A STUDY OF THE METALWORKING CURRICULUM IN TEXAS HIGH SCHOOLS, WITH SPECIAL REFERENCE TO THE MACHINE AREAS OF GENERAL METALWORKING I AND II

APPROVED:

[Signatures]

Major Professor

Wallace E. Hoffman

Minor Professor

[Signatures]

Chairman of the Department of Industrial Arts

Robert P. Toulmin

Dean of the Graduate School

The purpose of this study was threefold: (1) to determine what the curriculum offerings were in Texas high schools for General Metalworking I and II during the 1970-71 school year, (2) to determine whether the individual course offerings of Texas high schools for General Metalworking I and II agreed with the state prescribed curriculum as set forth by the Texas Education Agency in a monograph entitled *Metalworking, Grades 7-12* which was prepared by the Texas Industrial Arts Association, and (3) to determine in what ways the course offerings of the individual schools differed from the state prescribed curriculum.

The study was limited to 135 instructors in Texas secondary schools which offer General Metalworking I and II. These instructors were selected from a list provided by the Texas Industrial Arts Section of the Texas Education Agency. The study was also limited to the machine metalworking area, which included the lathe, shaper, milling machine, and grinders.
An instrument was designed to secure the needed information. It was mailed to 135 General Metalworking I and II instructors in the state of Texas. The instrument was completed and returned by sixty-eight, or 50.3 per cent of the instructors. All sixty-eight respondents taught General Metalworking I, and fifty also taught General Metalworking II.

Chapter II presents the curriculum suggested by the Texas Education Agency in a monograph entitled Metalworking, Grades 7-12, which was prepared by a committee from the Texas Industrial Arts Association.

Chapter III presents the data received from instructors concerning General Metalworking I and II. The data was tallied and presented in tabular form indicating just what the instructors were including in their curriculum. The data also indicated where the instructors were deviating from the state prescribed course of study.

Chapter IV contains a summary of the study, findings, conclusions, and recommendations which are based upon the data presented.

The following constitute the findings. Some instructors were not following the state prescribed curriculum concerning prerequisites. Milling machines were not being included by many instructors in the General Metalworking I curriculum. The shaper and grinding machines were not being included by
many instructors in General Metalworking II. Some topics concerning all machines were not included by a majority of the instructors.

The following recommendations were made: The Texas Education Agency should publish and distribute the Industrial Arts Metalworking Monograph. General metalworking instructors should follow the state prescribed curriculum concerning prerequisites. A study should be made to determine what physical facilities are available for general metalworking laboratories. Similar studies should be made in the advent of new curriculum guidelines.
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THESIS

Presented to the Graduate Council of the North Texas State University in Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

Robert P. Henley, B. S.
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CHAPTER I

INTRODUCTION

The metal industry was born early in the history of man, when the first crude metal tool was formed. As man has developed, so has the metal industry, until today it is the largest industry in the United States. It employs more workers than any other industry. Therefore, metalworking should be a very important part of the education of our youth. The courses taught at the secondary level should not only benefit the students who plan to enter industry, but should also benefit those students who will enter other fields to become consumers of the products of the metal industry.

The Texas Education Agency has approved courses of study for General Metalworking I and II (5). After reviewing several courses, there appear to be some inconsistencies in the curriculum of the metal courses of various secondary schools.

Statement of Problem

This is a study of the machine area of the state-prescribed curriculum for General Metalworking I and II in Texas high schools to determine if there are
deviations by the individual instructors from the prescribed curriculum.

Purpose of Study

A state-wide study to define the inconsistencies in the individual industrial arts courses in the high schools in Texas should be beneficial to metalworking instructors in standardizing their courses throughout the state.

Answers to the following questions were sought:

1. What are the curriculum offerings in General Metalworking I and II in Texas secondary schools?

2. Do the individual course offerings of Texas high schools for General Metalworking I and II agree with and fulfill the curriculum prescribed by the Texas Education Agency?

3. How do the offerings of the individual schools differ from the curriculum prescribed by the Texas Education Agency?

Limitations of the Study

This study was limited to Texas secondary schools which offer General Metalworking I and/or General Metalworking II, as described in a listing of course descriptions in industrial arts, presented by the Texas Education Agency, Division of Program Development, Industrial Arts Section, in June, 1971 (6). It was further limited to the part of the
course offerings pertaining to the machining of metal, and included only the lathe, shaper, milling machine, and grinder.

Definition of Terms

For the sake of clarity, it was necessary to define certain terms. They are as follows:

- **Industrial Arts** includes those phases of general education which deal with industry—materials, occupations, processes, and products—and with the problems resulting from the industrial and technological nature of society (8, p. 2).
- **Curriculum** refers to the total learning opportunities offered by the school for the student body.
- **Prescribed Course of Study** refers to the course of study prepared for the Texas Education Agency by the Texas Industrial Arts Association, entitled **Metalworking Grades 7-12** (6).
- **Secondary Schools** in this survey will be the Texas high schools which provide education in the 9th, 10th, 11th, and 12th grades and meet the accreditation standards of the Texas Education Agency.
- **Instructional staff** refers to those teachers who teach in the area of industrial arts General Metalworking I and II.
- **Physical Facilities** refer to the building, storage area, materials and equipment necessary to teach a particular course.
Instrument pertains to the checklist sent to industrial arts instructors in Texas who teach General Metalworking I and/or II.

Majority means more than one half, or 50 per cent, of the total number of instructors.

Minority as used in the study refers to less than one half, or 50 per cent, of the total number of instructors.

Related Studies

In 1969, Uselton (7) made a study of the course offerings in Machine Woodworking I and II in Texas high schools to ascertain if any deviations were made from the course of study prescribed by the Texas Education Agency. The study included ninety-six Texas secondary schools which offered both Machine Woodworking I and II. He found that the majority of the Machine Woodworking I and II teachers were following the general guidelines of the state-prescribed course of study with few exceptions.

Moore (3) in 1967, conducted a study to determine the qualifications and status of industrial arts teachers in Texas. To gather information, a questionnaire was used in the study, which included 152 Texas secondary schools. The findings of the study were that the average teacher conducts classes in two areas, usually woodworking and drafting. It was found that 83.5 per cent of the teachers surveyed taught only industrial arts classes and had held their positions for 6.8 years.
In 1949, Pippin (4) conducted a study to determine whether the vocational and industrial arts programs of Orange County, Texas, were meeting the needs of the community. Questionnaires were sent to present students, former students, and parents of present and former students to determine the use of vocational and industrial arts education by the students. The study found that out of twenty-four units offered only two were metal units, and the metal area was the fourth choice of students taking industrial arts courses. Pippin concluded that while the industrial arts programs were inadequate in both machinery and materials, they were meeting to some extent, the needs of the community.

In 1950, Enderby (1) conducted a study to determine to what extent the high school industrial arts teachers in Oklahoma are being trained to meet the needs and trends in the industrial arts field. A questionnaire was sent to teachers in the field of industrial arts. Enderby found that 25 per cent of the teachers had not majored in industrial arts and 8 per cent had no industrial arts education. He also found that most teachers taught in several areas and a large percentage of instructors in metal work indicated their training was inadequate.

Glenn, (2) in 1954, made a study of the qualifications and status of industrial arts teachers in Arkansas public schools. A questionnaire was sent to 190 industrial arts instructors. Glenn found that the teachers were prepared
only in the areas of metalworking, woodworking and drafting, and that industrial experience was a desirable qualification.

The preceding related studies cut across the purpose of this particular study. However, none of them provide answers to the questions previously mentioned. Usleton's study provided guidelines for this study.

Source of Data

The data in this study were obtained from books, materials from the Texas Education Agency, unpublished theses, and an instrument sent to Texas high school instructors who taught General Metalworking I and II. These materials were analyzed, tabulated, and presented in tabular form.

Procedures of Study

The following procedures were used in conducting this study:

1. The number of schools and the instructors for the study were selected from a list provided by the Texas Education Agency (5).

2. A study was made of the lathe, milling machine, shaper, and grinders included in the prescribed courses for General Metalworking I and II, approved by the Texas Education Agency (6).
3. An instrument was developed to determine the content of the courses taught by the instructors in various Texas high schools.

4. The instrument was mailed to instructors teaching General Metalworking I and II in Texas schools.

5. The data received from the instructors were compiled and presented in tabular form.

6. The data were compared with the state accepted course of study provided by the Texas Education Agency.

7. The deviations in course offerings by the individual instructors were presented from the state-prescribed curriculum.

Organization of the Study

This study consists of four divisions. Chapter I contains an introduction, a statement of the problem, the purposes and limitations of the study, definitions of terms, an account of related studies and of the sources of data, and of the procedures and organization of the study. Chapter II presents a study of the curriculum offerings and content published by the Texas Education Agency (6) in order to gain insight of the overall machine offerings for General Metalworking I and II in Texas. Chapter III presents the data received from instructors across the state who teach General Metalworking I and/or II. The deviations made by the instructors from the state-prescribed curriculum
are presented. Chapter IV includes a summary of the study, and a statement of findings, conclusions, and recommendations.
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7. Uselton, Michael T., "A Study of the Course Offerings in Machine Woodworking I and II in the High Schools in the State of Texas to Ascertain if any Deviations are Made from the State Prescribed Course of Study," unpublished master's thesis, Department of Industrial Arts, North Texas State University, Denton, Texas, 1969.

