significance of maintenance in this manner.

> ...Depreciation is rapid, the value of the investment shrinks, breakdowns occur production is interrupted, and profits are cut down. It is only common sense to prevent undue depreciation and to endeavour to secure maximum use of the property and equipment. Increased mechanization of industry...to speed up production has made the maintenance function increasingly important.

The objective of industry is to maximize profits and to make the best use of the property and equipment. It follows that proper maintenance must be secured to guarantee profit maximization.

Modern industry is making increased use of more efficient equipment and better trained manpower as a result of advances in knowledge and technology. It also happens that the cost of such equipment and manpower is steadily rising. Industry would lose rather than gain if maintenance were poorly secured. Newbrough (1967: 37) therefore, emphasizes the significance of effective maintenance to prolong the utility of expensive production factors. He says:

> ...good maintenance of plant and equipment aims to minimize downtime, while providing for the most effective use of facilities and manpower in order to secure the desired results at the lowest possible cost.

Reasonable maintenance is a process of securing the highest benefit-cost ratio. If maintenance is poor, manpower becomes idle, production is low, and hence low benefits and high costs result. On the contrary, good maintenance makes manpower active, production high, and hence produces maximum benefits for the cost.

The purposes for maintaining tools and equipment

has been described by Froese, (1972:81) who indicated basic reasons for keeping tools and equipment in first class condition should include:

> ...(1) maintenance responsibility, (2) record keeping, (3) maintenance program (4) equipment, and (5) service contracts.

In this case, the maintenance responsbility should be assigned to maintenance and teaching staff and to students. Record keeping must be accurate and an up-to-date record kept of equipment. A maintenance program should be developed for each piece of major equipment including the schedule of lubrication; cleaning and servicing; provision for repair; replacement and purchase. Service contracts should be used for service of specific items.

Structure of Maintenance

Since maintenance is more important in the world of industry nowadays, the function which was once performed by staff or group activities of an industry or a company has been changed to specific organizational group tasks. Blanchard and Lowery (1959:25) say that:

> As tasks were added, specific organizational groups emerged. And in recent years, most companies relate the function to unit, section or departmental level of organization.

The maintenance work, which is assigned in any one level of the organization, unit, section or department, depends on the size and type of the organization. In a

small organization, maintenance work may be placed in the section level under a department that reports to the director of engineering. Such section tasks will not be complicated since the level of decision-making will be low. Concerning the size and type of an organization, Newbrough (1967:18) states that:

> The size of the plant determines the number and position of decision-making centers in the organization. The decision-making centers are the intersections of the information flow.

According to Newbrough, the place of maintenance as a decision-making center in an organization must be considered on the basis of the size of the plant. For a small plant, there decision-making will center around three people: the maintenance foreman, the production foreman and the plant manager, as shown in figure 2.1.

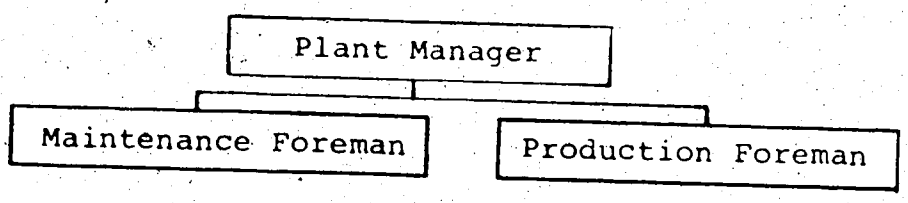


Figure 2.1

The Production Foreman and Plant Manager

The maintenance foreman is on the same level of the organization as the production foreman. The plant manager stands in the same relation to both. Each decision-making center has its own responsibil

Designation of a section of a department or unit to assume maintenance responsibility should not be done in an arbitrary manner. The selection of a department should be based on its ability to perform the function efficiently. Blanchard and Lowery (1969: 36) mention that the decision to select one department over another might be due to existing organizational relationships:

> ...a high degree of compatability does exist under present conditions, and the addition of maintainability would likely be received without permission. In fact, it could further the relationship. Unquestionably, factors of harmony and cooperation should be considered when placing the maintainability function in the company structure.

It is evident the selection of decision-making centers requires caution. Satisfaction of employees and high morale are essential in administration. If relationships in an organization are incompatible, disturbance may arise.

When maintenance work is more complex and the organization is bigger, there is a requirement for a superintendent in charge of maintenance foremen. Similarly, if the production section is also more complex, a superintendent is required to control the production foremen. (see Figure 2.2)

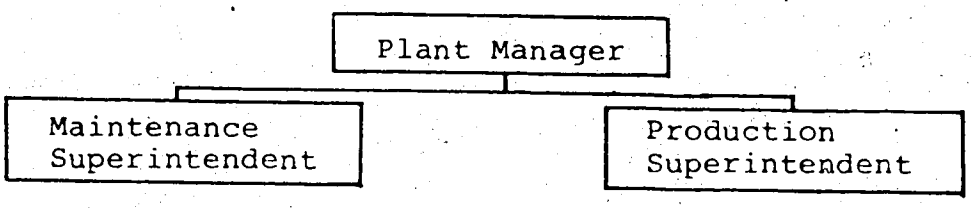


Figure 2.2

The Production Foreman

If discussion is necessary the maintenance superintendent would be likely to confer with the production superintendent to reach a decision. If the problem is so complex that they could not resolve it, regardless of possible decisions, the matter would undoubtedly be taken to the higher decision-making center.

In intermediate-sized plants, large plants or multiplants, the organization of the maintenance work becomes more complex with the necessity of employing a plant engineer as well as a manufacturing manager. Figure 2.3 shows the maintenance engineer and maintenance superintendent under the plant engineer. The production superintendent reports to the manufacturing manager.

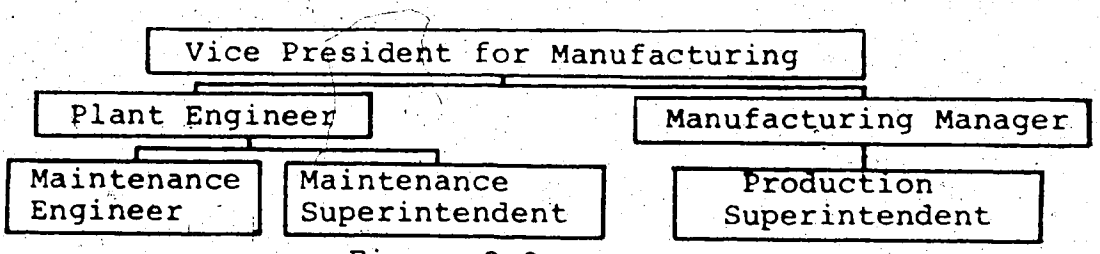


Figure 2.3

Manufacturing Manager

If the organization is very large and the maintenance department is autonomous, the maintenance manager plays a very important role in the organization. (see Figure 2.4)

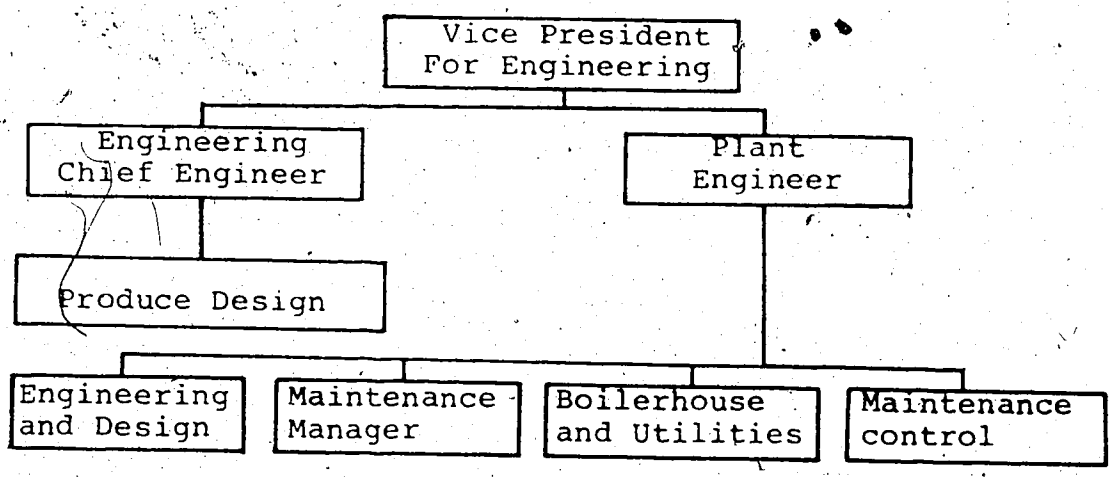


Figure 2.4

The Large Organization

In this case the plant engineer is in a very important position. He must be a highly skilled person and a professional manager (Newbrough, 1967).

Blanchard and Lowery (1967) agree with the idea that if the department manager has no interest in the subject of maintenance, he will probably do nothing to promote the function and the result will likely be failure. Blanchard and Lowery (1969:36) have this to say:

> The person must also be competent in management matters, and should have knowledge of program-support requirements.

Organization of Maintenance

In order to achieve effectiveness in maintenance management, a certain formal organization is necessary. Literature on the organization of maintenance directly applicable to the school situation was not found in this review. As in other kinds of educational management, we usually turn to the practice of business or industry. (The danger in studying the business or industry model is that the investigator may too enthusiastically adopt it in education without careful inspection of its weaknesses. Therefore, care must be exercised as to the way in which the model is applicable.)

A model from industrial management which could be looked at as an example is the Lewis and Pearson's functional organization. (Lewis and Pearson, 1960: 5-7) The model is depicted as Figure 2.5.

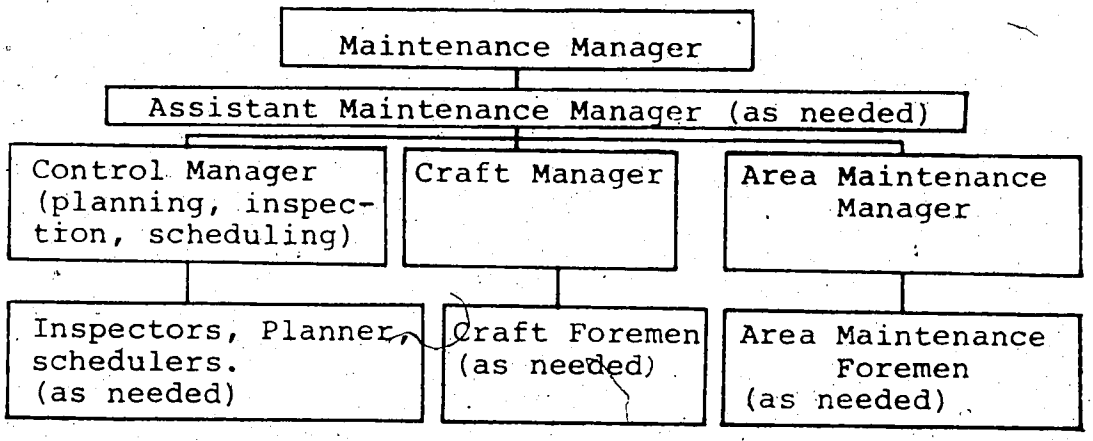


Figure 2.5

The Functional Organization

This model from Lewis and Pearson (1960:4-5) is based on these principles. It shows major components and their functions.

> (1) There must be a separation between the personnel responsible for planning the work and the personnel responsible for performing the work. In order to achieve this desired separation, a control group for inspection, planning, and scheduling is set up to relieve the area and craft maintenance supervisors of their job planning and scheduling duties...
>
> (2) If plant operations are such that certain areas can sustain a full-time workload for crews of craftsmen in the performance of routine repetitive maintenance functions, then area shops should be set up. These area shops would come under the plant maintenance organization for control purposes...

The department is under the charge of the manager and the assistant manager. There are three divisions in the department-control; crafts, and area maintenance. The duties of these divisions are as follows:

(1) Control - This division is responsible for detection of deficiencies; receipt of work requests; determination of job priorities; planning, estimating, and issuance of work orders; insuring that job site, tools, and materials are available prior to work scheduling; and the preparation and issuance of written work schedules.

(2) Crafts - Have responsibility for doing field and shop maintenance work according to schedules.

(3) Area Maintenance - Is responsible for performing routine, repetitive maintenance functions in production areas. (Lewis and Pearson, 1960:7).

A model for maintenance such as the one described above may be conceptualized as part of the overall industrial organization. In this organization, maintenance and production are the two main components. (Newbrough, 1967:18). However, the complexity of the two basic components may increase when the size of the plant increases. In a small plant, the two functions are neatly divided and are visible. In a medium-sized plant or large-sized plant, the maintenance component is less visible and is normally subsumed under the plant engineer department.

In education, instruction in classroom activities may be thought of as the production component because equipment and machinery are used by students and/or teachers in their projects. Similarly, the inspecting, repairing, cleaning, oiling, etc. may be viewed as the maintenance component of the vocational education department in the school. For a school system, the production component resides in each individual school, whereas the maintenance component may be organized within each individual school or may be set up as a separate unit for the whole system. In either case, CONTROL and CRAFTS are major responsibilities of the department while AREA MAINTENANCE becomes the responsibility of the teaching staff.

Planning of Maintenance

Planning is essential for all aspects of an organization hoping to be efficient and effective. Maintenance work is no exception. Planned maintenance keeps the system in good order and prevents interruption of the operating process. It reduces the costs of employing a large number of specialists to handle emergency repairs. Planned maintenance can reduce the problem of production delay from accidental operations which result in a major loss. Besides, continuous planning makes it possible to cut

costs on service expenses such as steam, air, water and electricity. Excessive inventory of spare parts can be avoided as well as decreasing the accumulation of obsolete or little used parts (Lewis and Pearson, 1960: 1-2).

In planning a maintenance schedule, several factors should be considered. These factors include emergencies, machinery conditions, the need for special parts, the use of expensive repair tools, and repair time required for individual jobs. Cornell (1958: 209-10) suggests the following guidelines for effective scheduling.

1. Emergency jobs must take precedence ove other repair jobs.
2. Machinery should be overhauled when the machinery is least needed for production purposes...
3. Certain repairs call for special material or parts that have to be ordered; time must be allowed for their delivery...
4. The same repair tools and equipment ay be required on two repair jobs. Since such equipment is frequently costly, ...one job must be postponed until the other job is completed.
5. It is very difficult to calculate the exact time a repair job will take.

It is difficult to develop an exact maintenance schedule. Planning may help estimate the cost and time for repair jobs. The establishment of sensible standards to measure work may, to some extent, predict the depreciation or downtime due to the interruption of an operation.

Planning is a continuous process. There should be both short-range and long-range planning. Newbrough (1960: 93, 94) suggests three time lines for maintenance planning: long-range, short-range and immediate.

Long-range planning is a process of updating the objectives, policies and procedures of an organization. In industry and business, knowledge of sales and production forecasts is necessary as are changes in maintenance equipment and facility requirements, changes in production equipment due to obsolescence, increased mechanization, progress in automation, higher machine speeds, and other technological improvements.

Short-range planning encompasses a time span of approximately one year. For industry and business, short-range planning is developed in several sections or divisions of the organization. Planning occurs under the direct supervision of the managers of these sections. In maintenance planning, three basic phases are involved: new equipment installation, cyclical work and preventive maintenance work.

The immediate plan is also important for equipment maintenance. The day-to-day job planning must be done effectively by the technicians and the foremen of the

particular equipment. (Newbrough, 1960: 99)

Problems of maintenance may occur if planning is inadequate. This is true because maintenance work varies in both nature and content. Possible factors that may cause problems in maintenance include confused and delayed communication due to incomplete job instructions received by the craftsman, shortage of required materials in stock, poor planning of the time required for each craft to perform its functions lack of prior detailed knowledge of the job components, and jobs being overmanned (Miller and Blood, 1963: 21).

In order to have effective maintenance planning, Miller and Blood (1963:22) suggest three basic requirments: a complete work order system which covers all work; a time keeping system which identifies actual labour hours against each work order; and material control.

Planning and control cannot be applied unless the job itself is controlled through a work order system and a time keeping system. Material control is also essential. A list of items of maintenance stores and spare parts carried in stores must be available. In addition, a good material delivery system is required.

Niazi (1967: 26) emphasizes three stages of planning for a job and its execution. He writes:

> The first stage is that of defining it, establishing the most suitable and economical method of carrying it out, and of determining the requirements for its execution. The second stage is of scheduling it to specific time periods and of allocating it to specific individuals. The third stage consists of controlling the execution according to the plan.

It may be concluded that long-range planning controls the policy and the work procedure of an organization. It is important for overall maintenance work because it provides alternative plans which may be immediately chosen in the light of change. Long-range planning will minimize the loss or downtime of industry. Short-range planning is important for specific jobs. To be more effective cyclical work such as painting, machinery, boiler and equipment overhaul can often be scheduled a few months earlier or later to reduce interference with other programs such as new equipment installation.

Maintenance planning should give an emphasis to thorough understanding of all the problems involved through sufficient study. No matter what the steps of planning are, long-range, short-range and immediate plans must include a statement of objectives. Evaluation must be done regularly at specific periods of time. This

will make known whether those plans should be continued or redeveloped.

Cost Budget for Maintenance

For general industry, maintenance is thought of as an indirect function consisting of overhead expenses. Broad policy is used to govern areas of indirect operation of which maintenance is a part. Harvey (1963: 43) states that the general policy of the Thompson Products Value Division of Thompson Ramo Wooldridge Inc. Cleveland, Ohio, is to measure performance to standard cost by the use of budgetary control. According to Harvey,

> ...The budgets are established from engineered high-task standards. These standards are necessary for measuring the indirect labour performance of operators' cost centers, plants, works, and divisions, establishing the standard overhead rate of each manufacturing cost center; estimating costs and establishing selling prices; and planning, scheduling and controlling production.

The justification for the cost of maintenance does not depend on one person. Each department or division in the industry has its own responsibility with regard to budgeting.

Harvey (1963) mentions that budget standards are developed in each cost center for each indirect labour account properly chargeable by the cost cneter and are recorded on budget standard rate sheets. He emphasizes

the importance of the revision of budget standards in certain circumstances. New budget standard rate sheets should be prepared annually prior to the revision of fixed standard costs. The new rate sheets are predicated on a forecast of normal value for the coming year and revised estimates for the number and types of occurrences.

A budget is a financial plan. When the budget is well-prepared, it becomes an effective instrument of control in that reports showing actual performance in relation to budgeted allowance provide a basis for corrective action. Newbrough (1960) states that budgets are statements of anticipated results. They should reflect actual plans and should be based on actual expectations Moreover, the budget should be flexible, and should be sensitive to economic circumstances. The operating budget must recognize changes. According to Newbrough (1967:7) the maintenance budget must be devised:

1. so that it fluctuates with income, and
2. so that sufficient budge authorization is allowed at lower production rates to permit the performance of the maintenance required to keep the plant in such condition that it will meet adequately the demands of productions.

The consideration of the extent of maintenance requirements is essential. It develops the necessary cost of the maintenance, service centers which group together related repair and technical functions. Newbrough (1967:78) disagrees with Harvey that the use of the previous year's cost as a budget is not good budget planning. He emphasizes that:

> ...The new budget must reflect the best thinking of the organization so that it becomes a living vital instrument. The budget should recognize improvement factors resulting from improved methods, improvements to machinery and equipment, and improvements in processes and in product design, as well as cost savings resulting from major rehabilitations and facility changes completed during the past year and anticipated for the coming budget period.

A rolling budget which is based on the re-examination of the annual budget each calender quarter is widely utilized. This kind of budget has two advantages. First, a continuity of budget planning throughout the year permits the fresh thinking and initiative and improves the quality of planning. Secondly, the budget becomes flexible and adaptable to changing situations.

Newbrough and Harvey maintain that budget preparation is not a one-man operation. Newbrough (1967:78) says

> Managers and supervisors are key personnel in budget preparation and in the control exercised, by using budgets. The plant engineer is responsible for maintenance

> budget preparation, actual development is the responsibility of his administrative staff, aided by maintenance superintendents general foremen, and other supervisors...

Interview Procedure

The literature was next examined for information about operational research techniques.

An important part of planning a research project is the selection of a method to collect data. The interview is one of the methods used. This method utilizes face-to-face communication between interviewer and interviewee. Adams (1958: 6, 7) explains the communication in the interview thus:

> ...the communication is a two-way system from interviewer to respondent and, in reverse from respondent to interviewer.

The interview consists of several broad phases, such as statement of problem, instrument construction and pretesting, interviewing, sampling, using interviews, recording the data, analysing and reporting.

Statement (Good: 1972) of the research problem must be logical and well-planned. It involves answering the questions we are asking. The answer must be as specific to that problem as possible.

With respect to instrument construction and pretesting, Mouly (1970) and Richardson (1965) refer to specific events and objects to be measured. The two core requirements in the design of instruments are validity and reliability. Validity has reference to whether the instrument measures what is intended to be measured. The reliability of an instrument has to do with whether the same answers are obtained to the same question on different occasions.

Interviewing is the subject of collecting information from interviewees by interviewers with the aid of an interview schedule. The interviewer must be able to communicate without distorting the question designed by the researcher. Mouly (1970: 266) states the main weakness of interviewing as follows:

> ...the major weakpoint of the interview is interviewer bias which, ironically, stems in large part from its flexibility which is, then, both its major advantage and disadvantage.

Sampling in a general sense refers to selecting from a universe of units a portion of the units which, as a group, is representative of the entire universe. Adams (1958) identified the purpose of sampling as estimating economically and accurately the characteristics of a universe by measuring those characteristics on a sample of the unit.

Using interviews, the items of the interview usually contain open-ended questions to which the respondent can offer a relatively free response. Wiersma (1969) explained that the open-ended question is one for which the respondent constructs his own response rather than selecting from a group of alternative responses. The interview provides a unique flexibility that the interviewer may pursue the response with the respondent. The interviewer may ask for an elaboration or a redefinition of the response, if it appears incomplete or ambiguous. Also, the interviewee's response may reveal other factors or feelings which the interviewer can choose to pursue and probe.

In recording the data of the interviewing procedure shorthand symbols and tape recordings are often used. For the shorthand record, it is rare to find an interviewer who has experience with shorthand. So tape recordings are increasingly used. The advantages of tape recordings over various forms, as Bucher (1956: 359-64) and his staff described, are:

> 2. The tape-recorded interview eliminates a major source of interviewer bias - the conscious and unconscious selection on the part of interviewer of the material to note down.
> 3. The tape-recorded interview not only eliminates the omissions, distortions, elaborations, considerations and other modifications of data usually found in

> written interviews, but it also provides an objective basis for evaluating the adequacy of the interview data in relation to the performance of the interviewer.
> 4. The tape-recorded interview is a liberating influence on the interviewer, because it permits him to devote full attention to the respondent.
> 5. Other t ngs being equal, the interviewer who uses a tape recorder is able to obtain more interviews during a given time period than an interviewer who takes notes or attempts to reconduct the interview from memory after the interview has been completed.

When a field of knowledge is being analysed to identify problems for study, the particular research area should be sufficiently limited to serve effectively as sources of specific problems for investigation. Mouly (1970: 277) identified analysis in this way:

> ...Analysis as a method underlines the whole process of research, from the selection of a problem and its reduction to manageable size to the point where the data are processed and the conclusions are searched. Since most educational problems are too broad to be attacked as a unit, they must be analysed into their constitutent parts as the primary stem in deriving significant relationships among them, in isolating rel t from irrelevant aspect, and in struct item in their scientific context.

Analysis refers to a broad general category of analytical techniques ranging from simple frequency counts to the observational studies of various degrees of precision, complexity, and sophistication, all attempting to identify the basic dimensions into which phenomena can be appraised in relation to a given problem.

It was hoped that as a result of the findings of this survey, some alternative solutions would be found for the original problem. If the statement of the problem was accurate and each phase of the survey was conducted diligently, the final report should provide possible answers for solving the problem under study.

CHAPTER III

METHODOLOGY

The main objective of this study was to develop a model of an industrial arts equipment maintenance system for the comprehensive schools in Thailand. This model was constructed from the analysis of maintenance systems in education, maintenance systems in industry and information from the comprehensive school project of Thailand. The researcher used the interview method to gather data from equipment maintenance systems of education and industry in Edmonton.

The first step in this study was the development of an interview schedule to be used to survey the indicated sources. Consideration was given to the information gathered from the review of the literature, the Department Chairman of Industrial and Vocational Education, University of Alberta, the program adviser, the thesis adviser, the equipment and supply supervisor of the Edmonton Public School Board, the shop director of the Northern Alberta Institute of Technology, supervisor of maintenance with the Edmonton Separate School Board and the researcher's experience.

The interview schedule was developed using the following topics:

1. Organizational Structure of the Maintenance System.

This section included the following sub headings: (1) Organization (2) personnel and (3) work planning.

2. Procedure of Maintenance.

This section covered the following: (1) areas of work, (2) inspection and (3) inventory equipment records.

3. Finance.

This section dealt with the budget for maintenance under the following headings: (1) budget for maintenance, (2) estimating the budget, (3) justification of budget.

4. Effectiveness. (Evaluation)

Under this heading the following aspects were considered: (1) Cost of maintenance, (2) Assessment of maintenance, (3) suggestions for improving maintenance.

The interview schedule was divided into two sets. One set was used for interviews in educational systems. (See Appendix A.) and another set was used for interviews with industrial systems (as shown in Appendix A.)

Sources of Data

There were two categories of sources which the researcher investigated, were (1) maintenance systems in education, and (2) maintenance systems in industry.

1. Maintenance Systems in Education

The data relative to education systems were drawn from (1) the Edmonton Public School Board (E.P.S.B.), (2) the Edmonton Separate School Board (E.S.S.B.), (3) the Victoria Composite High School, (4) the Jasper Place Composite High School, (5) the M.E. Lazerte Composite High School, (6) the Northern Alberta Institute of Technology (N.A.I.T.) and (7) the Department of Industrial and Vocational Education University of Alberta.

2. Maintenance Systems Outside of Education

The data relative to industrial systems were drawn from companies differing in their respective functions, each function requiring the supportive action of maintenance. The industries from which the researcher drew the data were:

1. Digital Equipment of Canada Limited (Digital equipment): equipment and service.

2. Gorman's Company Limited (Gorman): machinery supply and parts service.

3. MacCosham Van Line Company Limited (MacCosham): transportation service.

4. Stamco Speciality Tools and Manufacturing Company Limited (Stamco): duplicate spare parts

5. W.W. Cross Cancer Institute (W.W. Cross): equipment maintenance department.

Data Collection

The data for this study were gathered through interviews during the months of February to June 1973.

The sources of data for this research fell into two broad categories: (1) printed materials, and (2) information gathered through personal contacts. Both sources of data included records and organizational charts.

The data gathered through personal contacts resulted from interviews with the directors and persons who were in charge of maintenance of those organizations.

Interviews

Structured interviews were used with administrators and persons who were directly in charge of maintenance of those organizations. Unstructured conversation with some of the school shop teachers also helped to develop the whole picture of equipment maintenance.

Structured Interviews

On February 9, 1973 the researcher visited the Northern Alberta Institute of Technology (N.A.I.T.) and interviewed Mr. L. Lindgren, Shop Director and Mr. T.W. Turner, Head of Industrial Practices Section at the General Office and the Industrial Annex of N.A.I.T.

On April 11-13, 1973 the researcher interviewed the following people:

Mr. G. Sanders, Director of Vocational Education of Edmonton Public School Board.

Mr. T. Brown, Director of Maintenance & Operation of Edmonton Public School Board.

Mr. T.E. Robinson, Supervisor of Equipment of Edmonton Public School Board.

Mr. J. Moffatt, Supervisor of Industrial Arts of Edmonton Public School Board.

These persons were interviewed together at the Edmonton Public School Board offices and the Department of Maintenance and Operation.

On April 16, 1973 the researcher interviewed Mr. J. Cranston, Business Manager, and some shop teachers at Jasper Place Composite High School.

On April 18, 1973 the researcher interviewed Mr. T.R. Bryce, Assistant Principal, and Mr. J.G. Mills, Business Manager, of Victoria Composite High School and some shop teachers at the General Office and in the shops of the school.

On April 19, 1973, the researcher interviewed Mr. B. Dingman, Vice Principal, and some shop teachers of M.E. LaZerte Composite High School. After the interview the researcher was taken to visit the shops and school campus.

On April 24, 1973, the investigator interviewed Mr. C. Redge, Head Equipment Technician of Department of Industrial and Vocational Education University of Alberta, at the Industrial and Vocation Education Laboratories.

On May 7, 1973, the researcher interviewed Mr. L. Stenger, Machine Shop Supervisor of W.W. Cross Cancer Institute, at the machine shop of the instutute.

On May 8, 1973, the researcher interviewed Mr. C.E. Campbell, President and Manager of Stamco Tools and Mfg. Co. Ltd. at his office. He invited the researcher to visit his manufacturing plant and explained the process of work and maintenance procedure.

On May 22, 1973, the researcher interviewed Mr. C.H. Marson, Sales Manager of Gorman's Limited at his office, following which the researcher was taken on a tour of the plant and given an explanation of the process of work which the researcher wanted to know and study.

On May 29, 1973, the researcher interviewed Mr. Arthur Verlinde, Superintendent, and Mr. W. Fencott, Foreman Crating Room of MacCosham Van Lines, at the garage center of the Company.

On May 30, 1973, the researcher interviewed Mr. Jerry Seaman, Maintenance Supervisor; Mr. John Rabaud, Electrical and Mechanical Supervisor; Mr. Leo Connelly, Equipment and supplier officer.

On June 20, 1973, the researcher interviewed Mr. David Akitt, Field Service Representative of Digital Equipment of Canada Limited, at the Edmonton Branch Office.

When the researcher had completed the interviews, he transcribed the tapes which were made during interviews and sent the transcriptions to the parties interviewed in order that they could check the accuracy and validity of the information contained therein.

When the researcher received the corrected transcriptions of the interviews, he separated the data into two groups.

The first group covered equipment maintenace systems of

educational organizations. These are analyzed in Chapter 4. The second group dealt with equipment maintenance systems of industrial organizations. These are analyzed in Chapter 5.

Information was gathered from the Thailand Report (Coutts 1969,1971), the Terminal Report (Cunningham 1973), the Final Report (Gretsinger 1973), Thailand Comprehensive School Project and Temporary Maintenance Team. The topics of information studied were: (1) kinds and number of industrial arts shops in comprehensive schools, (2) kinds and number of industrial arts shops in each shop, (3) essential tools for maintenance work, and (4) vehicles used for maintenance. From the analysis of the data gathered for Chapters 4, 5 and 6, the researcher developed a model of an Industrial Arts equipment maintenance program for the comprehensive schools in Thailand, using logic, analogy, and his own experience. Consideration was given to such factors as economic feasibility and practicality in making judgments. The model was then sent to a panel of experts (Appendix B) for their comments and recommendations of the panel of experts in the preparation for the final draft of the model for Thailand as detailed in Chapter 7 and Chapter 8.

Criteria for Selecting the Panel of Experts

The criteria which the researcher used is selecting the personnel for the panel of experts were:

(1) One person who had had experience and knowledge of the administrative organization of comprehensive schools in Alberta and in Thailand as an administrator or as an admistrative adviser.

(2) One person who had had experience and knowledge of industrial arts programs offered in comprehensive schools in Alberta as well as in Thailand.

(3) One person who had had experience with equipment maintenance and first hand knowledge of the problems that are pecculiar to the comprehensive schools in Thailand relative to equipment maintenance.

(4) One person who had had experience with vocational education or industrial arts programs for high schools in other foreign countries as well as in Alberta.

(5) One person who had had experience and knowledge related to providing equipment, selecting equipment, warehousing, developing specifications of equipment, selecting equipment, and budget control in private firms and school systems.

Qualifications and Experience of each Member of the Panel of Experts.

On the basis of the criteria for selecting the panel of experts, the following persons were chosen:

1. Mr. S.G. Deane (B.A.; M.Ed.) had taught for several years in Alberta schools and had many years of experience as the principal of comprehensive schools, also in the Province of Alberta. Mr. Deane had spent four years as the Administrative Advisor to the Comprehensive School Project in Thailand. In the course of his duties there, he had visited all of the schools involved, assisting the administrators in the development of their educational programs and related administrative problems.

Mr. R.H. Cunningham (B.Ed.(I.A.), M.Ed.(I.E.)) had had experience in teaching industrial arts in Alberta's high schools and in teaching at the Southern Alberta Institute of Technology. He has taught both technical and education courses to industrial arts student teachers enrolled at the University of Alberta. He had been Supervisor of Industrial Arts for the Province of Alberta for three years and had been the High School Inspector of Vocational Education for six years prior to leaving for an assignment in Thailand. During those six years he was responsible for the development of all the vocational programs used in the vocational

schools of Alberta as well as the approval of the facilities and equipment. He had spent four years in Thailand as the Practical Arts Advisor to the Comprehensive School Project. In this capacity he was involved in the preparation of the equipment lists for the project schools and had supervised the installation of the equipment. He had visited each of the schools several times in order to provide consultative assistance to the administrators and teachers with respect to use and maintenance of equipment as well as implementation of the program of instruction.

3. Mr. L. Gretsinger (M.A.) had had experience in teaching insudtrial arts student teachers in the United States. In addition, he has worked several years as a maintenance supervisor with various paper mills in Canada. Mr. Gretsinger had spent two years in Thailand as an adviser on equipment maintenance. He had assisted in the organization of the maintenance program for the Comprehensive School Project in Thailand and in the training of staff for the maintenance teams. In carrying out his duties, he had visited each of the schools to check on the installation and maintenance of the equipment.

4. Mr. Otto Kingsep had had a comprehensive background of technical training and experience. He earned several journeyman and technician certificates in the electrical and mechanical fields. He had spent many years of work

experience in these fields including five years as an electrician, ten as a welder, machinist and tool maker, three as a technical instructor, department head and shop director at the Southern Alberta Institute of Technology and the Northern Alberta Institute of Technology, and had been school plant design consultant for Alberta.

In 1957-58 Mr. Kingsep worked two years on a Ford Foundation technical assistance project in Burma helping to set a technical high school in Rangoon. His work included teacher training, school curriculum and adviser to those responsible for metalworking shops. Mr. Kingsep was a Canadian International Development Agency (CIDA) expert who had worked in Nigeria in 1965 and between 1969-72. His position was Project Adviser of the Benin Technical High School. His duty as a planner for the Benin Technical High School included liaison with industry, initiation and development of training programs, delineation of resource requirments, and implementation of proposed plans. Installation, maintenance and checking of equipment appeared to be part of his involvement.

5. Mr. T.E. Robinson had had a comprehensive background of technical and business training and experience. He had earned several training certificates from universities and private firms. He had completed studies in business admin-

istration from La Salle University of Chicago and in engineering and drafting from Coutts Machinery Company Limited (Edmonton).

Mr. Robinson had had many years of work experience in industry and education. His experience had included (1) seven years in the head office and warehouse of D.Ackland & Son Ltd. of Winnipeg, Manitoba. There his duty had involved the operation of a large wholesale hardware, automotive and hardwood lumber organization, pricing invoices, purchasing, sales, setting up resale prices, accounting and general office procedures. (2) eighteen years as an accountant, office manager and branch director of Coutts Machinery Company Limited. His duties there had involved designing special items of equipment, setting up procedures for clearning into Canada merchandise purchased in England, Japan, the United States, etc., and selling power take offs, universal joints, bearings, sprockets, roller chains, belts and several items of the same nature, (3) seven years as equipment technologist and supervisor of equipment, for the Edmonton Public School Board. His functions had involved providing vocational equipment, developing specifications of all equipment for new schools, and administering the operating budget to cover the replacement of certain equipment for existing schools.

Summary

The interview methodology employing a tape recorder was used in this study to gather data from equipment maintenance systems in education and industry. The outcomes of the interviews were analyzed in Chapter 4 and Chapter 5 and were combined with the data from the review of literature and data from Thailand to develop the original model of the management of industrial arts equipment maintenance for comprehensive schools in Thailand. The model was sent to the panel of experts for reactions and recommendations. These responses were used for the revised final model.

