A STUDY OF CURRENT PRACTICES IN MAINTAINING INDUSTRIAL ARTS LABORATORIES IN SECONDARY SCHOOLS IN THE STATE OF TEXAS

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The problem of this study was to determine what are the maintenance practices and to what extent are they being used by industrial arts teachers in the subject areas of woodworking, metalworking, and drafting at the secondary level in the state of Texas.

In order to conduct the study, answers were sought to the following questions: 1. What are the maintenance practices used by industrial arts teachers? 2. How much maintenance does the industrial arts teacher perform, and what is required of him by the school system? 3. What type of maintenance procedures are performed by the industrial arts teachers? 4. How much and what kind of maintenance is performed by people other than the industrial arts teacher? 5. When is the maintenance performed by the industrial arts teacher? 6. Does the industrial arts teacher incorporate the maintenance he performs into his teaching? 7. How is maintaining the industrial arts laboratories financed? 8. Does the industrial arts teacher receive remuneration for maintaining the laboratories beyond his teaching salary?

Instruments were developed to gather data concerned with answering questions used in stating the problem. The instruments were sent to secondary teachers selected from a Texas Education Agency pamphlet entitled, "Texas Schools Having Industrial Arts Teachers During 1969-70." The data collected were recorded and analyzed. The findings from these data provided information from which conclusions and recommendations were made.

Chapter I of this study consists of an introduction, statement of the problem, basic assumptions, background and significance, definition of terms, delimitation of the study, related information, and procedures.

A description of the industrial arts laboratories, including woodworking, metalworking, and drafting, is presented in Chapter II.

Chapter III is concerned with the development and application of the instruments for use in the study.

The presentation of the data and the treatment of the data is the concern of Chapter IV.

Chapter V presents the summary, findings, conclusion, and recommendation of the study.

From the data gathered, it was found that all industrial arts teachers performed some maintenance. It was also determined that the maintenance work the industrial arts teachers performed was done in various amounts at different times. Some of the industrial arts teachers performed maintenance work

during school hours, but others spent time maintaining the industrial arts laboratories after school hours as well as during the summer months. The industrial arts teachers were responsible for all types of maintenance, such as preventive, repairs both major and minor, electrical, and sharpening of cutting tools. Budgets were allotted to only 35.5 per cent of the industrial arts teachers to maintain their laboratories, and 54.4 per cent of the teachers were in school systems that provided a maintenance staff to assist the industrial arts teachers. With the amount of maintenance and extra time the industrial arts teachers spent performing maintenance, they received very little extra remuneration.

The following recommendations were made: 1. Schools should provide methods to remunerate more industrial arts teachers that spend extra time in the industrial arts laboratories. 2. More of the school systems should allot budgets to maintain industrial arts equipment. 3. Industrial arts teachers should be supplied with tools to maintain the laboratories. 4. More school systems should use a maintenance staff to assist the industrial arts teachers in maintaining the laboratories. 5. Industrial arts teachers should implement a schedule of preventive maintenance. 6. The schools should provide free time for the industrial arts teachers to perform maintenance in the laboratories.

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THESIS

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By

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CHAPTER I

INTRODUCTION

Since the beginning of recorded history, man has been using his own hands as well as tools and equipment. One of the objectives of industrial arts is to teach a certain amount of skills in using tools and equipment (11, p. 21).

To teach industrial arts subjects properly and provide opportunities for the student to develop proper attitudes and respect for the equipment and tools he uses, the equipment must be properly maintained. Silvius states,

> It is only when equipment is continuously maintained in excellent condition that a complete and sound educational program may be offered. A teacher will only succeed where the students perform operations with tools and machines kept in first class condition" (8, p. 207).

A certain portion of the maintenance performed by the industrial arts teacher is necessary, while other maintenance is provided by either school maintenance personnel or commercial firms.

Statement of the Problem

The problem of this study was to determine what are the maintenance practices and to what extent they are being used by industrial arts teachers in the subject areas of woodworking

metalworking, and drafting at the secondary level in the state of Texas.

In order to conduct the study, answers were sought to the following questions:

1. How much maintenance does the industrial arts teacher perform, and what is required of him by the school system?

2. What are the maintenance practices used by industrial arts teachers?

3. What type of maintenance procedures are performed by the industrial arts teacher?

4. How much and what kind of maintenance is performed by people other than the industrial arts teacher?

5. When are the maintenance practices performed by the industrial arts teacher?

6. Does the industrial arts teacher incorporate the maintenance he performs into his teaching?

7. How is maintaining the industrial arts laboratory financed?

8. Does the industrial arts teacher receive supplementary pay for maintaining the laboratory beyond his teaching salary?

Basic Assumptions

The following assumptions were basic to the study:

1. Tools and equipment are presently being used in industrial arts laboratories and will continue to be used.

2. Tools and equipment will require some degree of care and maintenance by the industrial arts teacher.

3. It is essential that preparations must be made for closing laboratories for the summer.

4. It is basic to assume that cost for repairs and maintenance will exist.

Background and Significance of the Study

Civilization Through Tools, a publication of the Wilkie Foundation states, "Man lives by tools, extension of his hands and servants of his will" (14, p. 5). Tools were being used by men before he learned to make them. Primitive man used a trial-and-error method of learning that rocks and sticks of certain shapes and sizes helped him do things that he could not do with his bare hands. With the assistance of primitive tools, he was able to crack nuts, cut vines, and lift rocks (15, p. 8089).

Man then learned to change and shape his tools for special uses, developing knives and hammers of flint. He began to think in terms of desired shapes, sizes and proportions, of holes in objects, smooth surfaces, and desired lengths (14, p. 7). With continued use of the simple tools, man learned they worked more efficiently when equipped with handles.

As man continued to progress, he improved his tools and entered the Bronze age. During this period, man discovered metals and some of their simple uses. As the population and society developed, so did man's tools. It is stated by Howell,

> "Early agricultural peoples developed the hoe as an improvement over the sharp stick with which they had earlier scratched the ground to prepare

> it for seeds. The Egyptians probably developed the first plow while the Romans developed the first saw, and also the first shears, the blades of which were operated by a flat spring. These early peoples were helped in creating new tools by the discovery and use of iron. Steel was discovered in the middle ages, but was used chiefly for swords and other weapons" (15, p. 8089).

Howell states in the World Book that the steel age began in 1772, when René Antonine de Réamur, a Frenchman, developed a process to produce quantities of steel by placing malleable iron in a bath of cast iron (15, p. 3895).

The progress of steel processing continued until the middle 1800's. A high quality crucible type steel was produced in the United States. During this period of time the Bessemer converter was used to make a larger quantity of steel cheaply in the United States. Later in the 1800's and 1900's three other processes were developed. They were the open-hearth type furnace, the electric furnace, and the basic oxygen furnace (1, p. 7). It was these processes that led to the development of alloy steel, and alloy steel that made it possible for the development of our present day tools and equipment.

The development of tools and equipment progressed with the discovery and improvement of metals. The lathe is a good example of this development. The lathe began in the 17th century as a wooden pin stuck through a tree and turned by a rope. In the year 1797, Sir Henry Maudslay developed the first screw-cutting lathe. The spindle was geared to the lead screw, which drove the carriage. Lathes having iron ways were built around

1850 in the United States (12, p. 67). With the early development of the lathe and the newer alloy steels, the lathe has developed into a very sophisticated machine, as have a large number of other machines.

Tools and equipment that are in efficient operating order should be a prime concern of the industrial arts personnel. To obtain a worthwhile attitude on the part of the student concerning tools and equipment, the teacher must exemplify the attitude towards tools. It is significant that the teacher cannot expect the student to work to any degree of success and safety with improperly maintained tools. Silvius and Curry state that when a student finds he cannot do good work because the tools are in poor condition, he soon develops a negative attitude toward his work and becomes even deliberately abusive of the tools (8, p. 208).

One purpose of the study was to determine what practices the teacher uses to keep the tools and equipment in good condition. At the same time, he should integrate the conditioning of the tools and equipment into his teaching to further promote a good attitude. Silvius and Curry list the three following purposes for keeping tools in proper condition (8, p. 208): 1. To promote a high degree of efficiency. 2. To maintain safe working conditions. 3. To keep cost of the operation low and prolong the life of the equipment.

The industrial arts student cannot possibly work as well as he should, nor will he respect the tools if they are not in

a workable condition. He is more apt to work efficiently and have more respect for the tools he uses if they are in good shape and functioning properly. Therefore, it is essential that the tools and equipment be maintained continuously.

Dull tools are one of the major causes of accidents in school shops, and every effort should be made to prevent accidents. The application of the study may provide some insight for instructors as to how maintenance may be carried out more efficiently, leading to safer operations.