CHAPTER II

AN ANALYSIS OF THE CURRICULUM OFFERINGS AND CONTENT
AS OUTLINED FOR GENERAL METALWORKING I AND II
BY THE TEXAS EDUCATION AGENCY

A study of General Metalworking I and II to develop a curriculum for the metalworking courses was done by a committee consisting of seventeen members of the Texas Industrial Arts Association and was submitted in the form of a monograph on March 8, 1971, to the Texas Education Agency, for publication (3). The metalworking curriculum described in the monograph was used as the minimum state-prescribed curriculum in this study.

General Metalworking I and II are courses designed for ninth to twelfth grade students who are interested in gaining insight into the various areas of the metalworking industry, as outlined in the listing of course descriptions contained in the metalworking monograph. General Metalworking I and II include studies of at least four areas selected from art metalworking, sheet metalworking, welding, forging, founding, and metal spinning. This study was concerned with the machine metalworking area of General Metalworking I and II, and included only the lathe, milling machine, shaper, and grinder.
No attempt was made in this study to identify the particular brand, size, or type of machines used in the instruction of General Metalworking I and II. It should be recognized that the basic principles of construction and operation pertaining to one size machine pertain to larger and smaller machines of the same kind. Also, many of the principles of operations will pertain to different types of machines. If a student has mastered the principles regarding one size or type of any kind of machine, he may apply this knowledge of construction and operation of other machine tools (1, p. 5).

State-Prescribed Course of Study for General Metalworking I

General Metalworking I is designed for students in the ninth through the twelfth grades. The course content may be in the form of projects which include multiple operations on several machines (3). The students should upon completion of the course have an understanding of the following machines and their operation and maintenance.

The Metalworking Lathe

The metalworking lathe is used to cut or shape cylindrical metal objects by revolving the work against a sharp edge of the cutting tool as it moves either parallel or at an angle to the axis of the workpiece. It is regarded as the most important machine tool in metalworking and is usually
the first one the student learns to use (2, p. 277). The study of the metalworking lathe should include general information concerning the history and development of the lathe, the lathe as a basic machine of industry, kinds of metalworking lathes, industrial concepts of metalworking lathes, basic parts and their functions, care of the lathe, and safe practices necessary for the operation of the lathe.

The methods of chucking stock in the lathe are the universal chuck, independent chuck, collet chuck, Jacobs chuck, turning between centers, slotted face plates and mandrels. Lathe cutting tool technology should include carbon steel, high speed steel, and carbide tools. Also included should be the grinding, shapes, clearances, and rake on the various cutter bits.

Some metals, due to their various sizes and hardness, must be turned at different speeds and the tool fed into the work at different rates. Therefore, the factors to be considered should be the types of cuts used, cutting speeds and feeds, and allowances. The basic metalworking lathe operations introduced to the students should include facing, center drilling, drilling, turning, boring, reaming, contouring, shouldering, filing, and polishing. Students who machine projects having parts which fit together should have a basic knowledge of at least slip fits, press fits, and running fits. Knurling on the lathe should be introduced to the students and information included concerning
kinds of knurls, alignment of cutters, lubrication, and speeds and feeds to be used when knurling. Information concerning taper turning on the lathe should include the use of the compound rest, offset tailstock, taper attachment, and forming tools.

**The Milling Machine**

The milling machine, next to the lathe, is possibly the most adaptable and interesting machine in the metalworking laboratory. Therefore, the machine should be introduced to students in General Metalworking I. Metal is machined on the milling machine as it is passed into or under a revolving cutter usually containing several teeth which have cutting edges to remove the stock. The work is attached to a table, which may be moved longitudinally, transversely, or vertically into the cutter (1, p. 9). The types of milling machines introduced to students should include horizontal, vertical, plane, universal, and production milling machines. Students should have knowledge of end cutters, side cutters and form cutters, and should be able to install and remove them on horizontal and vertical milling machines. Information on right and left hand cutters and their direction of travel should also be studied. Information on holding devices used on milling machines should include the use and care of vises, the alignment of vises, step block, strap clamps, and "T" bolts.
General Metalworking II is designed for students in grades ten through twelve who have completed one year of General Metalworking I and desire further knowledge and skill in the metalworking area. The areas of metalworking included in the curriculum are an indepth study of the same areas included in General Metalworking I (3). In this study, the machine metalworking area of General Metalworking II includes procedures and technology concerning lathes, milling machines, shapers, and grinding machines.

The Metalworking Lathe

In the study of the metalworking lathe, the student should understand the importance of the metalworking lathe in industry, its basic parts and functions, the accessories used on the machine and the safe practices to be used in its operation. Standard and micrometer stops should be used on the carriage, crossfeed, and collets for the lathe. So that students may have a complete knowledge of threading procedures on the lathe, thread cutting should be performed and include both internal and external thread chasing and by using taps and dies.

The use of fixtures for turning on the metalworking lathe should be explored. These fixtures should be used with the chuck and faceplate for holding and positioning parts to be turned.
Students should be able to set up work between centers, and check alignment by using a steel test bar and dial indicator, or by turning diameters and checking with the micrometer. The attachment, alignment, and lubrication of steady rests and follow rests should be studied. Students should be competent in mounting work on various types of mandrels and testing them for accuracy.

Lathe cutting tools partly determine the quality of the work done on the lathe. Therefore, students should have an understanding of the types of lathe cutter bits, the shapes of lathe cutter bits, the angle of keenness, back and side rake, clearances, and the sharpening of lathe cutter bits.

Because many metals do not lend themselves to conventional tools, or because great accuracy is needed, it is necessary for students to have an understanding of the toolpost grinder. The student should be able to prepare the lathe for grinding, attach the grinder, select grinding wheels, select spindle speeds and feeds, and have a knowledge of dressing grinding wheels properly.

The Milling Machine

The importance of the milling machine to industry should be stressed in its introduction. Students should have an understanding of its basic parts, the accessories available to expand its usefulness, its care and maintenance,
and the safe practices necessary for its operation. The rotation of the milling cutter should be discussed. Students should understand the necessity of right and left hand cutters and the importance of their direction of travel.

The dial indicator is an important measuring instrument used in conjunction with milling machines and students should use it to align the milling head and vise. It is used also to align parts with the downward movement of the spindle on vertical milling machines and locating the center of holes and pins. The dial indicator may also be used to measure angles accurately, and align projects or fixtures on the mill table. The students should be able to center the milling cutter by the use of edge finders, mill wigglers, dial indicators, or paper to insure accuracy.

Other alignment tools which are used on milling machines and should be studies are alignment blocks, angle plates, fixtures, alignment straps, alignment pins, and vises. Additional factors in milling machine operation which students should understand are cutter speed, feeds, depth of cut, direction of travel and cutting fluids. Work holding attachments which should be introduced for the mill are the vise, the magnetic chuck, rotary and index tables, dividing head, and fixtures.

The milling operations which should be mastered by students on the milling machines are installing cutters,
slotting, face milling, side milling, gage milling, milling to tolerance, precision location of holes, drilling and reaming of holes, milling key ways, drilling and boring, use of rotary table dividing head with face plate, and the dividing head. The student should also be able to mill angular surfaces, align the dividing head and foot stock, cut gears, cams, and have an understanding of indexing.

The Metal Shaper

The shaper is a slower method of machining metal than those previously discussed, as it uses a single cutting tool with one cutting edge. Burghardt states that "The shaper is ordinarily used for finishing flat or partly curved surfaces of metal pieces few in number and not usually over a foot or two long." Again: "The cutting tool has a reciprocating (forward and return) motion, and cuts on the forward stroke only" (1, pp. 7-8). The work is fed into the tool as the table to which it is attached moves at a right angle to the reciprocating arm (1).

The introduction of the shaper should contain information about the size and types of shapers, the bases of shaper operation, and the safe practices necessary to operate the machine. Students should have a thorough understanding of the kinds of cutting tools, clearances on the tools, how to grind the tools, and the holders used
to support the tools. The work holding devices used to support the workpiece on the shaper should include the vise, parallels, step blocks, strap clamps, angle plates, and "T" bolts. In the study of the shaper the students should master such operations as squaring material, slotting, cutting key ways, making vertical cuts, horizontal cuts, angular cuts, contour cuts, and adjusting the machine for various speeds and feeds.

The Grinders

Grinding machines use abrasive wheels to achieve a high degree of accuracy and smooth finish on soft and hardened metal parts. The grinder allows machining of parts whose hardness would prevent their being machined in any other manner (1, p. 10).

The grinder introduction should cover the use of grinders in industry, the basic parts of grinders, the accessories used to expand the use of grinders, and the safe practices necessary for the operation of grinders. Technology is involved when selecting grinding wheels, since quality of the work produced by grinding machines is dependent on the grinding wheel. Therefore, the student should have a thorough knowledge of the types of abrasives, grain, bond, grain structure, shape, and care of grinding wheels. He must also know the safe revolutions per minute limits of grinding wheels, how to install and dress them,
and the identification systems used in identifying grinding wheels.

The student should be aware of the various types of grinding and should be introduced to cylindrical grinding, form grinding, internal grinding, surface grinding, centerless grinding, and universal tool grinding. The various methods of mounting work on grinders should include the vise, electromagnetic chuck, fixtures, mandrels, centers, chucks, collets, and arbors.

Presented in this chapter were the materials as suggested by the Texas Education Agency, which should be included in the curriculum for General Metalworking I and II. Chapter III presents data concerning what instructors are actually using for classroom instructional purposes.
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CHAPTER III

PRESENTATION OF THE DATA FROM INSTRUCTORS WHO
TEACH GENERAL METALWORKING I AND II
IN THE STATE OF TEXAS

In this chapter, data are presented which were collected from sixty-nine high school industrial arts instructors of General Metalworking I and II. These data were concerned with the curriculum content included in the machine metalworking area of the general metalworking courses. An instrument was designed and mailed to 135 high school metalworking instructors selected from a list of metalworking instructors provided by the Texas Education Agency (1). Sixty-eight instructors, or 50.3 per cent, completed and returned the instrument.