CHAPTER IV

ANALYSIS OF MAINTENANCE SYSTEMS IN EDUCATION

The focus of this chapter is the equipment maintenance systems of several education organizations. These organizations are:

1. The Edmonton Public School Board (E.P.S.B.) which is responsible for 167 schools at elementary, junior high, senior high and vocational school levels.

2. The Edmonton Separate School Board (E.S.S.B.) which is responsible for 77 schools at elementary, junior high, senior high, and vocational school levels.

3. Victoria Composite High School.

4. Jasper Place Composite High School.

5. M.E. LaZerte Composite High School.

6. Department of Industrial and Vocational Education, University of Alberta (D.I.V.E.).

7. Northern Alberta Institute of Technology (N.A.I.T.).

The maintenance systems of these organizations as reported through interviews with their personnel are shown in Table 4.1, 4.2, 4.3, and 4.4.

TABLE 4.1

A. STRUCTURE OF MAINTENANCE SYSTEMS

NAME OF ORGANIZATION	1. Organization: a. Formal Structure (Yes or No). b. Responsibility of teaching staff. c. Responsibility of maintenance.	2. Personnel a. Qualification of Technician. b. Experience of Technician.	3. Work Planning a. Responsible personnel. b. Planning procedures. c. Emergency cases.
Edmonton Public School Board (E.P.S.B.).	a. Yes (charts show on figure 4.1 to 4.6) b. Minor, e.g., oiling and cleaning. c. Equipment, building and facilities in 167 schools.	a. Vocational certificate and/or journeyman standing. b. Many years of experience.	a. Technicians, supervisors, and instructors. b. Monthly, semester, and year round. c. Responsibility of D.M..
Edmonton Seperate School Board (E.S.S.B.).	a. Yes (chart shows on figure 4.7). b. Minor, e.g. oiling and cleaning. c. Equipment, building and facilities in 77 schools.	a. Vocational certificate and/or journeyman standing. b. Minimum two years of experience.	a. Supervisors and instructors. b. Yearly inspection. c. Technician if posible otherwise letout to the subtrade.
Victoria Composite High School.	a. No. b. Minor, e.g., oiling and cleaning. c. Major maintenance done by D.M..	a. No permanent technician. b. N/A.	a. b. } Responsibility of D.M. c.
Jasper Place Composite High School.	a. No. b. Minor, e.g., oiling and cleaning. c. Major maintenance done by D.M..	a. No permanent technician b. N/A.	a. b. } Responsibility of D.M. c.
M.E. Lazerte Composite High School.	a. No. b. Minor, e.g., oiling and cleaning. c. Major maintenance done by D.M..	a. No permanent technician. b. N.A.	a. b. } Responsibility of D.M. c.
Department of Industrial and Vocational Education, University of Alberta (D.I.V.E.).	a. Yes (chart shows on figure 4.8). b. None. c. Maintenance and repairing all equipment of the department.	a. Minimum background from vocational institute and/or journeyman standing. b. Minimum three years of experience.	a. Technician staff. b. All year round maintenance activity. c. Head equipment technician.
Northern Alberta Institute of Technology (N.A.I.T.).	a. Yes (charts show on figure 4.9 and 4.10). b. Minor maintenance. c. Major maintenance and repairing done by permanent technician in each shop.	a. Vocational certificate and/or journeyman standing. b. Many years of experience.	a. Cribman and technician. b. Planning and schedule by means of the Peg Board. c. Shop head and technician.
	* D.M. = Department of Maintenance and Operation of E.P.S.B.		

TABLE 4.2

PROCEDURE OF MAINTENANCE SYSTEMS

NAME OF ORGANIZATION	1. Area of Work: a. Scope and/or area of work. b. Scope and/or area of liaison work.	2. Inspections: a. Inspectors and procedure. b. Result of inspection.	3. Inventory Equipment Record: a. Equipment record. b. Criteria for stocking parts. c. Estimate running time of machines.
Edmonton Public School Board (E.P.S.B.).	a. Machine, metal, woodworking, electronics shops and stock room. b. All areas of work in this department related together.	a. D.M. inspector: inspects the condition of equipment and recommend maintenance procedure. b. Used for carrying out the work holiday periods and for fulfilling the need of the schools.	a. Computer and service cards. b. Frequency of used and code of parts. c. From students and teachers used in lab and record hours of using lab.
Edmonton seperate School Board (E.S.S.B.).	a. Plumbing, electricity, painting, construction, etc. b. Curriculum aspect, principal, industrial arts instructors.	a. Supervisors, foremen instructors: used the memorandum of shop instructors as guideline. b. Used for repair and establishment of estimates for the following years budget.	a. Computer, property record cards. (shown on figure 4.11 and 4.12). b. Frequency of used, expensive parts never be in stock. c. From information on the maintenance record cards.
Victoria Composite High School.	a. Industrial arts, vocational education, typing, etc. b. Business manager.	a. } Responsibility of D.M. b. }	a. Inventory cards and equipment books. b. } c. } Responsibility of D.M.
Jasper Place Composite High School.	a. Industrial arts, vocational education, audio-visual, intercom areas. b. Business manager.	a. } Responsibility of D.M. b. }	a. Inventory cards and equipment books. b. } c. } Responsibility of D.M.
M.E. Lazerte Composite High School.	a. Industrial arts, vocational education, science lab and audio-visual areas. b. Business manager.	a. } Responsibility of D.M. b. }	a. Inventory cards and equipment books. b. } c. } Responsibility of D.M.
Department of Industrial and Vocational Education, University of Alberta (D.I.V.E.).	a. I.A. lab 260, 270, 360, 370, 460, 470. b. University technical service, Audio Visual Media Center, and specialised equipment suppliers.	a. Head equipment technician: checking, lubrication, proper operating equipment every teaching break. b. No record, only put on memorandum.	a. Computer. b. Never keep spare part inventory, only some hardware supplies kept on hand. c. From the record of class hours and multiple activities in lab.
Northern Alberta Institute of Technology (N.A.I.T.).	a. Planning, estimation capital, requestion capital, etc. b. Department of Public Work, Department of Education, etc.	a. Permanent technician and head of shop work: inspect mechanical function and general security monthly. b. No record, technician has his own routine.	a. Computer, inventory cards and master cards (shown on figure 4.12). b. Frequency of used parts. c. From machine running time per week and per year.

TABLE 4.3

FINANCE FOR MAINTENANCE SYSTEMS

NAME OF ORGANIZATION	1. Budget for Maintenance:	2. Estimation Budget:	3. Justification of Budget:
Edmonton Public School Board (E.P.S.B.).	$18,630 for maintenance material, $54,186 for wages maintenance material, $407,000 for equipment maintenance, $90,000 for replacement equipment.	The director of maintenance and his personnel estimated budget from the amount of money required with whatever facts are available.	Using the consideration of the Board of Trustee and the Director of maintenance.
Edmonton Seperate School Board (E.S.S.B.).	The maintenance budget is devided into several subheadings (shown on figure 4.13). Some headings are overlapped between general and education equipment maintenance.	The supervisor of maintenance and their staff who are concerned with maintenance estimate the budget from the previous years.	From the previous year's expenditure.
Victoria Composite High School.	Come from D.M.	Responsibility of D.M.	Responsibility of D.M.
Jasper Place Composite High School.	Come from D.M.	Responsibility of D.M.	Responsibility of D.M.
M.E. Lazerte Composite High School.	Come from D.M.	Responsibility of D.M.	Responsibility of D.M.
Department of Industrial and Vocational Education, University of Alberta (D.I.V.E.).	$3,500 for equipment maintenance. $2 000 for equipment replacement or about 1.3% of inventory capital.	The administrative officer consults with the head equipment technician in order to estimate the budget data from previous year's expenditure, amount of equipment to service and repair, the frequency of use of the equipment.	Using the recommendations of the lab instructors.
Northern Alberta Institute of Technology (N.A.I.T.).	Approximately $100,000 for equipment maintenance and furnishings of each year or about 1% of inventory capital.	The Shop Director and staff used requests for maintenance and furnishings in order to estimate the budget.	Using requests from each division.

TABLE 4.4

EFFECTIVENESS OF MAINTENANCE SYSTEMS

NAME OF ORGANIZATION	1. Cost of Maintenance:	2. Assessment of Maintenance:	3. Suggestion for Improving Maintenance:
Edmonton Public School Board (E.P.S.B.).	Keeping minimum cost.	Sent questionnaire and asked the teacher who is involved with equipment to evaluate and give suggestion.	Best advice, continuous discussion and communication, teachers should be encouraged to bring forward their thoughts and ideas.
Edmonton Seperate School Board (E.S.S.B.).	Comparing between the cost of repair and replacement.	Evaluated from the total amount of money spent.	Increase the maintenance budget, encourage teachers to pay more attention to maintenance work, assign students to do some maintenance work under the supervision of the teacher.
Victoria Composite High School.	Controlled by D.M.	Evaluated by D.M.	Red tape should be cut (less red tape) the maintenance people should be allowed in the schools to maintain the equipment as they see fit, within broad guidelines.
Jasper Place Composite High School.	Controlled by D.M.	Evaluated by D.M.	Quicker service, preventive maintenance, inservice training, prevent workers from delaying the job, maintenance contract with supply company.
M.E. Lazerte Composite High School.	Controlled by D.M.	Evaluated by D.M.	Protected from receiving low quality equipment by writing "tighter" specifications for equipment purchases which go out to tender.
Department of Industrial and Vocational Education, University of Alberta (D.I.V.E.).	Comparing the cost downtime of equipment with the cost of equipment replacement.	Measure from amount of downtime of equipment resulting in loss of teaching time.	Make sure that suppliers of new equipment are capable of supplying parts and instructions for repairs when required.
Northern Alberta Institute of Technology (N.A.I.T.).	Rising 4% to 8% of cost of that equipment.	No attempt to measure.	Hiring a top class man who is really experienced with machine tools maintenance, have basic preventive maintenance, also affecing maintenance is how the machine is operated and cared for by the operator.

STRUCTURE OF MAINTENANCE

Organizations

a. Formal Structure. With reference to Table 4.1, there was formal structure for maintenance at the school board level. In contrast, post-secondary education provided formal structure for maintenance at the instututional level.

Figure 4.1 illustrates the formal structure of maintenance at the E.P.S.B.. The Maintenance and Operations Branch of the E.P.S.B. was a division which consisted of ten other branches. Under the Director of the Branch were the Assistant Director, Co-ordinator of Buildings, Co-ordinator of Engineering, and Co-ordinator of Operations. Subdivisions of the Branches are shown in Figure 4.2 to 4.6.

Figure 4.7 depicts the formal structure of maintenance at the E.S.S.B.. The maintenance section of the E.S.S.B. was a division which consisted of two other sections. Under the Supervisor of Maintenance were the Supervisor of Building and Grounds, and Supervisor of Workshops.

Figure 4.8 illustrates the structure of maintenance at the D.I.V.E.. Maintenance work was under the responsibility

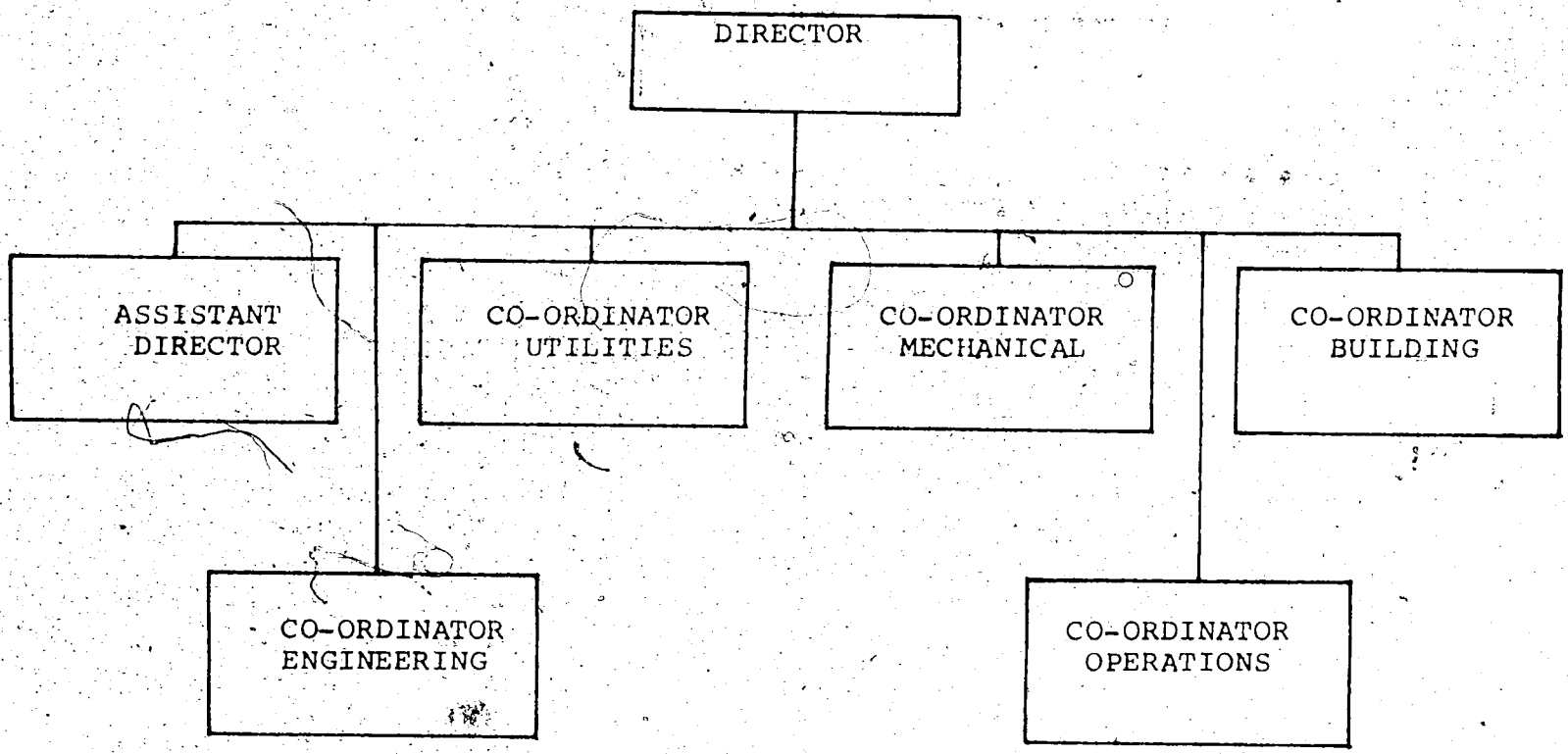


FIGURE 4.1

ORGANIZATION OF THE MAINTENANCE AND OPERATIONS BRANCH

OF EDMONTON PUBLIC SCHOOL BOARD

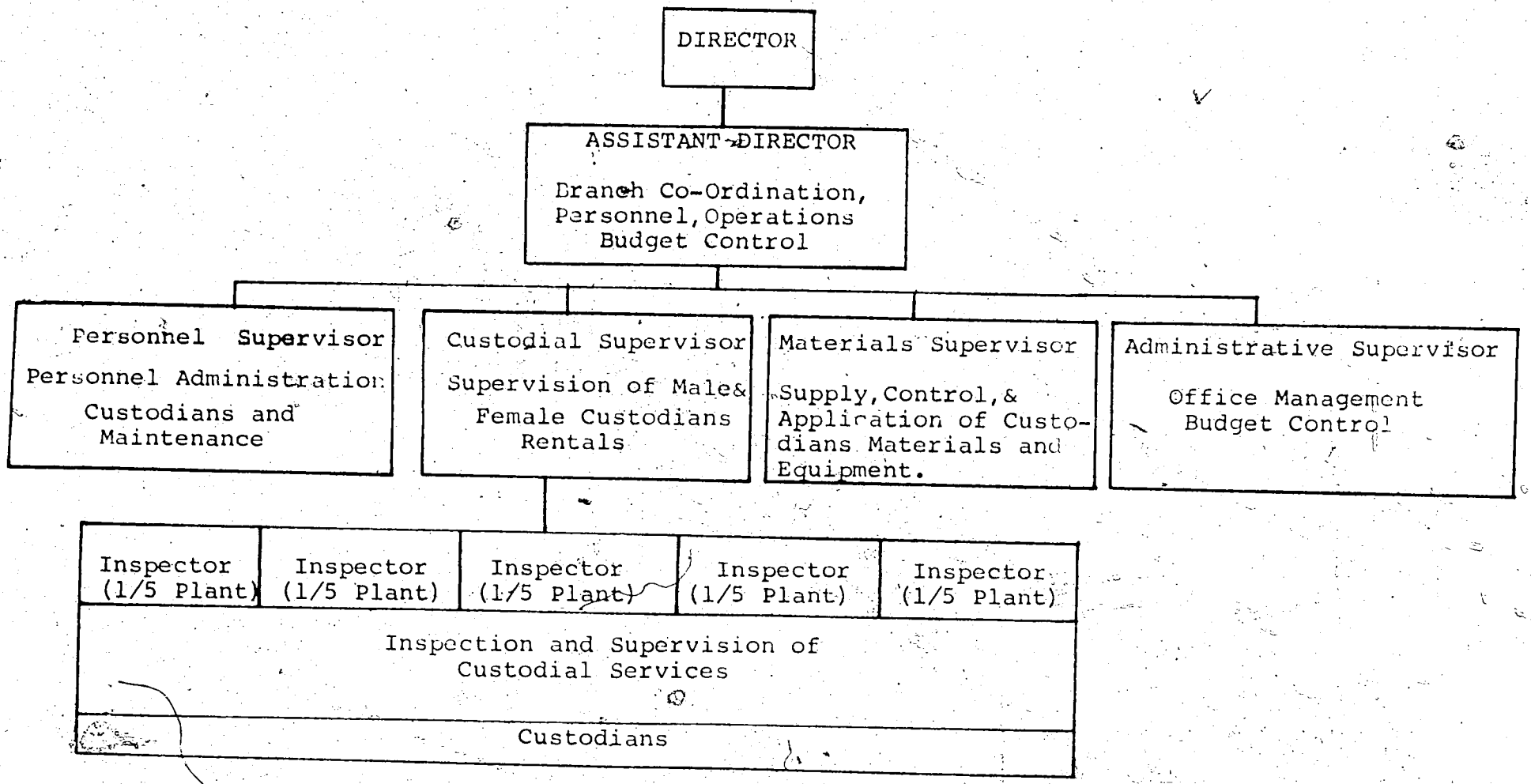


FIGURE 4.2

Overall Branch Organization
Of Edmonton Public School Board

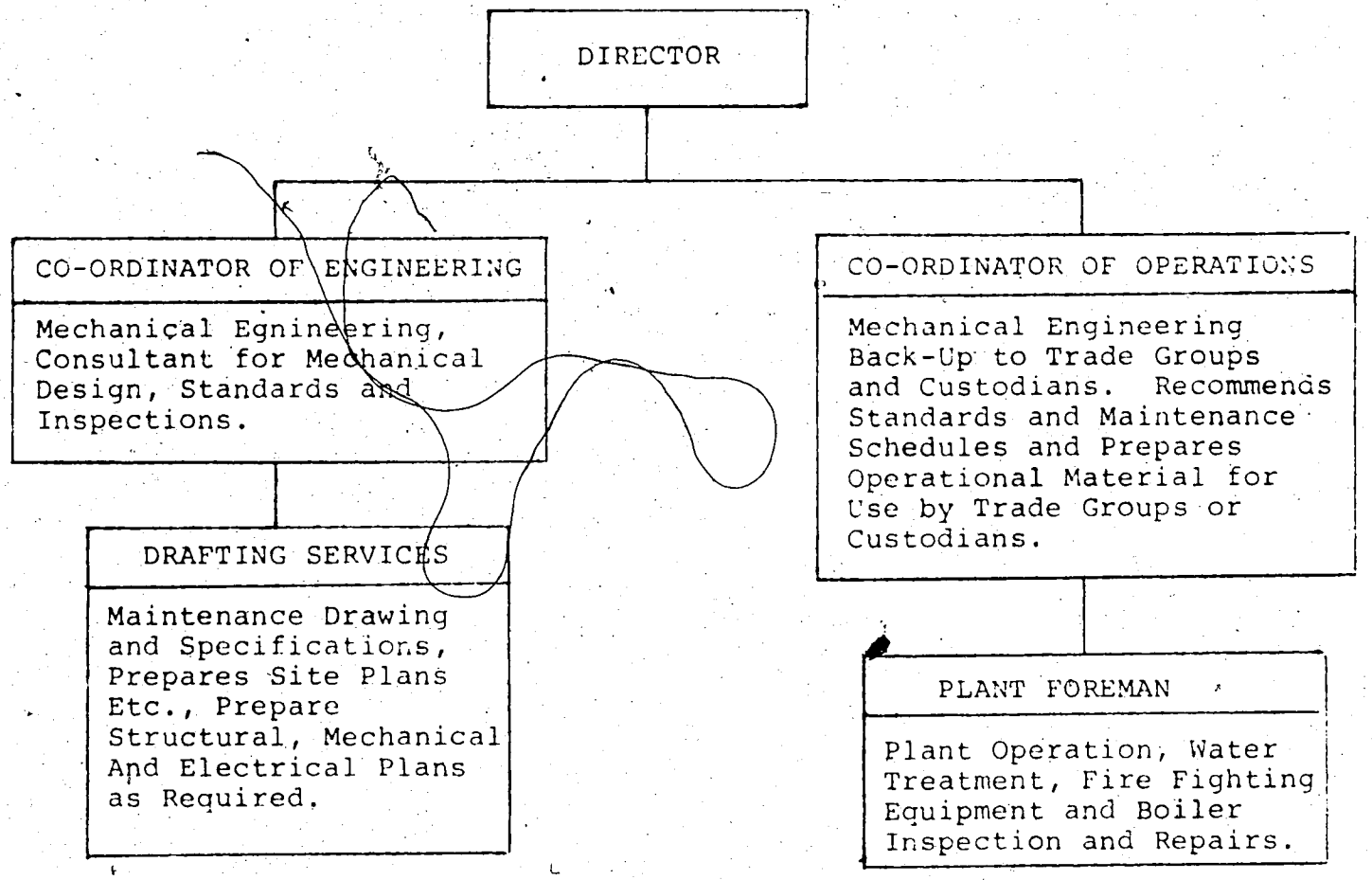


FIGURE 4.3

MAINTENANCE AND OPERATIONAL BRANCH

CO-ORDINATOR OF ENGINEERING AND CO-ORDINATOR OF OPERATIONS

OF EDMONTON PUBLIC SCHOOL BOARD

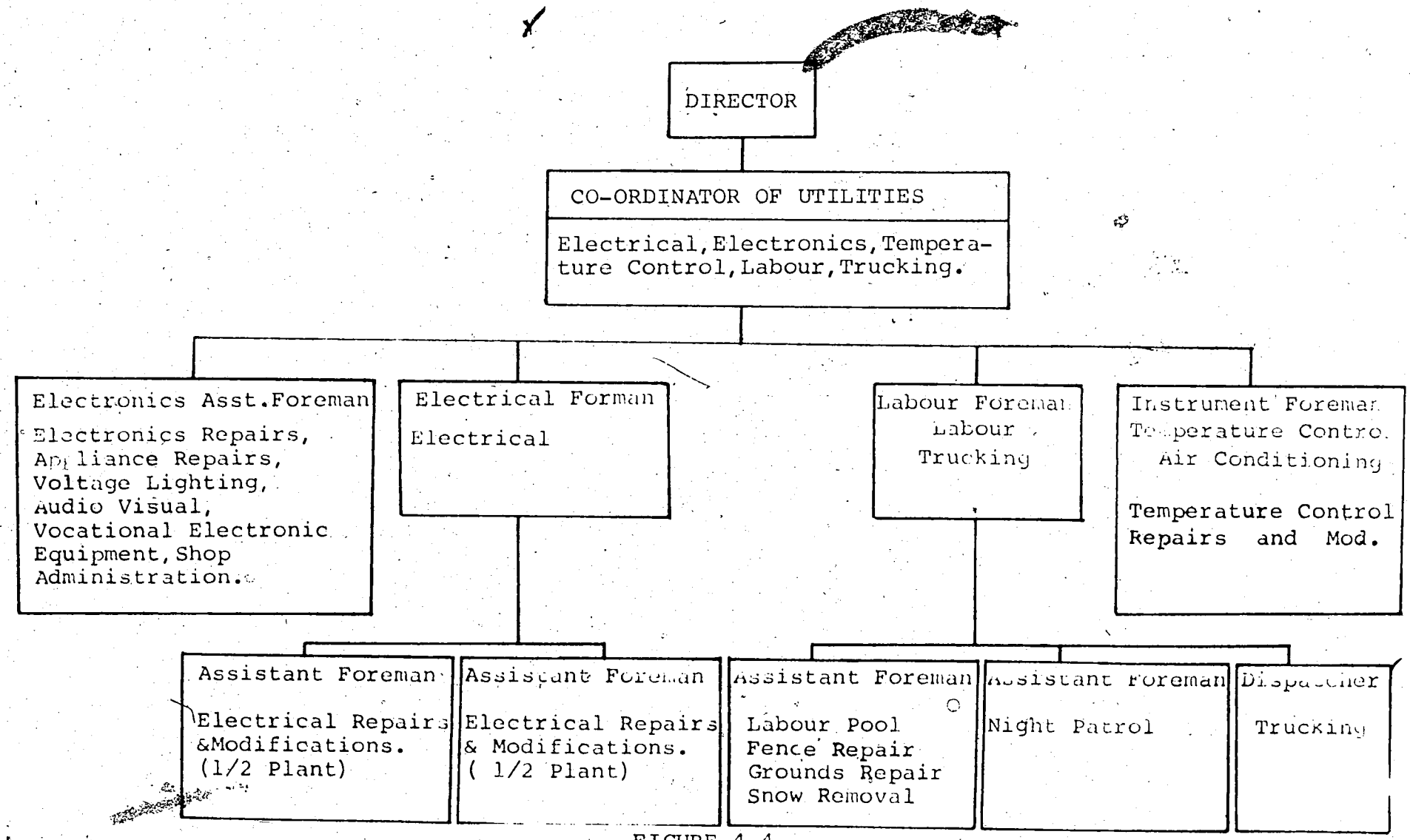


FIGURE 4.4

MAINTENANCE AND OPERATIONS BRANCH ORGANIZATION UNDER CO-ORDINATOR OF UTILITIES OF EDMONTON PUBLIC SCHOOL BOARD

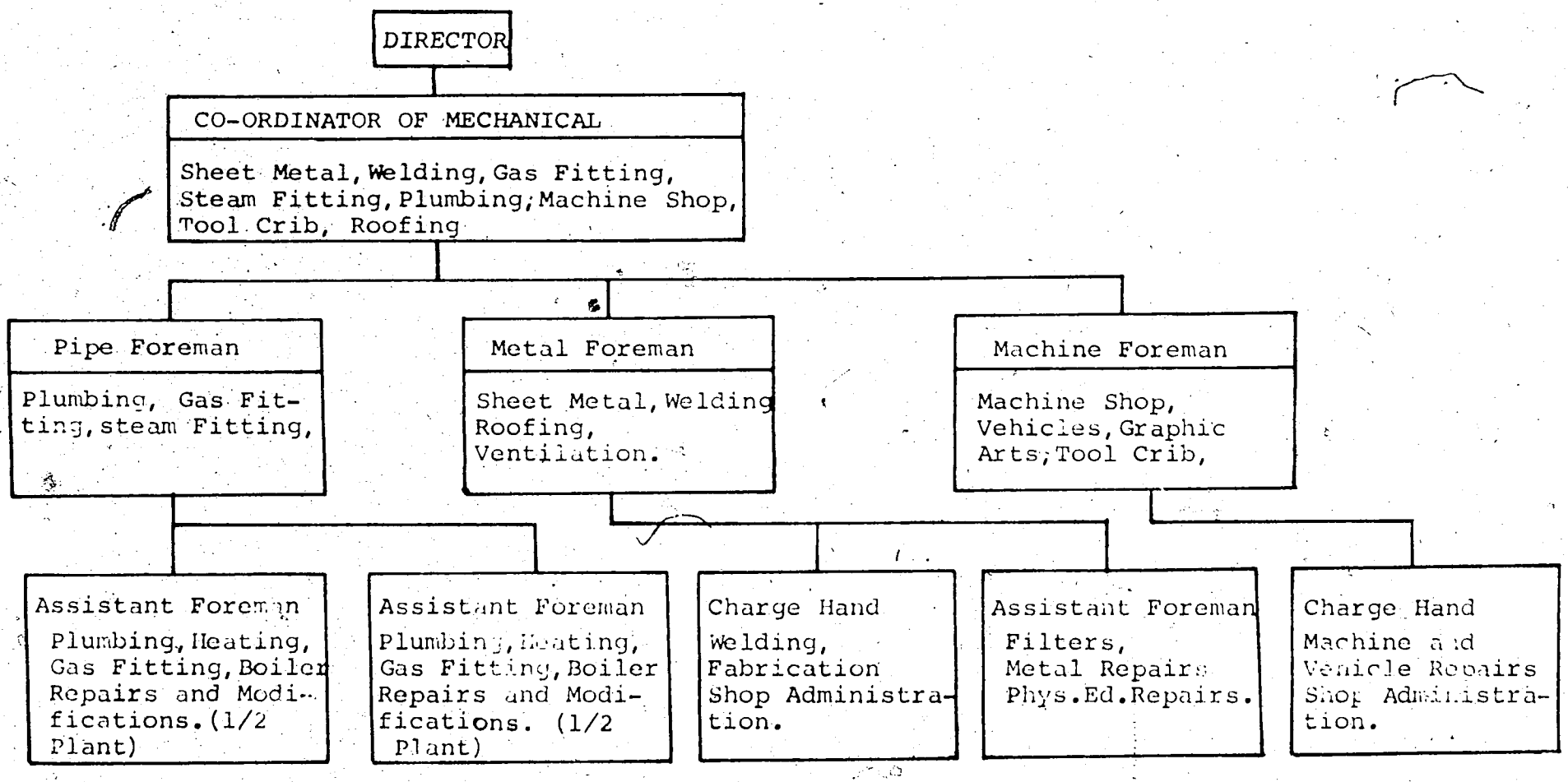


FIGURE 4.5

MAINTENANCE AND OPERATIONS BRANCH

Organization Under Co-Ordinator of Mechanical

Of Edmonton Public School Board

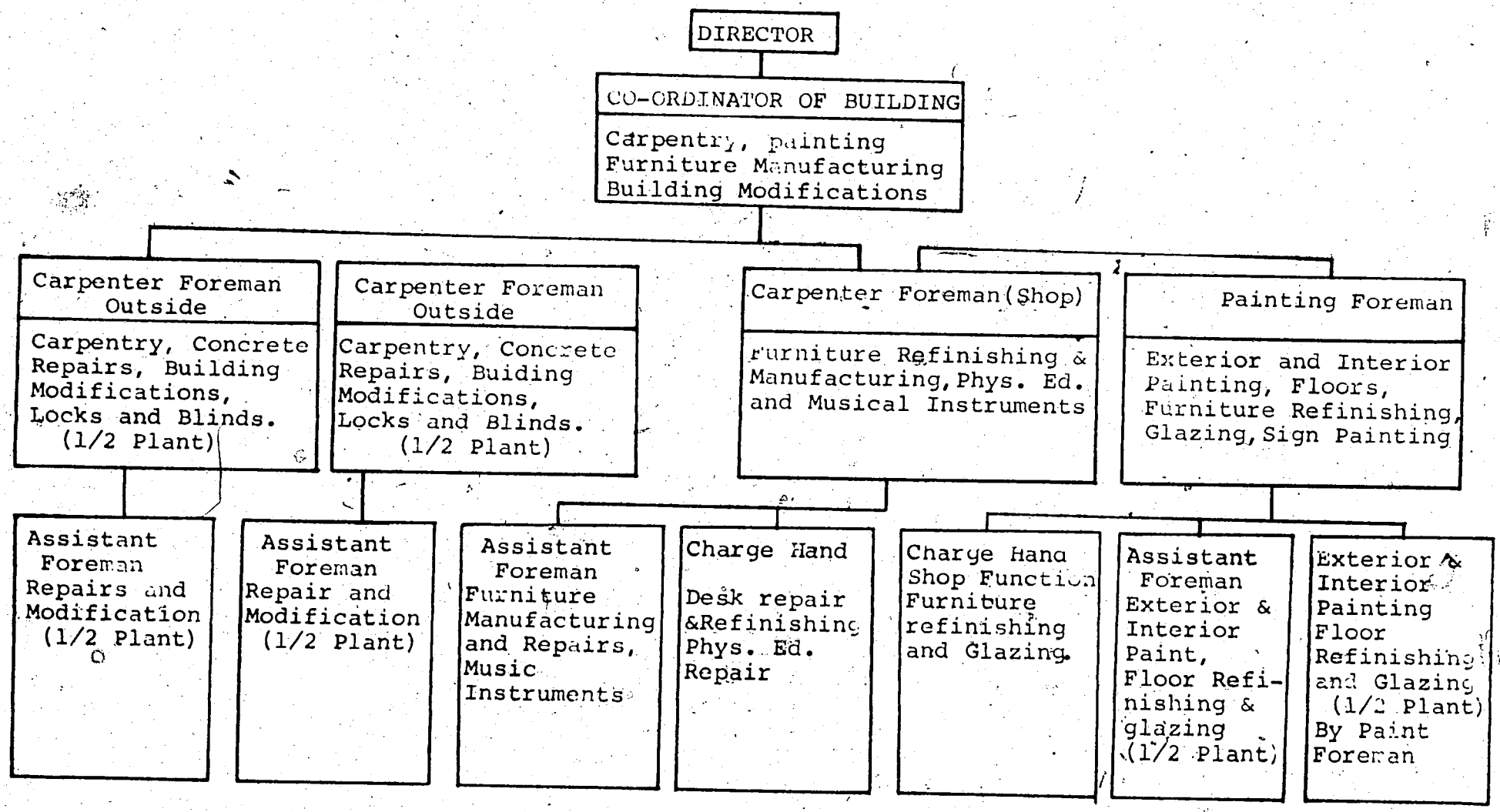


FIGURE 4.6

MAINTENANCE AND OPERATIONS BRANCH

Organization Under Co-Ordinator of Building Of Edmonton Public School Board

PROPERTIES DEPARTMENT

RECOMMENDED ORGANIZATION

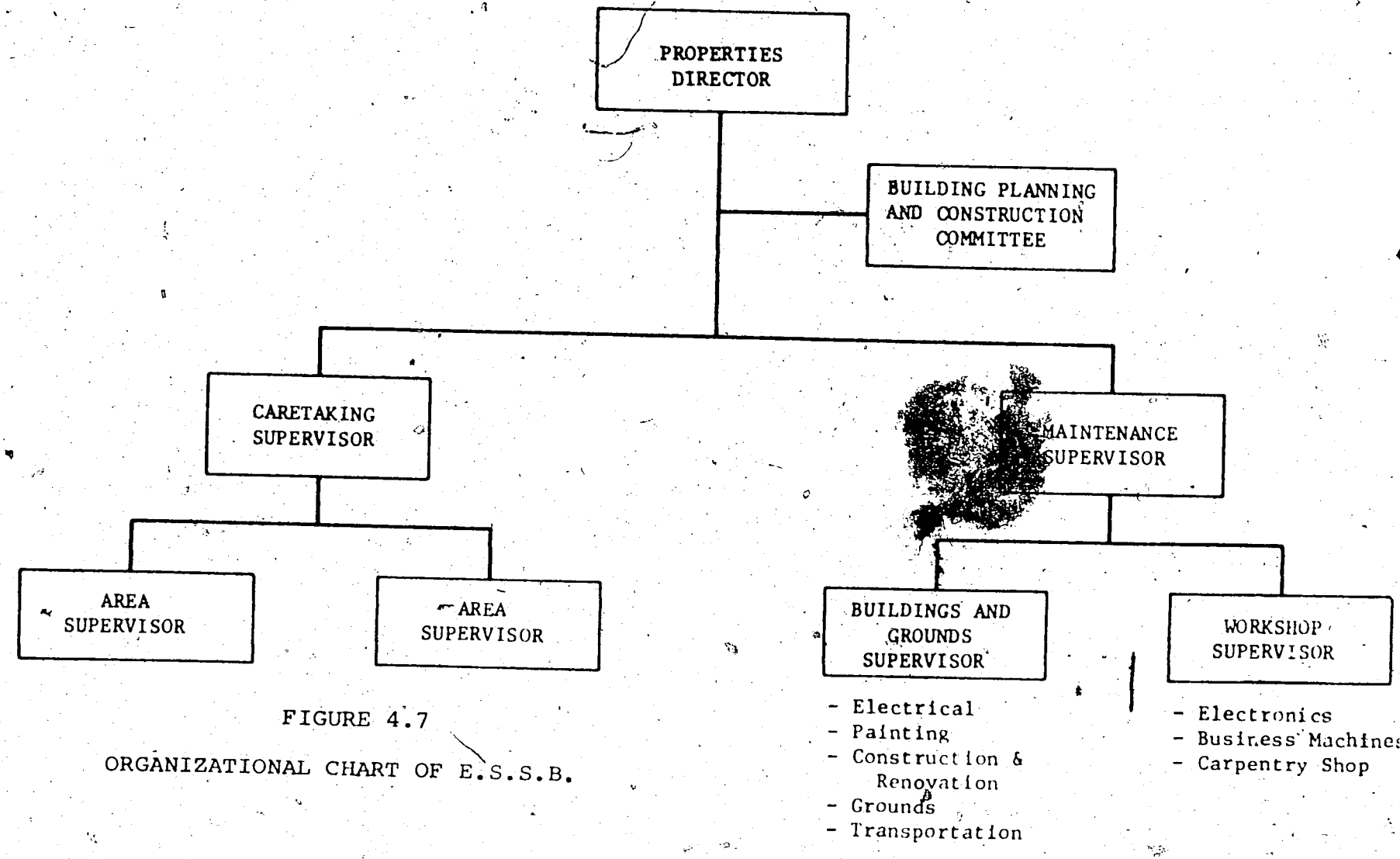


FIGURE 4.7

ORGANIZATIONAL CHART OF E.S.S.B.