Another purpose of the study concerned itself with the extent of use of the various maintenance practices. Cutting the cost of operation and increasing the life of the tools and equipment is the primary purpose of a maintenance program. In order to achieve the desired results of a sound maintenance program, daily upkeep and repair must be performed by some person or persons. Maintenance can be divided into two separate divisions, one of which is preventive maintenance, while the second one is remedial maintenance. Preventive maintenance pertains to such operations as lubricating and cleaning equipment. Remedial maintenance refers to those operations in which sharpening, repairing, and replacing worn parts are involved. Such operations as cleaning and lubricating periodically will prevent wear and will increase the life of the tools and machines. The industrial arts teachers should follow a rigid schedule in carrying out this maintenance program.

The maintenance that must be performed in the laboratory can be divided into three groups, as stated by Rusinoff (7, p. 51).

1. Maintenance which depends primarily on use rather than time. Lubricating, cleaning, minor adjustment, changing filter, and electronic are items in this group.

2. Maintenance which depends primarily on time rather than use. Replacing of gaskets, tension springs, certain electronic parts, and other replacements caused by deterioration with age comprise this group.

3. Maintenance which depends on both time and use. Realigning shafts, replacing damaged and used parts, rewiring motors fall in this group.

The various types of maintenance must be scheduled, performed, recorded, and the cost accounted for at regular intervals in order to keep the laboratory tools and machines running efficiently and safely for their serviceable lives.

As a result of this study, industrial arts teachers might be able to better apply maintenance procedures to their laboratories. This study was significant in that possible guidelines for laboratory maintenance could be developed and made available for use by industrial arts teachers. It was also significant to the extent that time and cost could be determined in order to assist in developing budgets, and, as a result, the industrial arts teacher might receive remuneration for the extra time devoted to maintenance.

Definition of Terms

For the purpose of this study, it was necessary to establish specific meanings for the use of certain terms, which are

explained as follows.

1. Maintenance as used in this study refers to the upkeep of property such as tools and equipment (13, p. 510).

2. Woodworking as referred to in this study is all the secondary courses in the subject matter area of wood as listed in Principles and Standards for Accrediting Elementary and Secondary Schools (9).

3. Metalworking in the study refers to all the secondary-level courses in the subject matter area of metal as listed in Principles and Standards for Accrediting Elementary and Secondary Schools (9).

4. Drafting in this study refers to all the secondary level courses in the subject matter area of drawing as listed in Principles and Standards for Accrediting Elementary and Secondary Schools (9).

5. Laboratory refers to the classroom-type facility used in teaching industrial arts courses. It is specially equipped with machines and tools of the individual area being taught.

6. Tools and equipment refer to hand tools, machine tools, and other items normally used in industrial arts laboratories.

Delimitation

The following delimitation was used in conducting the study: the study was limited to data collected from seventy-nine secondary-level industrial arts teachers in selected schools of Texas.

Related Information

A search of the literature revealed that very little research had been done concerning maintenance programs in industrial arts laboratories. Materials were found, however, that were related to this study. They are discussed as follows:

Capps (2, p. 4) conducted a study in 1951, entitled "Common Tool and Machine Maintenance Problems of 130 Industrial Arts Departments in Kansas High Schools." Capps studied the problems which industrial arts teachers encountered in maintaining their laboratories. He questioned the causes of these problems and how they were solved or repaired. He found that the causes of the problems were usually inadequate instruction, carelessness, or abuse. He also found that the problems could be lessened with more adequate teacher training at the college level.

A survey was conducted by the editors of Industrial Arts and Vocational Education in 1968 (6, pp. 26-27). It is entitled, "Machine and Tool Maintenance -- A Survey." This survey dealt with the types of systems for maintaining tools and equipment in different school districts. Generally the findings were that the larger districts usually had their own repair shop and maintenance men, with very little of the responsibility falling upon the teacher. The medium or smaller districts in the study had more of the burden placed on the teacher.

Coleman's article "Closing the School Shop for the Summer" (3, pp. 29-30) deals with the problem that industrial arts teachers encounter as the school year closes. It also lists

activities that the teacher should perform to properly maintain and account for the equipment in the industrial arts laboratories.

An article by Feirer, "Equipment: Maintenance, Care and Repair," presents problems with maintenance in the industrial arts laboratories (4, p. 29). The responsibilities of the teachers and the school district are listed in the article. Suggestions are also given to improve the maintenance, care, and repair of the industrial arts equipment resources.

"Equipment and Lubrication Records," an article by Griffin, offers industrial arts teachers a method of keeping records of the lubrication and care of each piece of equipment (5, p. 83). It also gives the teacher a guide to follow in the lubricating of the equipment, as well as being a teaching aid for presenting instruction in maintenance.

Procedures

The procedures used in the collection and treatment of data for the study were logical steps toward the answering of the questions listed in the statement of the problem. The following procedures were used:

1. Instruments were developed to gather data concerning maintenance procedures used by industrial arts teachers in industrial arts laboratories. The general field of industrial arts as well as the specific areas of woodworking, metalworking, and drafting were included in the instruments.

2. The instruments were sent to 150 secondary industrial

arts teachers selected from a Texas Education Agency pamphlet entitled "Texas Schools Having Industrial Arts Teachers During 1969-70 (10). The teachers were selected equally from each of the interscholastic league classifications of school size and from an equal number of schools in the urban and rural areas of Texas.

3. The data collected were recorded and analyzed. The findings from these data provided information from which conclusions and recommendations were made.

4. Background and related information were gathered from library material, both published and unpublished, written in the field of industrial arts.

Organization

Chapter I of this study consists of an introduction, statement of the problem, basic assumptions, background and significance, definition of terms, delimitation of the study, related information, and procedures.

A description of the industrial arts laboratories includes woodworking, metalworking and drafting and is presented in Chapter II.

Chapter III is concerned with the development and application of the instruments for use in the study.

The presentation of the data and the treatment of the data are the concern of Chapter IV.

Chapter V presents the summary, findings, conclusion, and recommendation of the study.

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CHAPTER II

INDUSTRIAL ARTS LABORATORIES

Industrial arts courses are designed (1) to develop in each student insight into the operation of industry, (2) to discover talents in students, (3) to develop problem-solving skills in students, as well as (4) to develop a measure of skill in the use of common tools and machines (6, pp. 19-20). To develop the qualities set forth in these goals, industrial arts classes must be a laboratory activity, and the laboratory must contain tools and equipment. To determine the proper specifications for a new or remodeled laboratory, there are certain factors which must be considered. Silvius states the following:

1. The aims of the course must be formulated.
2. The unit that will make up the content for the course to be offered and prescribe the needed equipment.
3. Method used to teach governs the placement of the equipment.
4. The number of students to be enrolled dictates the size per student (3, p. 181).

The industrial arts laboratory should be set up as a place where students are provided with learning experiences while using correct tools that are properly maintained. If

the four factors listed by Silvius are not followed, the laboratory probably will not supply the student with the correct tools with which to work. Disregarding these factors will also make maintaining the tools more difficult. Tools that are improperly used or abused require far more maintenance than properly used tools. The inexperience of the tool users in an industrial arts class is one reason the teacher must take time to maintain tools. Another factor influencing proper maintenance centers around safety. As mentioned earlier, this study includes maintenance practices in the areas of woodworking, metalworking, and drafting. It was deemed necessary to describe the tools and equipment usually found in the various laboratories, which are subject to preventive and remedial measures of maintenance.

Woodworking Equipment

Woodworking courses should provide varied experiences in working with design, construction, maintenance, repair, and testing of wood and wood products, as well as experiences in working safely with tools and machines (5, p. 44).

According to the guidelines presented, a woodworking class should begin by carefully planning the project to be constructed. Gaining skills with hand and machine tools is an important step when constructing a project. The student should have an opportunity to use all types of saws, chisels, planes, and other edge-cutting tools. As well as acquiring a measure of skill with hand tools, the student must have the

opportunity to learn to operate the machine tools. The Curriculum Guide for Industrial Arts in the Lewisville School System states,

> "They should set up and operate the following power tools: circular saw, band saw, radial saw, jointer, surfacer, drill press, jig saw, and sander. The portable power tools should also be demonstrated and have frequent use by the student. These machines include the belt sander, router, saber saw, and hand drill" (2, p. 25).

The following is a list of general machine tools needed to equip a woodworking laboratory (1, pp. 61-67).

Drill, Electric Portable (1/4")
Drill, Electric Portable (3/8")
Grinder, Edge tool (bench)
Jointer (6")
Jointer (8")
Lathe, Wood turning
Press, Drill (15")
Sander, Belt, Portable, Electric
Sander, Finishing, Portable, Electric
Saw, Band, Woodcutting
Saw, Circular, Power
Saw, Jig (scroll)
Saw, Radial-arm, Power
Saw, Sabre (bayonet)
Shaper, Spindle (floor model)
Surfacer (single surface planer)

Besides the machine tools already mentioned, the laboratory should be equipped with all types of hand tools, such as hammers, saws, chisels, drills, planes, and others too numerous to mention.