All sixty-eight of the instructors returning the instrument taught General Metalworking I, and fifty of these same instructors taught both General Metalworking I and II. Therefore, there was a larger number of instructors who participated in the study concerning General Metalworking I. For purposes of clarification, these materials were presented in two parts: (1) data pertaining to General Metalworking I and (2) data pertaining to General Metalworking II.
Only the numbers and percentages of instructors using the material presented in the prescribed course of study will be shown in the tables. Therefore, the numbers and percentages of instructors who did not use the material may be determined. For clarification, some of the least used topics are discussed in terms of a percentage of instructors who did not use them.

General Metalworking I

Table I contains data concerning the number of sections of General Metalworking I taught by the sixty-eight instructors. There were a total of 164 sections taught by all the instructors. The instructors taught an average of 2.4 sections per day. The majority of instructors indicated that they taught two or three classes per day.

### TABLE I

THE NUMBER OF SECTIONS OF GENERAL METALWORKING I TAUGHT DAILY BY INDUSTRIAL ARTS INSTRUCTORS

<table>
<thead>
<tr>
<th>Number of Sections</th>
<th>Number of Instructors</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>23.2</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>31.9</td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>30.4</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>13.0</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>68</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Approximately 23 per cent of the instructors taught one section of General Metalworking I, while nine, or 13.0 per cent, taught four sections of General Metalworking I. Only 1.5 per cent taught as many as five sections daily.

Table II contains data concerning prerequisites indicated for General Metalworking I by the respondents. Fifty-eight, or 85.3 per cent, of the instructors indicated they required no prerequisites for the course. Introductory metalworking was required by three instructors, or 4.4 per cent, while seven, or 10.3 per cent, of the instructors indicated other prerequisites were necessary. This indicated that 14.7 per cent of the instructors were not following the state-prescribed course of study concerning prerequisites for General Metalworking I.

TABLE II

PREREQUISITES FOR GENERAL METALWORKING I

<table>
<thead>
<tr>
<th>Prerequisites</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>58</td>
<td>85.3</td>
</tr>
<tr>
<td>General Drafting</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Introductory Metalworking</td>
<td>3</td>
<td>4.4</td>
</tr>
<tr>
<td>Other Prerequisites</td>
<td>7</td>
<td>10.3</td>
</tr>
<tr>
<td>Total</td>
<td>68</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Some of the prerequisites were General Shop I and II, vocational agriculture, distributive education, two years of
mathematics, junior or senior status, and one instructor required twelve prerequisites for the General Metalworking I course.

Table III presents data concerning the items included in the introduction of the metalworking lathe. Sixty-five, or 95.6 per cent, of the instructors included information on safe practices in their curriculum, while sixty, or 88.2 per cent, included care of the lathe. Only 41.2 per cent of the instructors included information on the history and development of the lathe.

**Table III**

**ITEMS INCLUDED IN THE INTRODUCTION OF THE METALWORKING LATHE IN GENERAL METALWORKING I**

<table>
<thead>
<tr>
<th>Items</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>History and Development</td>
<td>28</td>
<td>41.2</td>
</tr>
<tr>
<td>Basic Machine of Industry</td>
<td>43</td>
<td>63.2</td>
</tr>
<tr>
<td>Kinds of Metalworking Lathes</td>
<td>39</td>
<td>57.4</td>
</tr>
<tr>
<td>Industrial Concepts of the Metalworking Lathe</td>
<td>32</td>
<td>47.1</td>
</tr>
<tr>
<td>Basic Parts and Their Function</td>
<td>48</td>
<td>70.6</td>
</tr>
<tr>
<td>Care of the Lathe</td>
<td>60</td>
<td>88.2</td>
</tr>
<tr>
<td>Safe Practices</td>
<td>65</td>
<td>95.6</td>
</tr>
</tbody>
</table>

Table IV contains data concerning the methods of chucking material in the lathe as taught by the instructors. The
### Table IV

**METHODS OF CHUCKING MATERIAL IN THE METALWORKING LATHE USED IN GENERAL METALWORKING I**

<table>
<thead>
<tr>
<th>Method of Chucking</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal Chuck</td>
<td>60</td>
<td>88.2</td>
</tr>
<tr>
<td>Independent Chuck</td>
<td>55</td>
<td>80.9</td>
</tr>
<tr>
<td>Collet Chuck</td>
<td>37</td>
<td>54.4</td>
</tr>
<tr>
<td>Jacobs Chuck</td>
<td>43</td>
<td>63.2</td>
</tr>
<tr>
<td>Between Centers</td>
<td>59</td>
<td>86.8</td>
</tr>
<tr>
<td>Slotted Face Plates</td>
<td>39</td>
<td>57.4</td>
</tr>
<tr>
<td>Mandrels</td>
<td>20</td>
<td>29.4</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
<td>5.9</td>
</tr>
</tbody>
</table>

The three most used methods were the universal chuck, with 88.2 per cent, turning between centers with 86.8 per cent, and the independent chuck with 80.9 per cent. Only 29.4 per cent of the instructors used mandrels, which indicated that 70.6 per cent of the instructors are not complying with the state-prescribed curriculum concerning the use of mandrels. Only 5.9 per cent of the instructors indicated that they use methods of instruction other than the ones listed.

Table V contains data concerning the cutting tools used on the metalworking lathe. The data indicated the least used instructional material for cutting tools were carbon steel, with 41.2 per cent and carbide with 42.6 per cent.
TABLE V
LATHE CUTTING TOOLS USED IN THE INSTRUCTION OF GENERAL METALWORKING I

<table>
<thead>
<tr>
<th>Lathe Cutting Tools</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Steel</td>
<td>28</td>
<td>41.2</td>
</tr>
<tr>
<td>High Speed Steel</td>
<td>56</td>
<td>82.4</td>
</tr>
<tr>
<td>Carbide</td>
<td>29</td>
<td>42.6</td>
</tr>
<tr>
<td>Grinding of Cutter Bits</td>
<td>53</td>
<td>77.9</td>
</tr>
<tr>
<td>Shapes of Cutter Bits</td>
<td>56</td>
<td>82.4</td>
</tr>
<tr>
<td>Clearances</td>
<td>51</td>
<td>75.0</td>
</tr>
<tr>
<td>Rake</td>
<td>49</td>
<td>72.1</td>
</tr>
</tbody>
</table>

The most used cutting tools were high speed steel which 82.4 per cent of the instructors utilized in instructing their students in General Metalworking I. Also, 82.4 per cent of the instructors utilized information on the shapes of cutter bits, while the grinding of cutter bits was used for instruction by 77.9 per cent of the teachers.

Table VI contains data concerning cutting speeds and feeds used on the metalworking lathe. Fifty-four, or 79.4 per cent of the instructors, included types of cuts and speeds and feeds in their curriculum. Nine, or 13.2 per cent, indicated they included other information relating to speeds and feeds in addition to the course listing.
### TABLE VI
CUTTING SPEEDS AND FEEDS FOR THE METALWORKING LATHE USED IN INSTRUCTING GENERAL METALWORKING I

<table>
<thead>
<tr>
<th>Cutting Speeds and Feeds</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of Cuts</td>
<td>54</td>
<td>79.4</td>
</tr>
<tr>
<td>Cutting Speeds and Feeds</td>
<td>54</td>
<td>79.4</td>
</tr>
<tr>
<td>Allowances</td>
<td>35</td>
<td>51.5</td>
</tr>
<tr>
<td>Others</td>
<td>9</td>
<td>13.2</td>
</tr>
</tbody>
</table>

Table VII contains data concerning the basic operations included in the instruction of the metalworking lathe. Turning, with 92.6 per cent, and facing with 91.2 per cent, were the most frequently used, with center drilling and filing following with 89.7 per cent of the instructors. Contouring,
with 38.2 per cent of the instructors, and reaming, with 39.7 per cent, were the least used operations, while 16.2 per cent of the instructors reported the use of other operations in addition to the ones listed in the prescribed curriculum.

Table VIII presents data concerning the types of fits used in General Metalworking I. According to the data, both slip fits and press fits were used by 50 per cent of the instructors, while only 23.5 per cent used running fits in their instruction, which indicated that 76.5 per cent of the instructors were not complying with the state-prescribed curriculum concerning running fits.

Table IX contains data concerning factors of knurling used on the metalworking lathe. The responses ranged from 76.5 per cent for kinds of knurls to 72.1 per cent for the alignment of cutters and speeds and feeds for knurling.
TABLE IX
FACTORS OF KNURLING USED IN THE INSTRUCTION OF STUDENTS IN GENERAL METALWORKING I

<table>
<thead>
<tr>
<th>Factors of Knurling</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinds of Knurls</td>
<td>52</td>
<td>76.5</td>
</tr>
<tr>
<td>Alignment of Cutters</td>
<td>49</td>
<td>72.1</td>
</tr>
<tr>
<td>Lubrication</td>
<td>51</td>
<td>75.0</td>
</tr>
<tr>
<td>Speeds and Feeds</td>
<td>49</td>
<td>72.1</td>
</tr>
</tbody>
</table>

Table X contains data concerning types of taper turning used by the instructors in their curriculum. The table shows that the compound rest, with 76.5 per cent, is the most used method of turning tapers and that forming tools were used by only 14.7 per cent of the instructors which indicated that 85.3 per cent of them were not complying with the state-prescribed curriculum.