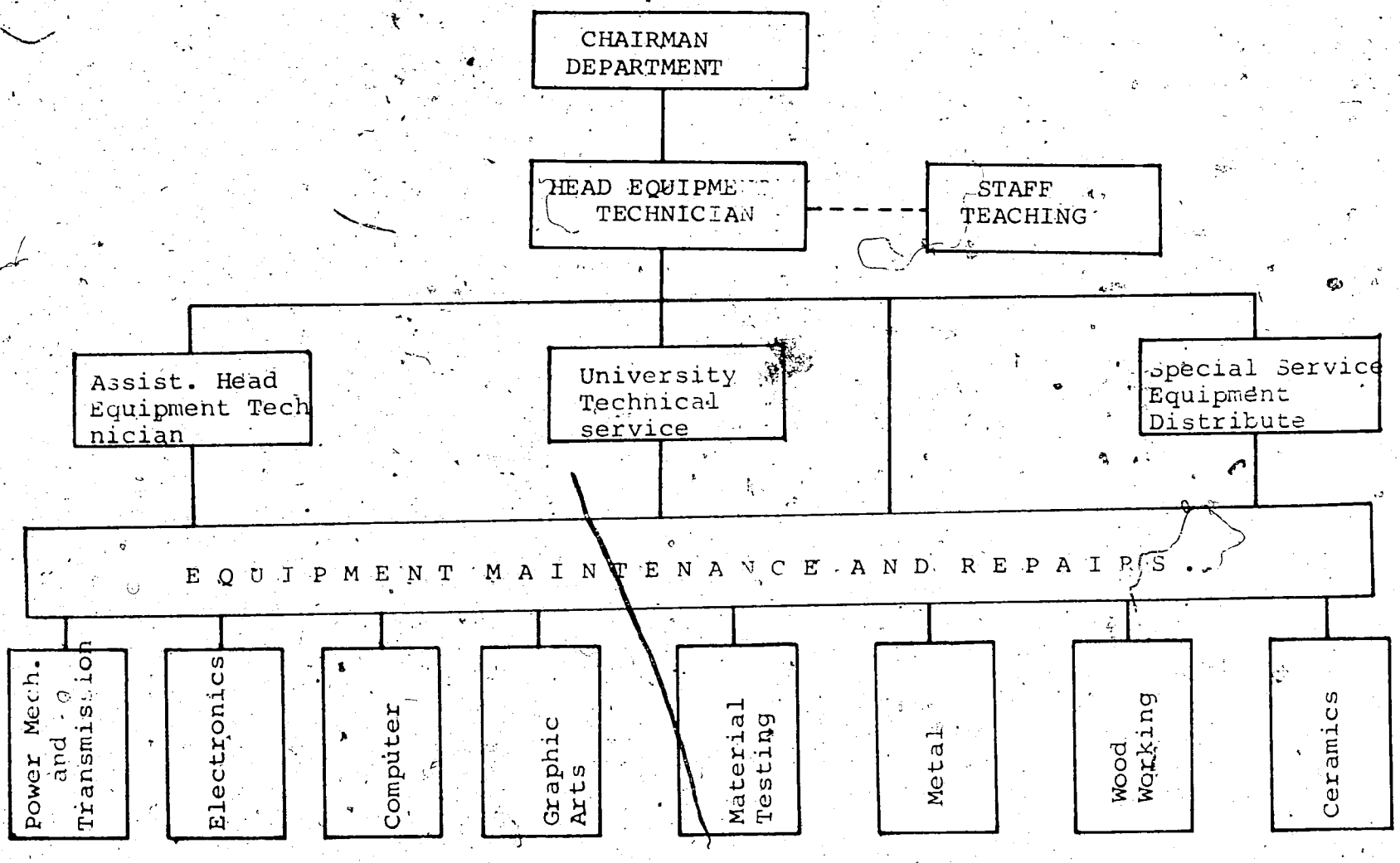


FIGURE 4.8

ORGANIZATIONAL CHART OF D.I.V.E.

of the Head of Equipment Technician and his assistant. The actual work of maintenance and repairing was on occasion done by the University Technical Service or the equipment distributors.

Figure 4.9 and 4.10 show the formal structure of maintenance at the N.A.I.T.. The shop Director's department records all educational equipment. Budget control and estimation for maintenance of educational equipment and furnishings are also under the responsibility of this department. Major components include the Plant Co-ordinator, the Capital Equipment Officer, and clerks. Under the Plant Co-ordinator were utility workers and technologists. An interview with the shop director indicated that almost every shop had a technician responsible for equipment maintenance. Some shops, such as food service, use the technician from the department.

Of the four systems that provided formal structure for maintenance, all were different in the number of components, degree of complexity, and areas of emphasis. The E.P.S.B. had the largest number of schools under its responsibility (167 schools). The E.S.S.B. had a relatively simple division of labor perhaps because of a smaller number of schools (77 schools). Organization at N.A.I.T. made use of the service

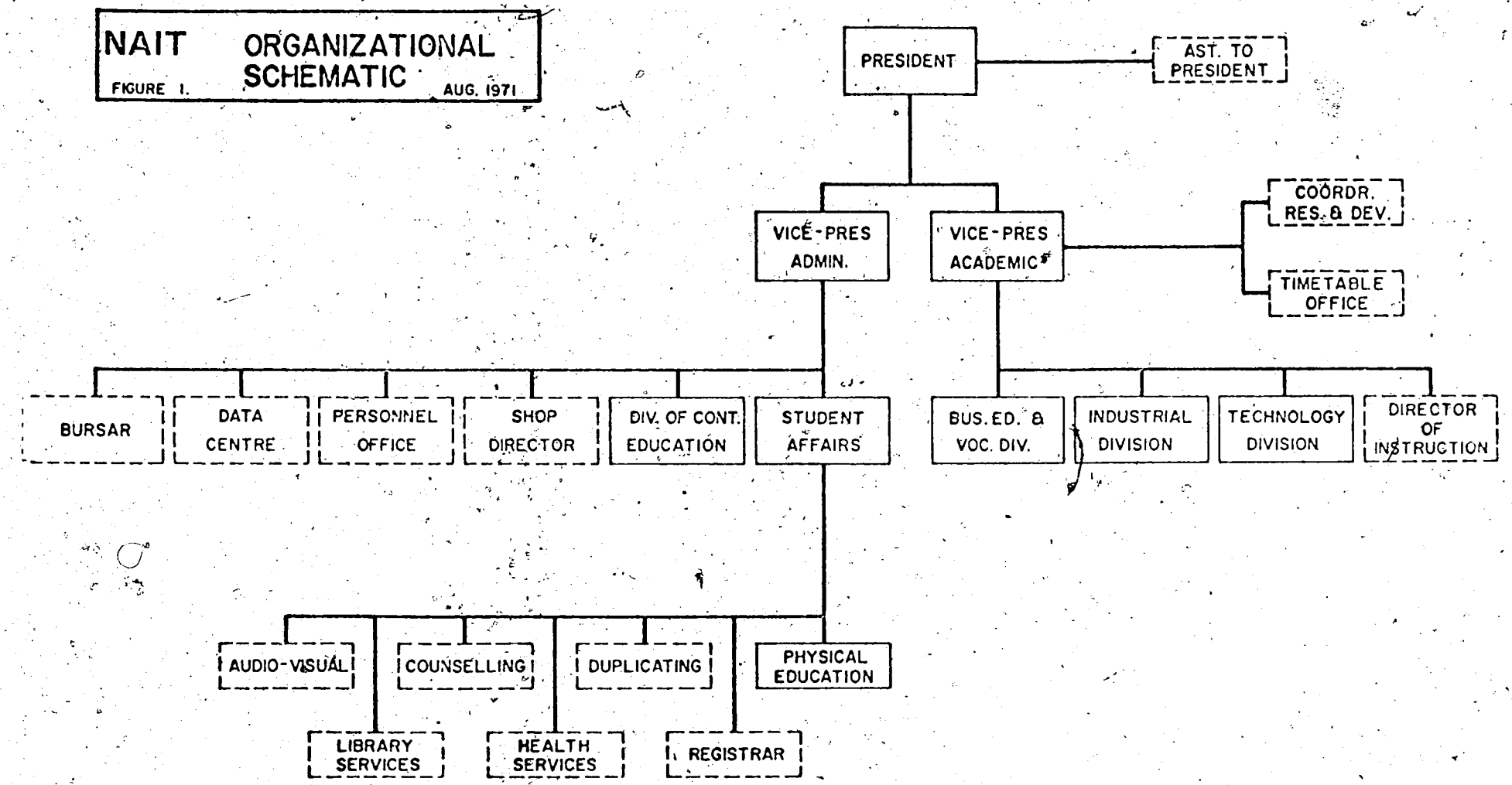
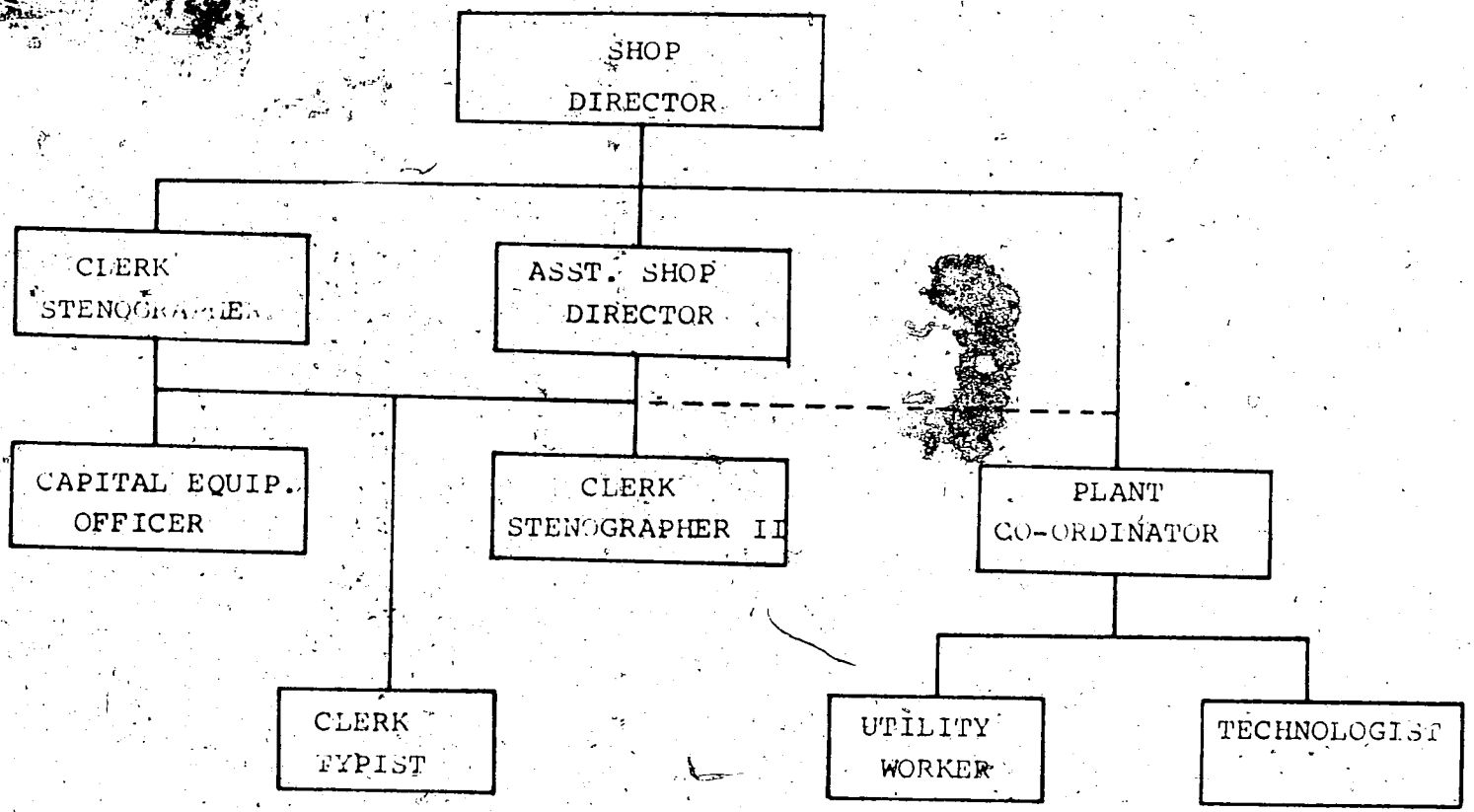


FIGURE 4.9

ORGANIZATIONAL SCHEMATIC OF N.A.I.T.



FIGRUE 4.10

ORGANIZATIONAL CHART OF SHOP DIRECTOR OF N.A.I.T.

of clerks (stenographers and typists) perhaps because the work involved a relatively greater amount of recording and reporting.

Prevalent, but not readily visible in the three systems (with an exception of D.I.V.E.), was the use of special services from outside. Occasions arose when assistance from the equipment distributors was necessary. These services were for practical purposes included in the structure although they are not shown in the organization charts of the three institutions.

b. Responsibility of Teaching Staff. Table 4.1 shows that the teaching staff was involved in minor maintenance work such as oiling and cleaning. It was only at D.I.V.E. that maintenance was not a responsibility of the teaching staff.

c. Responsibility of Maintenance Department. Table 4.1 shows that both school boards were responsible for major maintenance work of the schools under their jurisdiction. Such responsibility included equipment, buildings, and facilities. At the post-secondary education level, the responsibility of the maintenance department of the institutions was similar. At D.I.V.E. maintenance did not include the IBM. composer and offset printing presses, while at N.A.I.T. it did not include some shops such as that devoted to food services.

Personnel

a. Qualification of Technician. Table 4.1 shows no permanent technicians in the schools but there are some in E.P.S.B., E.S.S.B., D.I.V.E., and N.A.I.T. The minimum qualification for a technician is a Vocational certificate. A journeyman standing may also be required depending on the type of specialization. The technicians of such fields as electrical, mechanical, etc. employed by there organizations have similar qualifications.

b. Experience of Technician. Table 4.2 shows that the requirement for technician experience was not constant; in E.P.S.B. and N.A.I.T. the technician was expected to have many years of experience, in E.S.S.B. the technician was expected to have a minimum of two years experience, and in D.I.V.E. the technician was expected to have three years of experience. So, the importance of the technician's previous work experience depends on the needs of the institution.

Work Planning

a. Responsible Personnel. Table 4.1 shows that the personnel who were involved in work planning for schools of both school boards are technicians, supervisors and instru-

ctors. For the post secondary higher educational institutions, the persons who were involved in work planning are technicians and cribmen. At the school level, there were no permanent technicians because major maintenance work and planning were done by the department of maintenance of the school boards.

b. Planning Procedure. Table 4.1 shows that the E.P.S.B. had monthly, semester and year-round planning for maintenance work in schools, the E.S.S.B. had yearly inspection planning for maintenance work in schools during holiday and summer times. The schools did not have their own maintenance planning because it is done at the school system level. At D.I.V.E. maintenance activities continuous with concentration at periods of teaching breaks with weekly checks for machines used. Each shop at N.A.I.T. had its own plan for maintenance by the use of a peg board for planning and for record keeping.

c. Emergency Cases. Table 4.1 indicates that all emergency cases from schools under the responsibility of E.P.S.B. must report to the Department Head of Maintenance and are under his responsibility. In the E.S.S.B., the schools which were under their control when they had emergency cases should report to the school board which would in turn send a technician to make the necessary repairs if possible; otherwise the repair assignment would

be let out to a subtrade. At D.I.V.E. the emergency cases are the responsibility of permanant technicians and the head of the relevant shop.

PROCEDURE OF MAINTENANCE

Area of Work

a. Scope and/or Area of Work. Table 4.2 shows that the E.P.S.B. has its own Department of Maintenance with the following areas: machine shop, metal, wood working, electronics and stock room. The E.S.S.B. has plumbing, electricity, painting, construction and renovation, grounds, mechanical utility and transportation areas. In the schools there were graphic arts, typing, audio visual, industrial arts and vocational areas. In D.I.V.E. each I.A. lab was an area of work, i.e. Lab. I.A. 260, 360, 370, 460, 470, except for the computor composer and offset presses. In N.A.I.T. each shop was an area of work and in the Department of Shop Director the areas of work are planning for new space requirements, estimating capital needs, designing inventory procedures and updating operation systems, disposing of equipment, determining losses of capital equipment, work orders of buildings and equipment, and drawing of plans for rework orders and requisitions.

b. Scope of Liasion Work. Table 4.2 shows that all parts of the work in E.P.S.B. are related. In E.S.S.B. the curriculum supervisor, principal and I.A. instructors are concerned with the working areas. At the school level, the business manager is involved with the same working areas. In D.I.V.E., University Technical Services, Audio Visual Media Center and Specialized Equipment Suppliers are involved in working areas. N.A.I.T., the Department of Public works, Department of Education, Alberta Government Agencies, a Data Center, and the City Police Department are all concerned with this area of work.

Inspections

a. Inspector and Procedure. Table 4.2 shows that the inspectors of department of maintenance of E.P.S.B. inspect the condition of the equipment in schools in order to recommend maintenance procedures. They also consult with the instructors and follow a basic schedule. The E.S.S.B. use supervisors, foremen and instructors as inspectors and also use memoranda of shop instructors as guidelines for inspection. The E.S.S.B. sets schedules for inspection on general building maintenance in November and equipment maintenance in June. At the school level, the inspection procedure was the responsibility of the

school board. Within the D.I.V.E., the head equipment technician is responsible for all functions. In N.A.I.T., permanent technicians and the Head of Shop Work act as inspectors for equipment maintenance.

b. Result of Inspection. Table 4.2 shows that the E.P.S.B. used results of inspection to carry out work during holiday periods and to fulfill the needs of the schools. At the E.S.S.B., the results of inspection were used for repair and to establish estimates for the following year's budget. At the school level, the main inspection results are used as the basis for repairing defective equipment. N.A.I.T. did not keep records. Instead, each technician has his own routine for inspection and this has proven satisfactory because of reliable personnel.

Inventory Equipment Records

a. Equipment Records. Table 4.2 shows that, at the E.P.S.B., the equipment is recorded in the shop center and in schools by computer and service cards which were carried by repairmen of the department of maintenance. The two sets of records are kept in the department of maintenance. At the E.S.S.B. all of the equipment and property records are recorded by computer.

PROPERTY RECORD - EDMONTON SEPARATE SCHOOL DISTRICT

Item _____ Code _____ School _____

Make _____ Quantity _____ Dept. _____ Rm. # _____

Model _____ Serial # _____ Teacher _____

Cost $ _____ Date Purchased _____ Vendor _____ Phone _____

Accessories (List catalog number, cost, pertinent sizes, e.g. shafts, belts, motors, etc.):

_____

_____

Property Check						
	Date	Check by	Date	Check by	Date	Check by
	Qty.	Condition	Qty.	Condition	Qty.	Condition
	Date	Check by	Date	Check by	Date	Check by
	Qty.	Condition	Qty.	Condition	Qty.	Condition

Recommendations: _____

_____

Form PR-1

FIGURE 4.11

PROPERTY RECORD -EDMONTON SEPARATE SCHOOL DISTRICT

MAINTENANCE RECORD

Warranty Period _____

Service Policy with
Name: _____
Address: _____ Phone _____

Date	Requisition Number	Signature of Service Representative	Nature of Repairs	Cost

FIGURE 4.11

MAINTENANCE RECORD
OF EDMONTON SEPARATE SCHOOL BOARD

Figure 4.11 illustrates the property record card which indicates item, code, school make, quantity, department, room, model, serial, cost, date purchased, and vendor of equipment. On the back page of the card is shown the maintenance record which indicates service policy, warranty period, date of maintenance, requisition number, signature of service representative, nature of repairs and cost.

At the school level the equipment is recorded on inventory cards and in equipment books. Both of these records have the same list of equipment and code as in the computer program of E.P.S.B.. Two of these records are kept in the school shop and the main office of school.

At D.I.V.E., all of the equipment in Industrial Arts labs are recorded by computer. The record is kept in the main office of the Department of Industrial and Vocational Education.

At N.A.I.T., all equipment is recorded on computor, inventory cards and master cards. The records are kept in the data center on the master inventory cards. Another set is kept at the shops. The technicians have another set of inventory record cards to carry to the shops or to the center for new records of maintenance work.

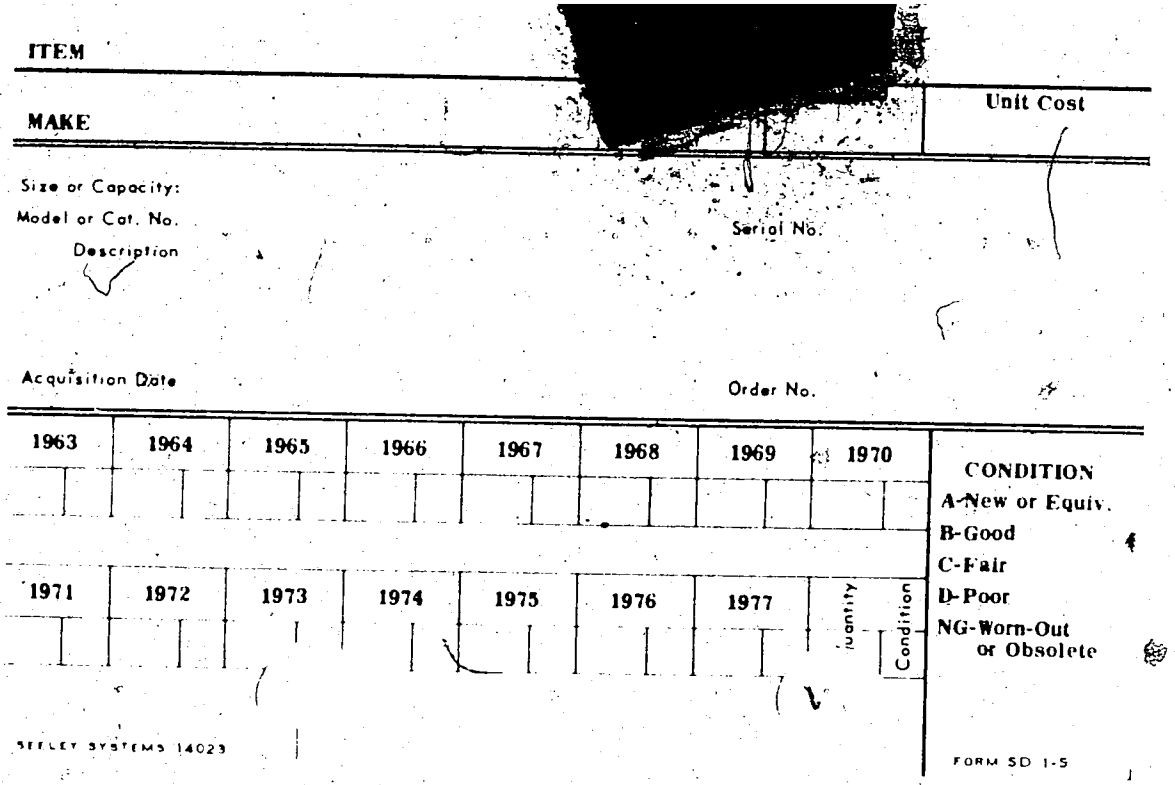


FIGURE 4.12

MASTER CARD

of the Northern Alberta Institute of Technology.

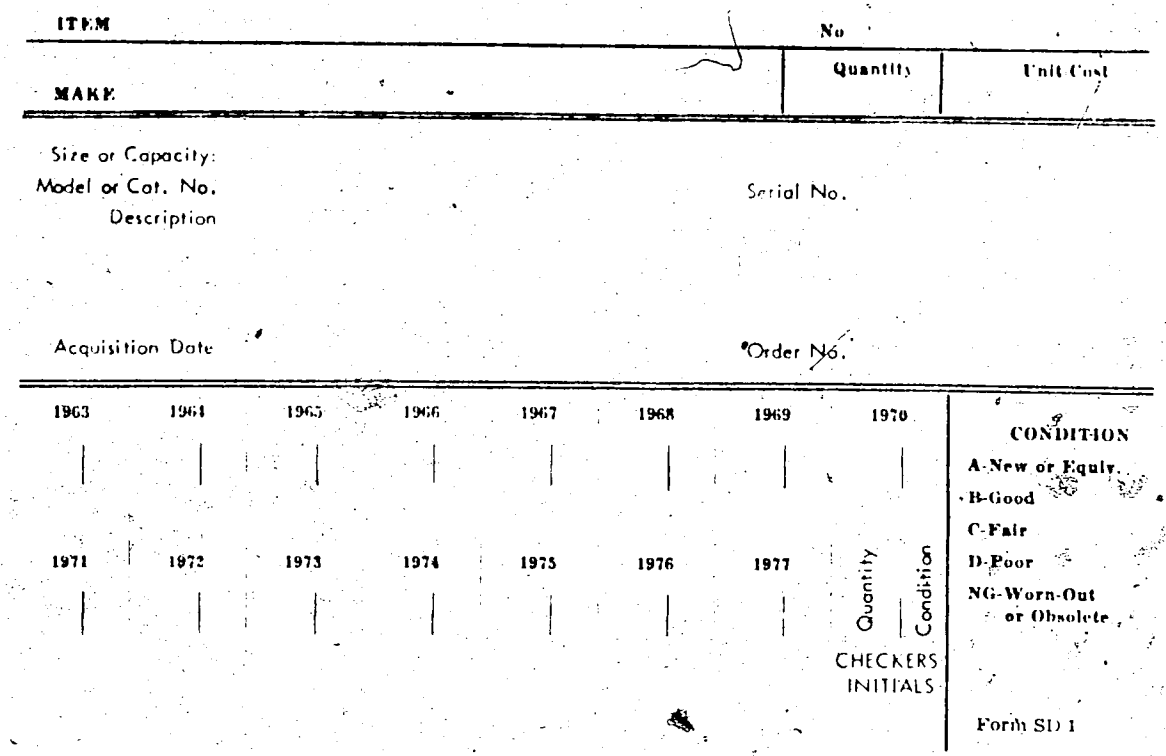


FIGURE 4.12

INVENTORY CARD

of the Northern Alberta Institute of Technology.

Figure 4.12 shows that the inventory and master cards which have the same details: item of equipment, number, make, quantity, unit cost, size or capacity, model or catalogue number, serial number, description of equipment, acquisition date, order number, date of inspection, signiture of inspector or repairer, and condition of equipment i.e. A = new or equivalent, B = good, C = fair, D = poor, and NG = worn out or obsolete.

b. Criteria for Stocking Parts. Table 4.2 shows that the E.P.S.B. employs frequency of use in deciding to carry or not to carry spare parts in stock. The decision to stock is influenced by its cost and availability. The E.S.S.B. also employs frequency of use in deciding to stock or not to stock parts. High cost parts are not stocked and spare parts are not stocked at individual schools. D.I.V.E. never keeps a spare part inventory because most spare parts are available from university stores or from equipment s[illegible] in the city. Some hardware supplies are kept on h[illegible]. At N.A.I.T. there is spare part storeage in each shop for frequently used spare parts as indicated in the statistics. N.A.I.T. stated that it is not necessary to stock the spare parts that are not frequently used. Purchasing these by a telephone call is convenient.

c. Estimate Running Time of Machine. Table 4.2 shows that the E.P.S.B. estimated the running time of machinery

from the timetable which students and instructors use in the lab. At the central department of maintenance shop, it is estimated from the recorded hours of the shops using the machines. At the E.S.S.B., machine running time is estimated by the supervisors and foremen. The estimates are calculated from information on the maintenance record cards.

At the school level, the estimation of machine running time is done by the department of maintenance of the school board.

At D.I.V.E. the machine running time is estimated from the record of class hours and multiple activities in the lab but this is not an accurate record of time.

At N.A.I.T., the machine running time is estimated from machine running per week and year using the following criteria:

Hours per week to 100% = 40 Mh / week.

Weeks per year to 100% = 40 week / year.

Therefore, hours of machine running time per year to 100% is 40 x 40 = 1600.

FINANCE

Budget for Maintenance

Table 4.3 shows that the E.P.S.B. maintenance budget is recognized in the current budget account. This budget is met from funds provided by the E.P.S.B. and the Department of Education.

At E.S.S.B., it is difficult to determine accurately the amount of money available for equipment maintenance. This is because E.S.S.B. is responsible for all kinds of maintenance in the Edmonton separate schools. The maintenance budget is divided into several subheadings (as shown in Appendix D). Some subheadings include both general and education equipment maintenance, such as: Caretaker's equipment, motor repairs, electronic repairs, industrial arts machinery, equipment repair, and so on. The money comes from the Department of Education of Alberta.

At the school level the budget for maintenance comes from the school board.

At D.I.V.E., the financing of maintenance is controlled by the main office of the department. The budget for equipment maintenance is approximately $3,500. In addition to

this there is an equipment replacement budget of $2,000. In other words the total budget for equipment maintenance and replacement is approximately 1.3% of total capital equipment. It must, however, be kept in mind that this figure of 1.3% of the capital equipment investment represents only direct costs to the department. Salaries of the people who contribute to the maintenance function are charged to other accounts. The true cost of maintenance is probably in the range of 10 to 12 per cent of the capital investment.

The budget at N.A.I.T. for maintenar e work for equipment and furnishings each year is approximately one per cent of the total capital equipment inventory. This one per cent figure, however, does not represent the true cost of maintenance as many costs are covered under other budget lines. It is likely that this 1% cost does not include salaries of maintenance workers and some maintenance done at the Northern Alberta Institute of Technology is done by the provincial government through another administrative arm.

Budget Estimation

Table 4.3 shows that at E.P.S.B. the estimation of budget for maintenance is done by the director of mainten-

ance and his personnel. They will estimate the amount of money required with whatever facts are available.

At the E.S.S.B., budget estimation is done by the supervisor of maintenance who consults with the staff concerned with maintenance work. The estimates of cost of maintenance have increased approximately 8% over the previous year.

At the school level, the estimation of the budget for maintenance is done by the school board.

In the D.I.V.E., the Administrative Office consults with the head equipment technician in order to estimate the budget for equipment maintenance. Data from the previous year's expenditure, amount of equipment to be serviced and repaired and frequency of the use of equipment are also considered.

At N.A.I.T. requests for maintenance and furnishings are submitted by each department to the office of the Shop Director, staff compiles these and makes budget estimates based on the maintenance and furnishings requests they receive.

Budget Justification

Table 4.3 shows that at E.P.S.B., the budget is presented to the board of trustees once a year and the director of maintenance is required to answer questions put forward by members of the board. After the board has considered each account in detail, they approve the budget.

At the E.S.S.B., the maintenance budget is justified from the previous year's expenditure.

At the school level, the maintenance budget is justified by the school board.

At the D.I.V.E., justification of the budget is done by the head equipment technician using recommendations of the lab instructors.

At N.A.I.T., it is done by the shop director's department who considers requests from each division.

EFFECTIVENESS

Cost of Maintenance

Table 4.4 shows that at the E.P.S.B., justification of

the cost of maintenance must always be the consideration of the maintenance department because costs have to be kept to a minimum. The maintenance department has two methods of handling these. Most repairs are completed by their own staff but where they do not have qualified personnel the unit requiring repair will be sent to an outside organization specializing in that field. The school board must always strive for improvement and work toward what is considered an optimum situation where they are able to provide the best possible service at the least possible cost.

At E.S.S.B., the cost of maintenance is justified from the total cost of the machines. The cost of repair is compared with the cost of replacement and life expectancy when the decision has to be made whether it should be repaired or replaced. At the school level, the control of maintenance costs is done by the department of maintenance of the school board. Most maintenance work is done by the department of maintenance because it is more efficient and more economical.

At the D.I.V.E., the justification cost of maintenance depends on comparison of the cost downtime of equipment with the cost of equipment replacement.

At N.A.I.T., for certain equipment, the cost of maintenance may rise to 8% of the cost of that equipment or in some cases, if the particular equipment becomes old, it may rise to 10% per year. Normally it has been running about 4% per year.

Assessment of Maintenance

Table 4.4 shows that the E.P.S.B. had sent out questionnaires and has asked the instructors who were involved with the equipment if they feel the department of maintenance is providing suitable service with respect to repair and how the service might be improved.

At the E.S.S.B., the effectiveness of maintenance is evaluated from the total amount of money that is spent. If the cost of maintenance is about 5% of the capital inventory, it is considered to be effective.

At the school level, the assessment of maintenance is evaluated by the department of maintenance.

At D.I.V.E., the measuring effectiveness of operations is based on the amount of downtime of equipment resulting in loss of teaching time.

At [redacted].T., no attempt is made to measure the effectiveness [redacted] maintenance work.

Summary

Equipment maintenance systems in the educational organizations examined were of three kinds: (1) post-secondary educational organizations such as universities and institutes of technology, (2) school boards, (3) composite high schools. Post-secondary educational organizations have their own divisions or departments of maintenance employing permanent technicians to take care of the equipment. School boards have responsibility for all equipment and building repairs in the schools for which they are responsible. In composite high schools, the school board takes care of equipment very meticulously because there is much equipment. Normally technicians are required to pass vocational certificates or journeyman qualifications depending on the type of work in which they specialize. The budget for maintenance is quite high both in post-secondary and school board operations.

CHAPTER V

ANALYSIS OF MAINTENANCE SYSTEMS OUTSIDE OF EDUCATION

The focus of this chapter is the study of maintenance systems in private firms and other enterprises outside of education whose functions are concerned with equipment maintenance.

These organizations reproduce spare parts of machines or automobiles which are not available on the market. They sell maintenance and transportation services as well.