For the student to receive the best possible experiences in woodworking, the equipment listed should be arranged in a room that will provide for both the needs of the students and the care of the equipment. The Texas Education Agency recommends that the woodworking laboratory be rectangular in shape,

being twice as long as it is wide, and the width being no less than thirty feet (4, p. 5). The agency also recommends that a woodworking laboratory contain 125 square feet per student, with 325 square feet of storage area (4, p. 5). For fire and accident prevention, the room should be provided with equipment to collect sawdust and shavings.

Metalworking Equipment

Metalworking courses may be offered in areas of bench metal, sheet metal, foundry, machine metal, and welding (5, pp. 48-50). As in woodworking, emphasis should be placed on the planning of a project and then carrying it through the stages of fabrication and finishing from raw materials. To be able to construct an object properly from metal, the student should have a grasp of the use of hand tools and machine tools, along with the various processes and procedures.

A laboratory equipped to provide the student with the proper amount of skill and insight into the use of these tools and processes should contain such tools and equipment as follows (1, pp. 46-54):

Arbor, Milling machine
Bar Folder
Bender, Universal
Brake, Box and pan
Buffer, Long arm
Drill, Electric, Portable (1/4")
Drill, Electric, Portable (1/2")
Electroplating Unit
Forge, Gas
Forming Roll, Slip
Furnace, Crucible
Furnace, Heat treating
Grinder, Heavy duty, Pedestal

Grinder, Surface
Indicator, Dial test
Lathes, Metalworking (10")
Milling Machines, Horizontal
Milling Machines, Universal
Milling Machine, Vertical
Press, Arbor
Press, Drill (15")
Press, Drill (17")
Saw, Band (power), Metal cutting
Saw, Hack (power)
Shaper, Metal
Shear, Squaring foot
Spray Gun Outfit
Torches, Gas
Welder, Arc
Welder, MIG
Welder, Spot
Welder, TIG
Welding Outfit, Oxyacetylene
Anvil

The equipment must be properly arranged within a well designed laboratory for the student to gain the best experience. The size of the metal laboratory would be identical to that of the woodworking laboratory, with the room having a two-to-one ratio of length to width and 125 square feet of space per student (4, p. 5). The classroom should also be well lighted, climate controlled, and well ventilated in addition to the mentioned shape and size.

Drafting Equipment

Drafting should develop an understanding of the principles of orthographic, isometric, oblique, and perspective projection (2, p. 11). To represent an object graphically, the student should master drafting skills such as lettering, line work, layout techniques, neatness, and accuracy in solving real problems. The laboratory should have the following

minimum equipment:

Compass, Chalkboard
Divider, Blackboard
Projection Box, Plastic, Instructor's
Projector, Filmstrip (35mm) and slide (2" x 2")
Projector, Motion picture, Sound
Projector, Overhead
Protractor, Chalkboard
Scale, Chalkboard (demonstration)
Screen, Projection
Triangle, Chalkboard, 30° - 60°
Triangle, Chalkboard, 45°
Compass and Divider (set)
Compass, Beam
Compass, Drop bow
Curve, Irregular (set)
Cutter, Paper
Dispenser, Drafting tape
Divider, Proportional
Fountain Pen (technical set)
Pencil Pointer, Lead pencil
Pencil Pointer, Mechanical
Pencil Sharpener, Draftsman's
Repair Kit, Drafting instrument
T Square
Erasing, Machine, Electric
Machine, Drafting (18")
Machine, Drafting (24")
Machine, Reproduction (dry type)
Machine, Reproduction (moist type)
Marking Tool, Electric

The drafting room is different from the two classrooms previously mentioned. There are few machine tools being used in the drafting room, with the paper cutter, blueprint and other reproduction machines making up the major portion of the machine tools. The student's work centers around individual stations, which are made up of a drafting desk and instruments. With there being less equipment in the drafting room and less reason for the students to move around, the call for space in the drafting room is not as great as in the woodworking and metalworking laboratories. A room with the length

to width ratio of two to one is called for, with 100 square feet per student being a desirable size and shape for the drawing laboratory (4, p. 5). The lighting is a very important consideration because of the nature of the work and the strain that may result from too much glare or from insufficient illumination. For the student to work well, the light should be at the right level of brightness and be properly diffused to be free of any glare.

Each of the above described industrial arts laboratories contains certain machine and hand tools along with many other pieces of equipment. In order that the student may develop skill and gain knowledge to the best of his ability, it is imperative that the equipment be kept in excellent working condition. At this point one might ask the following questions: Who performs the maintenance on the tools and equipment? How much maintenance is normally expected of the instructor? How much maintenance is performed by people other than the instructor, and how is the maintenance financed?

Data gathered by the instruments should provide answers to these questions in determining the current trends in maintaining industrial arts laboratories. A description of the development and application of the instruments is presented in Chapter III, which follows.

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CHAPTER III

DEVELOPMENT AND APPLICATION OF THE INSTRUMENTS

Developing the Instruments

Several types of instruments were investigated to determine which would be best in order to conduct the study. As a result, the checklist type was selected for use. This type could be developed in a more compact form, which could be answered easier and quicker by the teachers being surveyed. The instruments were written so that the information could be gathered according to the amount and kind of maintenance which was being done by industrial arts teachers in their laboratories as well as maintenance which was being done by other persons. The instruments also sought information as to the methods which were used to carry out the maintenance and how the maintenance program was financed. The questions within the instruments were stated so that they would directly lead to answering the questions in Chapter I.

The instruments were designed to study only the areas of woodworking, metalworking, and drafting. To gather the needed data on the areas being studied, the instruments were divided into two parts. The object of the first part was to gather information of a general nature about the teacher and the school, as well as general maintenance procedures.

The second part was divided into three sections. One section was devoted to woodworking, one to metalworking, and another to drafting. The questions in this section were designed to gather data about items that were peculiar to each of the subject areas. The questions centered around the kind and amount of those specialized activities which involved maintenance work.

The Application of the Instruments

There were 170,000 industrial arts students enrolled during the 1969-70 school year in Texas (1). Of this 170,000 students, there were 41,623 students enrolled in woodworking classes, 15,056 enrolled in metalworking, and 45,855 enrolled in drafting classes, which composed the largest portion of students enrolled in industrial arts classes (2, p. 1). These curriculum areas were chosen to be studied because the findings would deal with a wider range of students and teachers.

One hundred fifty instruments were sent to the teachers from a list of Texas industrial arts teachers, as explained in Chapter I. Fifty teachers were included in each of the three areas under study. The teachers were given the opportunity to reply in the major area of teaching, even though some of them taught in other areas.

Data pertaining to the number of teachers responding to the instruments are presented in Table I. Of the teachers to whom the instruments were sent, seventy-nine responded, with two instruments being returned because of insufficient addresses.

TABLE I

NUMBER OF INSTRUMENTS SENT AND RETURNED

Areas	Sent	Returned	Per Cent
Woodworking	50	26	52.0
Metalworking	50	24	48.0
Drafting	50	29	58.0
Total	150	79	52.7

This amounted to a fifty-three per cent return of the instruments. The woodworking area had twenty-six responses; twenty-four teachers responded to the section on the metalworking area; and there were twenty-nine returns for the drafting area.

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CHAPTER IV

PRESENTATION OF THE DATA

There were certain questions listed, along with the statement of the problem, for which answers were sought through the use of the instruments. It is the purpose of this chapter to present and interpret the data which were collected. The first portion of the data is concerned with general maintenance procedures in industrial arts, while the second portion pertains to the specialized areas of metalworking, woodworking, and drafting.

General Information

An attempt was made to gather information concerning grade levels and number of years teaching experience in order to relate these data to the maintenance practices as used by industrial arts teachers. It was found that the data were unusable, due to the fact that too many of the teachers did not respond to this particular part of the instrument.

The industrial arts teachers were asked how much maintenance they performed. Table II presents data concerning the amount of time the teacher spent during the school week performing maintenance. Of the seventy-nine teachers responding to the instrument, thirteen, or 16.4 per cent, spent one-fourth

hour per week; fourteen, or 17.8 per cent, spent two hours per week in maintaining industrial arts laboratories during the working week; the largest group, 30.7 per cent, spent one hour per week.