TABLE X
METHODS OF TAPER TURNING USED IN THE INSTRUCTION OF GENERAL METALWORKING I

<table>
<thead>
<tr>
<th>Taper Turning Methods</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compound Rest</td>
<td>52</td>
<td>76.5</td>
</tr>
<tr>
<td>Offset Tailstock</td>
<td>32</td>
<td>47.1</td>
</tr>
<tr>
<td>Taper Attachment</td>
<td>48</td>
<td>70.6</td>
</tr>
<tr>
<td>Forming Tool</td>
<td>10</td>
<td>14.7</td>
</tr>
</tbody>
</table>
Table XI contains data concerning types of milling machines to which students were introduced in General Metalworking I. Horizontal milling machines, with 44.1 per cent, were the most used and vertical milling machines, with 29.4 per cent, the second most used machine. The other three milling machines, although they are probably the most used by industry, were seldom used for instruction by the instructors.

Table XII contains data concerning the types of milling cutters used for instructional purposes. The data indicated that end cutters were the most used for instructional purposes by 41.2 per cent of the instructors, and that form cutters were the least used for instruction by 13.2 per cent of the instructors.
TABLE XII
TYPES OF MILLING CUTTERS USED FOR INSTRUCTION
IN GENERAL METALWORKING I

<table>
<thead>
<tr>
<th>Milling Cutters</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>End Cutters</td>
<td>28</td>
<td>41.2</td>
</tr>
<tr>
<td>Side Cutters</td>
<td>22</td>
<td>32.4</td>
</tr>
<tr>
<td>Form Cutters</td>
<td>9</td>
<td>13.2</td>
</tr>
</tbody>
</table>

Table XIII contains data concerning methods of installing and removing cutters. The data show that only 36.8 per cent of the instructors demonstrated installing and removing cutters on horizontal milling machines and only 27.9 per cent demonstrated installing and removing cutters on vertical milling machines.

TABLE XIII
METHODS OF INSTALLING AND REMOVING MILLING CUTTERS
USED IN GENERAL METALWORKING I

<table>
<thead>
<tr>
<th>Installing and Removing Cutters and Arbors</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installing and Removing Cutters on Vertical Mills</td>
<td>19</td>
<td>27.9</td>
</tr>
<tr>
<td>Installing and Removing Cutters on Horizontal Mills</td>
<td>25</td>
<td>36.8</td>
</tr>
</tbody>
</table>
Table XIV contains data concerning the holding devices used on milling machines. Vises, with 48.5 per cent of the instructions, and "T" bolts, with 32.4 per cent, were the most used holding devices used for instruction, while strap clamps, with 16.2 per cent, were the least used holding devices.

Table XV contains data concerning the rotation of milling cutters. The data indicated that 47.1 per cent

### TABLE XIV

**HOLDING DEVICES USED ON MILLING MACHINES IN GENERAL METALWORKING I**

<table>
<thead>
<tr>
<th>Holding Devices</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use and Care of Vises</td>
<td>33</td>
<td>48.5</td>
</tr>
<tr>
<td>Alignment of Vises</td>
<td>27</td>
<td>39.7</td>
</tr>
<tr>
<td>Step Blocks</td>
<td>16</td>
<td>23.5</td>
</tr>
<tr>
<td>Strap Clamps</td>
<td>11</td>
<td>16.2</td>
</tr>
<tr>
<td>&quot;T&quot; Bolts</td>
<td>22</td>
<td>32.4</td>
</tr>
</tbody>
</table>

### TABLE XV

**FACTORS CONCERNING THE ROTATION OF MILLING CUTTERS INCLUDED IN GENERAL METALWORKING I**

<table>
<thead>
<tr>
<th>Rotation of Cutter</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right and Left Hand Cutters</td>
<td>32</td>
<td>47.1</td>
</tr>
<tr>
<td>Direction of Travel</td>
<td>31</td>
<td>45.6</td>
</tr>
</tbody>
</table>
of the instructors included information on right and left hand milling cutters in their curriculum and 45.6 per cent included information on the direction of travel of the cutters.

All of the preceding data concerning the lathe and milling machine pertain to General Metalworking I. The following data pertain to General Metalworking II.

General Metalworking II

Table XVI contains data concerning the number of sections of General Metalworking II taught daily by fifty instructors. There was a total of eighty-five sections taught by all the respondents, and a majority of the instructors taught one or two classes of General Metalworking II. Forty-six per cent of the instructors taught

<table>
<thead>
<tr>
<th>Daily Sections of General Metalworking II</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23</td>
<td>46.0</td>
</tr>
<tr>
<td>2</td>
<td>21</td>
<td>42.0</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>8.0</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>4.0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
one class and 42 per cent taught two classes. None of the
respondents reported teaching five classes of General Metal-
working II. The General Metalworking II instructor taught
an average of 1.7 sections.

Table XVII contains data concerning the prerequisites
for General Metalworking II. Data indicated that General
Metalworking I was required by 47, or 94.0 per cent, of the
instructors as a prerequisite, while only 2 per cent of
them indicated that no prerequisites were necessary. Six

<table>
<thead>
<tr>
<th>Prerequisite</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>General Metalworking I</td>
<td>47</td>
<td>94.0</td>
</tr>
<tr>
<td>Introductory Metalworking</td>
<td>3</td>
<td>6.0</td>
</tr>
<tr>
<td>Other Prerequisites</td>
<td>3</td>
<td>6.0</td>
</tr>
</tbody>
</table>

per cent of the instructors indicated that they required
Introductory Metalworking and 6 per cent required other
prerequisites. Some of the instructors required more than
one of the prerequisites listed.

Table XVIII contains data concerning the items included
in the introduction of the metalworking lathe. The data
indicated that safe practices were used by 92 per cent of
TABLE XVIII
THE ITEMS INCLUDED IN THE INTRODUCTION OF THE METALWORKING LATHE IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importance of the Metalworking Lathe in Industry</td>
<td>36</td>
<td>72.0</td>
</tr>
<tr>
<td>Basic Parts and Function of the Metalworking Lathe</td>
<td>42</td>
<td>84.0</td>
</tr>
<tr>
<td>Accessories for the Metalworking Lathe</td>
<td>42</td>
<td>84.0</td>
</tr>
<tr>
<td>Safe Practices</td>
<td>46</td>
<td>92.0</td>
</tr>
</tbody>
</table>

the instructors for instructional purposes, and was the most mentioned item. The importance of the metalworking lathe in industry was used for instructional purposes by only 72 per cent of the instructors.

Table XIX contains data concerning the types of stops used on the metalworking lathe. The data indicated that stops were not widely used by instructors. Carriage stops, with 50 per cent of the instructors, were the most used stops, and collet stops were the least used, with only 12 per cent of the instructors using them. These data indicated that at least 50 per cent of the instructors were not following the state-prescribed curriculum concerning types of stops.
TABLE XIX

TYPES OF STOPS AND THEIR USES INCLUDED IN THE INSTRUCTION
OF GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Stops and Their Uses</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carriage Stops</td>
<td>25</td>
<td>50.0</td>
</tr>
<tr>
<td>Crossfeed Stops</td>
<td>19</td>
<td>38.0</td>
</tr>
<tr>
<td>Collet Stops</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Micrometer Stops</td>
<td>13</td>
<td>26.0</td>
</tr>
</tbody>
</table>

Table XX contains data concerning the thread cutting techniques used on the metalworking lathe. The use of dies, with 78 per cent of the instructors, was the most used method of thread cutting. However, only 40 per cent of the instructors used the chasing of internal threads in their instruction.

TABLE XX

THREAD CUTTING TECHNIQUES USED ON THE METALWORKING LATHE IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Thread Cutting</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chasing External Threads</td>
<td>38</td>
<td>76.0</td>
</tr>
<tr>
<td>Chasing Internal Threads</td>
<td>20</td>
<td>40.0</td>
</tr>
<tr>
<td>Taps</td>
<td>38</td>
<td>76.0</td>
</tr>
<tr>
<td>Dies</td>
<td>39</td>
<td>78.0</td>
</tr>
</tbody>
</table>
Table XXI contains data concerning fixtures used for turning on the metalworking lathe. The chuck and fixtures, with 82 per cent of the instructors, were the most used.

**Table XXI**

**USE OF FIXTURES FOR TURNING ON THE METALWORKING LATHE IN GENERAL METALWORKING II**

<table>
<thead>
<tr>
<th>Use of Fixtures</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face Plate and Fixtures</td>
<td>35</td>
<td>70.0</td>
</tr>
<tr>
<td>Positioning Parts</td>
<td>24</td>
<td>48.0</td>
</tr>
<tr>
<td>Chuck and Fixtures</td>
<td>41</td>
<td>82.0</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Twelve per cent of the instructors indicated they used fixtures other than those listed when instructing their students.

Table XXII contains data concerning techniques necessary for turning between centers. Seventy-six per cent of the

**Table XXII**

**TECHNIQUES NECESSARY FOR TURNING BETWEEN CENTERS IN GENERAL METALWORKING II**

<table>
<thead>
<tr>
<th>Turning Between Centers</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making Set Ups</td>
<td>38</td>
<td>76.0</td>
</tr>
<tr>
<td>Checking the Alignment with a Steel Test Bar and Dial Indicator</td>
<td>16</td>
<td>32.0</td>
</tr>
<tr>
<td>Checking Alignment by Turning Diameters</td>
<td>29</td>
<td>58.0</td>
</tr>
</tbody>
</table>
respondents included making setups in their curriculum. However, only 32 per cent checked the alignment with a dial indicator, which indicated that 68 per cent of the instructors were not following the state suggested course of study.