The researcher has interviewed five organizations They are:

1. Digital Equipment of Canada Limited (Digital Equipment)
2. Gorman's Company Limited (Gorman)
3. MacCosham Van Line Company Limited (MacCosham)
4. Stamco Speciality Tools and Manufacturing Company Limited. (Stamco)
5. W.W. Cross Cancer Institute. (W.W. Cross)

TABLE 5.1

STRUCTURE OF MAINTENANCE SYSTEMS

NAME OF ORGANIZATION	1. Organization: a. Formal function structure. b. Organizational chart.	2. Personnel: a. Qualification. b. Experience.	3. Work Planning: a. Responsible personnel. b. Planning procedure. c. Emergency case. d. Transportation. e. Time of delivery.
Digital Equipment of Canada Limited (Digital Equipment).	a. Sales and service computer systems, whole or part. b. Yes (chart shown on figure 5.1).	a. Graduate from technical institute or have previous computer experience. b. Not emphasized on years of experience.	a. Field service representative. b. Following the stutus of contract and equipment manual. c. Field service representative. d. Car, airplane. e. Instant response to two days.
Gorman's Limited (Gorman).	a. Sale service and rental of power tools, portable and stationary machinery; used in metal work, wood work and road machinery. b. Yes (chart shown on figure 5.2).	a. Factory training, mechanical training, technical institute and high school training. b. Not necessarily required.	a. Sale manager. b. Technician sent to look after the machines sold. c. None. d. Half-a-ton truck, panel truck, outside truck line. e. Range from twenty four hours to three or ten days.
MacCosham Van Line (MacCosham).	a. Moving, storage of household and general machandise service. b. Yes, (chart shown on figure 5.3).	a. Journeyman certificate and special training for particular position. b. Not necessary required.	a. Superintendent; mechinic. b. Condition of each vehicle recorded on files and request form from driver. c. Superintendent. d. Van, truck, railroad, airplane. e. Range from twenty four hours to one week depend on distance.
Stamco Specialty Tools and Manufacturing Company Limited (Stamco).	a. Rebuild machine and automotive spare parts, which were not available in the market. b. Yes (chart shown on figure 5.4).	a. Journeyman certificate. b. Many years of experience.	a. Technicians. b. Daily preventive maintenance. c. Manager. d. None. e. None, but time for rear ranging spare parts for customers is as soon as posible.
W.W. Cross Cancer Institute (W.W.Cross).	a. Produce some spare parts equipment and treatment machines. b. None.	a. Journeyman certificate. b. Thirty years of experience and five years as journeyman.	a. Technicians. b. No formal planning. c. Supervisor. d. None. e. None, but time for producing and repairing parts is as soon as possible.

TABLE 5.2

PROCEDURES USED IN MAINTENANCE SYSTEMS.

NAME OF ORGANIZATION	1. Area of Work a. Scope and/or areas of work. b. Scope and/or areas of liaison work.	2. Inspection a. Inspector and procedure. b. Result of inspection.	3. Inventory Equipment Record a. Equipment record. b. Criteria for stocking parts. c. Estimated running time of machines.
Digital Equipment of Canada Limited (Digital Equipment).	a. Installation, repair, preventive maintenance, inspection, site planning. b. Close communication with all other departments.	a. Field service representatives; procedure depending on equipment status code. b. Recorded and reported on normal service reporting form; used for considering maintenance and budget.	a. Recorded on a filing system, kept in branch office, district office, regional office. b. Determined by corporate field service stock room. c. Determined by corporate field service.
Gorman's Limited (Gorman).	a. Welding, painting, cleaning, general shop, electrical and tune-up. b. With parts area, center office, yard area, display area, shipping and servicing areas.	a. Receivers; equipment tested with appropriate power and inspected. b. Reported, if damaged or claimed shortage.	a. Recorded on cardex cards, kept in central office. b. Depending on recommendation from factory or on frequency of selling. c. None, but replacement of new model equipment every five years is suggested.
MacCosham Van Line (MacCosham).	a. Truck maintenance, overhaul & repair, lubrication, washing and painting. b. Not indicated.	a. Driver and mechanic; request form and garage form completed. b. Reported to the superintendent.	a. Recorded on a filing system, kept in garage and main office. b. No spare parts in stock except small or frequently used parts. c. Based on mileage.
Stamco Specialty Tools and Manufacturing Company Limited (Stamco).	a. Grinding, heat treatment, metal punching, plastic and rubber molds, small and fine machines, milling, sharpening and engraving. b. Not indicated.	a. None. b. None.	a. Recorded on a filing system, kept in the main office. b. Few small parts in stock. c. None.
W.W. Cross Cancer Institute (W.W. Cross).	a. Machine shop, physicist lab, radio therapy. b. X-ray department.	a. Supervisor; proper functioning of all parts relating to repair work. b. Reported in record book, used for considering maintenance budget.	a. Recorded on filing system, kept in the main office. b. None. c. None.

TABLE 5.3

FINANCE OF MAINTENANCE SYSTEMS

NAME OF ORGANIZATION	1. Budget for Maintenance	2. Budget Estimation	3. Budget Justification
Digital Equipment of Canada Limited (Digital Equipment).	10% to 12% of inventory capital.	Estimation budget is based on past experience.	Required to show a profit.
Gorman's Limited (Gorman).	About 10% of inventory capital.	Maintenance budget for rental equipment is based on past experience.	Justified by effectiveness of the machine after repair.
MacCosham Van Line (MacCosham).	About $500,000 per year.	Maintenance budget is based on cost of former years.	Determined by superintendent, based on comparision of repair and replacement costs.
Stamco Specialty Tools and Manufacturing Company Limited (Stamco).	About $6,000 per year for preventive maintenance and repairs.	Flexible, depended on amount of work.	Justified by effectiveness of the machine and work production.
W.W. Cross Cancer Institute (W.W. Cross).	Not indicated.	Estimation budget is based on past experience.	Done by administrative officials who decide how much each department gets.

TABLE 5.4

EFFECTIVENESS OF MAINTENANCE SYSTEMS

NAME OF ORGANIZATION	1. Cost of Maintenance	2. Assessment of Maintenance	3. Suggestion for Improving Maintenance.
Digital Equipment of Canada Limited (Digital Equipment).	Estimated on a per hour rate cost plus expected cost of replacement parts.	Good maintenance results in good customer relations.	A good maintenance system must be maintained & improved if possible in order to keep customers contented.
Gorman's Limited (Gorman).	Depends on cost and condition of equipment.	Financial returns, employee morale and effectiveness of machine after repair.	Faster delivery in filling after machines sold, identification of equipment be indicated when ordering as well as model and serial num[illegible]
MacCosham Van Line (MacCosham).	Considered to be an economical way of keeping the [illegible] running smoothly.	Satisfaction of clients and employees.	Not necessary.
Stamco Specialty Tools and Manufacturing Company Limited (Stamco).	Maintenance costs considered by the manager and depends on the condition of the machine.	Accurate production.	Machines can be kept within reasonable tolerance with preventive maintenance.
W.W. Cross Cancer Institute (W.W. Cross).	Depending on the highest standards in treating patients.	Considered to be satisfactory breakdown in treatment area.	Best technicians should be available some essential equipment is required for improved maintenance.

Tables 5.1 to 5.4 show the organization of their maintenance systems.

STRUCTURE OF MAINTENANCE

1. Organization

a. Formal Structure (Duty of Firms). Table 5.1 shows that the main functions of Digital Equipment are sales and service of computers and computer systems manufactured by this company in whole or part. At Gorman the main function is sales-service and rental of power tools as well as portable and stationary machinery for use in metal work, wood work, road work and electric motor and machine shops. This firm usually sells approximately 50% of all school industrial supplies in Edmonton area. The main function at MacCosham is moving and storage of household goods and general merchandise. It serves local or coast to coast customers. Stamco rebuilds, according to the need of clients, many kinds of machine and automotive spare parts not available on the market. Moulds for plstic and rubber goods and punch press tools are produced as well. At the machine shop of W.W. Cross, the main function is to produce spare parts for equipment and construct machines for medical treatment. None of these parts are available in the city and it takes a long time to order them from supplier firms. This machine shop also produces

equipment for radiation therapy research.

b. Organization Chart. Table 5.1 shows that most firms have their own organization chart. See figures 5.1, 5.2, 5.3, 5.4. Only one machine shop, W.W. Cross, has no formal organization chart because here there are only two technicians, each technician being highly skilled to operate the machines and produce the things which the physicists who design equipment, require.

Figure 5.1 indicates that the organization of the District Field Manager of Digital is divided into four branches: Calgary Branch, Edmonton Branch, Vancouver Branch and Future Office Expansion.

Figure 5.2 shows the organization chart of Gorman where there is President, Vice President and Sales Manager heading the management. Under sales manager there are three branches: sales, purchasing and recording. Under both sales and purchasing there are sales and mechanics. Under recording there are sales, shipping and mechanics.

Figure 5.3 shows the organization chart under supervision of MacCosham. It is concerned with

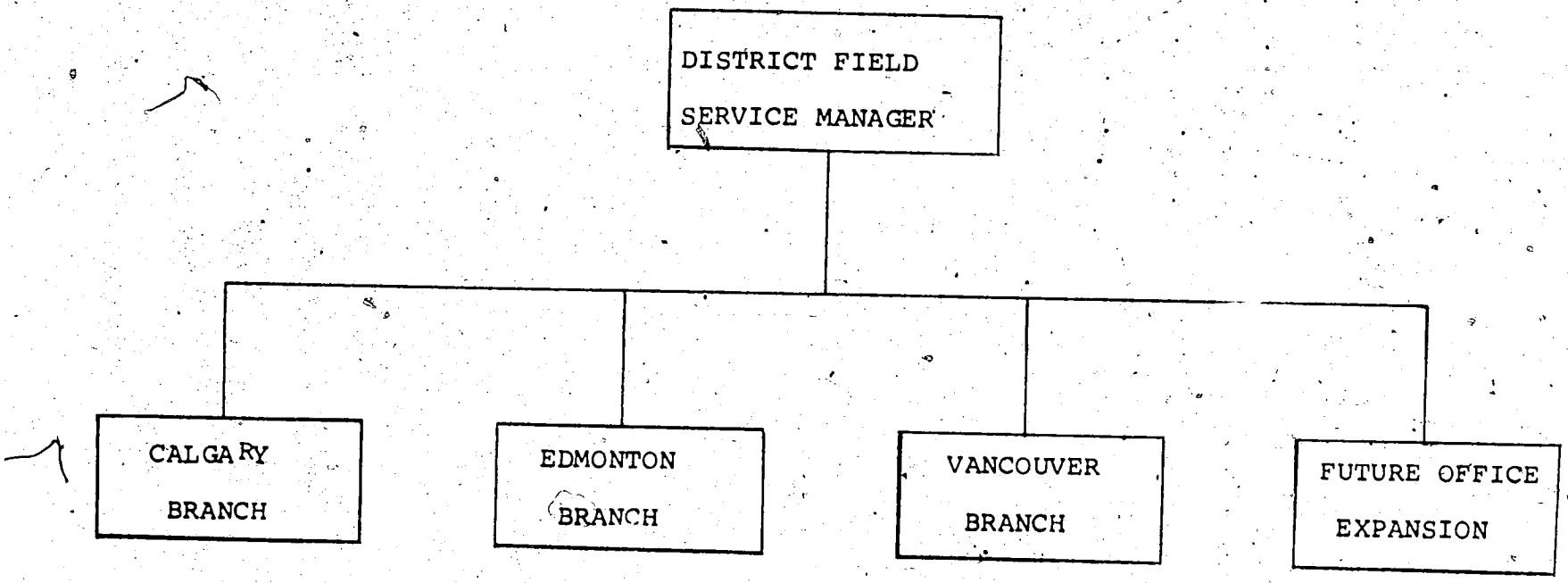


FIGURE 5.1

THE ORGANIZATIONAL CHART OF

FIELD SERVICE

DIGITAL EQUIPMENT OF CANADA LTD.

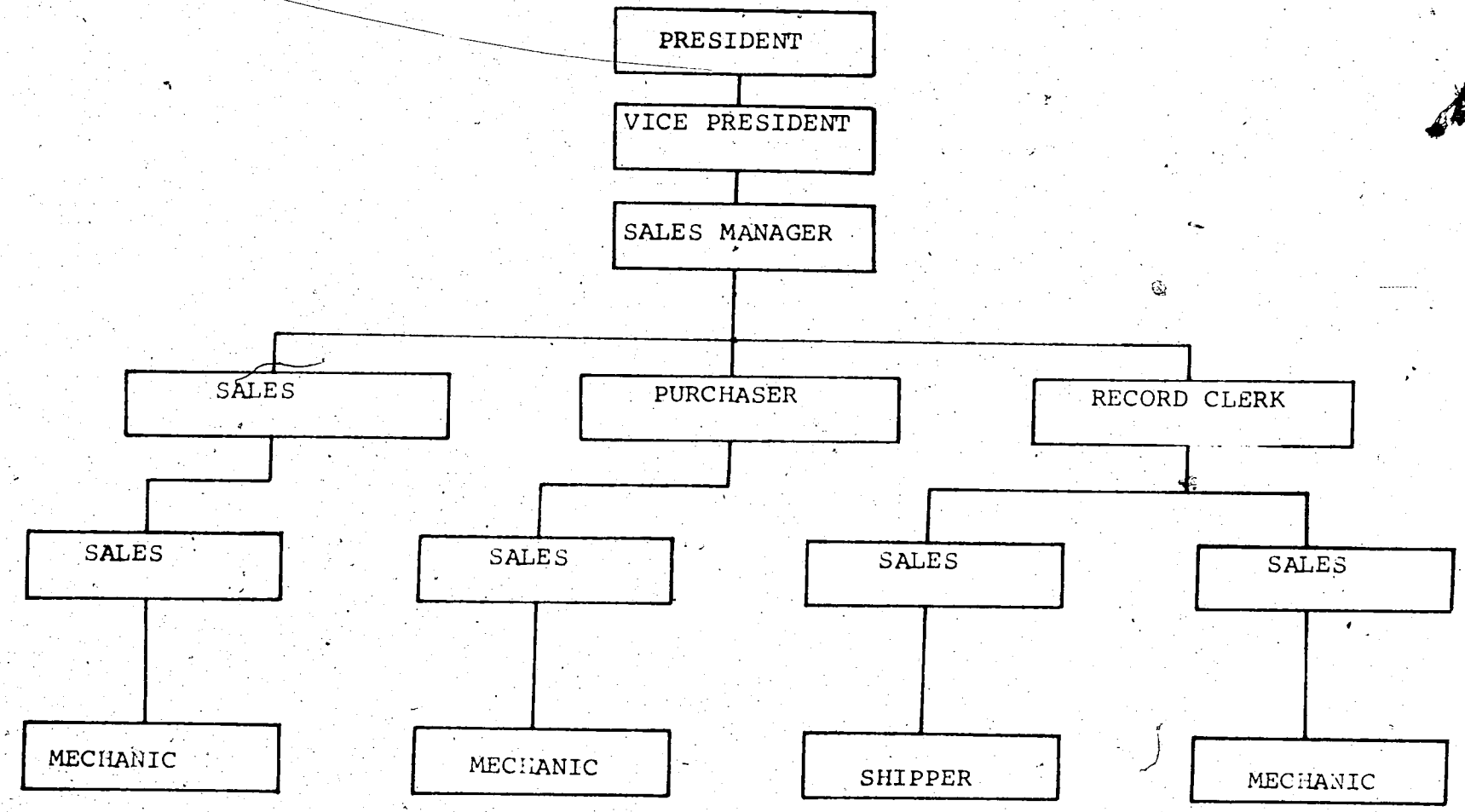


FIGURE 5.2

THE ORGANIZATIONAL CHART OF GORMAN'S LTD.

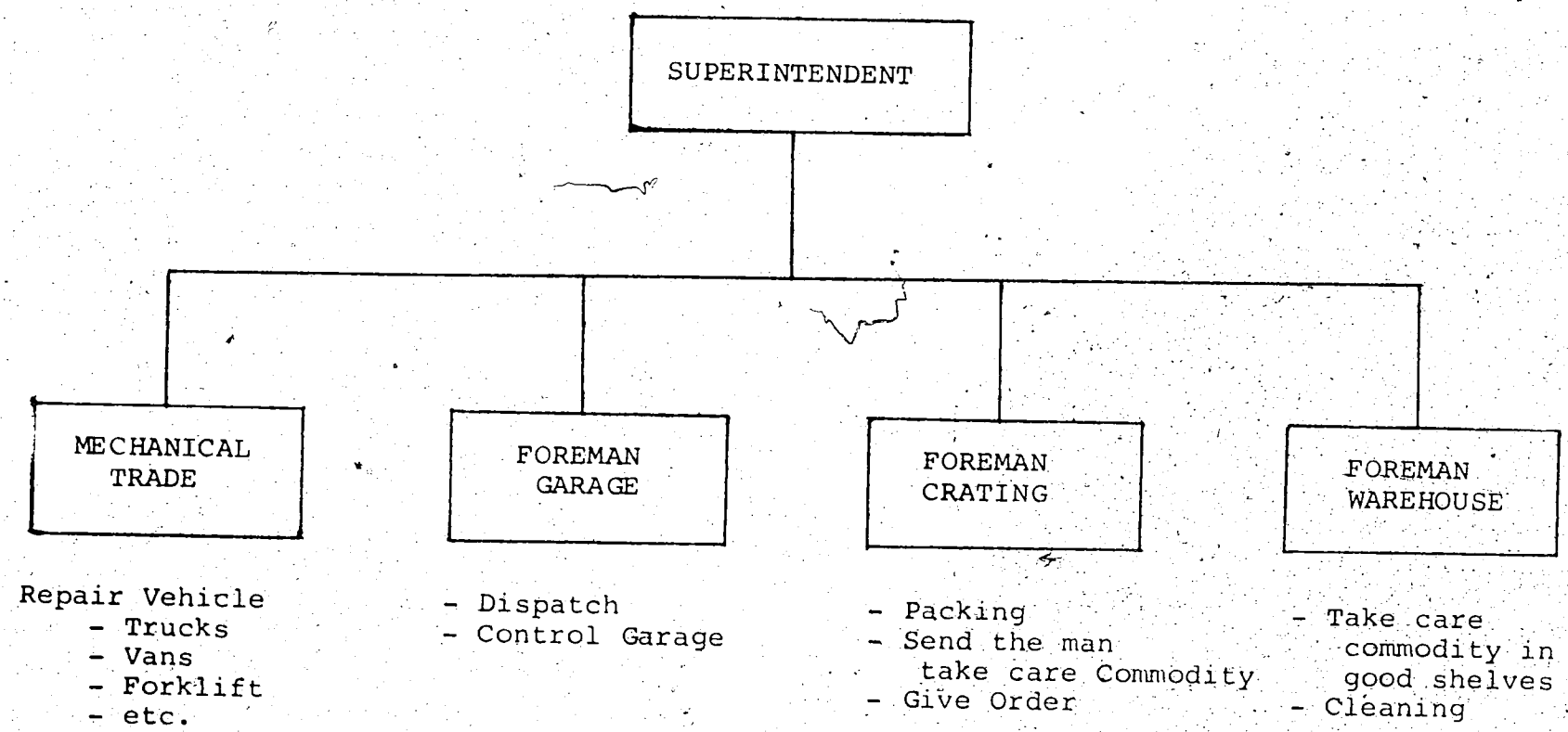


FIGURE 5.3

ORGANIZATIONAL CHART OF SUPERINTENDENT

OF MACCOSHAM VAN LINE

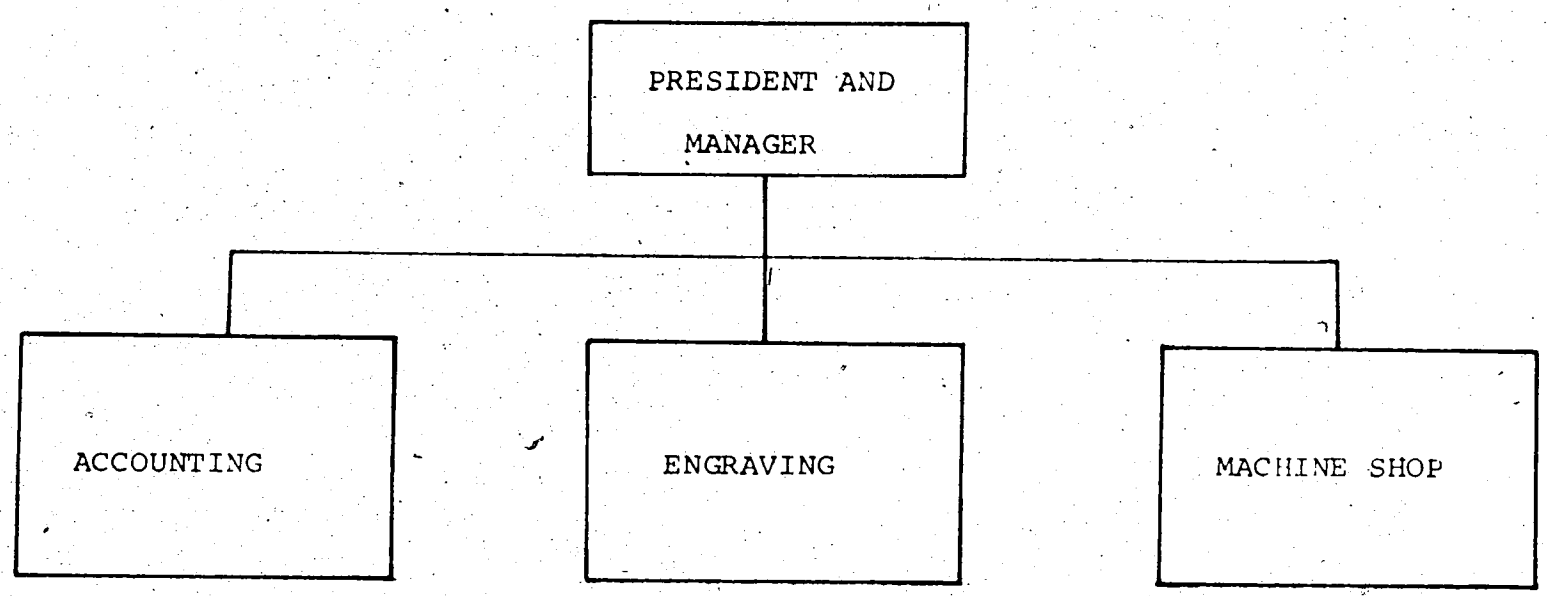


FIGURE 5.4

THE ORGANIZATIONAL CHART OF STAMCO SPECIALTY TOOLS AND MANUFACTURING COMPANY.

servicing and maintenance as indicated in the chart. Under the superintendent there are four branches: mechanical trades, garage foreman, crating foreman and warehousing foreman. The main function of mechanical trades is repairing vehicles such as trucks, vans, fork lifts, and so on. The function of the garage foreman is to dispatch and control vehicles. The main function of the crating division is packing and sending men out to care for commodities.

Figure 5.4 depicts the organization chart of Stamco which shows that under the president or manager there is an accounting section, engraving section and machine shop section.

2. Personnel

a. Qualification Table 5.1 shows that the technicians in Digital Equipment graduate from technical institutes or have previous computer experience. In Gorman, the technicians will have the qualification of factory training, mechanic training, university training technical institute or high school training. At MacCosham the technician must have a journeyman's certificate and take a special training program for his particular position in this company. In Stamco the technician should have the qualification of a

journeyman. At W.W. Cross the qualification of a technician is a journeyman's certificate.

b. Experience of Technician. Table 5.1 shows that the requirements for the technician in Digital Equipment does not emphasize years of experience because these people get company training on the equipment they will be required to service. In Gorman, the technician does not necessarily require experience because this company trains its people for their work. MacCosham did not mention the years of experience for a technician because each is trained for his specific position. At Stamco the technicians have many years of experience. Most technicians come from abroad, for example, from Germany, Poland and Italy. In the machine shop of W.W. Cross, the technician had 30 years of experience before coming to work for the institute.

3. Work Planning

a. Responsible Personnel. Table 5.1 shows that the person who takes responsibility of planning may have different titles depending on the company. At Digital Equipment, he is Field Service Representative; at Gorman's, Sales Manager; at MacCosham's, Superintendent and Mechanic; at Stamco, Technician, and at W.W. Cross, Technician.

b. Planning Procedure. Table 5.1 shows that the maintenance planning procedure of Digital Equipment depends on the status of contract between the company and the customers. Normally the maintenace works are practised according to the instructional manual. Gorman sends a technician to look after the machines that are sold to the customers as being scheduled in the record. At MacCosham, when a driver needs to maintain the vehicle or it is time for maintenance as indicated in the record, he makes a request to the superintendent. The superintendent consults with the technician for the proper work. At Stamco, the technician who is responsible for any particular machine must take care of preventive maintenance every day after work. The machine shop of W.W. Cross does not have formal planning for equipment maintenance. To change oil as indicated on the schedule for machine tools is routine. Since only two technicians are at work and the machines are not used on a production basis, they are not really worn out. Maintenance is not frequently required.

c. Emergency Case. Table 5.1 shows that at Digital Equipment, if the customer has an emergency case of machine break down, it is reported to the Field Services Representative. The Field Service Representative

considers company and decides what should be done. Gorman is not concerned with emergencies. At MacCosham if an emergency case occurs with a vehicle it is reported to the superintendent. At Stamco for a special case such as machine break down, the manager will ask the technicians to help repair it immediately. At W.W. Cross, if the treatment machine is broken down, everybody available, including the physicists will cooperate to get it back in operation. If there is a major break down, the supervisors will have to work around the clock to make repairs. If necessary, the company representatives and technicians will be called in.

d. Transportation. Table 5.1 shows that the vehicles used for transportation in Digital Equipment are primarily cars and airplanes, depending on distance. At Gorman's a half ton truck and a panel truck are used for transportation in the city (Edmonton) and outside truck lines are used in rural areas. At MacCosham moving ar delivery of commodities is done by small vans, trucks, railroad and airplane. Stamco and W.W. Cross do not use transportation.

e. Time of Delivery. Table 5.1 indicates that the time for servicing the dient of Digital Equipment

depends on the status of the service: guarantee, contract or telephone. If the equipment is guaranteed or on contract it receives immediate service. If the equipment is non-guaranteed or non-contract and the service is called for by telephone, the service ranges from instant response to two days. At Gorman, for deliverable commodities, if they are available in stock, the commodities will reach the customer in the city within 24 hours. For rural areas, such as the Northwest Territories, it takes three to ten days. MacCosham delivery commodities in the city area within 24 hours. This means packing and moving on the same day. In rural areas, servicing depends on the distance, ranging from one day to one week, for example, three days from Edmonton to Inuvik. For foreign countries, the company cannot control the time of shipping although initial handling is done very quickly. Stamco does not deliver its products. This company specializes in rearranging production schedules to accommodate the customer as soon as possible. The machine shop of W.W. Cross also does not use delivery. It concentrates on repairing and producing parts.

PROCEDURE OF MAINTENANCE

1. Area of Work

a. Scope and/or Area of Work. Table 5.2 shows that the maintenance section of Digital Equipment stresses

installation, repair, preventive maintenance, inspection and site planning. At Gorman, areas of maintenance work are welding, printing, cleaning, general shop, electrical and tune-up. The areas of maintenance work at MacCosham are truck maintenance overhaul, repair, lubrication, washing and painting. At Stamco, the areas of work are grinding, heat treatment, metal punching, moulding plastic and rubber, small and fine machines, milling, sharpening and engraving. At the machine shop of W.W. Cross the areas of maintenance work are machine shop, physicist laboratory and radiation therapy area.

b. Scope and/or Area of Liaison Work. Table 5.2 indicates that the scope of liaison work in Digital Equipment had close communication lines with all other departments. At Gorman the maintenance section has liaison with parts area, office area, yard area, display area, shipping and servicing area. MacCosham and Stamco did not reveal liaison work. In the machine shop of W.W. Cross the area of liaison work is the X-Ray Department which is in need of frequent mechanical help.

2. Inspections

a. Inspector and Procedure. Table 5.2 shows that the inspectors of Digital Equipment are field service representatives, the procedure depending on equipment

status. If equipment is under service contract, schedules are set up. Inspectors use the field service activity report/order form for reports, orders and suggestions. This form indicates such things as: serial number, customer name, cost center, request date and material used. Inspectors of Gorman, are also receivers. When equipment arrives in the warehouse, the shipping container is removed. The machines are put together according to the instructional manual. Then, it is tested with the appropriate electric power. At MacCosham, all equipment which is used for repair and maintenance is inspected daily by the mechanic. The trucks are first inspected by the drivers who use the request form (Figure 5.6) to record the result of inspection such as checking oil water, battery, etc., but the second check is done by the mechanic when the truck comes in to be maintained or repaired when the garage form is used (Figure 5.6).

Figure 5.5 shows the request form which indicates unit number, mileage, date, driver's name, driver's report on vehicle operation, work authorized, mechanic's name, and total cost.

Figure 5.6 shows the garage form which indicates

UNIT #:_____ MILEAGE:_____ DATE:_____

DRIVER'S NAME:_____

DRIVER'S REPORT ON VEHICLE OPERATION REPAIRS TO BE PERFORMED

_____

_____

_____

_____

_____

_____

WORK AUTHORIZED BY:

_____

MECHANIC'S NAME:

_____ _____ hours @ $_____ $_____

_____ _____ hours @ $_____ $_____

TOTAL $_____

FIGURE 5.5

REQUEST FORM OF MACCOSHAM VAN LINE

FIGURE 5.6

GARAGE FORM

MacCOSHAM GARAGE LIMITED

Mechanic:_____ Date_____

Truck#:_____ Make:_____ Serial#:_____ License:_____

Mileage_____

Completed	Amount	Parts	Amount
Gas.....		SUPPLIER & INVOICE NO.	
Oil.....			
Grease.....			
Wheel pack.....			
Filter.....			
Plugs.....			
Points.....			
Misc.			

Work Required:

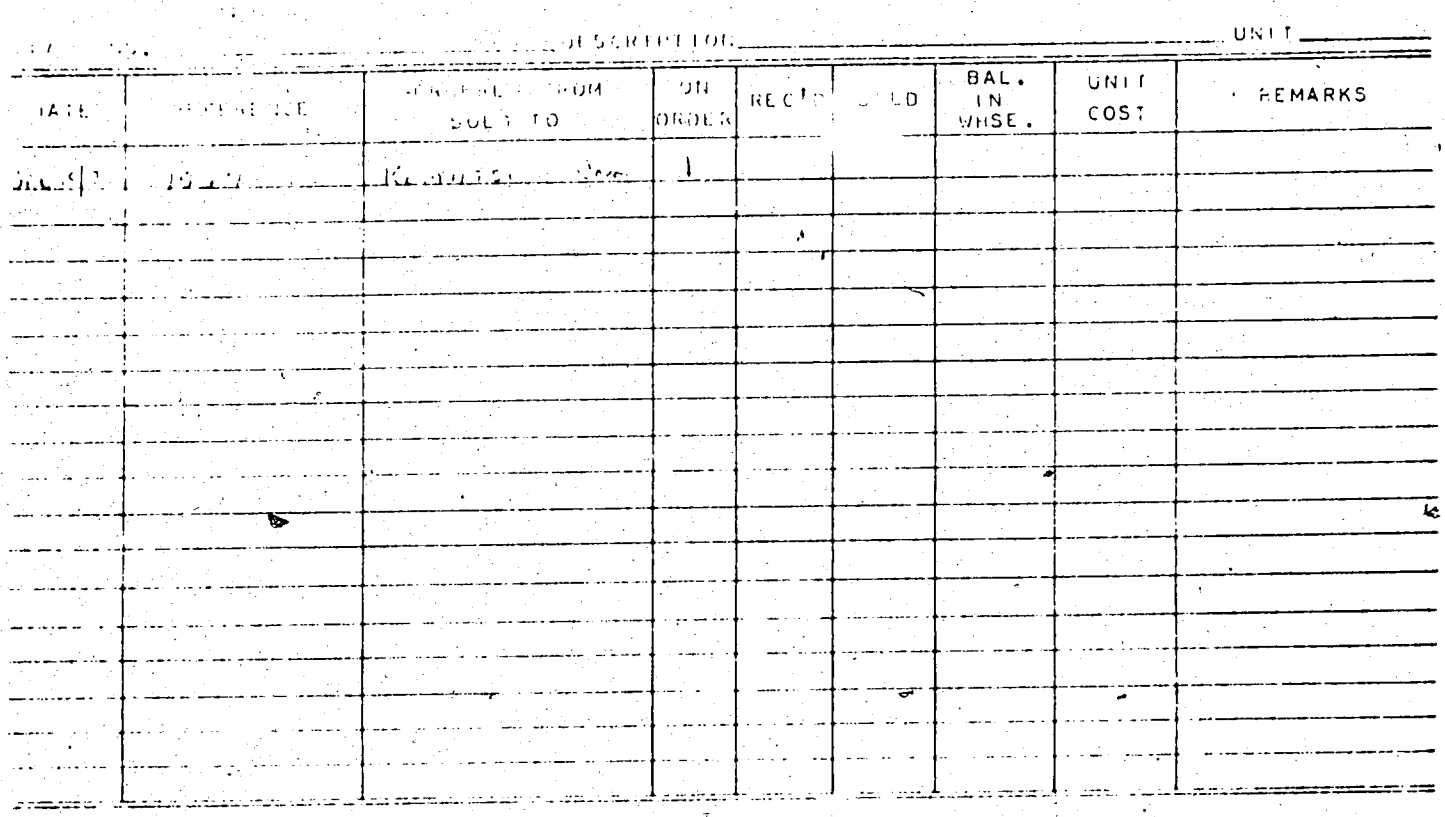
SUMMARY:

Gas&Oil		290/1
Service		290/3
Parts&Material		290/5
Labour	Hour@	290/2
W O #		TOTAL

mechanic, date, truck number, make serial number, license, mileage completed, amount, parts, work required and summary.

At Stamco they did not identify the inspector and procedure. At the machine shop of W.W. Cross the inspectors are carried out by the supervisor. The inspection covers proper functioning of all parts related to repair work done. Regular inspection takes place as required by a factory schedule or after any major repair.

b. Results of Inspection. Table 5.2 depicts that the results of inspection at Digital Equipment are recorded and reported on normal service reporting form. At Gorman the result of inspection is reported by letter to the company which transports the commodity, if the commodity is damaged. Claims are filed against the transportation company or the supplier for shortage. At MacCosham, the result of the inspection is reported to the superintendent. He consults with the machinist what is desirable, repair or replacement. Inspection results at Stamco are not shown. For W.W. Cross, the result of inspection is reported in the record book. record is kept all parts exchanged and repair done.



310-41-21200 Ball Nut Assy.

FIGURE 5.7

CARDEX CARD OF THE GORMANS' LTD.

3. Inventory Equipment Records

a. Equipment Record. Table 5.2 shows that all equipment and spare parts of Digital Equipment are recorded in a filing system. At Gorman, the new machines and spare parts are recorded on cardex (Figure 5.7). If a machine needs spare parts for repairing, the record of the parts will be investigated and then the work order will be passed to the parts department where the needed items may be supplied. The two records (work order and cardex) are kept on file in the central office. At MacCosham, trucks and new equipment are recorded in the filing system. There are two records:one is kept in the garage and the other in the main office. All machines of Stamco are recorded in a filing system. The spare parts manual of each machine is kept in the file as well. These records are kept in the shop office. At the machine shop of W.W. Cross, all machines are recorded on a numbering and filing system in the main store office and kept there.

b. Criteria for Stocking Parts. Table 5.2 shows that the criteria used at Digital Equipment are determined by the corporate field service stock room. At Gorman, the spare parts will be in the stock or not depending on the recommendation from the facoty, or on the frequency of selling those parts in one year (three time up is the minimum). MacCosham does not keep spare parts in stock,

except for some small parts which can be moved quickly and/or can fit most trucks such as spark plugs, tires, and so on, otherwise they order them when needed. At STamco, only a few spare parts such as cross feed screws and some feed screw nuts and bushings are kept in the storage room of the shop. W.W. Cross did not identify criteria for keeping spare parts.

c. Estimate Running Time of Machine. Table 5.2 illustrates that the estimated running time of machines at Digital Equipment are determined by corporate field services. At Gorman, the running time of the machine is not estimated. At MacCosham, the running time of the trucks is based on the mileage, for example, every 1500 miles the oil should be changed and the truck should be greased. For the machinery this is done every 100 working hours. At Stamco and W.W. Cross no estimate of running time was identified.