TABLE II

HOURS INDUSTRIAL ARTS TEACHERS SPENT DURING THE SCHOOL WEEK PERFORMING MAINTENANCE

Time Per Week	Number	Per Cent
To one-fourth hour	13	16.4
To one-half hour	19	24.0
To one hour	24	30.4
To one and one-half hours	9	11.4
To two hours and above	14	17.8
Total	79	100.0

The remainder of teachers spent between one hour and two hours per week. Approximately 55 per cent of the teachers spent between one-half and one hour per week doing maintenance work.

The teachers were questioned as to whether they had access to the laboratories and how much time they spent after working hours maintaining the laboratories.

TABLE III

NUMBER OF TEACHERS HAVING ACCESS TO THE INDUSTRIAL ARTS LABORATORIES AFTER SCHOOL HOURS

Teachers	Number	Per Cent
With access to the laboratories	75	94.9

Seventy-five, or 94.9 per cent, had access to the laboratories after school hours, while only four, or 5.1 per cent, did not have access to the laboratories after school hours. It was obvious that the 5.1 per cent group would not be able to perform additional maintenance after school hours.

Table IV presents data concerning time spent by industrial arts teachers doing maintenance work after school hours.

TABLE IV

TIME SPENT AFTER SCHOOL HOURS PERFORMING MAINTENANCE IN INDUSTRIAL ARTS LABORATORIES

Hours Per Week	Number	Per Cent
None	30	38.0
One-half hour	18	22.8
One hour	16	20.3
One and one-half hours	3	3.7
Two hours	12	15.2
Total	79	100.0

There were thirty teachers, or 38.0 per cent of those surveyed, who did not spend any time after hours. Eighteen, or 22.8 per cent of the teachers, spent one-half hour, and twelve, or 15.2 per cent, spent two hours per week performing maintenance on the industrial arts equipment after school hours. The remainder spent between one and one-half hours. There were 94.9 per cent of the teachers who had access to the laboratories after school hours, but only 58 per cent actually performed maintenance after school hours.

There were some school districts which required teachers to do a certain amount of maintenance during the summer months. The data concerning the number of teachers performing maintenance in the summer is presented in Table V.

TABLE V

TIME INDUSTRIAL ARTS TEACHERS SPENT PERFORMING MAINTENANCE DURING THE SUMMER MONTHS

Number of Hours Worked	Number of Teachers	Per Cent
None	52	65.8
2 - 10	11	13.9
11 - 30	8	10.1
31 - 50	4	5.1
51 - 160	4	5.1
Total	79	100.0

It was found that 52, or 65.8 per cent of the respondents, did not perform maintenance in the industrial arts laboratories during the summer. Of the teachers who did perform maintenance in the summer, there was an average of thirty hours performed per month by each teacher. The time spent varied from two hours to one-hundred sixty hours per month. There were eleven teachers, or 13.9 per cent, the largest group who spent from two to ten hours maintaining the industrial arts laboratories in the summer.

Data concerning the amount of time the industrial arts teachers spent maintaining the laboratories have been presented earlier. However, to be effective, it is necessary to show

what types of maintenance the teachers performed. The teachers were asked if they were responsible for major repairs in the industrial arts laboratories. There were forty-seven, or 59.9 per cent of the teachers, responsible for major repairs. When asked if they performed a yearly maintenance schedule for preventive maintenance, the industrial arts teachers' response was that seventy, or 89.5 per cent, did perform maintenance yearly.

Data in Table VI show the various types of maintenance the industrial arts teachers performed.

TABLE VI

TYPE OF MAINTENANCE INDUSTRIAL ARTS TEACHERS PERFORMED

Type of Maintenance	Yes		No	
	Number	Per Cent	Number	Per Cent
As part of your work load, are you responsible for major repairs on tools and equipment?	47	59.9	32	41.1
Do you perform preventive maintenance, such as oiling and greasing equipment?	75	94.9	4	5.1
Do you perform yearly maintenance in your laboratory?	70	88.6	9	11.4
Do you perform minor repairs on hand tools and machine tools?	77	97.7	2	2.3
Is a periodic time table set for preventive maintenance?	25	40.4	54	60.6
Does the industrial arts teacher do electrical work?	14	19.9	64	71.1
Do the teacher and student perform special activities to close the school year?	75	94.9	4	5.1
Are you responsible for cleaning the laboratory?	47	59.1	32	40.9

In response to the question "Do you perform preventive maintenance such as oiling and greasing equipment?", there were seventy-five, or 94.9 per cent, who answered in the affirmative, while four, or 5.1 per cent, responded negatively. Seventy-seven, or 97.7 per cent of the teachers who were contacted, stated they did minor repairs on both hand and machine tools. The teachers were asked if they used a periodic time table for preventive maintenance. Only twenty-five, or 40.4 per cent, replied that they did carry out a periodic schedule of preventive maintenance, with fifty-four, or 60.6 per cent, not following a time table. When asked if they performed electrical maintenance work in the laboratories, fourteen, or 19.9 per cent of the teachers, answered that they performed electrical maintenance work in the laboratories, as compared to sixty-four, or 71 per cent, who responded that they did not. The teachers were surveyed as to how many performed special activities to close the school year. It was found that seventy-five of the seventy-nine, or 94.9 per cent of the teachers, did especially condition the tools and equipment for the summer. The last question was concerned with the type of maintenance the teacher performed. The teachers were asked if they were responsible for getting the laboratory cleaned. Forty-seven, or 59.1 per cent of the teachers, did have to see that the laboratories were clean. Thirty-two, or 40.9 per cent of the teachers, were not responsible for cleaning the laboratories.

The teachers were questioned as to the availability of a free period to perform any emergency or necessary maintenance. The data are presented in Table VII. There were fifty-eight teachers, or 73.4 per cent, who reported that they did have the possibility of using the conference period for maintenance.

TABLE VII

TEACHERS HAVING FREE PERIOD MADE AVAILABLE FOR MAINTENANCE

Free Period	Number	Per Cent
Available	58	73.4
Not available	21	26.6
Total	79	100.0

The remaining 26.6 per cent were not provided this opportunity for emergency or necessary maintenance.

How much and what kind of maintenance was performed by persons other than the industrial arts teacher was of interest to the study. Table VIII presents these data.

TABLE VIII

SCHOOLS HAVING MAINTENANCE ASSISTANCE FOR INDUSTRIAL ARTS LABORATORIES

Maintenance Assistance	Number	Per Cent
Schools having maintenance staff	43	54.4
Schools having maintenance shop	33	40.9

The teachers were asked if they had repairs performed by the school maintenance staff. Forty-three, or 54.4 per cent of the teachers, responded that they worked in a school system which had a maintenance staff to perform part of the maintenance in the industrial arts laboratories. In some schools there were complete repair shops to perform the majority of all the maintenance to the industrial arts tools and equipment. It was found that thirty-three, or 40.9 per cent of the teachers, were in school systems that had maintenance shops, as shown by the data in Table VIII.

Data are presented in Table IX as to the most expedient method of performing maintenance.

TABLE IX

TEACHERS' OPINIONS AS TO THE MOST EXPEDIENT METHOD OF PERFORMING MAINTENANCE

Teachers' Opinions	Number	Per Cent
Maintenance performed by teacher	12	15.2
Maintenance performed by school maintenance shop	52	65.9
Maintenance performed by commercial firms	15	18.9
Total	79	100.0

Some schools sent equipment to commercial firms to be repaired. Thirty-three, or 40.9 per cent of the teachers, were located

in school districts that sent equipment to commercial firms for repairs. The teachers were questioned as to which of the three methods was the most expedient: 1) by teacher; 2) by maintenance shop; 3) or by outside firm. The teachers responded with twelve, or 15.2 per cent, favoring the teacher performing the repairs; fifty-two, or 65.9 per cent, favoring the maintenance shop; and fifteen, or 18.9 per cent believing that it would be most expedient to have the maintenance performed by commercial firms.

Some of the industrial arts teachers incorporate maintenance into their teaching. These data are included in Table X.

TABLE X

TEACHERS INCORPORATING MAINTENANCE INTO TEACHING

Teachers	Number	Per Cent
Teachers incorporating maintenance into teaching	66	83.4
Teachers permitting students to help with maintenance	73	93.5
Teachers who believe the students gain benefit from performing maintenance	71	89.9

Sixty-six, or 83.4 per cent of the teachers contacted, did incorporate maintenance into their teaching; seventy-three, or 93.5 per cent, permitted the students to help them with the maintenance. Seventy-one, or 89.9 per cent, believed

the students gained useful information by helping maintain the industrial arts laboratories.

Financing industrial arts maintenance has long been a problem. The industrial arts teachers were questioned as to the methods the school systems used in financing the maintenance for the industrial arts laboratories. Table XI presents these data.