Table XXIII contains data concerning the steady rest operations used on the metalworking lathe. More instructors included alignment of the steady rest in their curriculum, with 66 per cent of the instructors, than did attachment to the lathe, which was included by 64 per cent. Only 58 per cent of the instructors included lubrication of the steady rest in their curriculum.

<table>
<thead>
<tr>
<th>Steady Rest</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment to Lathe Bed</td>
<td>32</td>
<td>64.0</td>
</tr>
<tr>
<td>Alignment</td>
<td>33</td>
<td>66.0</td>
</tr>
<tr>
<td>Lubrication</td>
<td>29</td>
<td>58.0</td>
</tr>
</tbody>
</table>

Table XXIV contains data concerning the follow rest operations used on the metalworking lathe. Data concerning the use of the follow rest indicated that 46 per cent of the instructors included the attachment to the carriage in their curriculum, and 44 per cent of them included alignment.
### TABLE XXIV

**OPERATIONS NECESSARY FOR THE OPERATION OF THE FOLLOW REST ON THE METALWORKING LATHE IN GENERAL METALWORKING II**

<table>
<thead>
<tr>
<th>Follow Rest</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attaching to Carriage</td>
<td>23</td>
<td>46.0</td>
</tr>
<tr>
<td>Alignment</td>
<td>22</td>
<td>44.0</td>
</tr>
<tr>
<td>Lubrication</td>
<td>21</td>
<td>42.0</td>
</tr>
</tbody>
</table>

Table XXV contains data concerning mandrels used on the metalworking lathe. Types of mandrels were explained by 36 per cent of the instructors, and 34 per cent of the instructors included information on the use of mandrels and mounting workpieces on mandrels in their curriculum.

### TABLE XXV

**TYPES AND USES OF MANDRELS IN GENERAL METALWORKING**

<table>
<thead>
<tr>
<th>Mandrels</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of Mandrels</td>
<td>18</td>
<td>36.0</td>
</tr>
<tr>
<td>Use of Mandrels</td>
<td>17</td>
<td>34.0</td>
</tr>
<tr>
<td>Testing for Accuracy</td>
<td>12</td>
<td>24.0</td>
</tr>
<tr>
<td>Mounting Workpiece</td>
<td>17</td>
<td>34.0</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Twelve per cent of the instructors indicated they included information on mandrels in addition to those listed.
in the state-prescribed curriculum. The data indicated that at least 64 per cent of the instructors were not complying with the state-prescribed curriculum concerning mandrels.

Table XXVI contains data concerning cutting tool technology for the metalworking lathe. The three most used topics for instruction were types of lathe cutter bits included by 88 per cent of the instructors, shapes of cutting tools with 86 per cent, and sharpening lathe cutting tools with 84 per cent. Only 48 per cent of the instructors included information on the angle of keenness of cutting tools in their curriculum.

Table XXVII contains data concerning operations necessary for the operation of the tool post grinder on the metalworking
TABLE XXVII

OPERATIONS NECESSARY FOR THE OPERATION OF THE TOOL POST GRINDER IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Tool Post Grinder</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation of the Lathe</td>
<td>15</td>
<td>30.0</td>
</tr>
<tr>
<td>Attaching Grinder</td>
<td>17</td>
<td>34.0</td>
</tr>
<tr>
<td>Selecting Grinding Wheel</td>
<td>13</td>
<td>26.0</td>
</tr>
<tr>
<td>Spindle Speed and Feed</td>
<td>12</td>
<td>24.0</td>
</tr>
<tr>
<td>Dressing Wheels</td>
<td>15</td>
<td>30.0</td>
</tr>
<tr>
<td>Traverse</td>
<td>17</td>
<td>34.0</td>
</tr>
</tbody>
</table>

Lathe. Attaching the grinder and traverse feed were included in the curriculum by 34 per cent of the instructors, and were the most included operations.

Table XXVIII contains data concerning the introduction of the milling machine. The data indicated that safe practices,

TABLE XXVIII

ITEMS INCLUDED IN THE INTRODUCTION OF MILLING MACHINES IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importance of Milling Machines in Industry</td>
<td>24</td>
<td>48.0</td>
</tr>
<tr>
<td>Basic Parts of Milling Machines</td>
<td>29</td>
<td>58.0</td>
</tr>
<tr>
<td>Accessories of Milling Machines</td>
<td>28</td>
<td>56.0</td>
</tr>
<tr>
<td>Care of Milling Machines</td>
<td>30</td>
<td>60.0</td>
</tr>
<tr>
<td>Safe Practices</td>
<td>31</td>
<td>62.0</td>
</tr>
</tbody>
</table>
with 62 per cent of the instructors, were the most used topics included in the introduction of the milling machine. Forty-eight per cent of the instructors included the importance of the milling machine in industry. It was the topic least included in the curriculum by the instructors.

Table XXIX contains data concerning the methods used to center cutters on milling machines. The dial indicator was the most used device, with 32 per cent of the instructors, followed by paper, which was used by 30 per cent of the instructors. The mill wiggler was used by only 8 per cent of the respondents in their instruction. The data indicated that at least 68 per cent of the instructors were not complying with the state-prescribed course of study concerning the centering of milling cutters.

Table XXX contains data concerning the rotation of cutters on the milling machine. The forward rotation of

<table>
<thead>
<tr>
<th>Centoring of Cutter</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edge Finder</td>
<td>9</td>
<td>18.0</td>
</tr>
<tr>
<td>Mill Wiggler</td>
<td>4</td>
<td>8.0</td>
</tr>
<tr>
<td>Dial Indicator</td>
<td>16</td>
<td>32.0</td>
</tr>
<tr>
<td>Paper</td>
<td>15</td>
<td>30.0</td>
</tr>
</tbody>
</table>
TABLE XXX
FACTORS CONCERNING ROTATION OF MILLING CUTTERS IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Rotation of Cutter</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward</td>
<td>31</td>
<td>62.0</td>
</tr>
<tr>
<td>Reverse</td>
<td>30</td>
<td>60.0</td>
</tr>
<tr>
<td>Right and Left Hand Cutters</td>
<td>23</td>
<td>46.0</td>
</tr>
<tr>
<td>Direction of Travel</td>
<td>28</td>
<td>56.0</td>
</tr>
</tbody>
</table>

cutters was the most included topic and was used by 62 percent of the instructors, followed by reverse rotation, which was included by 60 percent of the instructors.

Table XXXI contains data concerning the use of the dial indicator on milling machines. The dial indicator appeared

TABLE XXXI
USE OF THE DIAL INDICATOR ON MILLING MACHINES IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Use of Dial Indicator</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment of the Milling Head</td>
<td>17</td>
<td>34.0</td>
</tr>
<tr>
<td>Alignment of the Vise</td>
<td>17</td>
<td>34.0</td>
</tr>
<tr>
<td>Alignment of the Part with Down Movement of Spindle on Vertical Milling Machine</td>
<td>13</td>
<td>26.0</td>
</tr>
<tr>
<td>Measurement of Angles Using the Dial Indicator</td>
<td>7</td>
<td>14.0</td>
</tr>
<tr>
<td>Locating the Center of a Hole</td>
<td>11</td>
<td>22.0</td>
</tr>
<tr>
<td>Locating the Center of a Pin</td>
<td>8</td>
<td>16.0</td>
</tr>
<tr>
<td>Use of Dial Indicator to Align Work on Mill Table</td>
<td>13</td>
<td>26.0</td>
</tr>
<tr>
<td>Use of Dial Indicator to Align Fixtures</td>
<td>9</td>
<td>18.0</td>
</tr>
</tbody>
</table>
to be lacking in the instruction on the milling machine, with at least 66 per cent of the instructors not including it in their courses of study. It was most used for instruction to align the milling head and the vise with 34 per cent of the instructors using it in their instruction for this purpose. The dial indicator was used to measure angles by only 14 per cent of the instructors.

Table XXXII contains data concerning the use of alignment tools on the milling machine. The most used alignment tools were vises, with 46 per cent of the instructors, and angle plates, used by 24 per cent of the instructors in their courses. None of the other alignment tools were used for instruction by more than 16 per cent of the respondents.

<table>
<thead>
<tr>
<th>Alignment Tools</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment Blocks</td>
<td>7</td>
<td>14.0</td>
</tr>
<tr>
<td>Angle Plates</td>
<td>12</td>
<td>24.0</td>
</tr>
<tr>
<td>Fixtures</td>
<td>8</td>
<td>16.0</td>
</tr>
<tr>
<td>Alignment Straps</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Alignment Pins</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Vises</td>
<td>23</td>
<td>46.0</td>
</tr>
</tbody>
</table>
Table XXXIII contains data concerning factors of milling machine operation included in the curriculum by the instructors.

TABLE XXXIII

FACTORS IN MACHINE OPERATION IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Factors in Machine Operation</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutter Speed</td>
<td>28</td>
<td>56.0</td>
</tr>
<tr>
<td>Depth of Cut</td>
<td>30</td>
<td>60.0</td>
</tr>
<tr>
<td>Feeds</td>
<td>29</td>
<td>58.0</td>
</tr>
<tr>
<td>Direction of Travel</td>
<td>26</td>
<td>52.0</td>
</tr>
<tr>
<td>Fluids</td>
<td>22</td>
<td>44.0</td>
</tr>
</tbody>
</table>

Depth of cut was the topic most used for instruction, with 60 per cent of the instructors, followed by feeds, with 58 per cent, and cutter speed, with 56 per cent.