FINANCE

1. Budget for Maintenance. Table 5.3 shows that the maintenance budget of Digital Equipment is about 10-12% of the capital equipment inventory. At Gorman, it is about 10% of the capital inventory. Stamco spends about $6,000 per year on preventive maintenance and repairs.

MacCosham spends about $500,000 for maintenance each year. The budget for the maintenance machine shop of W.W. Cross is not shown because most of the spare parts can be produced intermally except for some materials used for preventive maintenance such as oil, coolant and so on.

2. Budget Estimation. Table 5.3 shows that the estimation budget for maintenance of Digital Equipment is done from past experience. At MacCosham, the record of the former year is the criterion for estimation and justification for the next year. At Stamco, the maintenance budget goes up with the amount of work done. So if there is good volume of business and the machine is used many hours, more money will be spent to keep it running. In W.W. Cross, the estimation for the maintenance budget is made by the physicist in cooperation with the machine shop superintendent and electric technician.

3. Budget Justification. Table 5.3 shows that at Digital Equipment, budgeting is done by a field service representative who is required to show a profit. At Gorman, it depends on cost and condition of equipment, for example, if the cost of repairing is 65% of the cost of new machines, it will be more economical to replace it. If the cost of the new machines is too expensive, then repairing is considered. At MacCosham, it is the responsibility of the superintendent

to determine between repair and replacement. At Stamco, it is considered by the manager and depends on the condition of the machine. If the machine cannot be maintained economically, it should be replaced for example, if the machine costs $10,000 and it costs $1,000 a year to keep it running, it is usually more suitable to sell it and find a new one. On the other hand, if it costs $10,000 to be replaced while it costs $400 - $500 to keep it running, it may be better to maintain instead of replace. At W.W. Cross, the justification of the budget is done by the administrative officials who decide how much each department gets.

EFFECTIVENESS

1. Cost of Maintenance

Table 5.4 shows that the cost of maintenance of Digital Equipment is estimated on a per-hour-rate cost plus expected cost of replacement parts. At Gorman, it is justified by the effectiveness of the machine after repair. If the machine is repaired and it can work for one year more, it is worth the cost to repair. If the machine needs to be replaced in three year's work time, the cost of replacement is justified. MacCosham considers the economics of keeping the organization running smoothly and the effectiveness of the machine and work production.

At W.W. Cross, it is dependent on the highest standards in treating patients.

2. Assessment of Maintenance

Table 5.4 shows that the assessment of maintenance of Digital Equipment is measured in terms of customer relations. At Gorman, it is measured in terms of financial returns and employee morale. Moreover, the customers are satisfied with the company facilities. MacCosham considers the satisfaction of clients and employees. At Stamco, it is measured by the technicians who keep the machines running and producing accurately. At the machine shop of W.W. Cross, the effectiveness of operation is measured by the breakdown in the treatment area.

Summary

The equipment maintenance systems used by private industry vary. Some produce spare parts no longer available for the repair of specific machines and automobiles. Others supply spare parts, sales service and sales transportation. Most of the firms have their own department of maintenance, machine shop and general maintenance shop for repairs and preventive maintenance of their equipment. With respect to qualifications of technicians, some organizations required extended experience some did not. Instead they required only that the technician be a graduate from a vocational institute.

The maintenance budget of private firms is considerably higher than that of educational systems because most industrial machines run for longer periods per day.

CHAPTER VI

NEEDS AND REQUIREMENTS FOR MAINTENANCE IN THE THAI COMPREHENSIVE SCHOOL SYSTEM

The information about equipment data from Thailand has been drawn by the researcher from the reports on the Thailand Comprehensive School Project (1969 and 1971), a report submitted to the President of the Canadian International Development Agency (C.I.D.A.) by Dean H.T. Coutts, Director of the University of Alberta - Thailand Comprehensive School Project. This report consists of a submission from the Canadian team of consultants in Thailand, an account of the training program and a financial statement. Additional information is drawn from the reports of the Temporary Maintenance Team and the experience of the researcher who worked with that team for a period of time.

Following types of data from Thailand were considered:

1. Kind and number of industrial arts (I.A.) shops in the comprehensive schools.
2. Kind and amount of I.A. equipment in each shop.
3. Essential tools for maintenance work.
4. Vehicles used for maintenance.

Name of Schools / Name of Schools	General Electricity.	Unit Electricity and Electronics.	General Power Mechanics.	Unit Power Mechanics.	General Metal.	Unit Metal.	Drafting.	Wood & Construction.	Remarks.
Samsen Wittayalai	1	1	1	1	1	1	1	1	Co-Ed.
Piboon Wittayalai	1	1	1	1	1	1	1	1	Co-Ed.
Nakorn Sawan	1	1	1	1	1	1	1	1	Boys.
Rajseema Wittayalai	1	1	1	1	1	1	1	1	Boys.
Kaen Nakorn	1	1	1	1	1	1	1	1	Co-Ed.
Roi-ed Wittayalai	1	1	1	1	1	1	1	1	Boys.
Benjama Rajrangsarit	1	1	1	1	1	1	1	1	Co-Ed.
Yuparaj Wittayalai	1	1	1	1	1	1	1	1	Boys.
Udorn Pittayanukoon	1	1	1	1	1	1	1	1	Boys.
Piyamaha Rajalai	1	1	1	1	1	1	1	1	Co-Ed.
Kanarajsadorn Bamroong	1	1	1	1	1	1	1	1	Boys.
Samakkee Wittayakom	1	1	1	1	1	1	1	1	Boys.
Haad yai Wittayalai	1	1	1	1	1	1	1	1	Co-Ed.
Cholraj Umroong	1	1	1	1	1	1	1	1	Boys.
Saraburi	1	1	1	1	1	1	1	1	Boys.
Boonyawat Wittayalai	1	1	1	1	1	1	1	1	Boys.
Benjama Maharaj	1	1	1	1	1	1	1	1	Boys.
Chalerm Khuan	1	1	-	-	1	-	1	1	Girls.
Ayuthaya Wittayalai	1	1	1	1	1	1	1	1	Boys.
Benjama Rajuthid	1	1	1	1	1	1	1	1	Boys.
Total	20	20	19	19	20	19	20	20	

TABLE 6.1

Kind and Number of Industrial Arts Shop of the Thai Comprehensive Schools.

1. Kind and Number of I.A. Shops in the Comprehensive Schools.

Table 6.1 shows that in the comprehensive schools in Thailand, there are twenty general electricity shops, twenty unit electricity and electronics shops, nineteen general power mechanics shops, nineteen unit power mechanics shops, twenty general metal shops, nineteen unit metals shops, twenty drafting rooms and twenty unit wood constructionshops. The general shops are designed and equipped to offer an exploratory course for first year students. They may also be used to handle some of the second year classes when the unit shops are being used to capacity. The unit shops are designed and equipped to offer advanced training in a specific area. The "remarks" show that there are six co-educational schools, thirteen boys' schools, and one girls' school. The co-educational schools have the same shop and the same equipment as the boys' school. The girls' schools emphasize home economics more than industrial arts programs so the shops and equipment are different. The industrial arts shops are located in separate buildings. The electricity, electronics and the wood and construction shops occupy one 14 x 42 meter building while the drafting, general power and power mechanic shops occupy another 14 x 42 meter building. The general metal and metal working shops occupy another smaller building that measures 14 x 31.50 meters. All industrial arts shops are located

in these buildings. However, the girls' school had only two buildings because three areas of industrial arts are excluded. Those areas are general power mechanics shop, power mechanics shop and metal work shop. In Thailand, due to the climate, daylight is used more than electric light in these buildings. Both sides of industrial arts buildings have windows which open for light and cross ventilation.

Figure 6.1 shows the industrial arts building I. This building consists of general electricity shop, electricity and electronics unit shop and wood and construction unit shop. The first half of the building is arranged for general electricity shop and electricity and electronics unit shop. The reason that the general and the unit shop in the same subject area exist in the same building is that the general shop can also serve the students who are "over limit class" from the unit shop. Both shops use the same panic control switch, safety switch, teachers' room and ham radio station, but each has its own tool room. In the unit shop the power used is 220 volts 50 hertz single phase and 380-440 volts 50 hertz three phase electric power supply systems. In the general shop the power used is 220 volt 50 hertz single phase electric power supply system. The area of these two shops is approximately three hundred square meters. Each

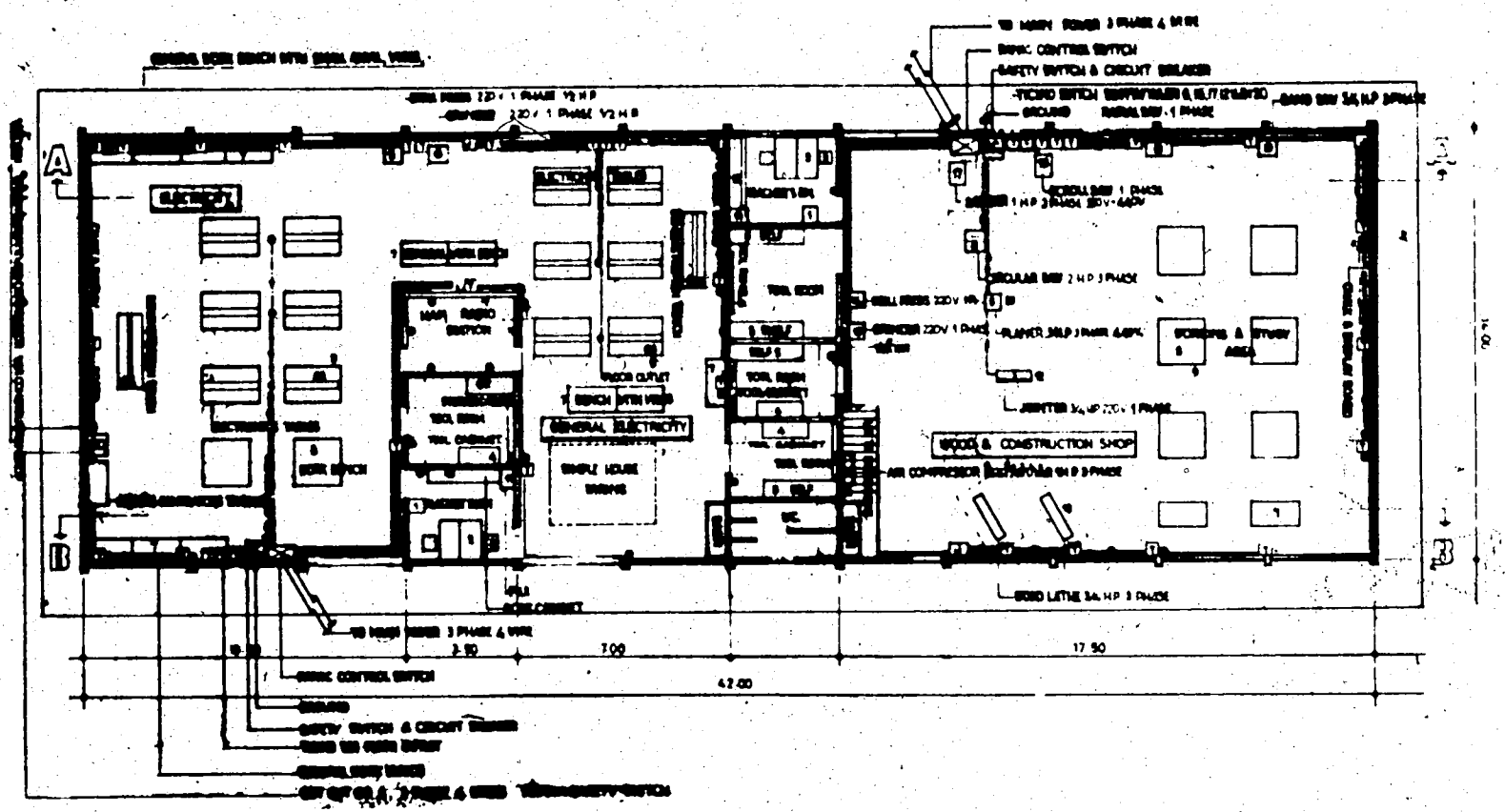


FIGURE 6.1

Industrial Arts Building 1

of the Comprehensive Schools in Thailand.

shop area can serve twenty five students at a time.

The second half of the building is arranged for a wood and construction shop. This area has its own panic switch and safety circuit breaker. The power used is 220 volts 50 hertz single phase and 380-440 volts 50 hertz three phase electric power supply systems. The area of this shop is approximately three hundred square meters.

Figure 6.2 shows the industrial arts building II. The building is divided into three sections: drafting room general power mechanics and power mechanics unit shop. The drafting room is located at the end of the building. The wall and chalk board are used to absorb the noises from the general and unit power mechanics shops. General and unit power mechanics shops are in the second and third section. These two shops have a common teachers' room and an open area joining the two facilities. This will enable the students and teachers to share certain pieces of equipment and work space. The two areas use the same panic switch to control electric power supplier. The power used is 220 volts 50 hertz single phase and 380-440 volts 50 hertz three phase.

Figure 6.3 shows the industrial arts building III. This building is smaller than the other two. It is divided

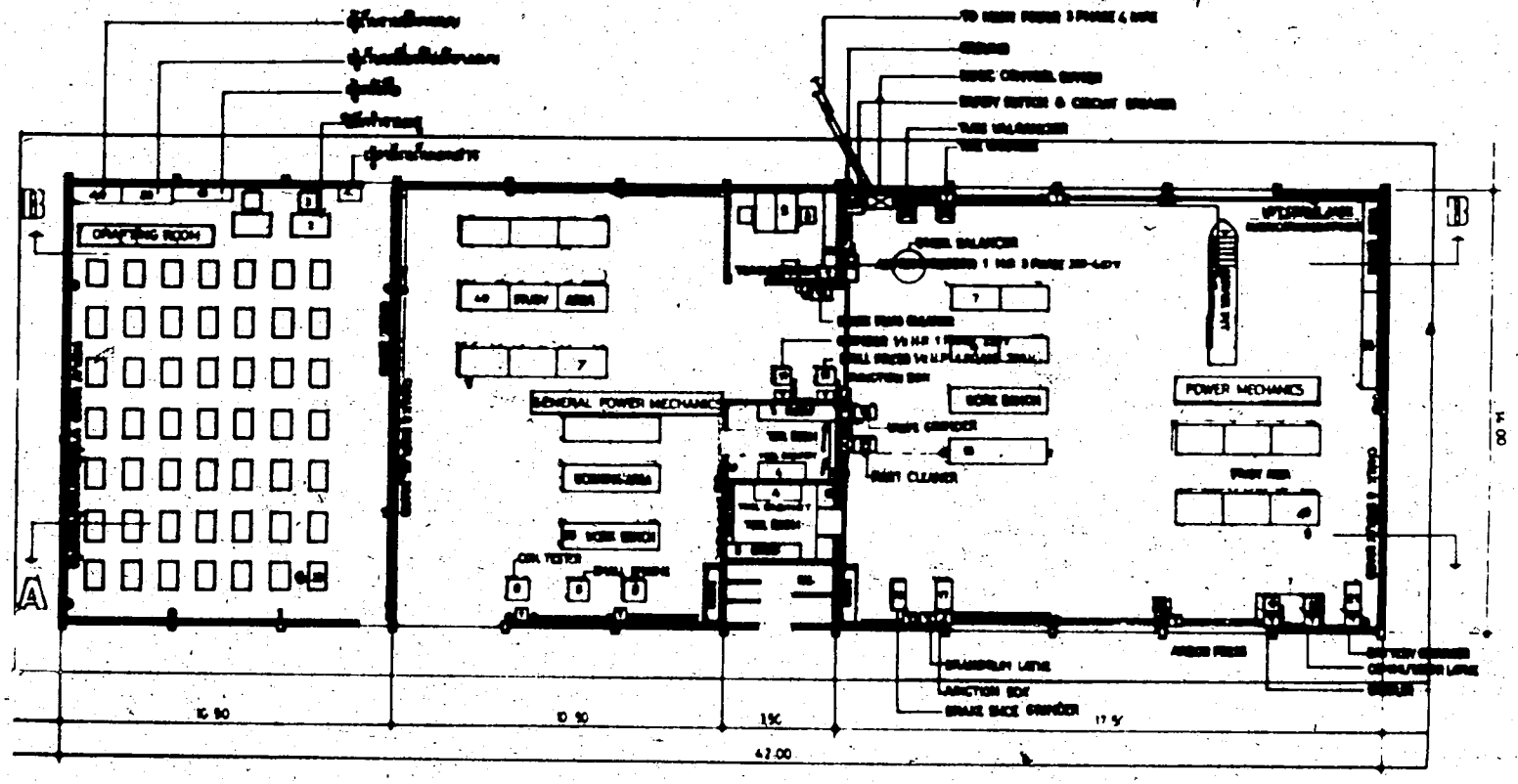


FIGURE 6.2

Industrial Arts Building II

of the Comprehensive Schools in Thailand.

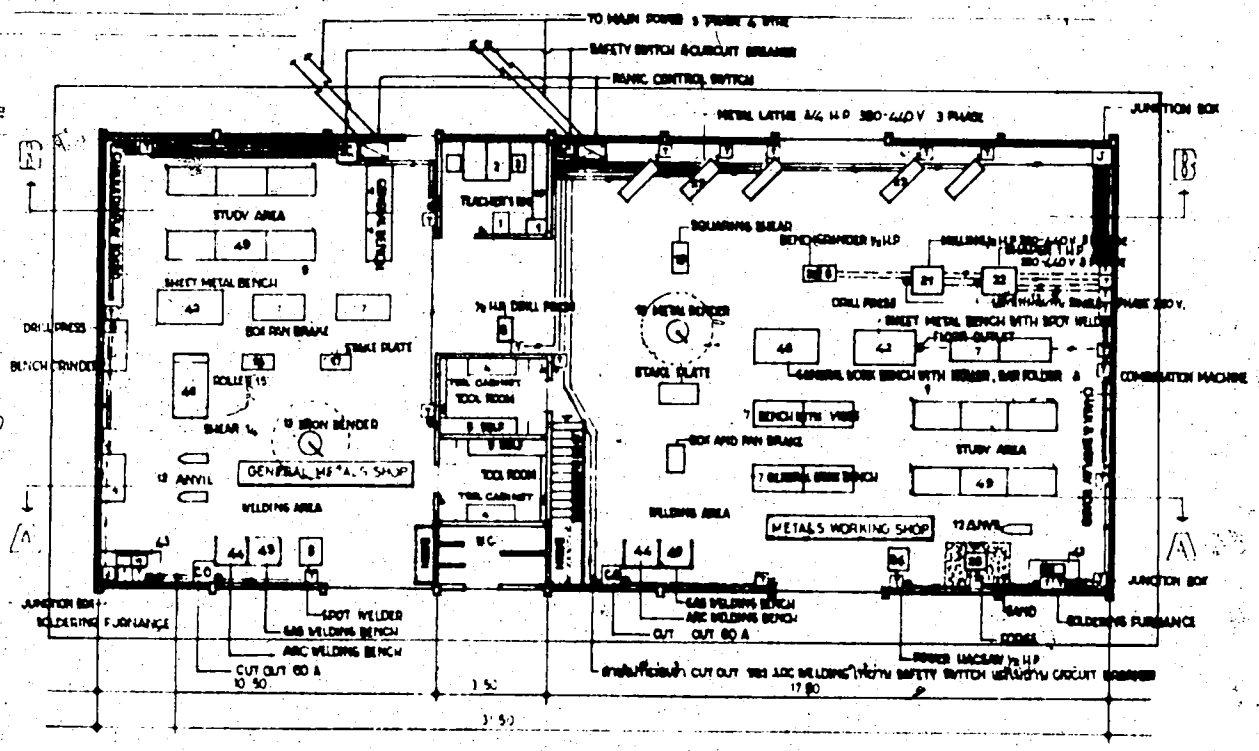


FIGURE 6.3

Industrial Arts Building III

of the Comprehensive Schools in Thailand.

into two sections, one for general metals shop; another for a unit metals shops. The area is approximately four hundred and thirty square meters. Each shop has its own panic switch, safety switch and tool room. Both areas are open to each other and share one teachers' room. The power used is 220 volts 50 hertz single phase and 380-440 volts 50 hertz three phase electric power supply systems.

2. Kind and Quantity of Equipment

a. General electricity shops. The equipment in this shop consists of basic hand tools, basic measuring instruments for electricity and low voltage A.C. and D.C. electric power. The description and quantity of each of the forty-five items of equipment are shown in Appendix C.

b. General metals shop. The equipment provided for this shop includes basic hand tools, basic measuring instruments, and basic power tools. These tools are used to explore the interests and aptitudes of the students. They permit students to become acquainted with them as well. The description and quantity of each item of equipment is shown in Appendix C.

c. General power mechanics shop. The equipment of this shop is used to explore the interests and abilities of first year students of the comprehensive school equivalent to grade 8. As far as equipment is concerned the emphasis is on hand

tools, measuring instruments and some machine tools. They include such items as nut driver set, wrenches, inside tubular, micrometer, spark plug cleaner and several others. The description and quantity of each of the seventy-six items of equipment are shown in the Appendix C.

d. Unit electricity and electronics shop. The equipment of this shop consists primarily of hand tools, complex measuring instruments, generators, motors, power supplies and audio-frequency generators, oscillo-scopes, electricity and electronics student kits and radio-frequency generators. The description and quantity of each of the seventy-eight items are shown in Appendix C.

e. Unit metals shop. Machine tools, complex hand tools, complex measuring instruments and forging equipment are emphasized in this shop. They include, for example, lathes, shaper, milling machine and several others. The description and quantity of each of one hundred and thirty items of the equipment are shown in Appendix C.

f. Unit power mechanics shop. The equipment in this shop consists of power tools for making repairs, hand tools, special hand tools for making repairs, tune-up and testing equipment. The description and quantity of each of the one hundred and seventy-four items of equipment are shown in Appendix C.

g. Unit wood and construction shop. Hand tools, port-

able tools, machine tools and measuring instruments for wood work and construction are emphasized in this shop. They include, for example, jack planes, keyhole saws, circular saws, wood lathes, marking gauges and several others. The description and quantity of each of the one hundred and twenty-eight items of equipment are shown in Appendix C.

h. Drafting room. This shop has only sixteen items of equipment. These are used for drawing and printing. The description and quantity of the equipment are shown in Appendix C.

3. Essential Tools for Maintenance Work

The Temporary Maintenance Team possesses some essential tools for maintenance work for the comprehensive schools all over the country. These tools are normally not available in the schools or, if there are some, they are in limited quantiy.

The existing tools are sufficient to maintain all equipment in the comprehensive schools. The maintenance equipment has been obtained from several sources:

a. A donation of ($1,500) fifteen hundred dollars from the Canadian Embassy in Thailand.

b. Equipment from Canada designated for certain schools but held at the warehouse for maintenance purposes until

the schools were completed.

c. Equipment purchased with regular project budget funds.

d. The Bank of Thailand Loan funds.

The major items of equipment and special tools are shown in Appendix C.

4. Vehicle Used for Maintenance

The duty of the Temporary Maintenance Team is to visit the school shops all over the country in order to help repair or install equipment. The vehicles are needed to carry the spare parts and equipment for repairing and maintaining the equipment in the schools. Five out of the six vans used for maintenance and warehouse work were donated by an American Air Base in Thailand. The Department of General and Adult Education spends a certain amount of money to repair and maintain these vehicles each year and keep them in good condition. The condition and size of the vehicles are described in the proposal of the Temporary Maintenance Team submitted to Director General of Department of General and Adult Education and Director of the Comprehensive School Project (Gretsinger, 1973). The vehicles are:

Jeep Wagoneer (2) - Both are in too poor mechanical condition to be considered for lengthy trips.

Even for short trips, the carrying capacity of these vehicles is too limited for maintenance equipment to be brought along.

Dodge Van-This is the vehicle best suited to maintenance purposes. The capacity, while not great, is adequate for most requirements. Comfort for long trips is acceptable and the horse power is sufficient to maintain a good travelling schedule on the highway. The problem with this vehicle is that it is becoming old and is increasingly in need of repair.

Land Rover is in good mechanical condition but is extremely uncomfortable for long trips. Also the load capacity is too limited to make it acceptable for most maintenance trips.

Pick-up truck-This half ton Chevrolet has room for two passengers only. The load is not protected from the weather or from thieves.

International Van -This one ton van is good for carrying heavy equipment but is too slow to be practical for long trips out of Bangkok. The fuel consumption is also too high to be practical.

The Temporary Maintenance Team has proposed the proposed purchase of a new vehicle for maintenance work. The specifications proposed for the vehicle are: (Gretsinger, 1973b)

Van type one ton body (minimum) with the front two rows of seats, space for equipment and luggage storage rear opening doors, and windows all around.
Power transmission 3 or 4 speed, synchro-mesh gear box with standard clutch transmission.
Engine 2.0 litre (minimum) V 4 or 4 in-line, capable of developing up to bhp. 90-gasoline preferred.
Brakes - Dual line hydraulic brakes required on all 4 wheels in addition to hand operated emergency brake.

Electrical system - 12 volts, including heavy duty battery.

Summary

Twenty comprehensive schools have been located throughout Thailand, each with its own industrial arts shops and equipment. Twenty shops are equipped for programs in general electricity, twenty in electricity and electronics, nineteen in general power mechanics, nineteen in power mechanics, twenty in general metals, nineteen in unit metal, twenty in drafting, and twenty in wood and construction. In these schools installation and equipment maintenance have been the responsibility of a temporary maintenance team which has some equipment used for maintenance and vehicles to transport maintenance supplies and permit supervision.

CHAPTER VII

THE REACTION OF THE PANEL OF EXPERTS TO PROPOSED MANAGEMENT OF INDUSTRIAL ARTS EQUIPMENT MAINTENANCE FOR COMPREHENSIVE SCHOOLS IN THAILAND

The model of management of industrial arts equipment maintenance for Comprehensive schools in Thailand was developed after analysing the results of maintenance systems of education in Alberta (Chapter 4) maintenance systems of industry in Alberta (Chapter 5) and requirements of equipment maintenance in Thai Comprehensive Schools (Chapter 6). This model was submitted to the five members of the panel of experts as described in Chapter 3. A Copy of the model which was sent to the panel is shown in Appendix B.

The purpose in seeking reactions from the panel of experts was to help in the development and refinement of the final Model of Management of Industrial Arts Equipment Maintenance for Comprehensive Schools in Thailand.

Every statement in the model submitted to the panel of experts allowed for responses on a three point scale included in the Response Form.

Write A Agree completely,

Write B Agree in principle, and indicate further the condition requirements or additional comments.

Write C Disagree and indicate an alternative if any.

The responses of the panel of experts are shown in summary tables 7.1 and 7.12, except comments made which are noted in the text. Each statement in the model together with the reaction of the panel to it is presented in this chapter.

STRUCTURE OF MAINTENANCE

1. Organization

1.1 Organizational Structure The organizational structure of I.A. equipment maintenance should include two levels of personnel: managerial and operational.

The organizational chart is shown on figure 7.1.

No panel responses were solicited for statement 1.1.

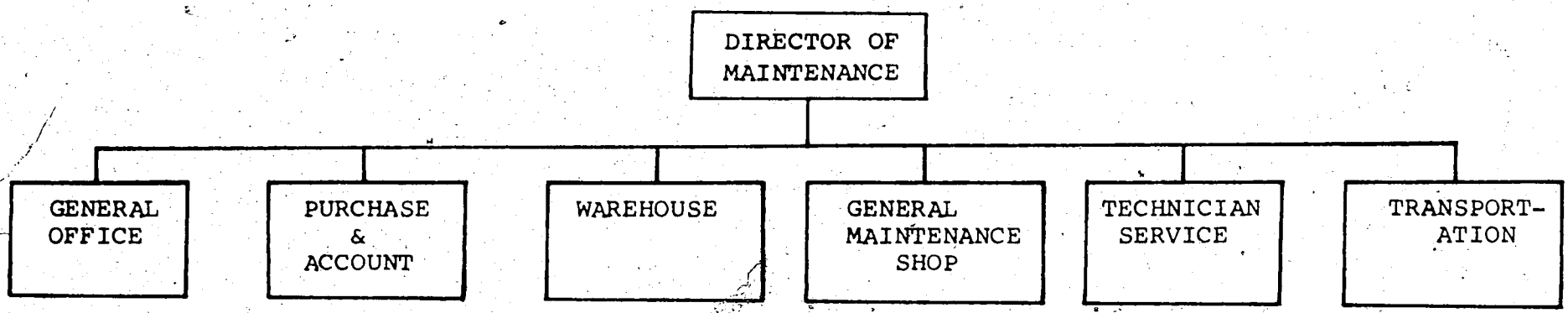


FIGURE 7.1

THE ORGANIZATIONAL CHART OF MANAGEMENT

I.A. EQUIPMENT MAINTENANCE OF COMPREHENSIVE

SCHOOLS IN THAILAND

A summary of the reactions of the panel of experts to this part of the model is shown in Table 7.1.

Table 7.1

Summary Table of Reaction of the Panel of Experts to Section 1, Organization of the Proposed Model for equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
1.	Organization	
1.1	Organizational Structure & Function	- - - - -
1.11	Managerial Level	A A A A B
1.12	Operational Level	A A A B B
1.121	General Office	A A A B A
1.122	Purchasing and Accounting	A A A B B
1.123	Warehouse	A A A B A
1.124	General Maintenance Shop	A A A B A
1.125	Technical Service	A B A B B
1.126	Transportation	A B A B A
1.2	Maintenance Function	- - - - -
1.21	Maintenance Staff	B B A B B
1.22	Teaching Staff	B A B B B

1.11 Managerial Level This level is to administrate the whole of maintenance policy and maintenance work for all comprehensive schools in Thailand.

Four of the panel members agreed completely and one agreed in principle. Panel member (5) suggested that the appointment of an assistant director be a further consideration. This appointment indicates a high salaried position. As an alternative, he suggested a highly qualified officer or business manager who would be able to assist the director until such time as development warranted the appointment of full time assistant director. He further suggested that available funds be directed more toward the technical staff, warehouse stocks, maintenance equipment, etc.

1.12 Operational Level This level is to serve the maintenance function (as defined in chapter 1 of the report). Included in this category are general office, purchasing and accounting section, warehouse, general maintenance shop, technical service section, and transportation.

Three of the panel members agreed completely, while panel member (4) recommended, depending upon the size of the operation, the combination of 1.121 and 1.122, 1.123

and 1.126, 1.124 and 1.125, to make three operational functions rather than six. Panel member (5) expressed concern that too much effort might be devoted to "paper work" and not enough to the actual maintenance function.

1.121 General Office The functions of the general office are proposed to include (1) coordination of various sections at the operational level, (2) provision of services to the other sections, (3) communication between the maintenance office and other bodies such as private firms and schools, (4) inventory card record, and arrangement of servicing trips. Two persons are required in this section, one a stenographic clerk and the other a business clerk.

Four of the panel members agreed completely with the model while panel member (4) again recommended the combination of functions 1.121 and 1.122.

1.122 Purchasing and Accounting Section The functions of the purchasing and accounting section are to: (1) survey requests from the other sections with respect to needs such as spare parts, (2) check the accuracy of specifications on those needs, (3) purchase equipment and material, (4) control budget. One person is needed to serve in this section.

Three panel members agreed completely and two agreed in principle. Panel member (4) again recommended the combination of functions 1.121 and 1.122. Panel member (5) advised that if we employed a highly qualified business manager, he could handle the work of assistant director as well as the purchasing and accounting section.

1.123 Warehouse The duties of warehouse include: (1) storekeeping, (2) distributing, (3) suggestion of purchase of material supply or spare parts, (4) crating, (5) receiving and sending. A minimum of two persons are required: one stock clerk, and one crating foreman.

Four of the panel members agreed completely. Panel member (4) agreed in principle and recommended the combination of functions 1.123 and 1.126.

1.124 General Maintenance Shop The functions of the general maintenance shop are to include, (1) fabricating parts that are not readily available, (2) repairing the equipment which was brought in from the schools if possible otherwise sending it to outside vendors. The general maintenance shop will take over the equipment that has been used by the Temporary maintenance team. Two technicians are required to serve this section.

Four of the panel members agreed completely. Panel member (4) agreed in principle and recommended the combination of functions 1.124 and 1.125.

1.125 Technical Service Section The functions of this section are to include: (1) equipment inspection in each school according to the scheduled list of maintenance, (2) installation of equipment, (3) consulting in planning maintenance work, (4) establishing the specifications for equipment, (5) checking new equipment, including establishing compatibility with the Thai electrical power distribution system. Two technicians are required to serve in this area. These technicians should alternate their duties with the technicians in the general maintenance shop.

Two of the panel members agreed completely with the model and three agreed in principle. Panel member (2) stated that two technicians on the road and two in the shop are not sufficient for the number of schools involved. He further recommended that the care of the equipment and tools in maintenance vehicles should be the responsibility of technicians. Panel member (4) recommended the combination of function 1.125 and 1.124. Panel member (5) made several suggestions concerning this part of the model. He indicated

that the technicians service section should establish the specification for equipment to be used at the warehouse for repair work. Further he suggested that all industrial arts programs in the Thai Comprehensive Schools should be fundamentally the same and that equipment in one school not differ substantially from that in another. Panel member (5) also suggested that when equipment is purchased the specifications be drawn up by the instructor in consultation with the technical service section.

1.126 Transportation Section The duties of this section are to: (1) supply transportation services for the divisions of the department when reasonably required, (2) supply transportation services for the technicians who make the trips to inspect and repair equipment in the schools, (3) check and record the condition of vehicles, (4) control preventive maintenance and repair vehicles, (5) control gas and oil used with vehicles, (6) assign the drivers, (7) care for equipment and tools which are fixed permanently in the truck or van for "moving maintenance work" in the schools, (8) contact with outside moving lines. For economic reasons, the temporary team maintenance vehicles should be used in this section. A minimum of one person would be required to serve this section.

Three of the panel members agreed completely with the model and two agreed in principle. Panel member (2) suggested that care of equipment and tools in the maintenance vehicles should be the responsibility of the technicians. Panel member (4) recommended the combination of functions 1.123 and 1.126.

1.2 Maintenance Functions Two groups of personnel are responsible for maintenance work: maintenance staff and teaching staff.

No panel responses were solicited for statement 1.2.

1.21 Maintenance Staff The maintenance staff has the responsibility for directing and carrying out maintenance work on industrial arts equipment in all comprehensive schools.

One of the panel members agreed completely with the model and four agreed in principle. Panel member (1) added that we should perform maintenance in all schools, assist at maintenance seminars, and work under a careful plan which includes routine servicing as well as emergency service. Panel member (2) suggested that the maintenance staff will no doubt be used to install the new equipment in

schools that are part of future projects. The maintenance staff should be responsible for maintenance of all practical arts equipment, not just industrial arts. Panel member (4) agreed in principle but he did not comment. Panel member (5) suggested that the use of the word "directing" indicated that the maintenance staff will set up their own policy with respect to maintenance work whereas it is his belief that actual policies and procedures for implementing these would be set up by the director. Most certainly, if the maintenance staff found that a certain policy or procedure was not working out and was cumbersome then the director should be available to meet with them and discuss how the situation might be improved or modified to suit the needs of the system in the most efficient manner.

1.22 Teaching Staff This staff has a minor function in maintaining industrial arts equipment in the schools where they are teaching. This maintenance work may include oiling and cleaning for instance.

One of the panel members agreed completely with the model and four agreed in principle. Panel member (1) suggested that maintenance seminars should be a part of a regular schedule. Panel member (3) suggested that a continuing effort be made to get teachers to accept a larger

share of the responsibility for maintenance than the model indicated. He supported this point stating "most schools are remote and consequently special maintenance is costly" and teaching loads are lighter than in Alberta so teachers have more time to make minor repairs". Panel member (5) said, "...it is suggested that certain electrical and mechanical repairs could be affected as students projects. This would provide the students with a meaningful undertaking and at the same time give them an insight into the working of the various machines..."