TABLE XI

SCHOOL BUDGETS ALLOTTED FOR INDUSTRIAL ARTS MAINTENANCE

School Budgets	Number	Per Cent
Schools with allotted budgets	29	36.6
Schools with emergency funds	54	67.1
Schools that allow teachers to make purchases	24	30.4

The teachers were asked if their school system had a budget allotted for maintenance. Twenty-nine, or 36.6 per cent of the teachers, had an allotted budget for maintenance, and fifty-four, or 67.1 per cent, had emergency funds available for maintenance, even though some of them did not have a budget. Of the school systems that had budgets for maintaining industrial arts equipment, 24 per cent budgeted money directly to the department in order that the teacher could make his own purchases when necessary for maintenance.

The final question asked the industrial arts teachers if they received any remuneration for the extra time and effort they devoted to maintenance. The data presented in Table XII show the remuneration received by industrial arts teachers for maintenance.

TABLE XII

TEACHERS RECEIVING REMUNERATION FOR MAINTENANCE IN INDUSTRIAL ARTS LABORATORIES

Remuneration	Number	Per Cent
Teachers remunerated for maintenance in laboratory during regular school year	13	16.4
Teachers remunerated for maintenance in laboratory during summer	22	27.8

Of the teachers questioned, it was found that only thirteen, or 16.4 per cent, did receive extra money for the extra work performed doing maintenance in the laboratories, while 83.6 per cent of the teachers surveyed did not receive remuneration during the regular school year. Twenty-two of the teachers, or 27.8 per cent, were paid for the maintenance work they performed during the summer months in the industrial arts laboratories.

This section presents data concerned with facets of performing maintenance that is general to most industrial arts

courses. The remaining section in this chapter deals with the areas of woodworking, metalworking, and drafting.

Woodworking Area

The woodworking laboratories, as well as the other industrial arts laboratories, requires maintenance that is peculiar to this area. It is the purpose of this portion of the chapter to present the data concerned with special maintenance activities in the industrial arts laboratories. The same basic questions were used to gather information on activities pertinent to maintenance practices in the woodworking laboratories.

Maintenance which the woodworking instructor performed is the major concern of this section. The teachers were asked if they were responsible for sharpening edge-cutting tools, such as plane irons, chisels, saws, and bits. The results are shown in the data presented in Table XIII.

Twenty-two, or 84.6 per cent of the teachers, replied that they were responsible for sharpening edge-cutting tools. Cutting tools were sharpened prior to the beginning of the school year in 80.7 per cent of the woodworking laboratories. When asked if they were responsible for sharpening the hand saw or machine saw blades, 30.1 per cent of the teachers replied that they sharpened the blades themselves. The data in Table XIII also show the number of teachers who believed it was more economical and expedient to send the saw blades to a commercial firm for sharpening. Twenty-two, or 84.6 per

cent, favored sending the blades to a commercial firm for sharpening because it was more expedient. It was believed to be more economical by sixteen, or 61.5 per cent of the teachers, to send the blades to commercial firms.

TABLE XIII

PRACTICES USED IN MAINTAINING CUTTING TOOLS IN WOODWORKING LABORATORIES

Practices	Number	Per Cent
Teachers responsible for sharpening edge cutting tools	22	84.6
Teachers sharpening tools prior to the beginning of the school year	21	80.7
Teachers responsible for sharpening saw blades	8	30.7
Teachers believing it was more expedient to send blades out	22	84.6
Teachers believing it was more economical to send blades out	16	61.5
Teachers responsible for sharpening jointer and planer knives	11	43.3
Teachers responsible for changing machine tool knives	24	92.5

The teachers were asked if they were responsible for sharpening machine tool knives, such as planer and jointer knives. Eleven of the teachers in woodworking, or 43.3 per cent, did sharpen these knives. The majority of the teachers,

twenty-four, or 92.5 per cent of the twenty-six woodworking teachers, did change these knives even though they did not sharpen them.

The amount of time the woodworking teacher spent sharpening the cutting tools is shown in Table XIV.

TABLE XIV

TIME SPENT SHARPENING WOODWORKING TOOLS

Maintenance Time	Number	Per Cent
None	4	15.5
5 per cent	9	34.6
10 per cent	11	42.3
25 per cent	2	7.6
Total	26	100.0

Nine, or 34.6 per cent of the woodworking teachers, spent 5 per cent of their maintenance time sharpening tools; eleven teachers, or 42.3 per cent, spent 10 per cent of their maintenance time sharpening tools; two teachers, or 7.6 per cent, spent 25 per cent of their maintenance time sharpening tools; and four teachers, or 15.4 per cent, did not spend any time sharpening tools.

The data pertinent to the number of teachers who did electrical maintenance work in the industrial arts laboratories are presented in Table XV. Twenty, or 76.9 per cent of all the woodworking teachers contacted, did minor electrical

maintenance work; but only five, or 11.5 per cent, did major wiring, such as connecting new machinery.

TABLE XV

TEACHERS DOING ELECTRICAL MAINTENANCE IN WOODWORKING LABORATORIES

Type of Work	Number	Per Cent
Minor electrical repair	20	76.9
Major electrical repair	5	11.5

The teachers were asked if they were responsible for maintaining band saw blades by means such as welding, sharpening, and setting them. The data in Table XVI show the number of teachers who maintained the band saw blades.

TABLE XVI

TEACHERS RESPONSIBLE FOR MAINTAINING BAND SAW BLADES

Teachers	Number	Per Cent
Responsible	14	53.8
Not responsible	12	46.2
Total	26	100.0

Fourteen, or 53.8 per cent of the teachers, did maintain the blades, with twelve, or 46.2 per cent, not being responsible for them.

The majority of the teachers changed their band saw blades approximately once a week, as the data in Table XVII show.

TABLE XVII

FREQUENCY OF CHANGING BAND SAW BLADES

Changes Per Week	Number	Per Cent
None	3	11.5
Once	20	76.9
Twice	2	7.7
Five	1	3.9
Total	26	100.0

One teacher, or 3.9 per cent of the teachers, changed the band saw baldes five times a week; two of the teachers, or 7.7 per cent, changed the blades twice a week; twenty, or 76.9 per cent of the teachers, changed the blades once a week; and three, or 11.5 per cent of the teachers, changed the blades less than once a week.

Considering whether teachers in the area of woodworking followed a time table and system for preventive maintenance is the concern of the data in Table XVIII. The teachers were asked if they followed a system to determine if the tools were dull or broken. Eighteen, or 73 per cent of the teachers, did use a system of checking the tools. However, only eight, or 30.7 per cent of the teachers, followed a time table for preventive maintenance.

TABLE XVIII

TEACHERS USING A SYSTEM AND TIME TABLE FOR MAINTAINING TOOLS AND EQUIPMENT

Maintenance Practices	Number	Per Cent
Teachers use a system to maintain tools	18	73.0
Teachers follow a time table to maintain laboratories	8	30.7

The instructors were also questioned as to the availability of tools with which maintenance of the woodworking laboratories could be performed. Table XIX presents the data showing that fourteen, or 53.8 per cent of the teachers, were in schools which had adequate tools to perform needed maintenance.

TABLE XIX

TEACHERS HAVING TOOLS AVAILABLE TO PERFORM MAINTENANCE

Tools	Number	Per Cent
Tools available	14	53.8

The woodworking teachers were questioned as to whether they instructed the students in methods of maintaining tools and equipment, and if the students were allowed to assist with the maintenance. The data in Table XX show the number of teachers who were giving instruction in maintenance and

allowing the students to participate. Twenty-two of the twenty-six woodworking teachers, or 84.6 per cent, instructed the woodworking students in maintenance and allowed them to help with lubrication and performing part of the maintenance.

TABLE XX

WOODWORKING TEACHERS INCORPORATING MAINTENANCE IN THEIR INSTRUCTION

Teachers	Number	Per Cent
Teachers instructing in maintenance	22	84.6
Teachers allowing students to perform some maintenance with supervision	22	84.6

Twenty-two, or 84.6 per cent of the woodworking teachers, allowed the students to do minor maintenance such as changing saw blades.

In some schools the woodworking teachers had to clean the laboratory floors. The number of woodworking teachers responsible for cleaning the floors appears in the data in Table XXI. The response was that twenty-one woodworking teachers, or 80.7 per cent, were responsible for cleaning the laboratories and that five, or 19.3 per cent, were not responsible. Apparently the woodworking teacher must often use some of the instructional time for cleaning the laboratories.

TABLE XXI

TEACHERS RESPONSIBLE FOR CLEANING LABORATORIES

Woodworking Teachers	Number	Per Cent
Responsible for cleaning laboratories	21	80.7
Not responsible for cleaning laboratories	5	19.3
Total	26	100.0

Metalworking Area

Maintaining a metalworking laboratory requires work that is different from the maintenance required of other industrial arts laboratories. This section of the study is concerned with the practices of maintenance which are peculiar to the metalworking laboratories. The first question is concerned with the amount of time the metalworking teacher spent sharpening cutting tools such as millcutters and drill bits, all of which must be precision ground.