Table XXXIV contains data concerning work holding attachments used on the milling machine. Vises were the most

TABLE XXXIV

WORK HOLDING ATTACHMENTS USED ON THE MILLING MACHINES IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Work Holding Attachments</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vises</td>
<td>32</td>
<td>64.0</td>
</tr>
<tr>
<td>Magnetic Chuck</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Index Tables</td>
<td>15</td>
<td>30.0</td>
</tr>
<tr>
<td>Rotary Tables</td>
<td>14</td>
<td>28.0</td>
</tr>
<tr>
<td>Dividing Head</td>
<td>17</td>
<td>34.0</td>
</tr>
<tr>
<td>Fixtures</td>
<td>15</td>
<td>30.0</td>
</tr>
</tbody>
</table>
included work holding attachments, used by 64 per cent of the instructors for instructional purposes, followed by the dividing head with 34 per cent. Only 12 per cent of the instructors included the magnetic chuck for the milling machine in their curriculums.

Table XXXV contains data concerning milling machine operations introduced to the students in General Metalworking II.

**TABLE XXXV**

MILLING OPERATIONS INTRODUCED TO STUDENTS IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Milling Operations</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installing Cutters</td>
<td>30</td>
<td>60.0</td>
</tr>
<tr>
<td>Slotting</td>
<td>25</td>
<td>50.0</td>
</tr>
<tr>
<td>Face Milling</td>
<td>29</td>
<td>58.0</td>
</tr>
<tr>
<td>Side Milling</td>
<td>25</td>
<td>50.0</td>
</tr>
<tr>
<td>Gage Milling</td>
<td>1</td>
<td>8.0</td>
</tr>
<tr>
<td>Milling to Tolerance</td>
<td>18</td>
<td>36.0</td>
</tr>
<tr>
<td>Precision Location of Holes</td>
<td>14</td>
<td>28.0</td>
</tr>
<tr>
<td>Drilling and Reaming of Holes</td>
<td>16</td>
<td>36.0</td>
</tr>
<tr>
<td>Milling Key Ways</td>
<td>24</td>
<td>48.0</td>
</tr>
<tr>
<td>Drilling and Boring</td>
<td>10</td>
<td>20.0</td>
</tr>
<tr>
<td>Rotary Table Dividing Head with Face Plate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dividing Head</td>
<td>13</td>
<td>26.0</td>
</tr>
<tr>
<td>Angular Surfaces</td>
<td>11</td>
<td>22.0</td>
</tr>
<tr>
<td>Alignment of Dividing Head and Foot Stock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indexing</td>
<td>13</td>
<td>26.0</td>
</tr>
<tr>
<td>Gear Cutting</td>
<td>9</td>
<td>18.0</td>
</tr>
<tr>
<td>Cam Cutting</td>
<td>3</td>
<td>6.0</td>
</tr>
</tbody>
</table>

The operations most used for instruction were installing cutters, with 60 per cent of the instructors, face milling with 58 per cent, and side milling and slotting, with 50 per
cent of the instructors. Cam cutting was reported used by only 6 per cent of the instructors, followed by gage milling, which was included in the curriculum of only 8 per cent of the instructors. These data indicated that 94 per cent of the instructors were not complying with the state-prescribed curriculum concerning cam cutting on the milling machine.

Table XXXVI contains data concerning the introduction of the shaper in General Metalworking II. Safe practices, with 44 per cent of the instructors, was the most used topic included in their curriculum, followed by the size of shapers, with 42 per cent of the instructors. Although

| Items Included in the Introduction of the Shaper in General Metalworking II |
|---------------------------------|----------------------|--------|
| Types of Shapers               | 16                   | 32.0   |
| Size (Length of Stroke)        | 21                   | 42.0   |
| Basics                          | 16                   | 32.0   |
| Safe Practices                  | 22                   | 44.0   |

the topic safe practices was included in the curriculums by more instructors than any other shaper topic, it was not included by 56 per cent of the instructors in their curriculums.
Table XXXVII contains data concerning cutting tools used on the shaper. The most used information given students concerning cutting tools was the kinds of cutting tools, with 40 per cent of the instructors including the information in their curriculums.

**TABLE XXXVII**

**CUTTING TOOLS USED ON THE SHAPER IN GENERAL METALWORKING II**

<table>
<thead>
<tr>
<th>Cutting Tools</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinds of Cutting Tools</td>
<td>20</td>
<td>40.0</td>
</tr>
<tr>
<td>Clearance on Cutting Tools</td>
<td>17</td>
<td>28.0</td>
</tr>
<tr>
<td>Grinding a Shaper Cutter</td>
<td>17</td>
<td>28.0</td>
</tr>
</tbody>
</table>

Table XXXVIII contains data concerning tool holders for the shaper. Regular tool holders were used by 42 per cent of the instructors, with only 18 per cent including extension tool holders in their curriculums.

**TABLE XXXVIII**

**SHAPER TOOL HOLDERS USED IN GENERAL METALWORKING II**

<table>
<thead>
<tr>
<th>Shaper Tool Holders</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular Tool Holders</td>
<td>21</td>
<td>42.0</td>
</tr>
<tr>
<td>Extension Tool Holders</td>
<td>9</td>
<td>18.0</td>
</tr>
<tr>
<td>Setting Tool Holders</td>
<td>14</td>
<td>28.0</td>
</tr>
</tbody>
</table>
Table XXXIX contains data concerning work holding devices used on shapers. Vises were used by 36 per cent of the instructors in their curriculum, followed by "T" bolts, with 26 per cent of the instructors. Stop blocks were the least used devices, with only 12 per cent of the instructors using them in the instruction of their courses.

**TABLE XXXIX**

WORK HOLDING DEVICES USED TO SECURE STOCK ON THE SHAPER IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Work Holding Devices</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vise</td>
<td>18</td>
<td>36.0</td>
</tr>
<tr>
<td>Placement on Table</td>
<td>17</td>
<td>34.0</td>
</tr>
<tr>
<td>Alignment</td>
<td>15</td>
<td>30.0</td>
</tr>
<tr>
<td>Parallels</td>
<td>8</td>
<td>16.0</td>
</tr>
<tr>
<td>Step Blocks</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Strap Clamps</td>
<td>7</td>
<td>14.0</td>
</tr>
<tr>
<td>Angle Plates</td>
<td>11</td>
<td>22.0</td>
</tr>
<tr>
<td>&quot;T&quot; Bolts</td>
<td>13</td>
<td>26.0</td>
</tr>
</tbody>
</table>

Table XL contains data concerning operations used on the shaper. The three operations most included in instruction were cutting speeds and feeds, squaring material, and horizontal cuts, all used by 38 per cent of the instructors. Contouring was used by only 18 per cent of the instructors.
TABLE XL

SHAPER OPERATIONS USED BY STUDENTS IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Shaper Operations</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting Speeds and Feeds</td>
<td>19</td>
<td>38.0</td>
</tr>
<tr>
<td>Squaring Material</td>
<td>19</td>
<td>38.0</td>
</tr>
<tr>
<td>Slotting</td>
<td>13</td>
<td>26.0</td>
</tr>
<tr>
<td>Key Ways</td>
<td>16</td>
<td>32.0</td>
</tr>
<tr>
<td>Vertical Cuts</td>
<td>16</td>
<td>32.0</td>
</tr>
<tr>
<td>Horizontal Cuts</td>
<td>19</td>
<td>38.0</td>
</tr>
<tr>
<td>Angular Cuts</td>
<td>14</td>
<td>28.0</td>
</tr>
<tr>
<td>Contouring</td>
<td>9</td>
<td>18.0</td>
</tr>
</tbody>
</table>

for the instruction of their students. The data indicated the three operations most included in the curriculum of the instructors were not used by at least 62 per cent of the instructors.

Table XLI contains data concerning the introduction of grinding machines to the students in General Metalworking II. Fifty-four per cent of the instructors included safe practices and 50 per cent included basic parts of grinders in their curriculum. However, 64 per cent of the instructors failed to include information on the accessories for grinders in their curriculums.
TABLE XLI
ITEMS INCLUDED IN THE INTRODUCTION OF GRINDING MACHINES IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of Grinders in Industry</td>
<td>22</td>
<td>44.0</td>
</tr>
<tr>
<td>Basic Parts of Grinders</td>
<td>25</td>
<td>50.0</td>
</tr>
<tr>
<td>Accessories for Grinders</td>
<td>18</td>
<td>36.0</td>
</tr>
<tr>
<td>Safe Practices</td>
<td>27</td>
<td>54.0</td>
</tr>
</tbody>
</table>

Table XLII contains data concerning grinding wheel technology introduced to students in General Metalworking II.

TABLE XLII
GRINDING WHEEL TECHNOLOGY USED IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Grinding Wheels</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of Abrasive</td>
<td>26</td>
<td>52.0</td>
</tr>
<tr>
<td>Grain of Grinding Wheels</td>
<td>22</td>
<td>44.0</td>
</tr>
<tr>
<td>Bond of Grinding Wheels</td>
<td>19</td>
<td>38.0</td>
</tr>
<tr>
<td>Grade of Grinding Wheels</td>
<td>19</td>
<td>38.0</td>
</tr>
<tr>
<td>Structure of Grinding Wheels</td>
<td>17</td>
<td>34.0</td>
</tr>
<tr>
<td>Shapes of Grinding Wheels</td>
<td>14</td>
<td>28.0</td>
</tr>
<tr>
<td>Care of Grinding Wheels</td>
<td>25</td>
<td>50.0</td>
</tr>
<tr>
<td>Installing Grinding Wheels</td>
<td>15</td>
<td>30.0</td>
</tr>
<tr>
<td>Safe RPM of Grinding Wheels</td>
<td>23</td>
<td>46.0</td>
</tr>
<tr>
<td>Marking Systems for Grinding Wheels</td>
<td>11</td>
<td>22.0</td>
</tr>
<tr>
<td>Dressing Grinding Wheels</td>
<td>30</td>
<td>60.0</td>
</tr>
</tbody>
</table>

Sixty per cent of the instructors included dressing grinding wheels in their curriculum, and 52 per cent included the
types of abrasive. The marking systems for grinding wheels was utilized by only 22 per cent of the instructors.