Implication for the Model, Section 1 of the model should remain substantially as originally presented to the panel of experts. All panel members agreed with Section 1 of the model either completely or in principle. Some suggestions for change were made.

At the operational level, 1.12, if financial constraints are a too limiting consideration, consideration should be given to combining some functions. The Technical Service Section rather than the transportation section should take responsibility for maintenance of equipment permanently mounted in the service vehicles as originally indicated in the model.

The duties of maintenance staff 1.21, should be expanded to include installation of the new equipment in schools and to provide maintenance seminars for teachers. The Teaching Staff, 1.22, should take more responsibility for maintenance than is indicated in the original model.

2. Qualification and Work Experience of Personnel

The personnel in organizational level are the important elements of the maintenance department. So the maintenance requires personnel who are highly qualified and experienced in maintenance work.

No [illegible]nel responses were solicited for statement 2.

A summary of the reactions panel of experts to this part of the model is shown in Table 7.2.

Table 7.2

Summary table of Reaction of the Panel of Experts to Section 2, Qualification of Personnel, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
2.	Qualification	
	2.1 Qualification	B A B B B
	2.2 Work Experience	B A B B B

2.1 Qualification The person who does maintenance work should have minimum qualification in any one of these: (1) vocational certificate, (2) journeyman standing and/or equivalent, such as millwright and electrician.

One of the panel members agreed completely with the model; four agreed in principle. Panel member (1) suggested that although there are well qualified Thai people the maintenance team might have difficulty in attracting them because civil service salaries are not generally competitive with salaries paid by private firms. Panel member (3) sug-

gested that one or two maintenance men might be paid on the same scale as teachers in order to attract good staff away from industry. This would also, he suggested, avoid having a good teacher give up teaching in order to do maintenance. Panel member (4) agreed in principle but did not comment. Panel member (5) suggested that although a vocational certificate might be desirable the important qualification should be journeyman status in millwright or electrician trades.

2.2 Work Experience The person who does the maintenance work should have at minimum two years experience after graduating from a vocational institute.

For the director or assistant director, professional or university level qualification in education (Industrial Arts) or engineering, with some background in administration and a minimum of five years of teaching experience in industrial arts is required.

One of the members agreed completely with the model and four agreed in principle. Panel member (1) suggested that it would be difficult to attract experienced personnel from industry because of the civil service's generally lower wage scale. Panel member (3) suggested that work experience is the most important factor for maintenance

workers. Panel member (4) suggested that a minimum of two years experience should be in maintenance work and not merely in the trade. Panel member (5) suggested that the prime requisite of the maintenance staff should be journeyman status.

Implications for the Model Section 2 of the model needs to be changed to increase the status and qualifications of maintenance personnel. The panel stressed the need to specify more precisely the kind and amount of experience required by maintenance personnel.

3. Work Planning This is the heart of maintenance program. Work planning includes scheduling of men and equipment as well as developing specific maintenance schedules for various items of equipment. The smoothness and efficiency of the maintenance departments work depends upon the skill with which work is planned.

No panel responses were solicited for statement 3.

A summary of the reactions of the panel of experts' reactions to this part of the model is shown in Table 7.3.

Table 7.3

Summary Table of Reaction of the Panel of Experts to Section 3, Work Planning, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
3.	Work Planning	
3.1	Planning Personnel	A A A B A
3.2	Planning Procedure	A A A B A
3.3	Emergency Cases	B A A A B
3.4	Transportation	B A A A B
3.5	Delivery Time	B A B B A

3.1 Planning Personnel The persons who take responsibility for maintenance planning are the director of maintenance and the technicians on his staff. The director of maintenance together with the technicians on his staff will be able to carry out their function because of the experience they will gain and their intimate knowledge of conditions existing in each industrial arts laboratory.

Four of the panel members agreed completely with the model. Panel member (4) agreed in principle but did not make any recommendation.

3.2 Planning Procedure The information used for planning maintenance work to be carried out on a monthly, semester or annual basis will be obtained from the following sources: (1) data from previous year's work, (2) inspection reports made by the director and his staff, and (3) request from the schools.

Four of the panel members agreed completely with the model and panel member (4) agreed in principle but did not make any recommendation.

3.3 Emergency Cases When a maintenance problem occurs which is thought to be an emergency situation by the teacher, or person who works with the particular piece of equipment, he reports this fact to the shop director who in turn consults with the principal. If the principal and shop director agree that an emergency situation does exist, they determine what procedure to follow. For example, they may decide: (a) the industrial arts staff should make the necessary repairs, (b) an outside vendor in the local area might be called in, or (c) they may contact the director of

maintenance and ask for help in making the required repairs.

Three of the panel members agreed completely with the model and two agreed in principle. Panel member (1) expressed the view that the channels of communication must be clearly indicated. Panel member (5) misunderstood the term "shop director". From his comments it appears likely that he would have agreed completely with the model had not this misunderstanding occurred.

3.4 Transportation The vehicles used for servicing and transporting equipment between center and schools are: (1) cars, (2) vans, (3) trucks, (4) moving company, (5) railroad and/or (6) airplane, depending on circumstances.

Three of the panel members agreed completely with the model and two agreed in principle. Panel member (1) suggested that the vehicle should be used for the transportation of the maintenance team but not for individual private use. Panel member (4) agreed in principle but did not comment.

3.5 Delivery Time The time for delivering equipment or commodities from center to the schools ranges from twenty four hours to one week, depending on distance and

location.

Two of the panel members agreed completely with the model and three agreed in principle. Panel member (1) suggested that this proposal must be for emergencies as normal delivery time in Thailand is often measured in months rather than days. Panel member (3) suggested that delivery within one week has not been possible up to now and delivery within two weeks to all schools probably will not be possible for at least another year. A more realistic delivery expectation should be established. Panel member (4) did not make a recommendation.

Implication for the Model Section three of the model should remain substantially as originally presented to the panel of experts. All panel members agreed with the items in section 3 either in principle or completely. Some suggestions for change were made.

The term "shop director" should be dropped from the model and the term "head of practical arts department" substituted. The use to which maintenance vehicles may be put should be very clearly spelled out in the model and a more realistic indication of delivery time should be incorporated.

The channels of communication in emergency cases should also be clearly delineated in the model as these will be different from the normal channels of communication. The need here is to ensure rapid delivery of maintenance service when an emergency arises.

PROCEDURE OF MAINTENANCE

4. Kind or Type of Work This section emphasizes the kinds of tasks which are directly concerned with the maintenance and liaison function.

No panel responses were solicited for statement 4.

A summary of the reactions of the panel of experts' to this part of the model is shown in Table 7.4.

Table 7.4

Summary Table of Reaction of the Panel of Experts to Section 4, Kind or Types of Work, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
4.	Kind or Type of Work	
	4.1 Maintenance Work	B A B B B
	4.2 Liaison Work	B A B B A

4.1 Maintenance Work The maintenance work covers all industrial arts areas of all comprehensive schools, some audio visual equipment which is used in industrial arts labs and general maintenance shops in the center.

One of the panel members agreed completely with the model and four agreed in principle. Panel member (1) suggested that the model include installation of new equipment as part of the duties of the maintenance department. Panel member (3) suggested that the model should include maintenance of home economics equipment and some building mainten-

ance. Panel member (4) agreed in principle but did not make a recommendation. Panel member (5) suggested that outside agencies be considered for some maintenance tasks particularly where specialized skills are required and where there would not be enough work to keep a specialist employed full time.

4.2 Liaison work Liaison work is a necessary part of a maintenance program. For smooth operation of the maintenance department it is necessary that channels of communication be maintained between each of the following: general office, technical service, department of vocational education, police department, and private firms.

Two of the panel members agreed completely with the model and three agreed in principle. Panel member (1) suggested that communication with the schools is vital. Panel member (3) agreed in principle but queried the provision of a channel of communication maintained with the police department. Panel member (4) agreed in principle but made no suggestion.

Implication for the Model Section 4 of the model should remain substantially as originally presented to the panel of experts, except that outside agencies should be utilized for

some specialized tasks and emphasis should be put on maintaining channels of communication with the schools.

5. Inspection This section deals with inspecting personnel, inspecting procedure, and outcome of inspection, as shown in the subheadings below.

No panel responses were solicited for statement 5.

A summary of the reaction of the panel of experts to this part of the model is shown in Table 7.5.

Table 7.5

Summary Table of Reaction of the Panel of Experts to Section 5, Inspection, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
5.	Inspection	
5.1	Inspection Personnel	A A A A A
5.2	Inspection Procedure	B A A B B
5.3	Outcome of Inspection	B A A A B

5.1 Inspecting Personnel Most of the inspectors of the systems in Alberta are the head persons of maintenance departments and technicians who are involved with maintenance work. The similar positions of inspectors applied to the Thai comprehensive schools are: (1) director or assistant director, (2) technicians (3) instructors.

All the members of the panel agreed completely with the original model.

5.2 Inspecting Procedure The procedure for inspecting should be similar to systems in Alberta. It consists of (1) consulting with planning personnel to set schedules for inspecting equipment monthly, semesterly, and yearly, (2) checking the condition of equipment, (3) checking the operating function of equipment, (4) inspecting new equipment, repaired equipment and assessing compatibility of new and repaired equipment with existing equipment and fixtures.

Two of the panel members agreed completely with the model and three agreed in principle. Panel member (1) suggested that inspection procedures include observing the equipment in normal use. Further panel member (1) suggested that the maintenance personnel provide instructors with description on the proper use and maintenance of equip-

ment when necessary. Panel member (4) noted that the maintenance instruction supplied with machines should be consulted. Panel member (5) suggested that routine inspections should be carried out.

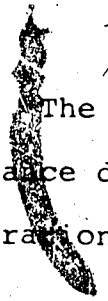
5.3 Outcomes of Inspection The results of inspection are used: (1) as indication of immediate needs for maintenance, (2) as information for planning, (3) as the basis for estimation of the next year's budget, (4) for claims to suppliers of transportation companies if equipment is damaged or some items are missing.

Three of the panel members agreed completely with the model and two agreed in principle. Panel member (1) indicated that the primary outcome of the maintenance departments' work must be the "...continuous and efficient operation of all equipment and machines in every I.A. shop. All other outcomes are secondary". Panel member (5) emphasized the need for accuracy of inspection outcomes if these outcomes are to be used for damage claims on shipped goods.

Implication for the Model Section 5, of the model should remain substantially as originally presented to the panel of experts. All panel members agreed with the items in section 5 either in principle or completely. Some sugges-

tions for change were made.

In the inspecting procedures, item 5.2, inspection procedures should include observing the equipment in normal use. The maintenance instructions supplied with machines should be consulted.



The outcomes of inspection 5.3, outcome of the maintenance department work must be continuous and efficient operation of all equipment and machines in each I.A. shop.

6. Inventory This item deals with equipment record, criteria for spare parts stocking, and estimation of machine running time as shown in the headings below.

No panel responses were solicited for statement 6.

A summary of the reaction of the panel of experts' to this part of the model is shown in Table 7.6.

Table 7.6

Summary Table of Reaction of the Panel of Experts to Section 6, Inventory, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
6.	Inventory	
6.1	Equipment Record	A A A B A
6.2	Criteria	A A A B A
6.3	Estimation of Machine Running Time	B B A B B

6.1 Equipment Record All equipment which is used in the industrial arts department of all comprehensive schools and in the center must be recorded on: (1) master cards (as shown in figure 7.2) and be kept in the center, (2) inventory cards, which have the same details as master cards. There are two sets of inventory cards, identical to the master cards. One set of inventory cards, are kept in the center and are used by the technicians to record maintenance work, and another set is kept in the schools. The spare parts stock is recorded on cardex cards (as shown in

Figure 7.3).

Four of the panel members agreed completely with the model and panel member (4) agreed in principle but did not make a suggestion.

6.2 Criteria for Stocking Spare Parts Parts for specific pieces of equipment may be stocked, based on two criteria: (1) the frequency with which repairs requiring a particular part are made and (2) the cost of the part. General items of hardware that are inexpensive and which have many applications must also be stocked. Spare parts are usually kept in the stock room in the maintenance warehouse. Up-to-date inventories should be maintained. A stocking clerk should take the responsibility for the security of these spare parts; he should handle the inventory cards and keep them updated.

Four of the panel members agreed completely with the model and panel member (4) agreed in principle but did not make a suggestion.

6.3 Estimation of Machine Running Time The running time of machines is estimated from: (1) the record of class hours and multiple activities in labs, (2) the information on maintenance record cards.

One of the panel members agreed completely with the model and four agreed in principle. Panel member (1) suggested that the record should include frequency and cost of repairs. Panel member (2) recommended it is not practical to try to keep track of the running time of various machines in a school that is a [redacted] situation from an industrial plant where machines [redacted] steady every day. It is better to set up a [redacted]e for periodic servicing. Panel member (4) agreed in principle but did not make a suggestion. Panel member (5) suggested that a great amount of information could be considered helpful and the nature of information must be constantly reviewed and used; otherwise it has little value.

Implication for the Model Section 6 of the model should remain substantially as originally presented to the panel of experts. All panel members agreed with the items in section 6 either in principle or completely. Some suggestions for change were made.

In the estimation of machine running time, 6.3, the records should include frequency and cost of repairs. The nature of information recorded must be reviewed periodically and its value assessed.

FINANCE OF MAINTENANCE

7. Budget The budget is prepared for equipment maintenance in all the comprehensive schools and the center.

No panel responses were solicited for statement 7.

A summary of the reactions of the panel of experts to this part of the model is shown in Table 7.7.

Table 7.7

Summary Table of Reaction of the Panel of Experts to Section 7, Budget, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
7.	Budget	
7.1	Budget for Maintenance	B C B B B

7.1 Budget for Maintenance The budget for maintenance in several systems in Alberta approximates one per cent to

twelve per cent of inventory capital. Normally for educational systems, this percentage is lower than in industrial systems. For the Thai comprehensive schools the amount of money in maintenance budget should range from $84,000 (1%) to $1,008,000 (12%). These amounts are based on the value of the capital equipment which is 8.4 millions of dollars.

Four of the panel members agreed in principle and one disagreed. Panel member (1) felt that the proposed maximum budget of 12% is too high for a country like Thailand and that probably 4% or 5% should be a maximum.

Implication for the Model Section 7 of the model should be revised in terms of the suggestions of the panel members, four of whom agreed in principle with the model and one of whom disagreed. It is likely that a budget of five per cent would be satisfactory initially provided this left some reasonable amount after certain fixed costs are subtracted and provided that such costs as are not normally incurred. In Alberta school systems these are not included as part of the maintenance budget. It is inevitable that the provision would need to be increased as equipment becomes older and needs extensive repair or replacement.

8. Budget Estimation

A summary of the reactions of the panel of experts to this part of the model is shown in Table 7.8.

Table 7.8

Summary Table of Reaction of the Panel of Experts to Section 8, Budget Estimation, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
8.	Budget Estimation	
	8.1 Budget Estimation	A B A B A

8.1 Budget Estimation The budget for maintenance is estimated from (1) previous years expenditure, (2) frequency of use and frequency of repairs, (3) Project experience.

Three of the panel members agreed completely with the model and two agreed in principle. Panel member (2) indicated the need for more details. Panel member (4) suggested

that a fourth item "(4) average age of equipment" be added in this proposal.

Implication for the Model Section 8 of the model should remain substantially as originally presented to the panel of experts. All panel members agreed with all parts of the model either in principle or completely. The average age of equipment should be taken into account when estimates are made.

9. Budget Justification

A summary of the reactions of the panel of experts to this part of the model is shown in Table 7.9.

Table 7.9

Summary Table of Reaction of the Panel of Experts to Section 9, Budget Justification, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
9.1	Budget Justification	A A A B B

9.1 Budget Justification The budget must be based on input from the following sources (1) cost of equipment, (2) condition of equipment, (3) requests from the schools and (4) approval of the Budget Bureau.

Three of the panel members agreed completely with the model and two agreed in principle. Panel member (4) suggested that "(1) cost of preventive maintenance is justified on the basis that lack of same results in higher costs due to breakdowns and need for more frequent major reconditioning, (2) repair & major reconditioning are justified on the basis that replacement costs are higher". Panel member (5) pointed out that all of the necessary equipment would have been purchased under a capital budget account and that there should be a small replacement budget separate from the maintenance budget for replacement of small tools.

Implication for the Model Section 9 of the model should remain substantially as originally presented to the panel of experts. All panel members agreed with all parts of the model either in principle or completely. The budget for maintenance is not intended to cover the cost of replacing small hand tools. All small hand tools must be purchased from regular budget of each school.

10. Cost

A summary of the reactions of the panel of experts to this part of the model is shown in Table 7.10.

Table 7.10

Summary Table of Reaction of the Panel of Experts to Section 10, Cost, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
10.	Cost	
10.1	Cost of Maintenance	B B A B B

10.1 Cost of Maintenance Normally the cost of maintenance should be kept to a minimum. The cost of maintenance of each item of equipment may range between 4 per cent and 8 per cent of capital cost. This depends on the condition of each piece of equipment.

One of the panel members agreed completely with the

model and four agreed in principle. Panel member (1) suggested eight per cent of capital cost for maintenance is probably too high for Thailand. Four or five per cent of capital cost should be maximum. Panel member (2) expressed the view that it is difficult to determine whether this is a reasonable figure until it is known what the budget is expected to cover. Travelling costs of the technicians and shipping of new equipment are both large items if they are to be included. Panel member (4) suggested that the economics of keeping a school shop running are difficult to determine when the maintenance department may be confronted with an expensive repair job that can not be predicted in advance. Panel member (5) suggested that maintenance costs running between four per cent and five per cent of the capital costs of equipment would be considered to be acceptable.

Implication for the Model. Section 10 of the model should remain substantially as originally presented to the panel of experts. All panel members agreed with all parts of the model either in principle or completely. The cost of maintenance should be reduced to a five per cent as a minimum.

11. Assessment of Operation

A summary of the reactions of the panel of experts to this part of the model is shown in Table 7.11.

Table 7.11

Summary Table of Reaction of the Panel of Experts to Section 11, Assessment of Operation, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
11.	Assessment of Operation	
	11.1 Evaluation Criteria	B A A B A

11.1 Evaluation Criteria The criteria used for evaluating the operation of maintenance work are (1) the accuracy of outcomes, (2) satisfaction of schools and staff, (3) cost effectiveness.

Panel member (3) suggested that the present budget is fairly low because equipment is new, and that the percentage will increase as machines grow older. Panel member (4)

suggested that the shop teachers are the key figures in any effective maintenance program, especially in regard to the budget for maintenance. High or low expenditures will depend on the instructor, whether he does his job as a member of the maintenance team or not. Panel member (5) pointed out that there is a considerable difference between 1% and 12% in actual dollars. Insofar as any budget is concerned, we will find that there are certain "fixed" costs which can be determined quite accurately. To determine the amount of the budget in the beginning, fairly accurate guessing is required. If we have information gleaned over a two or three year period, we can then begin to estimate yearly costs more accurately. Panel member (2) disagreed with the model for the following reason: the budget for Thailand and Alberta schools would be quite different since the budget for Thailand includes the salaries of the staff, costs of transportation, and per diem allowances for travelling staff. No breakdown is given for the budget. No indication is given as to whether or not the budget makes provision for replacement equipment that is uneconomical to repair or beyond repair. Alberta's schools would not have travelling expenditures, so the comparison is difficult to make.

Three of the panel members agreed completely with the

model and two agreed in principle. Panel member (1) suggested that the wording "satisfaction of schools and staff" in this section is not clear and the terminology of "the cost effectiveness" should be changed to "cost of keeping equipment in a satisfactory condition". Panel member (4) suggested that the criteria should be rewritten and the following additions made: (1) evaluate comments and suggestions by school instructors and administrators; (2) evaluate amount of down time of equipment; (3) determine maintenance costs in relation to replacement costs; (4) evaluate quality of work done; (5) compare costs between schools having similar equipment and use, and evaluate reasons for the difference.

Implication for the Model Section 11 of the model should remain substantially as originally presented to the panel of experts except that the suggestion made by Panel Member (5) and the comments made by Panel Member (2) need to be considered in developing the budget.

12. Suggestion

A summary of the reactions of the panel of experts to this part of the model is shown in Table 7.12.

Table 7.12

Summary Table of Reaction of the Panel of Experts to Section 12, Suggestion, of the Proposed Model for Equipment Maintenance.

Item No.	Heading	Panel Evaluation 1,2,3,4,5.
12.	Suggestion	
12.1	Suggestion for Improvement	A A A B A

12.1 Suggestion for Improvement The maintenance department should attempt to improve efficiency and keep up to date by (1) maintaining good communication with schools and community, (2) encouraging teachers to pay more attention to maintenance work, (3) setting tighter specifications for equipment, (4) decreasing red tape, and (5) providing inservice training.

Four of the panel members agreed completely with the model and one agreed in principle. Panel member (4) suggested that "the proposal should include the items from

10.1 and 11.1 where evaluation has shown a need for improvement.

Implication for the Model Section 12 of the model should remain substantially as originally presented to the panel of experts. All panel members agreed with section 12 either in principle or completely.

CHAPTER VIII

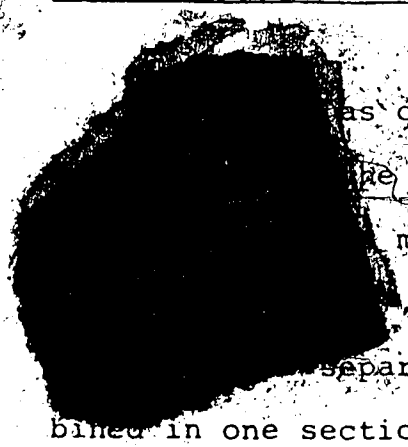
MANAGEMENT OF INDUSTRIAL ARTS EQUIPMENT MAINTENANCE PROGRAM FOR COMPREHENSIVE SCHOOLS IN THAILAND

Summary of Study

The final model for management of industrial arts equipment maintenance programs for comprehensive schools in Thailand was revised from the original model developed by the researcher. The common elements found in a review of literature was included in chapter 2, an analysis of educational maintenance systems in Alberta was described in chapter 4, an analysis of industrial maintenance systems in Alberta was presented in chapter 5, and requirement for maintenance in Thai Comprehensive Schools was included in chapter 6. The choice of common elements for establishing the original model is based on the needs, requirements, and administrative constraints. It is also based on the rationale of efficiency, logic, analogy, and practicality. After the original model had been developed, it was sent to the five members of the panel of experts whose qualifications and experience were described in chapter 3. Chapter 7 presented the model as originally developed by the researcher as well as the reactions of the panel of experts to the

model and implication for revisions in the model. This, the final chapter of the study presents the revised model for the management of industrial arts equipment maintenance program for the comprehensive schools in Thailand.

Major Revision of the Model



as originally devised met with substantial
he panel of experts. However, a few major
made based on the recommendations of the
8, 9, and 10 of the original model
separate major headings, have now been combined in one section designated Budget. The total amount of the Budget, a per cent portion of the capital investment, has been changed, and evaluation criteria have been included as suggested by the panel.

The Final Model

The revised model for management of industrial arts equipment maintenance for the comprehensive schools in Thailand is based on four major components of a maintenance system. These components are structure, procedure, finance and evaluation.

The nine sections of the final model were derived from the four major compenents of maintenance mentioned above. The nine sections are: (1) organization, (2) qualification and work experience of personnel, (3) work planning, (4) kind or type of work, (5) inspection maintenance procedure, (6) inventory, (7) budget for maintenance, (8) assessment of operation, and (9) suggestion for improvement. Each section of the final model is presented below.

1. Organization

1.1 Organizational Structure. The organizational structure for industrial arts equipment maintenance includes two levels of personnel. One is the managerial level and other the operational level. Both levels appear in the organizational chart, figure 8.1.

1.11 The Managerial Level. This level is designed to administer the whole maintenance policy and operations for the comprehensive schools in Thailand. It is shown in the block diagram of the operational chart (Figure 8.1) as Director of Maintenance.

1.12 Operational Level. This level is designed to serve the maintenance functions such as servicing, purchasing, repairing, fabricating, storekeeping, distribution, planning, installing equipment and the keeping of records

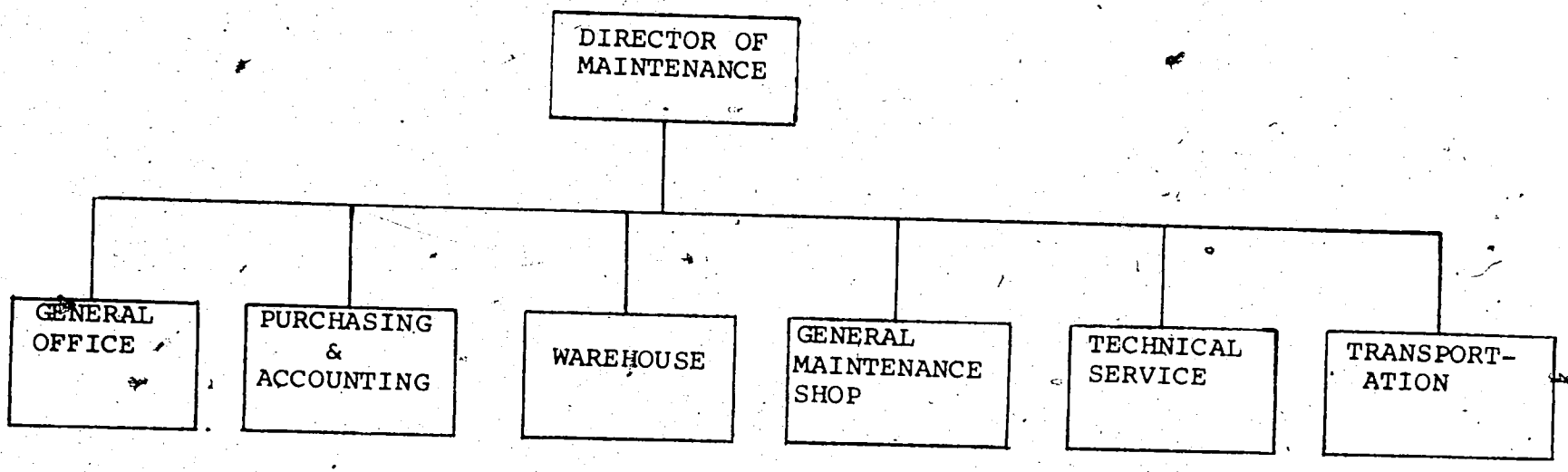


FIGURE 8.1

THE ORGANIZATIONAL CHART OF MANAGEMENT OF INDUSTRIAL ARTS EQUIPMENT MAINTENANCE OF COMPREHENSIVE SCHOOLS IN THAILAND

of all activities. This level is shown in the block diagram of the organizational chart (Figure 8.1) as General Office, Purchasing & Accounting, Warehouse, General Maintenance Shop, Technical Services, and Transportation.

General Office. The functions of the general office include: (1) consideration of the various sections at the operational level; (2) provision of services to the other sections; (3) communication between the maintenance office and other such bodies as private firms and schools; (4) inventory recording; (5) arrangement of servicing trips.

Two persons are required in this section, one a stenographic clerk and the other a business clerk.

Purchasing and Accounting Section. The functions of the purchasing and accounting section are to (1) survey requests from the other sections with respect to needs such as those for spare parts; (2) check the accuracy of specifications on those needs; (3) purchase equipment and material; and (4) budget control.

One person is needed to serve in this section.

Warehouse. The functions of warehouse include (1)

storekeeping; (2) distributing; (3) suggesting the purchase of materials, supplies and spare parts; (4) crating; (5) receiving; and (6) shipping.

A minimum of two persons are required, one a stock clerk and one a crating foreman.

General Maintenance Shop. The functions of the general maintenance shop include (1) fabricating parts that are not readily available; (2) repairing the equipment brought in from the schools, if possible, or sending it to outside vendors. The general maintenance shop will take over the equipment that has been used by the temporary maintenance team. The technicians are required to serve this section.

Technical Service Section. The functions of the technical service section include (1) equipment inspection in each school according to a scheduled list of maintenance; (2) installation of equipment; (3) consultation with respect to planning maintenance work; (4) establishing the specification for equipment; (5) demonstrating to teachers new equipment and/or complicated activities; (6) checking new equipment, including establishing compatability with the Thai electrical power distribution systems; and (7) caring for the equipment and tools in maintenance vehicles.

Two technicians are required to serve this section. These technicians should alternate their duties with the technicians in the general maintenance shop.

Transportation Section. The duties of this section are to (1) supply transportation service for the sections of the department when required for carrying out their duties; (2) supply transportation service for technicians who make the trip to inspect, install and repair equipment in schools; (3) check and record the condition of vehicles; (4) control preventive maintenance and repair of vehicles; (5) control gas and oil used for vehicles; (6) assign the drivers; (7) contact outside vendors of moving equipment when necessary.

For economic reasons, the vehicles which serve the temporary maintenance team should be used in this section. One person would be required to serve this section.

1.2 Maintenance Functions

1.21 Maintenance Staff. The maintenance staff has the responsibility for directing and carrying out maintenance work and installation on industrial arts equipment in all the comprehensive schools in Thailand and also for providing maintenance seminars for teachers.

1.22 Teaching Staff. This staff has the responsibility for routine preventive maintenance and minor repair of industrial arts equipment in the school where they are teaching. The routine maintenance work involves such things as oiling, cleaning, adjusting and replacing belts.

2. Qualification and Work Experience of Personnel

2.1 Training and Work Experience. Any person who does maintenance work and installation of equipment should have a minimum qualification in any one of the following: (1) vocational certificate (five years after grade 10), (2) journeyman standing such as for example, a millwright or electrician. He should also have a minimum of two years' experience in maintenance work after graduating from a vocational institute.

For the director, professional or university level qualifications, in education (Industrial Arts) or engineering, with some background in administration and a minimum of five years of teaching experience in industrial arts is required.

3. Work Planning

3.1 Planning Personnel. The persons who take responsibility for maintenance planning are the director of the

maintenance department and the technicians on his staff. The director of maintenance, together with the technicians on his staff will be able to carry out their function because of the experience they will gain and their intimate knowledge of condition existing in each industrial arts laboratory.

3.2 Planning Procedure. The information used for planning maintenance work to be carried out on a monthly, semesterly or annual basis will be obtained from the following sources: (1) data from previous years work; (2) inspection reports made by the director and his staff; and (3) requests from the schools.

3.3 Emergency Servicing. When a maintenance problem occurs which is thought by the teacher or the person who works with the particular piece of equipment to be of an emergency nature, that person reports the fact to the head of the department of practical arts, who in turn consults with the principal. If the principal and head of the department of practical arts agree that an emergency situation does exist, they determine what procedure to follow. For example, they may decide that (1) the industrial arts staff should make the necessary repairs, (2) an outside vendor in the local area should be called in, or (3) the

director of maintenance be asked for help in making the required repairs.

3.4 Transportation. The vehicles used for servicing and transporting equipment between the maintenance center and the schools are (1) cars, (2) vans, (3) trucks, (4) moving company equipment, (5) rail road cars, and/or (6) airplanes, depending on circumstances. Practices for use of the maintenance vehicles should be very clearly spelled out.

3.5 Delivery Time. The time for delivering the equipment or commodities from the maintenance center to the schools should range from twenty-four hours to two weeks, depending on distance and location.

4. Kind or Type of Work

4.1 Maintenance Work. The maintenance work covers all industrial arts area in the comprehensive schools and the general maintenance shop in maintenance center. It should also include arranging for outside vendors to repair certain types of equipment at economical prices.

4.2 Liaison Work. Liaison work is a necessary part of the maintenance program. For smooth operation of the maintenance department, it is necessary that channels of

communication be maintained between the following: schools, the general office, technical services, the department of vocational education, the police department, and private firms. Special emphasis should be put on the maintaining channels of communication with schools.

5. Inspection of Maintenance Procedures

5.1 Inspecting Personnel. The persons involved in inspecting the maintenance programs are (1) the director of the maintenance division, (2) technicians and (3) industrial arts instructors.

5.2 Inspecting Procedure. The procedure for inspecting the maintenance program should consist of (1) consulting with planning personnel and maintenance manuals supplied with the equipment to set schedules for inspecting equipment on a monthly, semesterly and annual basis, (2) checking the condition of equipment, (3) checking the operating of equipment, (4) inspecting new and repaired equipment and assessing compatibility of new and repaired equipment with existing equipment and fixtures and (5) observing of equipment in normal use and giving assistance to instructors in the proper use and maintenance of equipment.

5.3 Outcome of Inspection. The results of inspection

provide (1) indications of immediate need for maintenance, (2) information for future planning, (3) the basis for estimating of the next year's budget, and (4) the basis for approving claims to suppliers or transportation companies if equipment is damaged or if items are missing, (5) information about machines that are frequently left idle because the instructor is not familar enough with the use or repair of the machine. In this case, the goal should be to correct the situation.

6. Inventory

6.1 Equipment Record. All equipment used in the industrial arts laboratories of all the Thai comprehensive schools and in the maintenance center must be recorded on (1) master cards with the following data included on one side shown in figure 8.2: item, code, unit cost, condition, and the like. The obverse of master card is used for the maintenance record which includes service policy, warranty period, nature of repair, and cost of repair. The details of the maintenance as shown figure 8.3, should be kept in the maintenance center. Inventory cards should be kept in the school and in the maintenance center. The two sets of inventory card and master card are identical one set of inventory cards is for use by the technicians to record maintenance work. The other set is kept in schools.

MASTER CARD

Item:_____ Code:_____ Cost:_____

Make:_____ Model:_____ Serial:_____

Date Purchase:_____ Vendor:_____ Phone:_____

School:_____ Department:_____ Room:_____

Accessories(catalog number, cost, pertinent size, etc.)

_____

_____

								Date.	CONDITION
								QTY. Cond.	A =New or Equiv.
								Checker In.	B =Good.
								Date.	C =Fair.
								QTY. Cond.	D =Poor
								Checker In.	NG =Worn-out or Obsolete.
								Date.	
								QTY. Cond.	
								Checker In.	

FIGURE 8.2

MASTER CARD

MAINTENANCE RECORD

Warranty Period

.....

.....

Service Policy With

Name: _____

Address: _____

Phone: _____

Date	Requisition Number	Nature of Repairs	Cost	Signature of Technician.

FIGURE 8.3

MAINTENANCE RECORD

The spare parts, stock and hardware are recorded on cardex cards; recorded are part list number, catalog number, unit cost, name of machine, total amount, and the name of receiver for instance. The detail of the cardex card is shown in figure 8.4.

6.2 Criteria for stocking Spare Parts. Parts for specific pieces of equipment may be stocked, based on two criteria: (1) the frequency with which repairs requiring a particular part are made, and (2) the cost of the part. General items of hardware that are inexpensive and which have many applications must also be stocked.

Spare parts are usually kept in stock room in the maintenance warehouse. Up-to-date inventories should be maintained.

A stock clerk should take the responsibility for the security of spare parts. He should also handle the inventory cards and keep them current.

6.3 Estimation of Machine Running Time. The running time of machines is estimated from (1) the record of class hours and multiple activities in laboratories, (2) the information on maintenance record cards including

CARDEX

Part list number_____ Catalog#_____ Cost_____

Name of machine_____ Shop_____ Department_____

Total amount_____ Date of purchase_____

Requistion number	Date	Name of Receiver	Amount	Cost	Done by

FIGURE 8.4

CARDEX CARD

frequency and cost of repairs.

The nature of information recorded must be reviewed periodically and its value assessed.

7. Budget

7.1 Budget of Maintenance. The budget for the maintenance program, such as preventive maintenance, spare parts, cost of transportation and per diem allowances for travelling staff should range between $84,000 to $420,000, 1% to 5% of the inventory cost of capital equipment (8.4 million of dollars). This amount should be increased as equipment becomes older and require extensive repair or replacement. It must be noted that the range recommended by the panel of experts was not intended to include salaries of people working in the Maintenance Division. The monies discussed above would only be used for direct expenditures by the Maintenance Division. If salaries of maintenance workers are included, the range would be in the order of 10 per cent to 15 per cent of the capital investment.