The teachers were asked if they were responsible for sharpening the cutting tools. The responses are shown by the data in Table XXII. There were 87.5 per cent, or twenty of the twenty-four metalworking teachers, who were responsible for sharpening the precision tools.

TABLE XXII

TEACHERS RESPONSIBLE FOR SHARPENING PRECISION CUTTING TOOLS

Metalworking Teachers	Number	Per Cent
Teachers responsible	21	87.5
Teachers not responsible	3	12.5
Total	24	100.0

Data concerning the amount of time the teachers spent sharpening the precision tools is presented in Table XXIII.

TABLE XXIII

AMOUNT OF TIME METALWORKING TEACHERS SPENT SHARPENING TOOLS

Hours Spent Per Week	Number	Per Cent
None	1	4.1
One-fourth hour	9	37.5
One-half hour	10	41.6
One hour	3	12.5
One and one-half hours	1	4.1
Total	24	100.0

Nine of the metalworking teachers, or 37.5 per cent, spent one-fourth hour per week; ten teachers, or 41.6 per cent, spent one-half hour per week; three teachers, or 12.5 per cent, spent one hour per week; and one teacher, or 4.1 per

cent, spent one and one-half hours sharpening the precision cutting tools for the metalworking laboratories. There was one teacher, or 4.1 per cent, who did not spend any time sharpening precision cutting tools.

The teachers were asked if all cutters, such as mill and lathe cutters, were sharpened prior to the beginning of school. The number of teachers who sharpened the tools before the beginning of the school year is shown in the data in Table XXIV.

TABLE XXIV

TEACHERS SHARPENING TOOLS BEFORE SCHOOL OPENED

Tool Sharpening	Number	Per Cent
Teachers who sharpened tools before school opened	14	58.3
Teachers who did not sharpen tools before school opened	10	41.7
Total	24	100.0

Fourteen, or 58.3 per cent of the metalworking teachers, did sharpen the tools before the beginning of the school year. Ten, or 41.7 per cent, indicated that they did no sharpening of tools prior to the new school year.

Sixty-two per cent of the teachers believed it was more expedient to send the tools to commercial sharpening firms rather than grinding the tools themselves, as the data show in Table XXV.

TABLE XXV

MOST EXPEDIENT METHOD OF SHARPENING TOOLS

Methods	Number	Per Cent
Teachers sending tools to commercial firms to be sharpened	15	62.5
Teachers sharpening tools in the laboratories	9	37.5
Total	24	100.0

Nine, or 37.5 per cent of the teachers, sharpened the tools in the school laboratories rather than sending them out.

The purpose of the next group of questions is to determine what the metalworking teachers did in the area of maintenance.

In Table XXVI, the questions and data are shown. The teachers were questioned as to their responsibility for changing and dressing the grinding wheels. Twenty-three of the twenty-four teachers, or 95.8 per cent, were responsible for maintaining the grinding wheels. Twenty-three, or 95.8 per cent of the teachers, were responsible for performing minor maintenance repair work in the laboratories. Fifteen, or 62.5 per cent of the metalworking teachers, did minor electrical maintenance work. However, only five teachers, or 20.8 per cent, did major electrical work, such as wiring new machinery.

TABLE XXVI

MAINTENANCE DONE BY METALWORKING TEACHERS

Practices	Teacher Response			
	Yes		No	
	Number	Per Cent	Number	Per Cent
Is the teacher responsible for changing and dressing grinding wheels?	23	95.8	1	4.2
Is the teacher responsible for minor repair work?	23	95.8	1	4.2
Does the teacher do minor electrical repair work?	15	62.5	9	28.5
Does the teacher do major electrical work such as wiring the machinery?	5	20.8	19	79.2
Does the teacher use band saw blades that are pre-welded?	17	66.6	7	33.4

Prewelded band saw blades were used by seventeen, or 66.6 per cent of the metalworking teachers, which meant that 33.4 per cent of them did some kind of maintenance in regard to broken saw blades.

The metalworking teachers were questioned as to the method of preventive maintenance which they performed. The data are presented in Table XXVII.

Fifteen teachers, or 62.5 per cent, did have a system to check tools for breakage, dullness and loss. Fifteen, or

62.5 per cent of the teachers, followed a time table for preventive maintenance in the metalworking laboratories.

TABLE XXVII

PREVENTIVE MAINTENANCE PERFORMED BY METALWORKING TEACHERS

Practices	Number	Per Cent
Using a system to check tools and equipment	15	62.5
Following a time table for preventive maintenance	15	62.5

The metalworking teachers were then questioned as to the availability of tools to perform maintenance. Eighteen, or 75 per cent of the metalworking teachers, had an adequate supply of tools to lubricate and maintain the equipment properly.

The extent to which the students were involved in maintaining the metalworking laboratories is another area of concern. The data in Table XXVIII show to what extent the students were involved with maintenance in the metalworking laboratories.

One hundred per cent of the teachers instructed the students in maintenance procedures on the machines and equipment and allowed the students to help maintain them. Twenty-one of the teachers, or 88.5 per cent, used a system of class organization to clean and care for tools and equipment during

the class period. The teachers were asked if they used the students to help clean the floors in the laboratories. Nineteen of the teachers, or 79.2 per cent, stated that the laboratories were cleaned by the students.

TABLE XXVIII

CAPACITY IN WHICH STUDENTS WERE INVOLVED IN MAINTENANCE

Student Responsibility	Yes		No	
	Number	Per Cent	Number	Per Cent
Students instructed and allowed to help with maintenance	24	100.0	0	0
Teachers that use class organization to clean tools and equipment	21	88.5	3	11.5
Students clean floors in metalworking laboratories	19	79.2	5	20.8

Drafting Area

The area of drafting differs from the woodworking and metalworking areas due to the minimum amount of machine tools and equipment used in the drafting laboratories. This leads to situations involving maintenance which was different from that in the other industrial arts laboratories. The type of maintenance the drafting instructor conducted is the concern of the first portion of this section.

Table XXIX presents the data from the responses received from the drafting teachers as to the type of maintenance they

performed. Twenty-five, or 86.2 per cent of the drafting teachers, replied that they were responsible for repairing the drafting instruments. Fifteen, or 51.7 per cent of the teachers, sent major repairs to commercial firms. Sixteen, or 55.1 per cent of the drafting teachers, resurfaced the drafting boards that were used by the students.

TABLE XXIX

TYPES OF MAINTENANCE PERFORMED BY DRAFTING TEACHERS

Practices	Yes		No	
	Number	Per Cent	Number	Per Cent
Is the industrial arts teacher responsible for repairing drafting equipment?	25	86.2	4	13.8
Are major repairs sent out to be repaired?	15	51.7	14	48.3
Are the drafting boards resurfaced by the teacher?	16	55.1	13	44.9
Are the drafting supplies bought by the teacher and distributed to the students?	23	72.4	6	27.6

Of the twenty-nine drafting teachers surveyed, twenty-three, or 72.4 per cent, purchased the drafting supplies and distributed them to the students as a service.

With the majority of the drafting teachers being responsible for maintaining the equipment, a certain amount of time was required to care for the equipment.

Table XXX presents the data concerning the amount of time used by the drafting teachers in performing maintenance.

TABLE XXX

TIME PER WEEK REQUIRED TO MAINTAIN DRAFTING INSTRUMENTS

Time Per Week	Number	Per Cent
One-half hour	15	51.7
One hour	9	31.1
Two hours	3	10.4
Three hours	2	6.8
Total	29	100.0

The teachers responded with fifteen, or 51.7 per cent, spending one-half hour per week maintaining the instruments. Nine, or 31.1 per cent of the teachers, spent one hour; three, or 10.4 per cent, spent two hours; and two, or 6.8 per cent, spent three hours in the maintenance of the drafting instruments.

Some of the drafting teachers spent a certain amount of time maintaining equipment in the laboratories during the summer months. The amount of time spent during the summer months is shown in Table XXXI.

Twelve, or 41.4 per cent of the drafting teachers surveyed, did not spend any time maintaining the drafting laboratory equipment during the summer months. However, four, or 13.8 per cent of the drafting teachers, spent one hour; five,

or 17.2 per cent, spent five hours; four, or 13.9 per cent, spent ten hours; and four, or 13.8 per cent, spent more than ten hours performing maintenance in the industrial arts drafting laboratories during the summer months.

TABLE XXXI

TIME SPENT BY DRAFTING TEACHERS PERFORMING MAINTENANCE DURING SUMMER

Time	Number	Per Cent
None	12	41.4
One hour	4	13.8
Five hours	5	17.2
Ten hours	4	13.8
More than ten hours	4	13.8
Total	29	100.0

Drafting laboratories were equipped with some type of storage. Data in Table XXXII show the number and types of locked storage.