Table XLIII contains data concerning the kinds of grinding used in General Metalworking II for the instruction of students. Universal tool grinding was the most used kind of grinding, with 28 per cent of the instructors, and cylindrical grinding and surface grinding both were used for instruction by 24 per cent of the instructors. Centerless grinding was used by only 8 per cent of the instructors in their curriculum, which indicated that 92 per cent of the instructors were not following the state-prescribed curriculum.

Table XLIV contains data concerning devices used to mount work on the surface grinder. The vise, with 26 per cent of the instructors, is the most used device for mounting

<table>
<thead>
<tr>
<th>Kinds of Grinding</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylindrical Grinding</td>
<td>12</td>
<td>24.0</td>
</tr>
<tr>
<td>Form Grinding</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Internal Grinding</td>
<td>8</td>
<td>16.0</td>
</tr>
<tr>
<td>Surface Grinding</td>
<td>12</td>
<td>24.0</td>
</tr>
<tr>
<td>Centerless Grinding</td>
<td>4</td>
<td>8.0</td>
</tr>
<tr>
<td>Universal Tool Grinding</td>
<td>14</td>
<td>28.0</td>
</tr>
</tbody>
</table>
TABLE XLIV
MOUNTING WORK ON SURFACE GRINDERS IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Surface Grinder</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electromagnetic Chuck</td>
<td>8</td>
<td>16.0</td>
</tr>
<tr>
<td>Fixtures</td>
<td>9</td>
<td>18.0</td>
</tr>
<tr>
<td>Vise</td>
<td>13</td>
<td>26.0</td>
</tr>
</tbody>
</table>

work on the surface grinder. In the instruction of the surface grinder, 26 per cent of the instructors used the vise to mount work, while only 16 per cent used the electromagnetic chuck.

Table XLV contains data concerning the mounting of work on center type cylindrical grinders. Centers were used for instruction by 12 per cent of the instructors, and were

TABLE XLV
MOUNTING WORK ON CENTER TYPE CYLINDRICAL GRINDERS IN GENERAL METALWORKING II

<table>
<thead>
<tr>
<th>Center Type Cylindrical Grinder</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centers</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Mandrels</td>
<td>5</td>
<td>10.0</td>
</tr>
<tr>
<td>Fixtures</td>
<td>4</td>
<td>8.0</td>
</tr>
</tbody>
</table>

the most used method of mounting work in the center type cylindrical grinder.
Table XLVI contains data concerning the mounting of work on internal grinders. The most used method of chucking materials in internal grinders was by using chucks and collets, with 12 per cent of the instructors including each in their curriculums.

Table XLVII contains data concerning the mounting of work on universal tool grinders. Arbors and chucks each

<table>
<thead>
<tr>
<th>Internal Grinder</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chuck</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Collet</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Fixtures</td>
<td>2</td>
<td>4.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Universal Tool Grinder</th>
<th>Number of Teachers</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbors</td>
<td>5</td>
<td>10.0</td>
</tr>
<tr>
<td>Chuck</td>
<td>5</td>
<td>10.0</td>
</tr>
<tr>
<td>Mandrel</td>
<td>3</td>
<td>6.0</td>
</tr>
</tbody>
</table>
were utilized by 10 per cent of the instructors to mount work in the universal tool grinder.

This chapter has presented data concerning whether or not the instructors of General Metalworking I and II were following the state-prescribed curriculum. Presented in the following chapter are a summary, some findings, conclusions, and recommendations.
CHAPTER BIBLIOGRAPHY

CHAPTER IV

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose for this study was threefold. The first was to determine what the curriculum offerings were in Texas high schools for General Metalworking I and II during the 1970-71 school year. Purpose number two was to determine whether the individual course offerings in Texas high schools in General Metalworking I and II agreed with the state-prescribed curriculum as set forth by the Texas Education Agency in a monograph entitled Metalworking, Grades 7-12 (2), which was prepared by a committee working in conjunction with the Texas Industrial Arts Association and the Texas Education Agency. The third purpose was to determine in what ways the course offerings of the individual schools differed from the state prescribed curriculum.

The study was limited to 135 instructors in Texas secondary schools which offer General Metalworking I and II. These instructors were selected from a list provided by the Texas Education Agency, Industrial Arts Section (1). The study was also limited to the machine
metalworking area, which included the lathe, shaper, milling machine, and grinders.

An instrument was designed to obtain the needed information. It was mailed to 135 General Metalworking I and II instructors in the state of Texas. The instrument was completed and returned by sixty-eight, or 50.3 per cent, of the instructors. All sixty-eight respondents taught General Metalworking I while fifty of this same group taught General Metalworking II.

Several studies were found with information relating to the metalworking curriculum. However, the most closely related study was completed in 1969 by Uselton (3). Uselton's study was concerned with the course offerings in Machine Woodworking I and II, and attempted to ascertain if any deviations were made from the state-prescribed course of study. Uselton found the majority of Machine Woodworking I and II teachers followed the state-prescribed curriculum suggested by the Texas Education Agency in a monograph entitled Metalworking Grades 7-12, which was compiled by a committee from the Texas Industrial Arts Association (2).

Chapter III presents the data received from instructors concerning General Metalworking I and II. The information was tallied and presented in tabular form indicating what the instructors were including in their curriculum. The
data also indicated where the instructors were deviating from the state-prescribed course of study.

This chapter contains a summary of the study, findings, conclusions, and recommendations which are based upon the data presented.

Findings

Based on the data obtained in this study the following findings are presented:

1. The average General Metalworking I instructor taught 2.4 sections per day, while the average General Metalworking II instructor taught 1.7 sections per day.

2. The state-prescribed curriculum indicates that there are to be no prerequisites for General Metalworking I; however, the data indicated that "introductory metalworking" was required by 4.4 per cent of the instructors. "Other prerequisites" were required by 10.3 per cent of the instructors.

3. The state-prescribed curriculum requires a prerequisite of General Metalworking I for the course of General Metalworking II. However, 2 per cent of the instructors required no prerequisite, 6 per cent required introductory metalworking and 6 per cent required "other prerequisites" rather than General Metalworking I.

4. Less than 50 per cent, or a minority, of the General Metalworking I instructors included history and development
or industrial concepts in their study of the metalworking lathe.

5. A large majority of the General Metalworking I instructors did not include the use of mandrels, carbon steel and carbide cutting tools, or reaming and contouring operations in their curriculum.

6. Types of fits and topics concerning taper turning were included in the curriculum by approximately 40 per cent of the sixty-eight General Metalworking I instructors.

7. Less than 50 per cent, or a minority, of the sixty-eight metalworking instructors included all topics concerning milling machines and their operations.

8. Horizontal and vertical milling machines were the most used milling machines, while the plane, universal and production milling machines were each included by less than 10 per cent of the total instructors for instructional purposes.

9. All topics concerning the use of stops, follow rests, mandrels and tool post grinders on the metalworking lathe were included by 50 per cent, or less of the fifty instructors in the General Metalworking II curriculum.

10. Elements of lathe operation, such as chasing external threads, the positioning of parts with fixtures, checking the alignment of the lathe with a steel test bar and dial indicator, and the angle of keenness of lathe cutting tools
were omitted from the curriculum by a majority of the fifty General Metalworking II instructors.

11. All milling machine topics concerning the centering of the cutter, the dial indicator, and the alignment of tools were not included in the curriculum by a majority of the fifty General Metalworking II instructors.

12. Of the General Metalworking II instructors, 48 per cent, included the importance of the milling machine in their curriculums.

13. Work holding attachments for the instructors on the milling machine were not used by a majority of the instructors of General Metalworking II. Vises were utilized for instructional purposes by 64.0 per cent of the same instructors.

14. The majority of milling machine operations were not included in the curriculum by a majority of the fifty General Metalworking II instructors.

15. The shaper topics were not included by a majority of the fifty instructors in the General Metalworking II course offerings.

16. Most topics concerning grinding machines and operations were used by a minority of the instructors, while the basic parts of grinders, safe practices, types of abrasives and the dressing of grinding wheels were included by a majority of the instructors in their curriculum.
Conclusions

The following conclusions are based on the findings of the study:

1. Since some of the instructors were not following the state-prescribed curriculum concerning prerequisites, they probably were not in possession of the state-prescribed course of study, or they were choosing not to follow it.

2. Milling machines were not included by most instructors of General Metalworking I. This is probably due to a lack of equipment, neglect, or their unawareness of the state-prescribed curriculum.

3. Instruction on the use of shapers and grinders was not provided by most of the instructors of General Metalworking II because of lack of equipment, neglect, or their unawareness of the state-prescribed curriculum.

4. Some topics concerning all machines used in General Metalworking I and II were not included by a majority of instructors in their curriculums because of a lack of equipment, neglect, or their unawareness of the state-prescribed curriculum.

5. There appear to be inconsistencies between the prescribed course of content among the various schools offering General Metalworking I and General Metalworking II. It might be concluded that the instructors do not
believe certain of the prescribed offerings should be included in their curriculums.

Recommendations

In terms of the findings and conclusions of the study, the following recommendations appear to be justified:

1. The Texas Education Agency should publish and distribute the industrial arts metalworking monograph in order that instructors in Texas secondary schools would be aware of the course content to be included in the curriculums.