7.2 Budget Estimation. The budget for maintenance is estimated from: (1) the previous year's expenditure, (2) frequency of use and repairs, (3) experience of the project staff, and (4) the average age of equipment.

7.3 Budget Justification. The budget must be based on input from the following sources: (1) costs of equipment, (2) condition of equipment, (3) requests from the schools, and (4) approval of the Budget Bureau.

The budget for maintenance is not intended to cover the cost of replaci g small hand tools such as files, pliers, and hammers, for instance. All small hand tools must be provided from the regular budget of each school.

7.4 Cost of Maintenance. Normally the cost of maintenance should be kept to a minimum. The maximum cost of maintenance of each item of equipment should not be over 5% of its capital cost. The actual cost depends on the condition of each peice of equipment.

Although the cost of maintenance must be kept to a minimum, there are two factors which have not been considered which tend to increase maintenance costs over time. The first of these is the increasing age of equipment. As equipment is used, it tends to wear and thus, increased maintenance costs must be expected as equipment becomes older. The second factor is that of inflation. As the price of equipment rises, so does the price of spare parts and hardware, and therefore, maintenance costs tend to increase.

8. Assessment of Operation. The criteria used for evaluating the operation of maintenance work are: (1) evaluative comments and suggestions, (2) estimates of the amount of down time of equipment, (3) maintenance cost in relation to replacement cost (4) quality of work done, (5) comparative costs between schools having similar equipment with reasons for any differences.

9. Suggestion

9.1 Suggestion for Improvement. The maintenance department should attempt to improve effeciency and keep up-to-date by (1) maintaining good communication with schools and communities, (2) encouraging teachers to pay more attention to maintenance work, (3) setting more rigid specifications for equipment, (4) decreasing unnecessary regulation, and (5) providing inservice training.

Recommendation

When the Department of General and Adult Education of the Ministry of Education in Thailand is reorganized, it should put a division of maintenance in the organization to serve and maintain equipment, buildings and facilities in the schools and make the director responsible for this division. At the present time, the Department of General and Adult Education does not have a formal maintenance

division. It is recommended that the department establish a director of maintenance to administer maintenance policies and operations for the present comprehensive schools and any schools to be established in the future.

In addition, it is recommended that the following studies be made: (1) Research into the equipment maintenance program for vocational organizations of the Vocational Education Department, Ministry of Education, in Thailand; (2) Research into the comparison of equipment maintenance in education and industrial organizations in Thailand; (3) Research into the influence and impact of technology on the vocational education program in Thailand. (4) Research into the feasibility of establishing maintenance divisions for other curricular areas.

This study has been focused on developing improved and procedures for an equipment maintenance program for industrial art in the comprehensive schools of Thailand. It concludes with recommendations designed to effect such improvement.

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APPENDIX A.

EDMONTON PUBLIC SCHOOLS

10010 - 107A Avenue Edmonton Alberta T5H 0Z8 Telephone (403) 429-5621

April 12, 1973

Mr. W.A. Kiffiak,
Administrative Assistant,
Division of Field Experiences,
University of Alberta,
Edmonton, Alberta.

Dear Mr. Kiffiak:

RE: Research Request - Mr. D. CONGCAR

This project has been approved on a permissive basis following examination by our department and consultation with Mr. G. Sanders, our Director of Vocational Education. Mr. Sanders has already arranged to meet with Mr. Congcar.

In addition, the following persons, in the schools indicated below would be able to meet with Mr. Congcar:

Mr. T. Bryce	Victoria Composite
Mr. J. Dingman	M.E. LaZerte Composite
Mr. N. Fitl	Jasper Place Composite
Mr. V. Semeniuk	Harry Ainlay Composite
Mr. J. Smith	W.P. Wagner High School
Mr. E. Harder	L.Y. Cairns Vocational

Mr. Congcar should now contact the principals of the above schools to arrange the dates and time of the meetings.

Sincerely,

Tom Blowers, Ph.D.
DIRECTOR OF RESEARCH
EDMONTON PUBLIC SCHOOLS

TAB/ak

c.c. Mr. D.F. Terriff, Principal - Victoria Composite
Mr. R. Baker, Principal - M.E. LaZerte
Mr. E. Meyer, Principal - Jasper Place
Mr. M. Smeltzer, Principal - Harry Ainlay
Mr. D.P. Stetsko, Principal - W.P. Wagner
Mr. E. Harder, Principal - L.Y. Cairns
Mr. D. Congcar
Dr. F. Illot
Mr. G. Sanders

INTERVIEW SCHEDULE

FOR EDUCATIONAL ORGANIZATIONS

A. Organizational Structure

1. Chain of Command

a. What is the organizational structure of your department of maintenance?

b. Could you draw the organization chart?

c. What kind of maintenance work is done by teacher?

d. What kind of maintenance work is done by the department of maintenance?

2. Personnel by Division

a. What are the qualifications of the technician?

b. What is experience of technician?

3. Work Planning

a. How does the department plan for its year round activities?

b. What are the steps in planning activities?

c. Who is involved in planning?

d. Is there a formalized planning and scheduling system in this department?

e. If any, please describe the system?

f. How do you handle emergencies caused by break-down of machines?

B. Maintenance Operation

1. Area of work

a. What are the areas of work in this department?

b. What are the areas of liaison work with other departments?

2. Inspection

a. Who is involved in inspection?

b. What are the procedures of inspections?

c. When do inspections take place?

d. How is the result of an inspection reported?

3. Record and analysis of machinery

a. How is the new equipment recorded? By computerization, filing or how else?

b. How many records are kept?

c. Where are the records kept?

d. How is inventory secured?

e. How are the statistics of the use of those spare parts recorded?

f. How do you decide which parts to carry in stock and which parts to purchase as needed?

g. How is running time of machinery estimated?

h. How do you estimate man-hours for maintenance?

C. Finance

1. How much is the budget for maintenance? ($)
2. Where does the budget come from?
3. How do you estimate the maintenance budget?
4. How do you justify the budget?
5. How do you work out the replacement schedule?
6. How are decisions made or arrived at concerning replacement or repair of equipment?

D. Effectiveness

1. How do you justify the costs of maintenance?
2. How do you measure effectiveness of your operation?
3. In your opinion, how can maintenance be improved?

****

INTERVIEW SCHEDULE

FOR ORGANIZATIONS OUTSIDE OF EDUCATION

A. Organizational Structure

1. Please describe briefly the main function of this company.

2. Please draw the organizational chart of this company.

3. What is the system of the cataloguing of machines and spare parts for supplying the consumer, by alphabetically, by function, or how else?

4. How many days does it take to deliver commodities in the city, in rural areas, and in other countries?

5. What kind of transportation do you use for servicing?

6. How many kinds of personnel does this company employ?

7. What experience and qualification do the employees in each catagory have especially technicians?

B. Maintenance Operation

Area of Work

1. Do you have the Maintenance Section or Department in this company?

2. If so, what are the areas of work for maintenance?

3. What are the areas of liaison work of the maintenance department with other departments?

Inspections

1. How are the procedures for machinery and spare parts inspected?

2. Who is involved in inspections?

3. How is the result of the inspections reported?

Record and Analysis of Machinery and Spare Parts

1. How are the new machinery and spare parts for maintenance recorded? by computer, filing or how else?

2. How many records are kept? Where are they kept?

3. How is the spare parts inventory secured?

4. How do you decide which parts to carry in stock and which to purchase as needed?

5. How do you estimate the running time of the machine and man-hour for maintenance?

Finance

1. How much is the budget for maintenance? (in per centage of inventory capital)

2. How does this company estimate the maintenance budget?

3. How do you justify the budget?

4. How are decisions made or arrived at concerning replacement or repairment of equipment?

D. Effectiveness

1. How do you justify the cost of maintenance?

2. How do you measure the effectiveness of your operation?

3. In your opinion, how can maintenance be improved?

APPENDIX B

OPINIONNAIRE

Purpose

The purpose of this opinionnaire is to survey the views of a panel of experts with respect to a proposed maintenance system for Thai comprehensive schools. These views will be included in a Master's thesis entitled Management of Industrial Arts Equipment Maintenance for Comprehensive Schools in Thailand to be submitted to the Department of Industrial Arts and Vocational Education, The University of Alberta.

Procedure

The material is presented in two parts. The first part deals with summary tables of some relevant elements drawn from selected maintenance systems in Alberta and those elements selected for the purpose of developing a maintenance system for Thai comprehensive schools. The second part describes in greater detail those elements for the Thai school system.

The next step of the procedure involves the development of a Thai maintenance system by incorporating the views of the panelists.

Direction

Each panelist is provided PROPOSED GUIDELINES FOR INDUSTRIAL ARTS EQUIPMENT MAINTENANCE IN THAI COMPREHENSIVE SCHOOLS including summary tables and RESPONSE FORM. To complete this form please follow

the procedure listed below:

1. Study the guidelines and summary tables thoroughly.

2. Pass value judgements on the proposed guidelines, in whole as well as in part, on the basis of your knowledge and experience.

3. Indicate your value judgements by completing the supplied RESPONSE FORM.

4. A suggested format for your response is as follows:

Write A if you agree completely.

Write B if you agree in principle and indicate further the conditions, requirements or additional comments if you wish.

Write C if you disagree and indicate an alternative if any.

PROPOSED MANAGEMENT OF I. A. EQUIPMENT MAINTENANCE FOR COMPREHENSIVE SCHOOLS IN THAILAND

The guidlines that follow are chosen from common elements found in an analysis of educational and industrial maintenance systems in Alberta. The choice is based on the needs, requirements, and administrative constraints. It is also based on the rational of efficiency, logic, analogy and practicality.

Table 1 shows the structure of maintenance which includes organization, qualification and work planning as appears in the first column. The common elements found in the analysis appear in the second column. Selected elements to be applied to the Thai system are shown in the third column.

Table 2 contains the procedure of maintenance including kind or type of work, inspection, and inventory equipment record. The explanation of table 1 applies to table 2 as well.

Table 3 deals with the finance of maintenance which includes budget, estimation, and justification.

Table 4 contains topics on evaluation of maintenance including the cost, assessment, and suggestions for improvement. The explanation of table 1 applies to these tables as well.

The elements selected for application to the Thai system are explained below.

STRUCTURE OF MAINTENANCE

1. Organization

1.1 Organization Structure The original structure for I.A. equipment maintenance should include two levels of personnel: managerial and operational.

1.11 Managerial Level This level is to administrate the whole of maintenance policy and maintenance work for all comprehensive schools in Thailand.

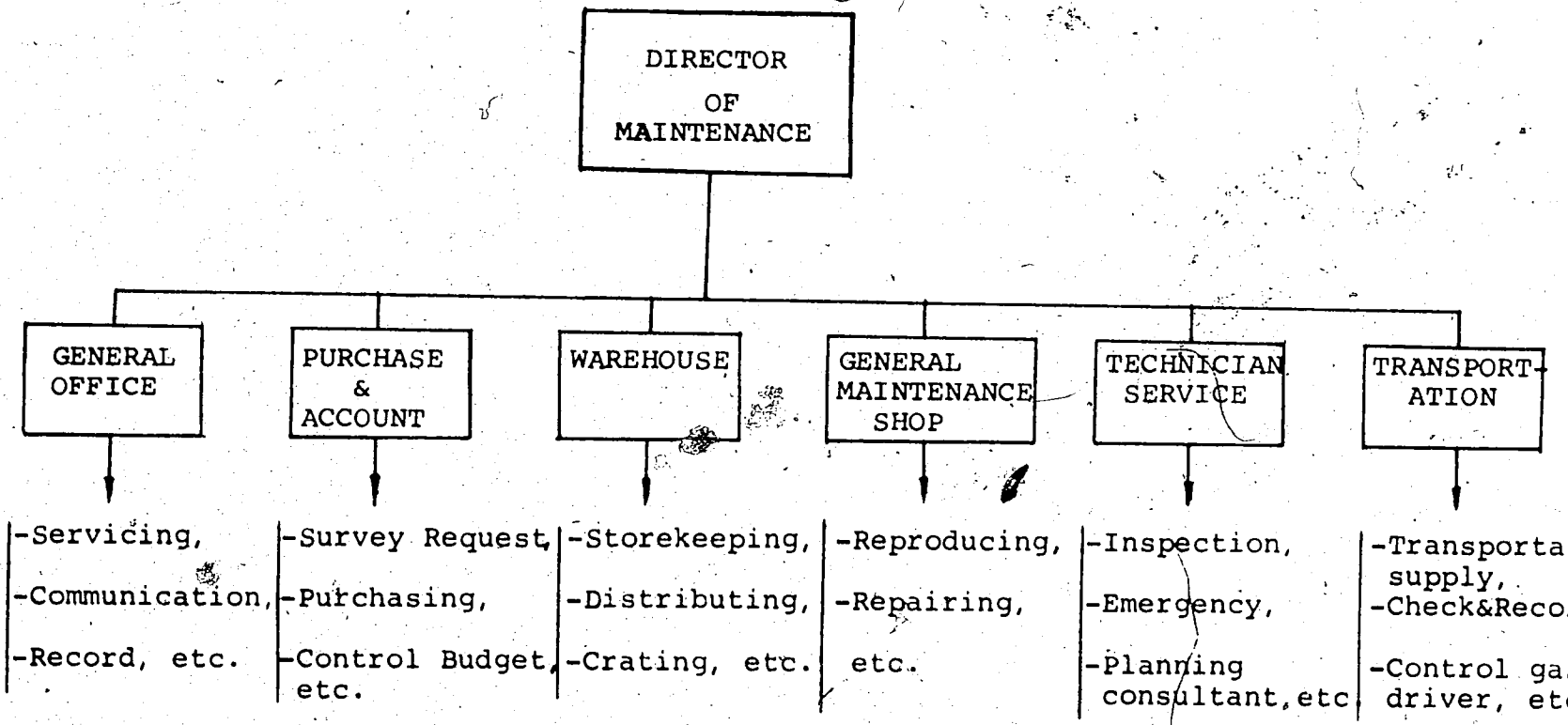
1.12 Operational Level This level is to serve the maintenance function (as defind in chapter 1 of the report). Included in this category are general office, purchasing and accounting section, warehouse, general maintenance shop, technical service section, and transportation.

The organizational structure is depicted in figure 7.1.

1.121 General Office The functions of the general office are proposed to include (1) coordination of various sections at the operational level, (2) provision of services to the other sections, (3) communication between the maintenance office and other bodies such as private firms and schools, (4) inventory card record, and (5) arrangement of servicing trips. Two persons are required in this section, one a stenographic clerk and the other a business clerk.

1.122 Purchasing and Accounting Section. The functions of the purchasing and accounting sections are to (1) survey requests from the other sections with respect to needs such as spare parts, (2) check the accuracy of specifications on those needs, (3) purchase equipment and material, (4) control

FIGURE 1



THE ORGANIZATIONAL CHART OF MANAGEMENT

I.A. EQUIPMENT MAINTENANCE OF COMPREHENSIVE

SCHOOLS IN THAILAND.

budget. One person is needed to serve in this section.

1.123 Warehouse The duty of warehouse including: (1) storekeeping, (2) distributing, (3) suggestion of purchase of material supply or spare parts, (4) crating, (5) receiving, and (6) sending. A minimum of two persons are required; one stocking clerk, and one crating foreman.

1.124 General Maintenance Shop The functions of the general maintenance shop are to include: (1) fabricating parts that are not readily availbale, (2) repairing the equipment which was brought in from the schools if possible otherwise sending it to outside vendors. The general maintenance shop will take over the equipment that has been used by the Temporary maintenance team. Two technicians are required to serve this section.

1.125 Technical Service Section The functions of this section are to include: (1) equipment inspection in each school according to the scheduled list of maintenance, (2) installation of equipment; (3) consulting in maintenance planning work, (4) establishing the specifications for equipment, (5) checking new equipment, including establishing compatibility with the Thai electrical power distribution system. Two technicians are required to serve this area. These technicians should alternate their duties with the technicians in the general maintenance shop.

1.126 Transportation Section The duties of this section are to: (1) supply transportation service for the divisions of the department when reasonably required, (2) supply transportation service for the technicians who make the

trips to inspect and repair equipment in schools (3) check and record the condition of vehicles (4) control preventive maintenance and repair vehicles (5) control gas and oil used with vehicles (6) control the drivers (7) care for equipment and tools which are fixed permanently in the truck or van for "moving maintenance work" in the schools (8) contact with outside moving lines. For economic reasons, the temporary team maintenance vehicles should be used in this section a minimum of one person would be required to serve this function.

1.2 Maintenance Function Two groups of personnel are responsible for maintenance work: maintenance staff and teaching staff.

1.21 Maintenance Staff The maintenance staff has the responsibility for directing and carrying out maintenance work on industrial arts equipment in all comprehensive schools.

1.22 Teaching Staff This staff has minor function in maintaining industrial arts equipment in the school where they are teaching. The maintenance work are oiling and cleaning for instance.

2. Qualification and Work Experience Second Level Personnel

The personnel in operational level are the important elements of a maintenance department. So the maintenance department requires personnel who are highly qualified and experienced in maintenance work.

2.1 Qualification The person who does maintenance work should have minimum qualification in any one of these (1) vocational certificate (2) Journeyman standing and/or

equivalent, such as, millwright and electrician.

2.2 Work Experience The person who does the maintenance work should have at minimum two years experience after graduating from a vocational institute.

For the director or assistant director, professional or university level qualifications in educations(industrial arts) or engineering, with some background in administration and a minimum of five years of teaching experience in industrial arts is required.

3. Work Planning This is the heart of a maintenance program. Work planning includes, scheduling of men and equipment as well as developing specific maintenance schedules for various items of equipment. The smoothness and efficiency of the maintenance departments'work depends upon the skill with which work is planned.

3.1 Planning Personnel The person who take responsibility for maintenance planning are the director of maintenance and the technicians on his staff. The director of maintenance together with the technicians on his staff will be able to carry out their function because of the experience they will gain and their intimate knowledge of condition existing in each industrial arts laboratory.

3.2 Planning Procedure The information used for planning maintenance work to be carried out on a monthly, semesterly or annual basis will be obtained from the following sources: (1) data from previous years work, (2) inspection reports made by the director and his staff, and (3) requests from the schools.

3.3 Emergency Cases When a maintenance problem occurs which is thought to be on emergency situation by the teacher, or person who works with the particular piece of equipment, he reports this fact to the shop director who in turn consults with the principal. If the principal and shop director agree that an emergency situation does exit. They determine what procedure to follow. For example, they may decide: (a) the industrial arts staff should make the necessary repairs, (b) an outside vendor in the local area might be called in, or (c) they may contact the director of maintenance and ask for help in making the required repairs.

3.4 Transportation The vehicles used for servicing and transporting equipment between center and schools are: (1) cars, (2) vans, (3) trucks, (4) moving company, (5) railroad and/or (6) airplane, depending on circumstances.

3.5 Delivery Time The time for delivering the equipment or commodities from center to the schools range from 24 hours to one week, depending on distance and location.

4. Kind or Type of Work This section emphasizes the kinds of tasks which are directly concerned with the maintenance and liaison function.

4.1 Maintenance Work The maintenance work covers all industrial arts areas of all comprehensive schools, some audio visual equipment which is used in industrial arts labs, and general maintenance shops in the center.

4.2 Liaison Work Liaison work is a necessary part of a maintenance program. For smooth operation of the maintenance department it is necessary that channels of communication be maintained between each of the following: general office, technician services, department of vocational education, police department, and private firms.

5. Inspecting Personnel This section deals with inspecting: personnel, inspecting procedure, and outcomes of inspection, as shown in the subheadings below.

5.1 Inspecting Personnel Most of the inspectors of the systems in Alberta are the head persons of maintenance departments and technicians who are involved with maintenance work. So the similar positions of inspectors applied to the Thai comprehensive schools are: (1) director or assistant director, (2) technicians (3) instructors.

5.2 Inspecting Procedure The procedure for inspecting should be similar to systems in Alberta. It consists of (1) consulting with planning personnel to set schedules for inspecting equipment monthly, semesterly, and yearly, (2) checking the condition of equipment, (3) checking the operating

MASTER CARD

Item:_____ Code:_____ Cost:_____

Make:_____ Model:_____ Serial:_____

Date Purchase:_____ Vendor:_____ Phone:_____

School:_____ Department:_____ Room:_____

Accessories(catalog number, cost, pertinient size, etc.)

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																Date.			CONDITION
																QTY.		Cond.	A =New or Equiv.
																Checker In.			B =Good.
																Date.			C =Fair.
																QTY.		Cond.	D =Poor
																Checker In.			NG =Worn-out or Obsolete.
																Date.			
																QTY.		Cond.	
																Checker In.			

FIGURE 2

MAINTENANCE RECORD

Warranty Period

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Service Policy With

Name: _____

Address: _____

Phone: _____

Date	Requisition Number	Nature of Repairs	Cost	Signature of Technician.

FIGURE 2a

CARDEX

Part list number_____Catalog#_____Cost_____

Name of machine_____Shop_____Department_____

Total amount_____Date of purchase_____

Requistion number	Date	Name of Reciever	Amount	Cost	Done by

FIGURE 3

function of equipment, (4) inspecting new equipment, repaired equipment and assessing compatibility of new and repaired equipment with existing equipment and fixtures.

5.3 Outcomes of Inspection The results of inspection are used (1) as indication of immediate needs for maintenance (2) as information for planning (3) as the basis for estimation of the next years budget, (4) for claims to suppliers of transportation companies if equipment is damaged or some items are missing.

6. Inventory This item deals with equipment record, criteria for spare parts stocking, and estimation of machine running time as shown in the headings below.

6.1 Equipment Record All equipment which is used in the industrial arts departments of all comprehensive schools and in the center must be recorded on (1) master cards (as shown in figure 7.2) and be kept in the center, (2) inventory cards, which have the same details as master cards. There are two sets of inventory cards, identical to the master cards. One set of inventory cards is kept in the center and are used by the technicians to record maintenance work, and another set is kept in the schools. The spare parts stock is recorded on cardex cards (as shown in figure 7.3)

6.2 Criteria for Stocking Spare Parts Parts for specific pieces of equipment may be stocked based on two criteria. (1) the frequency with which repairs requiring a particular part are made and (2) the cost of the part. General items of hardware that are inexpensive and which have many applications must also be stocked.

Spare parts are usually kept in the stock room in the maintenance warehouse. Up-to-date inventories should be maintained. A stocking clerk should take the responsibility for the security of these spare parts, he should handle the inventory cards and keep these updated.

6.3 Estimation of Machine Running Time The running time of machines is estimated from (1) the record of class hours and multiple activities in labs, (2) the information on maintenance record cards.

FINANCE OF MAINTENANCE

7. Budget The budget is prepared for equipment maintenance in all the comprehensive schools and the center.

7.1 Budget for Maintenance The budget for maintenance in several systems in Alberta approximates 1 percent to 12 percent of inventory capital. Normally for educational systems, this percentage is lower than in industrial systems. For the Thai comprehensive schools the amount of money in the maintenance budget should range from $84,000 (1%) to $1,008,000 (12%). These amounts are based on the value of the capital equipment which is 8.4 millions of dollars.

8. Estimation

8.1 Budget Estimation The budget for maintenance is estimated from (1) previous years expenditure, (2) frequency of use and frequency of repairs, (3) Project experience

9. Justification

9.1 Budget Justification The budget must be based on inputs from the following sources (1) cost of equipment, (2) condition of equipment, (3) requests from the schools and (4) approval of the Budget Bureau.

OPERATIONAL EVALUATION

10. Cost of Maintenance Normally the cost of maintenance should be kept to a minimum. So, the cost of maintenance of each item of equipment may range between 4 percent and 8 percent of capital cost. This depends on the condition of each piece of equipment.

11. Assesment of Operation

11.1 Evaluation Criteria The criteria used for evaluating the operation of maintenance work are (1) the accuracy of outcomes, (2) satisfaction of schools and staff, (3) cost effectiveness.

12. Suggestion

12.1 Suggestion for Improvement The maintenance department should attempt to improve efficiency and keep up to date by (1) maintaining good communication with schools and community, (2) encouraging teachers to pay more attention to maintenance work, (3) setting tighter specifications for equipment, (4) decreasing red tape, (5) providing inservice training.

REPONSE FORM

(If space is not enough, please write on additional paper)

1. Organization (Table 1)

1.1 Organizational Structure and Function

1.11 Managerial Level .....

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1.12 Operational Level .....

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1.121 General Office .....

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1.122 Purchasing and accounting .....

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1.123 Warehouse .....

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1.124 General maintenance shop .....

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1.125 Technical service .....

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1.126 Transportation .....

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1.2 Maintenance Function

1.21 Maintenance staff .....

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1.22 Teaching staff .....

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2. Qualifications

2.1 Qualifications .....

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2.2 Work Experience .....

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3. Work Planning

3.1 Planning Personnel .....

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3.2 Planning Procedure .....

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3.3 Emergency cases .....

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3.4 Transportation .....

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3.5 Delivery Time .....

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Reaction to Structure (See Figure 1 & Table 1)

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4. Kind or Type of Work (Table 2).

4.1 Maintenance Work .....

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4.2 Liaison Work .....

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5. Inspection.

5.1 Inspecting Personnel .....

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5.2 Inspecting Procedure .....

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5.3 Outcome of Inspection .....

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6. Inventory

6.1 Equipment Record .....

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6.2 Criteria .....

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6.3 Estimation of Machine Running Time .....

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Reaction of Procedure of Maintenance .....

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Finance of Maintenance (Table 3)

7. Budget.

7 Budget for Maintenance .....

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8. Estimation.

8.1 Budget Estimation .....

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9. Justification.

9.1 Budget Justification .....

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Reaction of Finance of Maintenance.

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Operational Evaluation (Table 4).

10. Costs

10.1 Costs of Maintenance .....

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11. Assessment of Operation.

11.1 Evaluation Criteria .....

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12. Suggestion.

12.1 Suggestion for Improvement .....

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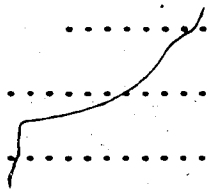
Reaction of Operational Evaluation



Overall Reaction.

APPENDIX C

Equipment of General Electricity Shop

Item No.	Description	Quantity	
1.	Plier, diagonal cutting, 6"	1	doz.
2.	Plier, diagonal cutting, heavy duty, 6"	1	doz.
3.	Plier, round nose, 5"-6"	1	doz.
4.	Plier, electricians' side cutting, 6"	1	doz.
5.	Plier, chain nose, 5"	6	pr.
6.	Crimper cutter, bolt slicer	6	pr.
7.	Plier combination, slip joint, 6 1/2"	1	doz.
8.	Soldering Gun, 100/140 watt	1	doz.
9.	Soldering Iron, electric, 100 watt	1	doz.
10.	Solder, plastic rosin core	6	lb.
11.	Standard Wire Gauge, for non-ferrous	2	
12.	Nut Driver, set of seven	1	set
13.	Screwdriver, 4" blade, 1/4" tip	1	doz.
14.	Screwdriver, 3" blade, 3/16" cabinet tip	1	doz.
15.	Hammer, electricians, for nailing straps	1	doz.
16.	Hammer, Ball Peen, 12 oz.	6	
17.	Vise, mechanics, 3" jaw	2	
18.	Hacksaw Frame, 10-12"	6	
19.	Hacksaw Blades, 10", 24 T.P.I.	2	doz.
20.	Transformer, step-down, 100 watt, 3, 6, 12, 24V	6	
21.	Power Supply Unit, low voltage, AC-DC	6	
22.	Voltmeter. DC, 0-15v	6	
23.	Voltmeter, DC, 0-50v.	6	
24.	Voltmeter, AC, 0-2.5v.	6	
25.	Voltmeter, AC, 0-250v.	6	
26.	Voltmeter, AC, 0-250v.	6	
27.	Ammeter, AC, 0-2.5 amperes	6	
28.	Ammeter, AC, 0-10 amperes	6	
29.	Ammeter, DC, 0-1 amperes	6	
30.	Ammeter, DC, 0-5 amperes	6	
31.	Milliammeter, DC, 0-10milliamperes	6	
32.	Milliammeter, AC, 0-250 milliamperes	6	
33.	Ohmmeter, 0-10, 000 ohms	6	
34.	Calvanometer, DC, 30-0-30	1	
35.	Campass, metal case, 25 mm. diameter	1	doz.
36.	Electro-magnet, U-form, removable coils	1	
37.	Solenoid, demonstrate magnetic lines of force	1	
38.	Push button, round, unmounted	4	doz.
39.	Receptacles, minature, for Edison 10 bulb	4	doz.
40.	Switch, knife, SPST	4	doz.
41.	Switch, knife, SPDT	4	doz.
42.	Switch, knife, DPST	4	doz.
43.	Switch, knife, DPDT	4	doz.
44.	Primary and Secondary coils with removable	1	
45.	Electric Buaaer, double pole for 6-10 v.	2	doz.

Equipment of General Metal Shop

Item No.	Description	Quantity	
1.	Drill, portable, electric, 3/8"	1	
2.	Grinder, bench, 7"	1	
3.	Wire Wheel, 6"	1	
4.	Buffing Wheel, cotton flannel, 8"	2	
5.	Wheel Dresser, star type	1	
6.	oilstone, carborundum, 1"x8"x2"	2	
7.	Safety Goggles	4	pr.
8.	Shield, Face	2	
9.	Brush, bench duster	8	
10.	Brush, wire, hand	2	
11.	First Aid Kit	1	
12.	Welding Kit, oxy-acetylene	1	
13.	Goggles, welding	4	
14.	Hand Shields, Arc Welding	4	
15.	Welder, Arc, 180 amp.	1	
16.	Welder, Spot	1	
17.	Gloves, welding	2	pr
18.	Soapstone	1	doz
19.	Soapstone holder	2	doz
20.	Wrench, pipe, 14"	1	
21.	Drill Press, 15"	1	
22.	Roller, sheet metal, 24"	1	
23.	Shear, sheet metal, 24"	1	
[illegible]	ox and Pan Brake, 24"	1	
25.	v[illegible]e, drill press, 3" jaw	1	
26.	An[illegible], 100 lb.	2	
27.	Hamm[illegible], 2 lb. blacksmith	2	
28.	Hamme[illegible] rivetting, 12 oz.	6	
29.	Hammer setting. 12 oz.	6	
30.	Hammer plastic ball peen. 12 oz.	6	
31.	Hammer plastic tip, 16 oz.	2	
32.	Mallet wood	1	doz
33.	Malle[illegible], rawhide, 10 oz.	2	
34.	Wren[illegible], adjustable, 6"	1	
35.	Wre[illegible]h, adjustable, 8"	1	
36.	W[illegible]ch, adjustable, 10"	1	
37.	W[illegible]nch, allen, set of 13	1	
38.	[illegible]ench, Box and open end, set of eleven 3/8"tol"	1	set
	Punch, solid, set of three-1/8", 3/16", 1/4"	3	sets
	Punch, prick	4	
41.	Punch, center	4	
42.	Stamps, letter, 3/16"	1	set
43.	Stamps, number, 3/16"	1	set
44.	Pliers, electricians, side cutting, 7"	4	
45.	Pliers, combination, slip joint 6"	4	
46.	Pliers, diagonal cutting , 6"	4	
47.	Pliers, hand seamer	2	
48.	Pliers, vise grip, 8"	2	
49.	Chisel, cold, set of three- 1/2", 5/8", 1/4"	4	sets
50.	Scissors, 8"	2	

Item No.	Description	Quantity	
51.	Hacksaw frame, 10-12" adjustable	6	
52.	Hacksaw blade, 10", 18 T.P.I.	100	
53.	Hacksaw blade, 10", 24 T.P.I.	100	
54.	Hand drill, 3/8"	2	
55.	Coun nk, 82 , rose	2	
56.	Twis l, fractional sizes, set	2	
57.	File, mill, single cut	1	doz
58.	File, double cut, bastard	1	doz
59.	File, 6" mill, single cut	1	doz
60.	File, 8" triangular, second cut	1	doz
61.	File, 10" half round, double cut, bastard	1	doz
62.	File Handle, twelve each of # 1, 2, 3	3	doz
63.	File Card and Brush	6	
64.	Tap and Die Set, general utility	1	
65.	Screwdriver, 4" blade 1/4" tip	4	
66.	Screwdriver, 6" blade 5/16" tip	2	
67.	Screwdriver, 10" blade, 7/16" tip	1	
68.	Screwdriver, Robertson, set of 3 sizes	1	set
69.	Screwdriver, Phillips, set of 3 sizes	1	set
70.	Soldering Copper, 2-1 lb. coppers	4	sets
71.	Soldering Furnace	2	
72.	Soldering Iron, electric, 200w.	1	
73.	Clamp, "C" 4" opening	6	
74.	Clamp, "C", 6" opening	2	
75.	Oil can, 4 oz	2	
76.	Tinners' Snips, combination, 1 1/2 cut	8	
77.	Bench Plate	1	
78.	Stake, 11", hatchet	1	
79.	Stake, hollow mandrel	1	
80.	Stake, blowhorn	1	
81.	Stake, bever-edge square	1	
82.	Rivet Set -#5	2	
83.	Rivet Set -#6	2	
84.	Rivet Set -#7	2	
85.	Revet Set -#8	2	
86.	Groover, hand, 3/16:	2	
87.	Groover, hand, 1/4"	2	
88.	Groover, hand, 1/8"	2	
89.	Vise, mechanics, 4" jaw	10	
90.	Dividers, 8"	4	
91.	Vernier Caliper, 6"	1	
92.	Micrometer, 0-1"	1	
93.	Square, double, 4" blade	2	
94.	Calipers, hermaphrodite, 6"	2	
95.	Scribers, steel	1	doz
96.	Square, try, 8"	6	
97.	Square, combination	6	
98.	Steel Rule, 6"	6	
99.	Steel Rule, 12"	6	
100	Tape, Steel, 3 meters	2	
101	Square, Steel, 24"x16"	2	
102	Protractor, steel, swinging blade	1	
103	Gauge, Depth, 6" rule	1	
104	Standard Wire Gauge 0-36	1	
105	Gauge, Screw pitch, 4-30 T.P.I.	1	

Equipment of General Power Mechanics Shop

Item No.	Description	Quantity
1.	Micrometer, caliper, outside, 0-4"	1
2.	Micrometer, inside, tubular, 1.500" to 8.000"	1
3.	Micrometer, caliper, outside, 1-1"	1
4.	Caliper, outside.	1
5.	Caliper, inside, 4"	1
6.	Twist Drill, fractional sizes, set, 1/16" to 1/2"	1
7.	Punch, Pin, set of three, 1/8", 1/4", 3/8"	2
8.	File, 10", flat bastard, mill, single cut	1 doz
9.	File, 6", round, second cut	1 doz
10.	File Ignition point file	4
11.	Oilers, 1/2 pt	2
12.	Funnel, 4"	2
13.	Nut Driver set of eight sizes	1
14.	Screwdriver, stubby	2
15.	Screwdrivers, Offsel, set of three sizes	1
16.	Screwdriver, set of three 4", 6", 8" shank	4
17.	Screwdriver, Phillips, set of three sizes	1
18.	Screwdriver, Robertson, set of three sizes	1
19.	Screwdriver, neon tube	2
20.	Pliers, vise grip 8"	2
21.	Pliers, diagonal cutting 7"	4
22.	Pliers, chain nose, 6"	2
23.	Pliers, tongue and groove, 10"	1
24.	Pliers, combination, slip joint	4
25.	Pliers, lock ring, 8"	1
26.	Wrench, drain plug, for female plugs	1
27.	Wrench, drain plug, for hex male plug	1
28.	Wrench, adjustable, set of three -6", 8", 10"	1 set
29.	Wrench, box and open end, set of 7 from 7/16" to 7/8"	2 sets
30.	Wrench, box and open end, set of 13-6mm. to 18mm.	2 sets
31.	Wrench, Torque, 0-150 ft. lb.	1
32.	Ring Compressor, 21/8" to 5"	2
33.	Ring Compressor, 1 1/2" to 3"	2
34.	Wrench, ignition, set of eight wrenches	1 set
35.	Wrench, ignition, British standard	1
36.	Socket Set 1/4" drive	1 set
37.	Socket Set, 3/8" drive	1 set
38.	Socket Set, metric, 3/8" drive	1 set
39.	Socket, Spark Plug, 13/16", 3/8" drive	2
40.	Wrench, Pipe, 2" capacity	1
41.	Wrench, Allen, set of 13 wrenches	1 set
42.	Soldering Gun, 325 watts	1
43.	Wrench, 4 way wheel wrench	2
44.	Tire Tester	2
45.	Battery Filler	1
46.	Battery Hydrometer	1
47.	Battery Carrier, strap	2
48.	Spark Plug cleaner and tester	1
49.	Spark Plug tool and wire gauge	2
50.	Power Timing light	1
51.	Jack, hydraulic, service, 2 tons	1