TABLE XXXII

TYPE OF LOCKED STORAGE IN DRAFTING LABORATORIES

Type of Locks on Storage Areas	Number	Per Cent
Key lock	15	51.7
Combination lock	4	13.8
None	10	34.5
Total	29	100.0

When asked if there were individual locked storage areas provided for the drafting students, fifteen, or 51.7 per cent of the teachers, responded that locked storage was provided. Ten, or 34.5 per cent of the teachers, reported they did not have locked storage space. Four, or 13.8 per cent of the teachers, reported they used combination locks on storage areas. With most of the teachers being responsible for maintenance of the locks on storage areas provided for the students, a certain amount of time was spent performing repairs and maintenance. This time is presented in Table XXXIII.

TABLE XXXIII

TIME SPENT MAINTAINING LOCKS IN DRAFTING LABORATORIES

Time Per Week	Number	Per Cent
None	14	48.3
One-half hour	12	41.3
One hour	3	10.4
Two hours	0	0
Total	29	100.0

There were twelve teachers, or 41.3 per cent, who spent one-half hour per week maintaining the locks; three, or 10.4 per cent, spent one hour per week; and fourteen, or 48.3 per cent, did not spend any time maintaining locks.

Information was gathered from the drafting teachers to determine if they instructed the students in the proper care and methods of maintaining the drafting equipment. Data in

Table XXXIV shows the number of teachers who instructed their students in maintaining equipment.

TABLE XXXIV

DRAFTING TEACHERS INSTRUCTING STUDENTS IN MAINTENANCE

Practices	Number	Per Cent
Drafting teachers instructing students in maintenance	17	58.6
Drafting teachers who believe maintenance instruction is beneficial to the students	16	55.2

Seventeen, or 58.6 per cent of the drafting teachers, did instruct and permit the students to assist with maintenance of the drafting equipment. Sixteen, or 55.2 per cent of the teachers, believed that instruction in maintenance was beneficial to the students.

Data collected by the instruments are presented in this chapter. From the data presented, the summary, findings, conclusions, and recommendations are derived and presented in Chapter V.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The specific purpose of this study is to determine what maintenance practices were used by industrial arts teachers in the subject areas of woodworking, metalworking, and drafting in the secondary schools of Texas. Data were gathered, presented, and interpreted in an attempt to determine (1) how much maintenance the industrial arts teachers performed; (2) what type of maintenance procedures were performed by the industrial arts teachers; (3) what amount and kind of maintenance were performed by those other than industrial arts teachers; (4) when the industrial arts teachers performed maintenance; (5) whether the industrial arts teachers incorporated the maintenance into their teaching and whether the instruction on maintenance benefited the students; (6) how maintaining the industrial arts laboratories was financed; (7) whether the industrial arts teachers received extra remuneration for the work they did maintaining the industrial arts laboratories.

The data for the study were obtained by use of instruments designed to gather information from the industrial arts

teachers in the areas of woodworking, metalworking, and drafting. (See Appendix A and B).

The instruments were designed to gather information concerning the maintenance practices performed by the industrial arts teachers. The instruments consisted of two parts. The first part was designed to gather data concerning general maintenance in industrial arts laboratories. The second part of the instruments was divided into three sections: one for each of the subject areas of woodworking, metalworking, and drafting. The instruments were sent to 150 industrial arts teachers, selected as explained in Chapter I, from the secondary schools of the state of Texas. There were fifty industrial arts teachers in each of the three subject areas. In all three areas, seventy-nine returns were received, with twenty-six from woodworking teachers, twenty-four from metalworking teachers, and twenty-nine from drafting teachers.

The industrial arts laboratories are described in order to present some idea of what the industrial arts teachers are maintaining.

The data are presented in tabular form and discussed in order to answer the questions as to how much maintenance, what kind of maintenance, and when the maintenance was done by industrial arts teachers and others concerned.

Findings

In view of the data obtained, the following findings are presented.

1. All of the industrial arts teachers included in the study spent a certain amount of time maintaining industrial arts laboratories, with 54.4 per cent spending from one-half to one hour during the school week. However, only 16.4 per cent of the teachers included in the study received extra remuneration.

2. A majority, 94.9 per cent of the industrial arts teachers, had access to and performed maintenance in the industrial arts laboratories after school hours.

3. Thirty-four-and-one-tenth per cent of the industrial arts teachers did maintenance work in the summer months in the industrial arts laboratories.

4. Industrial arts teachers were responsible for most of the maintenance in the industrial arts laboratories, with 59.9 per cent being responsible for major repairs, 94.9 per cent performing preventive maintenance, 97.7 per cent performing minor repairs in the laboratories, and electrical maintenance being done by 19.9 per cent of the teachers.

5. The school systems in which 54.4 per cent of the teachers were employed had maintenance men, and 40.9 per cent had shops to assist them with maintenance problems. Maintenance performed by school maintenance shops was believed most expedient by 40.9 per cent of the teachers.

6. Maintenance was incorporated into the teaching by 83.4 per cent of the industrial arts teachers, with 89.9 per cent believing instruction in maintenance was beneficial.

7. Only 35.5 per cent of the industrial arts teachers had budgets for maintenance purposes, and the remainder had to request funds as they were needed.

8. Sharpening tools was a major responsibility of the industrial arts teachers in the areas of both woodworking and metalworking. Cutting tools were sharpened by 84.6 per cent of the woodworking teachers and by 87.5 per cent of the metalworking teachers.

9. Preventive maintenance was a large part of the industrial arts teachers' responsibility; 94.9 per cent practiced it, but only 40.4 per cent of the teachers followed a time table for performing preventive maintenance.

10. Tools with which to perform maintenance in the industrial arts laboratories were supplied to 53.8 per cent of the industrial arts teachers.

11. Cleaning the laboratories was the responsibility of 80.7 per cent of the woodworking teachers and 70.1 per cent of the metalworking teachers.

12. Special activities to protect the equipment during the summer months were performed by 94.9 per cent of the industrial arts teachers.

13. Locked storage consumes maintenance time for 51.7 per cent of the drafting teachers.

Conclusions

The following conclusions are derived from a study of the findings:

1. Industrial arts teachers will probably be involved in performing some maintenance in the industrial arts laboratories.

2. Industrial arts teachers will be performing some maintenance after school hours and during the summer months because ample time will not be available during the school day.

3. The industrial arts teachers in some school systems can expect to receive support from a maintenance staff in maintaining the industrial arts laboratories.

4. Only a small group of industrial arts teachers can expect a budget for industrial arts maintenance programs, and the remaining teachers must request funds as needed.

5. The industrial arts teachers will be responsible in most cases for the majority of maintenance performed in the industrial arts laboratories.

6. The majority of the industrial arts teachers will be responsible for sharpening tools, preventive maintenance, and repairs, as well as for cleaning the laboratories and preparing the equipment for the summer.

Recommendations

The following recommendations are based on the findings of this study:

1. The schools should provide methods to remunerate more of the industrial arts teachers who spend extra time in the laboratories performing maintenance.

2. More of the school systems should allocate budgets

to operate the industrial arts maintenance programs.

3. All industrial arts teachers should be supplied with tools to maintain the laboratories properly.

4. More of the school systems should use their maintenance staff to help relieve some of the maintenance load from the industrial arts teachers.

5. The school should supply custodial help to assist the industrial arts teachers in keeping the laboratories clean.

6. The industrial arts teachers should be relieved of the responsibility of performing major electrical maintenance.

7. Industrial arts teachers should organize and implement a preventive maintenance program in the industrial arts laboratories.

8. It is recommended that the administration provide adequate release time for the industrial arts teacher to perform essential maintenance in industrial arts laboratories.

APPENDIX A

LETTER OF INQUIRY

LETTER OF INQUIRY

Route 2, Highway 24E.
Denton, Texas

Dear Industrial Arts Teacher:

I am presently engaged in a masters degree program in the area of industrial arts at North Texas State University. My research study is concerned with the current trends of maintenance procedures used in the industrial arts laboratories at the secondary level in the state of Texas. The purpose of the study is to determine the maintenance practices used by industrial arts teachers and to provide insight in improving those procedures.

I am soliciting your assistance in conducting the study. A checklist is enclosed for your use. I trust you will complete and return it at your earliest convenience.

Be assured that you and your school will remain anonymous. Only the data provided will appear in the body of the study.

I thank you in advance for your interest and cooperation in providing me with the requested information.