2. General metalworking instructors should follow the state-prescribed curriculum concerning prerequisites.

3. A study should be made to determine what physical facilities are available for General Metalworking I and II laboratories.

4. Similar studies should be made in other areas of the industrial arts program.

5. It is further recommended that in the future a follow-up study be conducted in the event that new curriculum guidelines are developed.
CHAPTER BIBLIOGRAPHY


3. Uselton, Michael T., "A Study of the Course Offerings in Machine Woodworking I and II in the High Schools in the State of Texas to Ascertain if any Deviations are Made from the State Prescribed Course of Study," unpublished master's thesis, Department of Industrial Arts, North Texas State University, Denton, Texas, 1969.
Dear Sir:

I am engaged in a graduate study at North Texas State University for the completion of a Master of Science degree in Industrial Arts. The study is concerned with the machine work which is included in the courses, General Metalworking I and II.

I would appreciate your assistance in providing me with information by completing the enclosed checklist and returning it at your earliest convenience. The information will be used in a professional and confidential manner. Be assured that you will remain anonymous.

If you wish a copy of the summary of the study, please check the space provided in the checklist. A return envelope is included for your convenience.

Sincerely yours,

Robert P. Henley

Sponsored by
Dr. Jerry G. McCain

RPH/dw

Enc: Instrument
APPENDIX B

A STUDY OF MACHINES USED IN GENERAL METALWORKING I AND II IN TEXAS HIGH SCHOOLS

Part I

GENERAL INFORMATION

Directions: Please provide the following information.

Name ____________________________ School ____________________________

How many sections of General Metalworking I do you teach? ______

How many sections of General Metalworking II do you teach? ______

Prerequisites for General Metalworking I and II.

<table>
<thead>
<tr>
<th>General Metalworking I</th>
<th>General Metalworking II</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ) None</td>
<td>( ) None</td>
</tr>
<tr>
<td>( ) General Drafting</td>
<td>( ) General Metalworking I</td>
</tr>
<tr>
<td>( ) Introductory Metalworking</td>
<td>( ) Introductory Metalworking</td>
</tr>
<tr>
<td>( ) Other Prerequisites</td>
<td>( ) Other Prerequisites</td>
</tr>
</tbody>
</table>

Part II

GENERAL METALWORKING I

Directions: Please check ( ) only those items which you actually use in instructing your students in General Metalworking II.

METALWORKING LATHE

Introduction

( ) History and development
( ) Basic machine of Industry
Kinds of metalworking lathes
Industrial concepts of the metalworking lathe
Basic parts and their function
Care of the lathe
Safe practices

Methods of chucking

Universal Chuck
Independent Chuck
Collet Chuck
Jacobs Chuck

Between centers
Slotted face plates
Mandrels
Others

Carbon steel
High speed steel
Carbide

Grinding of cutter bits
Shapes of cutter bits
Clearances
Rake

Lathe cutting tools

Cutting speeds and feeds

Types of cuts
Cutting speeds and feeds
Allowances
Others

Basic operations

Facing
Center drilling
Drilling
Turning
Boring
Reaming
Contouring
Shouldering
Filing
Polishing
Others

Fits and fitting

Slip fits
Press fits
Running fits

Knurling

Kinds of knurls
Alignment of cutters

Lubrication
Speeds and feeds

Taper turning

Compound rest
Offset Tailstock
Taper attachment
Forming tool
**MILLING MACHINES**

Types of milling machines

( ) Horizontal ( ) Universal
( ) Vertical ( ) Production
( ) Plane

Milling cutters

( ) End cutters ( ) Side cutters ( ) Form cutters

Installing and removing cutters and arbors

( ) Installing and removing cutters on vertical mills.
( ) Installing and removing cutters on horizontal mills.

Holding devices

( ) Use and care of vises ( ) Strap clamps
( ) Alignment of vises ( ) T bolts
( ) Step blocks

Rotation of cutter

( ) Right and left hand cutters
( ) Direction of travel

**Part III**

**General Metal II**

Directions: Please check only those items which you actually use in instructing your students in General Metalworking II.

**METALWORKING LATHE**

Introduction

( ) Importance of the metalworking lathe in industry.
( ) Basic parts and function of the metalworking lathe
( ) Accessories for the metalworking lathe
( ) Safe practices

Stops and their uses

( ) Carriage stops ( ) Collet stops
( ) Crossfeed stops ( ) Micrometer stops
Thread cutting

( ) Chasing external threads ( ) Taps
( ) Chasing internal threads ( ) Dies

Use of fixtures for turning

( ) Face plate and fixtures ( ) Chuck and fixtures
( ) Positioning parts ( ) Others

Turning between centers

( ) Making set ups
( ) Checking the alignment with a steel test bar and dial indicator
( ) Checking alignment by turning diameters

Steady rest

( ) Attachment to lathe bed ( ) Attaching to carriage
( ) Alignment ( ) Alignment
( ) Lubrication ( ) Lubrication

Follow rest

Mandrel

( ) Types of mandrels ( ) Mounting Workpiece
( ) Use of mandrels ( ) Others
( ) Testing for accuracy

Cutting tools

( ) Types of lathe cutter bits
( ) Shapes of cutting tools
( ) Angle of keenness
( ) Rake-side and back
( ) Clearances
( ) Sharpening lathe cutting tools

Tool post grinder

( ) Preparation lathe
( ) Attaching grinder
( ) Selecting grinding wheel
( ) Spindle speed and feed
( ) Dressing wheels
( ) Traverse
MILLING MACHINE

Introduction

( ) Importance of milling machines in industry
( ) Basic parts of milling machines
( ) Accessories of milling machines
( ) Care of milling machines
( ) Safe practices

Centering of cutter

( ) Edge finder ( ) Dial indicator
( ) Mill wiggler ( ) Paper

Rotation of the cutter

( ) Forward ( ) Right and left hand cutters
( ) Reverse ( ) Direction of travel

Use of the dial indicator

( ) Alignment of the milling head
( ) Alignment of the vise
( ) Alignment of part with down movement of spindle on vertical milling machine
( ) Measurement of angles using the dial indicator
( ) Locating the center of a hole
( ) Locating the center of a pin
( ) Use of dial indicator to align work on mill table
( ) Use of dial indicator to align fixtures

Alignment tools

( ) Alignment blocks ( ) Alignment straps
( ) Angle plates ( ) Alignment pins
( ) Fixtures ( ) Vises

Factors in machine operation

( ) Cutter speed ( ) Direction of travel
( ) Depth of cut ( ) Fluids
( ) Feeds

Work holding attachments

( ) Vises ( ) Rotary tables
( ) Magnetic chuck ( ) Dividing head
( ) Index tables ( ) Fixtures
Milling Operations

( ) Installing cutters
( ) Slotting
( ) Face milling
( ) Side milling
( ) Gage milling
( ) Milling to tolerance
( ) Precision location of holes
( ) Drilling and reaming holes
( ) Milling key ways
( ) Drilling and boring
( ) Rotary table dividing head with face plate
( ) Dividing head
( ) Angular surfaces
( ) Alignment of dividing head and foot stock
( ) Indexing
( ) Gear cutting
( ) Cam cutting

SHAPER

Introduction

( ) Types of shapers ( ) Basic
( ) Size (Length of stroke) ( ) Safe practices

Shaper cutting tools

( ) Kinds of cutting tools
( ) Clearance on cutting tools
( ) Grinding a shaper cutter

Shaper tool holders

( ) Regular tool holders
( ) Extension tool holders
( ) Setting tool holders

Work holding devices

( ) Vise
( ) Placement on table
( ) Alignment
( ) Parallels
( ) Step blocks
( ) Strap clamps
( ) Angle plates
( ) "T" bolts

Shaper operations

( ) Cutting speeds and feeds
( ) Squaring material
( ) Slotting
GRINDING MACHINES

Introduction

- Use of grinders in industry
- Basic parts of grinders
- Accessories for grinders
- Safe practices

Grind wheels

- Types of abrasive
- Grain of grinding wheels
- Bond of grinding wheels
- Grade of grinding wheels
- Structure of grinding wheels
- Shapes of grinding wheels
- Care of grinding wheels
- Installing grinding wheels
- Safe RPM of grinding wheels
- Marking systems for grinding wheels
- Dressing grinding wheels

Kind of grinding

- Cylindrical grinding
- Form grinding
- Internal grinding
- Surface grinding
- Centerless grinding
- Universal tool grinding

Mounting of work on grinder

Surface grinder

- Electromagnetic chuck
- Fixtures
- Vise

Center type cylindrical grinder

- Centers
- Mandrels
- Fixtures
Internal grinder

( ) Chuck
( ) Collet
( ) Fixtures

Universal tool grinder

( ) Arbors
( ) Chuck
( ) Mandrel

( ) Please send me a copy of the summary of this study.

Name

Address

City ______________ State _______ Zip _______
BIBLIOGRAPHY

Books


Monograph

Texas Education Agency, Metalworking, Grades 7-12, Austin, Texas Education Agency Printing Office, 1971

Unpublished Materials


Pippin, Carroll B., "A Survey to Determine if the Vocational Education and Industrial Arts Program of the Orange Public Schools is Meeting the Needs of the Community," unpublished master's thesis, North Texas State University, Denton, Texas, 1949.

Uselton, Michael T., "A Study of the Course Offerings in Machine Woodworking I and II in the High Schools in the State of Texas to Ascertain if any Deviations are Made from the State Prescribed Course of Study," unpublished master's thesis, Dept. of Industrial Arts, North Texas State University, Denton, Texas, 1969.