Item No.	Description	Quantity
52.	Axle Stands, 2-3 tons capacity	8
53.	Grease gun, hand operated	1
54.	Engine oil Powering spout	1
55.	Brush, wire, cleaning	4
56.	Hammer, ball peen, 1 lb.	4
57.	Hammer, ball peen, 12 oz.	6
58.	Hammer, composition tips, 1 lb.	2
59.	Role, steel, 6"	2
60.	Rule, steel, 12"	2
61.	Punch, gasket	2
62.	Feeler gauge, ignition and spark plug	1
63.	Pressure, hose, 1/4", 25 ft.	2
64.	Speed Couplers	2 sets
65.	Compression Tester	1
66.	Trouble Light	1
67.	Extension cord. 25 ft.	1
68.	Knife shop	1
69.	Putty knife	4
70.	Tap and Die set, machine screw sizes	1
71.	Valve Lifter, "C" type, for air cooled engines	1
72.	Valve Keeper insert tool	1
73.	Piston Ring Expander	1
74.	Piston Ring Compressor, range 1 1/2" to 3"	1
75.	Piston Ring groove cleaner	1
76.	Gasoline Safety Can, 1 gallon	1

Equipment of Unit Electricity and Electronics Shop

Item No.	Description	Quantity
1.	Pliers, diagonal cutting, 6"	6
2	Pliers, diagonal cutting, 6" heavy duty	4
3.	Pliers, round nose, 5-6"	6
4.	Pliers, electricians' side cutting 6"	6
5.	Pliers, chain nose, 6"	6
6.	Pliers, combination, 6 1/2"	2
7.	Pliers, linemans', 8"	2
8.	Snips, tinners, straight pattern, 10"	2
9.	Hacksaw Frame, 10"-12", adjustable	2
10.	Hacksaw Blades, 10", 24 P.T.I.	100
11.	Saw, Compass, 12"	1
12.	Punch, Center	6
13.	Crimper Cutter	6
14.	Rule, Tape, three meter	2
15.	Rule, 6" , steel	4
16.	Rule, 12", steel	4
17.	Combination square	2
18.	Drill, hand. 3/8" chuck	1
19.	Drill, electric, portable, 3/8", two speed	1
20.	Drill, Stand, for 3/8" electric drill	1
21.	Twist Drill, set 1/16: ti k.2: by 1/64 ths.	1
22.	Drill, Masonry drill point kit, set of four	1 set
23.	Vise, Mechanics, 3: jaw	4
24.	Hammer, ball peen, 12 oz.	6
25.	Hammer, Upholsterers; magnetic, 7 oz.	6
26.	Soldering Gun, electric, 100/140 watts	2
27.	Soldering Iron, electric, 100 watts	6
28,	Soldering, plastic rosin core	5 lb
29.	Gauge, for copper wire	2
30.	Micrometer, caliper, 0-1"	1
31.	Screwdriver, 4" blade, 1/4" tip	6
32.	Screwdriver, 3" blade, 3/16" cabinet tip	1 doz.
33.	Screwdriver, neon tube	6
34.	Screwdriver, Phillips tip, set of three sizes	1 set
35.	Screwdriver, Robertson tip, set of three sizes	1 set
36.	Nut Drivers, set of seven	2 sets
37.	Wrench, Allen, set of thirteen	2 sets
38.	Wrench, Adjustable, 6"	2
39.	Wrench, Adjustable, 8"	2
40.	Wrench, Combination box and open and set 3/8" to 7/8"	1 set
41.	File, Flat, 10", double cut bastard	1 doz.
42.	File, three square, 10", bastard	1 doz.
43.	File, half round, 10", bastard	1 doz.
44.	File, rat tail, 10", bastard	1 doz.
45.	File, rat tail, 6", bastard	1 doz.
46.	Milliameter, DCA, DCMA multirange	6
47.	Ammeter, AC, 0-25A	6

Item No.	Description	Quantity
48.	Voltmeter, AC, multimeter, 8 ranges	6
49.	Voltmeter, DC, multimeter, 10 ranges	6
50.	Galvanometer, 500-0-50 microamps	1
51.	Multimeter, VOM, AC-DC	6
52.	Voltmeter, VTVM	6
53.	Oscilloscope	4
54.	Oscilloscope, Dual Trace	1
55.	Power Supply, 0-400 V.D.C.	6
56.	Generator, audio signal	3
57.	Generator, radio frequency	1
58.	Electricity-Electronics Student Kits	4
59.	Power Supply Unit, Output 12-24V, AC&DC	6
60.	Annunciator, 6-8 volts, 4 drop	1
61.	Conductor, single, apparatus to demonstrate field of force	1
62.	Helix Coil, demonstration Kit	1
63.	Transformer, variable, 2 K.V.A.	1
64.	Transformer, isolation	4
65.	Transformer, Bell, 4, 8, 12v. output	6
66.	Switch, knife, S.P.S.T.	1 doz.
67.	Switch knife, S.P.D.T.	1 doz.
68.	Switch knife, D.P.S.T.	1 doz.
69.	Swithc knife, D.P.D.T.	1 doz.
70.	Lamp Socket, medium base	4 doz.
71.	Lamp Socket, miniature base	4 doz.
72.	Fuse Holder	1 doz.
73.	Permanent Magnet, bar, 3"	2
74.	Permanent Magnet, horseshoe, 1"	2
75.	Compass, magnetic, 45 mm.dia.	1 doz.
76.	Grinder, Bench, 7"	1
77.	Revolutions Counter	1
78.	Electrical Machine Teacher	1

Equipment of Unit Metals Shop

Item No.	Description	Quantity
1.	Drill , Portable, Electric 3/8"	1
2.	Bench Grinder, 7"	2
3.	Milling Machine	1
4.	Vise, Precision machine for miling machine	1
5.	Index Head, plain	1
6.	Milling Cutters and Saws	32 items
7.	Power Hacksaw, 6"x6" capacity	1
8.	Oxy-Acetylene Welding Kit	1
9.	Goggles, welding	4
10.	Drill Press, 15"	1
11.	Vise, Drill Press, 3" jaw	1
12.	Lathe, Metal Turning, 9"x22 1/2"	6
13.	Arc Welder, AC-DC, 200-250 amp	1
14.	Arc Welding Shields	5
15.	Spot Welder	1
16.	Wrench, welder's nine way	1
17.	Key, Oxygen and Acetylene Cylinder	1
18.	Tap and Die Set, general purpose	1
19.	Wheel Dresser, star type	1
20.	Soldering Iron, electric, 200 watt	1
21.	Soldering Furnace, propane	1
22.	Soldering Copper, 1 lb. per pair	3 pr.
23.	Soldering Copper, 2lb. per pair	3 pr.
24.	Forge, Hand Operated Blower	1
25.	Tongs, Blacksmith's, 24", curve lip	1
26.	Tongs, Blacksmith's, 24", gad	1
27.	Tongs, Blacksmith's, 24", for flat stock	1
28.	Vise, Mechanics, 4"	10
29.	Metal Bender	1
30.	Bar Folder, 30", 22 gauge capacity	1
31.	Slip Roll Forming Machine, 30"	1
32.	Squaring Shear,	1
33.	Anvil, Blacksmith's, 100 lb.	1
34.	Box and Pan Brake	1
35.	Rotary Throatless Machine	1
36.	Sheet Metal Stakes, Set of five	1 set
37.	Stake Plate	1
38.	File, long angle, 10"	1 doz.
39.	File, 10", half round, double cut bastard	1 doz.
40.	File, 10", mill, second cut.	1 doz.
41.	File, 8", square, second cut.	1 doz.
42.	File, 8", three square.	1 doz.
43.	File, 6"round, second cut.	1 doz.
44.	File, 6"half round, double cut.	1 doz.
45.	File, 5½", jewellers.	1 doz.
46.	File Handles, 1 doz each of #1, 2, 3.	3 doz.
47.	Gauge Screw Pitch.	1
48.	Gauge, Universal Serface.	1
49.	Gauge, Center 60'	6
50.	Vernier Caliper.	6

Item No.	Description	Quantity	
51.	Square, double 4"blade	2	
52.	Micrometer, outside 1" to 2"	1	
53.	Micrometer, outside 0-1"	6	
54.	Calipers, outside 4"	6	
55.	Caliper, inside 4"	6	
56.	Calipers, hermaphrodite 4"	2	
57.	dividers 8"	2	
58.	Center drills 1/8"X 5/16"X 2"	2	doz.
59.	Screw Extractor set No. 1 to 5.	1	set.
60.	Vee block, 2"X 1½" square	1	
61.	Drills, twist, number sizes.	1	set.
62.	Drills, twist, letterd sizes	1	set
63.	Drills, twist, fractional sizes	2	sets.
64.	Gauge, Drill, numbered sizes	1	
65.	Gauge, Drill, lettered sizes	1	
66.	Gauge, Drill, fractional sizex	1	
67.	Gauge, Drill Point	1	
68.	Gauge, Sheet Metal, S.W.G.	1	
69.	Gauge, English Standard Wire	1	
70.	Rule, 12", steel, metric and English	12	
71.	Rule, 6", steel, metric and English	12	
72.	Square, steel, 16"x24"	2	
73.	Square, Try, 8"	6	
74.	Combination Set,	1	
75.	Tape Measure 3 meter	6	
76.	Marking Stamps, letters A to Z, 3/16"	1	set
77.	Marking Stamps, numbers0 to 9, 3/16"	1	set
78.	Trammels, Steel Beam, 14"	1	set
79.	Countersink, 1/2", 82	4	
80.	Hammer, Ball Peen, 12 oz.	4	
81.	Hammer, Ball Peen, 8 oz.	6	
82.	Hammer, Ball, Peen, 1 lb.	6	
83.	Hammer, Blacksmith's hand, 40 oz.	1	
84.	Hammer, Soft Face, 16 oz.	2	
85.	Hammer, Setting, 16 oz.	4	
86.	Hammer, Round Steel Raising, 2 1/2" lb.	1	
87.	Hammer, Rivetting, 12 oz.	6	
88.	Mallet, Hardwood, 2 1/2"x5 1/2"	12	
89.	Mallet, Rubber Head, 2 1/2" x 4"	1	
90,	Mallet, Rawhide, 2" diameter, 10 oz.	1	
91.	First Aid Kit, Class size	1	
92.	Buffing Wheel, Cotton flannel, 8"	2	
93.	Wrench set, Sockets and handles 3/8" drive	1	set
94.	Wrench set of 11 box and open end wrenches	1	set
95.	Wrench, Pipe, 2"capacity	1	
96.	Wrench, Adjustable, set of 4 -one each of 6", 8", 10" 12"	1	set
97.	Wrench set, Allen	1	set
98.	Clamp, "C", 6" opening	4	
99.	Clamp, "C", 6" opening	4	
100	Safety Goggles	4	
101	Oil Stone, 2"x 8" x 1"	2	
102	Carborundum hone, 3" x 7/8"	6	
103	Drill, Hand, 3/8"chuck	1	

Item No.	Description	Quantity	
104.	Tinners' Snips, 10", combination	6	
105.	Tinners' Snips, circular or duckbill, 13"	1	
106.	Punch, Solid, set of three-1/8", 3/16", 1/4	1	set
107.	Punch, Prick, 4"	6	
108.	Punch, Center, 4"	6	
109.	Punches, Pin, set of three-1/8", 1/4", 3/8"	1	set
110.	Punches, Hollow, set of 7 from 1/4" to 1"	1	set
111.	Chisel, Flat, set of 3-1/2, 5/8", 3/4"	2	sets
112.	Chisel, Cape, set of 3-1/4", 5/16", 3/8"	1	set
113.	Chisel, Round Nose, set of two - 1/4"and 3/8"	1	set
114.	Chisel, Diamond Point, Set of two-1'4"and 3'8"	1	set
115.	Awl, Scratch	12	
116.	Pliers, 6"diagonal cutting	2	
117.	Pliers, 6", combination	2	
118.	Pliers, Vise Grip, 8"	1	
119.	Pliers, Side Cutting, 7"	2	
120.	Pliers, Needle Nose, 6"	2	
121.	Pliers, Handy Seamer	2	
122.	Hand Groover, set of three sizes 3,4,5	2	
123.	Rivet Set, set of four, sizes 4,5,6,7,8	2	
124.	Hacksaw Frame, 10-12" blades	6	
125.	Hacksaw Blades, 10", 18 T.P.I.	4	doz
126.	Hacksaw Blades, 10", 24 T.P.I.	4	doz
127.	Screwdriver, set of four-4", 6", 8", 10" Blade	2	sets
128.	Screwdriver, Robertson(socket), set of three	1	set
129.	Screwdriver, Phillips styles set of three sizes	1	set
130.	File Card and Brush	6	

Equipment of Power Mechanics Shop

Item No.	Description	Quantity
1.	Air Compressor	1
2.	Jack, utility, 3 tons	1
3.	Mobile Crane, one tone capacity	1
4.	Jack, hydraulic, service, 2 tons	1
5.	Axle stands	8
6.	Grinder, bench, 7"	1
7.	Electric drill, 3/8"	1
8.	Drill Press, 15"	1
9.	Vise, drill press	1
10.	Reamerw, set of eight, 15/32" to 11/16"	1 set
11.	Reamers, set of seven, 1/4" to 15/32"	1 set
12.	Lathe, armature	1
13.	Lathe, brake drum	1
14.	Grinder, brake shoe	1
15.	Wheel balancer, static	1
16.	Battery charger, quick charge	1
17.	Valve Seat Grinder	1
18.	Valve Refacer	1
19.	Tire Changer and Bead Braker	1
20.	Expander, bead, band type	1
21.	Electric Drill 1/2"	1
22.	Gear lubricant dispenser	1
23.	Grease gun, hand	2
24.	Valve grinder, hand type	1
25.	Magnetic pick-up tool	1
26.	Goggles, safety	4
27.	Muffler cut-off tool	1
28.	Tube Bender set	1
29.	Tube cutter	1
30.	Tube Flaring tool	1
31.	Dial Test Indicater	1
32.	Tachometer, high tension	1
33.	Soldering iron, 200 watt	1
34.	Countersink, rose pattern	1
35.	Snips, tinners, 10"	1
36.	Clamps, "C", 4" capacity	4
37.	Clamps, "C", 8" capacity	2
38.	Gauge, drill, for fractional sizes	1
39.	Gauge, drill point	1
40.	Twist Drill set, fractional sizes	1 set
41.	Micrometer, caliper, outside, 0-4"	1
42.	Micrometer, caliper, outside, 0-1"	1
43.	Micrometer, caliper, inside 1.5"-8.0"	1
44.	Combination set	1
45.	Steel Rule, 6"	6
46.	Steel Rule, 12"	6
47.	Brush, bench duster	6
48.	Squeegie, floor, 18"	2
49.	Vise, mechanics, 4"	2

Item No.	Description	Quantity
50.	Vise, mechanics 5"	4
51.	Vise, mechanics, 6"	1
52.	Wrench set, metric, box and open end	1 set
53.	Wrench ignition, British standard	1
54.	Wrench set tappet, British standard	1 set
55.	Wrench set, Allen, metric sizes	2 sets
56.	Wrench set, Allen 0.050" to 3/8"	1
57.	Wrench set, ignition set of 8	1 set
58.	Wrench, wheel, 4 way	2
59.	Wrench, drain plug, for female plugs	1
60.	Wrench, drain plug, for male plugs	1
61.	Wrench set, adjustable set of 4 sizes	1
62.	Wrench set, combination box and open end	1
63.	Wrench pipe, 2" capacity	1
64.	Wrench set, tappet, 7/16" to 11/16"	1 set
65.	Wrench, torque, 0-150 ft. pounds	1
66.	Wrench, ratchet, 3/8" drive	2
67.	Wrench, ratchet, 1/2" drive	1
68.	Wrench, speeder handle, 3/8" drive	2
69.	Wrench, speeder handle, 1/2" drive	1
70.	Extension bars, 3/8" drive, set of three	1 set
71	Extension bars, 1/2" drive, set of three	1 set
72.	Universal joint socket, 3/8" drive	1
73.	Universal joint socket 1/2" drive	1
74.	Wrench, flex handle, 3/8" drive	1
75.	Wrench, flex handle, 1/2" drive	1
76.	Sockets, 3/8" drive sizes 1/4" to 7/8"	2 sets
77.	Sockets, 1/2" drive, sizes 3/8" to 1 1/4"	2 sets
78.	Socket, spark plug, 3/8" drive, 13/16"	2
79.	Socket, deep, 3/8" drive, 9/16"	1
80.	Socket set, metric, 3/8" drive	1
81.	Socket set, metric, 1/2" drive	1
82.	Nut drivers, set	1 set
83.	Driver, flexible shaft, c/w six sockets	1
84.	Pliers, vise grip, 8"	2
85.	Pliers, diagonal cutting 7"	4
86.	Pliers, tongue and groove joint, 10"	1
87.	Pliers, combination slip joint, 8"	4
88.	Pliers, lock ring, 8"	1
89.	Plier, brake spring, all purpose	1
90.	File, 10", mill, single cut bastard	1 doz
91.	File, 8", three square, single cut	1 doz
92.	File, 6" , round, bastard	1 doz
93.	File, 10", flat, double cut, bastard	1 doz
94.	File, 8", three square, single cut	1 doz
95.	File Handles, one doz each of # 1, 2, 3	3 doz
96.	File card and brush	6
97.	Tap and Die set	1
98.	Screwdriver, stubby	2
99.	Screwdriver, Offset, set of three	1 set
100.	Screwdriver, for slotted screws, set of three	4 sets
101.	Screwdriver, Phillips style, set of three	1 set
102.	Screwdriver, Robertson style, set of three	1 set
103.	Screwdriver, Neon tube,	2

Item No.	Description	Quantity
104.	Hacksaw frame	4
105.	Hacksaw blades, 10", 24 T.P.I.	8 doz
106.	Hacksaw blades, 10", 18 T.P.I.	8 doz
107.	Chisel set, flat or cold, set of three	2 sets
108.	Chisel set, cape, set of three sizes	1 set
109.	Punch set, pin, set of three	2 sets
110.	Punch, long taper, 9"	2
111.	Punch, Center,	4
112.	Punch, hand, set of three	1 set
113.	Pry bar, 16"	2
114.	Hammer, soft face, one lb.	2
115.	Hammer, soft face. 2 lb.	1
116.	Hammer, ball pein. 8 oz.	2
117.	Hammer, ball pein. 2 lb.	2
118.	Hammer, ball pein, 2 lb.	2
119.	Mallet, fender, rubber, 2 lb.	2
120.	Brush, wire , hand	1
121.	Chain, 3'8" links, 14"	1
122.	Creepers, garage	2
123.	Trouble light	2
124.	Extension cord	2
125.	Knife, shop	2
126.	Bushing driver set	1
127.	Hoze air pressure	2
128.	Speed couplers for air hoze	4 sets
129.	Air blow gun	2
130.	Wheel dresser	2
131.	Arbor Press, 3 tons	1
132.	Soldering Gun, 325 watt	1
133.	Sharpening Stone, 8"x2"x1"	1
134.	Battery Terminal Spreader	1
135.	Booster Cable set	1
136.	Battery Cell Tester	1
137.	Battery Hydrometer	1
138.	Batter Carrier Strap	2
139.	Tube Vulcanizer, electric	1
140.	Tire tester	2
141.	Tire irons, spoon type, straight	1
142.	Tire irons, spoon type, curved	2
143.	Valve Core Tool	2
144.	Brake adjusting tool	1
145.	Screw Extractor set	1
146.	Stud Remover, 1/2" drive socket	1
147.	Feeler gauge set, ignition and spark plug	2
148.	Spark Plug Cleaner and Tester	1
149.	Puller set	1
150.	Ridge Reamer	1
151.	Hone, Cylinder, range 1 1/2" to 2 "	1
152.	Hone, Cylinder, range 2.0"to 2.6"	1
153.	Hone, Cylinder, range 2 11/16" to 4 1/2"	1
154.	Coil and Condenser Tester	1
155.	Power Timing Light	1
156.	Vacuum and Fuel Pump Tester	1

Item No.	Description	Quantity
157.	Compression Tester	1
158.	Punch, Gasket	1
159.	Feeler Gauge Stock, 8 sizes	1
160.	Feeler Gauges, Combination	4
161.	Valve Guide Cleaner	2
162.	Ring Compressor, 2 1/8" to 5"	1
163.	Ring Compressor, 1 12/" to 3"	1
164.	Valve Lifter, "c" type	1
165.	Valve Lifter, "Stub" type	1
166.	Hone, Brake Cylinder	1
167.	Engine Oil Pouring Spout	2
168.	Oilers, 1'3 pt., piston pump	2
169.	File, point file	2
170.	Steering unit with brakes, model	1
171.	Transmission and Clutch, model	1
172.	Differential Gear, model	1
173.	Two stroke cut-away motor, model	1
174.	Four Stroke cut-away motor, model	1

Equipment of Unit Wood And Construction Shop

Item No.	Description	Quantity
1.	Drill Press, 15"	1
2.	Bench Grinder, 7"	1
3.	Drill, Electric, Portable, 3/8"	1
4.	Planer, Electric, Portable	1
5.	Lathe, Wood, 12" swing	2
6.	Scroll Saw, 24"	1
7.	Saw, Circular, table, 10"	1
8.	Bandsaw, 14"	1
9.	Spray gun equipment and air compressor	1
10.	Plane, Jack, 14", steel	1
11.	Plane, Smooth. 9", steel	6
12.	Plane, Block, 6"	4
13.	Spokeshave, steel	2
14.	Scraper, steel, Cabinet	2
15.	Plane, Router	1
16.	Plane, Wood Body 14"	6
17.	Plane, Wood Body 9"	6
18.	Saw, Dovetail, 10"	4
19.	Saw, Crosscut, 26" 8. T.P.I	3
20.	Saw, Rip, 26" , 5 1/2 T.P.I.	3
21.	Saw, Coping, for 6 1/2" blades	6
22.	Saw Blade, Coping	100
23.	Saw, Keyhole, 10" blade	1
24.	Saw Set, for handsaws	1
25.	Rule, Tape, 8ft. steel	6
26.	Rule, 12", steel	4
27.	Square, combination	8
28.	Square, Try, 8" blade	6
29.	Bevel, T.8" blade	6
30.	Square, Steel, Rafter	6
31.	Trammel Points	1 set
32.	Gauge, Marking	6
33.	Calipers, Outside 6"	2
34.	Calipers, Inside, 6"	2
35.	Dividers, 8"	1
36.	Hammer, Tack, magnetic	2
37.	Hammer, Nail, 13 oz.	6
38.	Hammer, Nail, 16 oz.	6
39.	Mallet, Woodworkers' hardwood	12
40.	Knife, Utility	4
41.	Chisel, Mortise, 1/4"	4
42.	Chisel, Mortise, 3'8"	4
43.	Gauge, Outside Bevel. set of five	2 sets
44.	Gauge, Inside Bevel, set of five	2 sets
45.	Chisel, pocket, set of six from 1/4" to 1"	6 sets
46.	Screwdriver, 4" blade, 3/16" cabinet tip	2
47.	Screwdriver, 4" blade, 1/4" tip	6
48.	Screwdriver, Robertson style tip, set of 3	1 set
49.	Screwdriver, 10" blade 7/16" tip	2

Item No.	Description	Quantity
50.	Screwdriver, Robertson style tip, set of 3	1 se
51.	Bit Brace, 10" Swing	2
52.	Drill, Hand 3/8" capacity	2
53.	Auger Bit, set of 13 from 1/4" to 1"	1 se
54.	Countersink Bit 3/4" rose type	2
55.	Bit, Expansive, 7/8" to 3" capacity	1
56.	Bit, Spade, set of six 3/8" to 1"	1 set
57.	Twist Drill, set, size 1/16" to 1/2 by 1/32 nds	2
58.	Awl, Scratch	6
59.	File, "Surform" type, straight	2
60.	File. Auger Bit	2
61.	File, 10" half round bastard cut	1 doz
62.	File, 8", cabinet rasp	1 doz
63.	File, 10 double cut, mill bastard	1 doz
64.	File, 8" triangular slim taper	1 doz
65.	File handle, eight each of # 1, 2, 3 wood	2 doz
66.	Pliers, 8" combination	1
67.	Pliers, 7" diagonal cutting	1
68.	Nail Set, set of three; one each of 1/32 2/32, 3/32	2 sets
69.	Oilstone 2" x 8" x 1"	2
70.	Oilstone, slip	2
71.	Oiler, one pint	2
72.	Glass Cutter	2
73.	Wrench, adjustable, 6"	1
74.	Wrench, adjustable, 10"	1
75.	Burnisher, 4 1/2" blade	1
76.	Clamp "C" 6" opening	6
77.	Clamp. "C" 8" opening	6
78.	Clamp, I-Bar, 24"	6
79.	Clamp, I-Bar, 36"	6
80.	Clamp, I-Bar, 48"	6
81.	Clamp, I-Bar, 60"	4
82.	Hand Screw, 4 1/2" jaw opening	6
83.	Hand Screw, 8 1/2" jaw opening	6
84.	Punch, center	6
85.	Brush, Bench duster	12
86.	Face Shields	4
87.	Dresser, Grinding wheel	1
88.	Mitre Box	1
89.	Saw Blade, circular, crosscut, 10"	1
90.	Saw Blade, circular, rip, 10"	1
91.	Saw Blade, circular, Lollow ground, 10"	1
92.	Dado Head set, 8" , 5/8" arbor	1
93.	Lathe Chisel, set of eight chisels	2
94.	Clamp "C" 4" opening	12
95.	Scutch and comb	2
96.	Level, spirit, 30"	2
97.	Plumb Bob	4
98.	Hammer, Club, 2 1/2lb.	2
99.	Rule, course counting space rule	2
100.	Tape, Masons' modular steel tape, 10"	2
101.	Jointer, Raker, 3/4" and 5/16"	2

Item No.	Description	Quantity
102.	Sled Runner, half round	2
103.	Slicker 1/4" and 3/8"	2
104.	Stone Beader, 3/8" and 1/2"	2
105.	Jointer, round and sunk	2
106.	Edger, Concrete, 6" long	2
107.	Groover, narrow bit	2
108.	Hatchet, half hatchet	1
109.	Masons' bit, set of six	1 set
110.	Bricklayers' set, 2 1/2" , 3" and 4" blades	1
111.	Reamer, pipe, straight flute, 1/8" to 2"	1
112.	Pipe Cutter, capacity 1/8 + to 2"	1
113.	Wrench Pipe, 3" capacity jaw	2
114.	Wrench , Pipe, 2" capacity jaw	2
115.	Wrench, strap, 1" to 5" capacity	1
116.	Wrench, Chain, 2 1/2" capacity	1
117.	Taps, Pipe, set of nine- 1/8" to 2"	1 set
118.	Tank cutter, capacity 1" to 4 "	1
119.	Threader, Pipe, ratchet handle, sizes 1/8" to 1 1/2"	1 set
120.	Extractors, Pipe, set of six from 1/8" to 1/2"	1 set
121.	Vise, Pipe, plumbing 1/8" to 2 1/2"	1
122.	Tape Measure, 50 steel	2
123.	Drill, Star, set of four 1/4" to 2/4"	1 set
124.	Level, Builders' Dumpy level	1
125.	Shovel, hand, square point	4
126.	Hoe, plasterers' mortar mixing	2
127.	Wheelbarrow, for concrete	1
128.	Braided Lines, 250 ft.	1

Equipment of Unit Drafting Shop

Item No.	Description	Quantity
1.	Scale, architects' triangular, metric	25
2.	Scale, combination architects, engineers	25
3.	Sharpener, pencil	1
4.	Triangle, 30'-60', 12"	25
5.	Triangle, 45', 8"	25
6.	French curves, set of four	25 sets
7.	Protractor, 5"	25
8.	T-square, fixed head, 90 cm. blade	25
9.	Shears, paper cutting, 10"	1
10.	Compass, chalkboard	1
11.	Drawing set	25
12.	Pencil pointer	3 doz
13.	Shield, erasing, metal	25
14.	Duster, draftsman's, 14 1/2"	25
15.	Guide, lettering	25
16.	White Print Machine, 27" cap.	1

Major Items of Equipment and Special Tools

Item number	Description	Quantity
1	Ramset gun *	2
2	Knife grinder *	1
3	Saw blade welder*	1
4	Electric hand drill 3/8"*	1
5	Electric hand drill 1/2"	1
6	Air compressor *	1
7	Power hack saw *	1
8	Saw sharpening machine *	1
9	Jointer *	1
10	Hydraulic press	1
11	Parts cleaner *	1
12	Tube checker *	1
13	V.O.M.	1
14	V.T.V.M. *	1
15	Power supply *	1
16	Pipe taps	1
17	Taps UNF-UNC	1 set
18	Outside micrometer	1 set
19	Letter drills	1 set
20	Extractor drills	1 set
21	Arc Welder *	1 set
22	Gas welder	1 set
23	Tool post grinder *	1 set
24	Drill press *	1
25	Bench grinder *	1
26	Tool & cutter grinder	1
27	Metal cutting band saw *	1
28	Horizontal milling machine *	1
29	Dividing head for milling machine	1
30	Disc sander *	1 set
31	Involute gear cutters	1
32	Keyway broachers	1 set
33	Spray painting equipment *	1 set
34	Radial arm saw *	1
		1

* These tools require 220 volts 50 hertz electric power.

APPENDIX D

Budget for Repair & Preventive Maintenance

Facilities & Equipment of E.S. S. B. 1973.

Code	Capital equipment	Alotment
410-1	Caretaker's Equipment	4,000
410-2	Caretaker's Supplies	92,200
415	Upgrading of Equipment	
440	Telephone-Schools	
441	Telephone-Administration Building	
442	Telephone-Service Building	
	TOTAL	96,200
510-1	Exterior Painting	27,400
510-2	Interior Painting	
510-3	General Building Repairs	41,400
510-4	Vandalism	30,000
510-5	Portables&Moves	25,000
510-6	Hardware Repairs	7,000
510-7	Roof Repairs	18,000
510-8	Fire Marshall's Recommendations	7,100
510-9	Floor Repairs	7,700
510-10	Gym Floor Refinishing	2,500
511	Repairs to Administration Bldg.	2,700
512	Repairs to Service Building	2,500
513	Other Buildings	600
515	Upgrading&Renovations	82,000
	TOTAL	253,900
520-1	Playfield Repairs&Maintenance	18,600
520-2	Maintenance, Shrubs, Trees, etc.	1,550
520-3	Weed Control, Fertilizing etc.	2,800
520-4	Fencing, Field Equipment Repairs	13,000
520-5	Paving, Parking Lot Repairs	4,600
520-6	Miscellaneous Repairs	2,500
520-7	Snow Removal	8,000
520-8	Surveys	1,500
521	Administration Building-Grounds	800
522	Service Building-Grounds	500
	TOTAL	53,750

Code	Capital equipment	Alotment
530-1	Plumbing Repairs	28,900
530-2	Boiler Maintenance	28,000
530-3	Motor Repairs	5,500
530-4	Fire Alarm, Electrical Repairs	10,500
530-5	School Lighting Maintenance	9,700
530-6	Controls	18,500
530-7	Clock&Intercoms	6,000
530-8	Ventilation Equipment	22,000
530-9	Industrial Arts Machinery	18,500
530-10	Dept.Equipment Maintenance	600
530-11	Service Contracts	5,000
530-12	Car Plug-ins	2,500
530-13	Incinerators	1,600
530-14	Caretaker Equipment Repairs	800
530-15	Fire Prevention Equipment	1,800
530-16	Electronics Repairs	27,800
530-17	Science Equipment	700
530-18	Musical Equipment	7,500
530-19	Typewriters, Business Machines	27,000
531	Administration Bldg.Equipment	3,500
532	Service Building Equipment	3,000
535	Mechanical & Electrical Upgrading	-
	TOTAL	228,000
560-1	General Deliveries	4,200
560-2	Truck& Tractor R pairs	4,700
565	Transport Upgrading	3,300
	TOTAL	12,200

Code	Capital equipment	Alotment
640	Shop Stock	-
640-1	Furniture-General Repairs	5,500
640-2	Locker Repairs	200
640-3	Bulletin,Cork,Chalkboard Repairs	400
640-4	A.V.Equipment Repairs	500
640-5	Music,Drama Equipment	600
640-6	Sports Equipment Repairs	500
640-7	Science Equipment Repairs	100
640-8	Library Equipment Repairs	100
640-9	Drapes,Blinds,Repairs	2,000
640-10	Architect's Equipment Repairs	1,200
640-11	Home Ec.& Ind.Arts Equip.Rep	100
640-12	Art Equipment Repairs	100
640-13	Maintenance Equipment Repairs	450
641	Admin,Bldg.Furniture Repairs	450
642	Service Bldg.Furniture Repairs	100
646		
647		
	TOTAL	11,800

ADMINISTRATION(Section D)

Salaries:Administrative and Supervisory	$ 240,600	
Clerical	367,100	
Trustees	31,200	
Employee Benefits	44,100	
Transportation	6,800	
Office and Printing Supplies	52,000	
Postage	9,900	
Election-Census	20,000	
Advertising	7,200	
Conventions and Seminars	7,000	
Legal and Audit Fees-Sundry	28,800	$ 814,700

OPERATION OF PLANTS (Section E)

Salaries:Caretakers	$ 1,617,200	
Employee Benefits	127,600	
Caretaker's Supplies	96,200	
Fuel	186,500	
Utilities(Water,Light,Phones)	525,300	$2,552,800

MAINTENANCE OF PLANTS(Section F)

Salaries:Supervisors, Warehouse	$ 145,100	
Repairmen	462,500	
Employee Benefits	49,400	
Transportation	22,650	
Buildings-Renovations	82,000	
Grounds-Repairs	171,900	
Equipment-Repairs	228,800	
Insurance	63,000	$1,279,100

FURNITURE AND EQUIPMENT (Section G & H) $ 165,000

VITA

NAME: Damkerng CONGCAR

PLACE OF BIRTH: Utaithani, Thailand

YEAR OF BIRTH: 1937

QUALIFICATION

High School Cert.	From Chiengrai Samakkeetham Wittayakom School, Chiengrai, Thailand 1948-54,
Engineering Cert.	From Patumwan Engineering School Bangkok, Thailand 1954-57,
Technical Cert., & Dip.in I.A.&Voc.Ed.	From Bangkok Technical Institute, Bangkok, Thailand 1957-60,
B.Ed.(Voc.)	From Prasarnmit College of Education, Bangkok, Thailand 1962-65,
Grad.Dip.in Ed.Admin.	From University of Alberta, Edmonton, Alberta, Canada 1968-69.
M.Ed.(I.A.)	From University of Alberta, Edmonton, Alberta, Canada 1972-74.

EXPERIENCE

7 Years	As industrial Arts Teacher and Head Department of Practical Arts in High Schools.
3 Years	As Industrial Arts Supervisor and Canadian Equipment Maintenance Advisor Counterpart for the Thai Comprehensive School Project.

He specializes in equipment maintenance, electrical power and school shop planning. Since his studies at the University of Alberta, he has been a member of Epsilon Pi Tau an international honory professional fraternity in Industrial Arts and Industrial Vocational Education and a member of American Industrial Arts Association.