Sincerely,

William V. Rainey, Jr.
Graduate Student

WVR:mg
Enc.: Checklist

APPENDIX B

CHECKLIST

CHECKLIST

This study concerns itself with the maintenance practices used by industrial arts teachers in the areas of woodworking, metalworking, and drafting. The following checklist consists of two parts. Part I requests general information, while the second consists of three areas of instruction: metalworking, drafting, and woodworking. It is not necessary to complete all three sections of Part II. Complete only those areas in which you teach.

Name of school_____

Circle the grade or grade levels that you teach.

A. 9, B. 10, C. 11, D. 12

1. Please indicate tha major subject area in which you teach.

   A. Metalworking B. Woodworking C. Drafting

2. Number years experience (including Fall 1970). Circle number.

   1. 1-5 years 2. 6-10 years 3. 11-15 years

   4. 16-20 years 5. 20 years or more

	(Yes)	(No)
3. As a part of your work load, are you responsible for major repairs on tools and equipment?	( )	( )
4. Do you perform yearly maintenance in your laboratory?	( )	( )
5. As an industrial arts teacher, are you responsible for all maintenance in the laboratory you occupy?	( )	( )
6. Are the repairs performed by school maintenance staff?	( )	( )

		(Yes)	(No)
7.	Do you perform preventive maintenance, such as oiling and greasing equipment?	( )	( )
8.	Do you perform minor repairs on hand tools and machine tools?	( )	( )
9.	Is a periodic time table set for the preventive maintenance?	( )	( )
10.	Are you responsible for cleaning the laboratory?	( )	( )
11.	Do you incorporate maintenance into your teaching?	( )	( )
12.	Are the students allowed to help with maintenance and repairs?	( )	( )
13.	Do the students gain useful information by helping with the maintenance and repairs?	( )	( )
14.	Is it more expedient to have the maintenance done by: A. Outside company B. By the teacher C. Maintenance shop.	( )	
15.	Does the school district have a maintenance shop to repair industrial arts equipment?	( )	( )
16.	Does the school district have outside maintenance companies to do industrial arts maintenance to the equipment?	( )	( )
17.	Is it financially more efficient for the industrial arts teacher than for others to do the maintenance?	( )	( )
18.	Does the industrial arts teacher do the electrical work?	( )	( )
19.	How much time per week is spent in maintaining the industrial laboratory during school hours? 1. 1/4 hour 2. 1/2 hour 3. 1 hour 4. 1 1/2 hours 5. 2 hours	( )	
20.	Does the teacher have an allotted budget for maintenance?	( )	( )

	(Yes)	(No)
21. How many hours per week are spent after hours in maintaining the industrial arts laboratory? 1. None 2. 1/2 hour 3. 1 hour 4. 1 1/2 hours 5. 2 hours	( )	
22. Is any summer maintenance required in the industrial arts laboratory? Estimate hours per month.	Est. hrs. _____	
23. Is a conference period allotted in such a manner that it could be used for maintenance?	( )	( )
24. Does the industrial arts teacher have access to the laboratory after school hours in order to perform maintenance?	( )	( )
25. Is there a system used by the school district for acquiring parts for the maintenance?	( )	( )
26. Are these monies (1) budgeted directly to the department, or (2) must it be approved through the administration?	( )	
27. Are there emergency funds for major repairs?	( )	( )
28. Does the teacher receive additional money for his extra time and effort spent doing maintenance?	( )	( )
29. Is the teacher paid for summer time spent in maintenance?	( )	( )

30. Comments: (Specify)_____

_____

_____

_____

CHECKLIST

Part II

Section I: Metalworking

The area of metalworking has special problems and needs. The following questions are pertinent to this area. Please respond by placing a check (✓) in the appropriate space.

		(Yes)	(No)
1.	Is the teacher responsible for sharpening cutting tools such as millcutters, lathe tools, and drill bits?	( )	( )
2.	If so, how much time is spent in sharpening tools? 1. 1/4 hour weekly 2. 1/2 hour weekly 3. 1 hour weekly 4. 1 1/2 hours weekly	( )	
3.	Are all tools sharpened prior to the beginning of the school year?	( )	( )
4.	Is it more expedient to send cutting tools out rather than grinding them at school?	( )	( )
5.	Is the teacher responsible for changing and dressing grinding stones?	( )	( )
6.	Is the teacher responsible for minor repair work?	( )	( )
7.	Does the teacher do minor electrical repair work?	( )	( )
8.	Does the teacher do major electrical work, such as wiring the machinery?	( )	( )
9.	Does the teacher use band saw blades that are prewelded?	( )	( )
10.	Does the teacher employ a system to check tools at the end of each period for dullness, breakage, and loss?	( )	( )
11.	Does the metal shop follow a periodic table for preventive maintenance?	( )	( )
12.	Is the shop equipped with adequate tools to repair and maintain the equipment in the shop?	( )	( )

	(Yes)	(No)
13. Are students instructed and allowed to help repair and maintain tools and equipment?	( )	( )
14. Is a classroom organization used in the laboratory by both students and teacher?	( )	( )
15. Are the students responsible for cleaning the floors?	( )	( )
16. Do the teacher and students perform special activities to close the school year?	( )	( )
17. Are the machines specially treated for the summer?	( )	( )
18. Are the hand tools reconditioned at the end of the school year?	( )	( )
19. Is the laboratory given a special conditioning at the end of the school year?	( )	( )
20. Is an inventory of the laboratory equipment taken at the end of the school year?	( )	( )

21. Comments: (Specify)_____

_____

_____

_____

Section II: Woodworking

The area of woodworking has special problems and needs. The following questions are pertinent to this area.

		(Yes)	(No)
1.	Is the industrial arts teacher responsible for sharpening edge-cutting tools such as plane irons, chisels, saws, and bits?	( )	( )
2.	If so, what percentage of the maintenance time is spent doing the sharpening of the tools?		
	A. 5% B. 10% C. 25% D. Other	( )	
3.	Are all of the cutting tools sharpened prior to the beginning of the new school year?	( )	( )
4.	Is the teacher responsible for both hand saw and machine saw blade sharpening?	( )	( )
5.	Is it more expedient to send blades out for sharpening than for the teacher to sharpen them?	( )	( )
6.	Is it more economical for the teacher to do the blades or send them out?	( )	( )
7.	Does the teacher sharpen machine tools such as the planer and jointer knives?	( )	( )
8.	Does the teacher change these knives?	( )	( )
9.	Is the teacher allowed to do minor electrical work?	( )	( )
10.	Does the teacher do major electrical work, such as installing wiring on a new machine?	( )	( )
11.	Are you responsible for maintaining band saw blades?	( )	( )
12.	How often are band saw blades changed?		
	A. 5 per week B. 3 per week C. 2 per week D. 1 per week	( )	
13.	Do the teacher and students follow a system in determining if any tools are dull or broken?	( )	( )

	(Yes)	(No)
14. Does the woodshop follow a periodic table of maintenance?	( )	( )
15. Is the shop equipped with adequate tools to maintain and lubricate the tools and equipment in the laboratory?	( )	( )
16. Are the students instructed and allowed to lubricate and help maintain the machines?	( )	( )
17. Are students allowed to perform maintenance practices such as changing saw blades?	( )	( )
18. Are the teacher and students responsible for cleaning the floor?	( )	( )

19. Comment: (Specify)_____

_____

_____

_____

Section III: Drafting

The area of drafting has special problems and needs. The following questions are relative to this particular area.

		(Yes)	(No)
1.	Is the industrial arts teacher responsible for repairing drafting equipment?	( )	( )
2.	What amount of time is spent each week in repairing and maintaining drafting equipment?		
	A. 1/2 hour B. 1 hour C. 2 hours D. 3 hours	( )	
3.	Are major repairs sent out to be performed?	( )	( )
4.	Are the drafting boards resurfaced by the teacher?	( )	( )
5.	Are the drafting supplies bought by the teacher and distributed to the students?	( )	( )
6.	Is time spent during the summer months maintaining the drafting equipment? If so, what amount of time is spent?		
	A. 1 hour B. 5 hours C. 10 hours D. More than 10 hours	( )	
7.	Does the student have individual locked storage?	( )	( )
8.	If so, what type of locks are used?		
	A. Combination B. Key C. None	( )	
9.	How much time is required to maintain these locks weekly?		
	A. 1/2 hour B. 1 hour C. 2 hours	( )	
10.	How much does key loss require of the teacher's time weekly?		
	A. 1/2 hour B. 1 hour C. 2 hours	( )	
11.	Does the teacher have a budget to buy replacement parts?	( )	( )
12.	Is there money available through other sources for repairs?	( )	( )

(Yes) (No)

13. Is the teacher allowed to purchase materials for the repairs from the distributor of his choice? ( ) ( )

14. Comment: (Specify)_____

_____

_____

_____

Please check in the provided space if you wish to receive a copy of the summary. ( )

Name_____

Street_____

City_____

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