A STUDY OF THE KNOWLEDGE AND SKILLS
REQUIRED OF MACHINISTS IN THE
DALLAS-FORT WORTH AREA

APPROVED:

G. Frank Nelson
Major Professor

E. C. W. Casey
Minor Professor

C. E. Blanding
Director of the Department of
Industrial Arts

Robert B. Terlouw
Dean of the Graduate School
A STUDY OF THE KNOWLEDGE AND SKILLS
REQUIRED OF MACHINISTS IN THE
DALLAS-FORT WORTH AREA

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Larry E. Mosby
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</table>
CHAPTER I

If one were to reflect upon our present day surroundings it would appear self-evident that the majority of our environment is extracted or fabricated through complimentation of a machine. The machine, a mainstay to our cities, industries, and farms, is responsible for the existence of our food, transportation, and livelihood. The key ingredient to every machine is the machinist who operates and fabricates the machinery.

Many technological advances have been made in the machinist's trade. This is possibly due to the many technological advances made possible of new metallurgical developments. The knowledge and skills of machinists are probably being challenged more now than were before. Consequently, the metals industry has continued to grow, creating a vast demand for skilled machinists.

Many of the high school students upon graduation will be seeking employment in industry, some of which may be employed as machinists. Therefore, the objective of this study is to determine what knowledge and skills are being required of machinists currently employed in the Dallas-Fort Worth Area, and to what extent these may be incorporated and taught in industrial arts machine metalworking courses.
Statement of Problem

This study was designed to identify the knowledge and skills that machinists employed in industries in the Dallas-Fort Worth Area should possess. In order to find a probable solution to the problem, it was necessary to answer the following questions:

1. What are the educational requirements of prospective machinists?
2. How would a person enter the machinist trade?
3. What types of admission tests are administered?
4. How much emphasis is placed on personal interviews?
5. How much emphasis is placed on admission tests?
6. What are the minimum, maximum, and preferred ages?
7. Is there any certification or licensing required?
8. Is there any previous experience required?
9. Are special qualifications required for a prospective employee regarding restricted areas of the machinist trade?
10. What are the anticipated three-year needs for a machinist due to growth in the field and also replacement of current employees?
11. Do firms have in-service training programs for prospective employees?
12. What knowledge of machinery is required of prospective employees?
It is hoped that this study will provide pertinent and current information that may be useful in developing criteria for evaluating and revising industrial arts metalworking courses.

Method of Procedure

In seeking answers to the questions mentioned in the statement of the problem, the following procedures were followed to determine the knowledge and skills required of machinists in the Dallas-Fort Worth Area.

A sampling of manufacturing firms in the Dallas-Fort Worth area employing machinists were taken from five sources:

1. The printed series provided by the Dallas Chamber of Commerce entitled Manufacturing Firms in Dallas Metropolitan Area with over 25 Employees (3).
2. Greater Dallas Telephone Directory (6).
4. The printed series provided by the Dallas Chamber of Commerce entitled Non Manufacturing Firms in Dallas County with over 100 Employees (4).
5. A list of cities in the Dallas-Fort Worth Area from the Texas Almanac (5).

A letter was sent to one hundred twenty-five firms explaining briefly the purpose of the study and inquiring whether or not they would participate in the study by completing and returning a questionnaire (Appendix A). Of the one hundred twenty-five firms contacted 82, or 65.6 per cent, returned the enclosed post card (Appendix B). Fifty-one of
the firms returning the cards indicated they did employ machinists and would complete and return a questionnaire. Twenty-two firms returning the card did not employ machinists, and nine did employ machinists, but would not participate in the study.

The questionnaire (Appendix B) and a letter of explanation (Appendix A) were directed to the fifty-one firms, and twenty-eight returned within two weeks. A follow-up letter (Appendix C) was then directed to the remaining twenty-three firms, resulting in the return of eleven more questionnaires. A total of thirty-nine, or 76.5 per cent, of the original fifty-one, returned the questionnaires.

Source of Data

The data used in this study were obtained from questionnaires completed and returned by thirty-nine firms in the Dallas-Fort Worth, Texas area.

Limitations of the Study

Of the thirty-nine questionnaires returned, thirty-eight, or 97.4 per cent, were usable for the purpose of this study. Therefore, the study was limited to thirty-eight firms in the Dallas-Fort Worth area. The study was further limited in that, upon occasions, no response was made to certain items on the questionnaires. Four firms failed to respond to two items, six firms did not respond to three items, and ten firms omitted a response to one item of the questionnaire. Due to the omissions to certain items on the
questionnaire, some of the totals in the tabulated data will not result in a total of 100 per cent.

This study was made with further limitations. They were as follows:

1. The study was limited to four job classification of machinists, categorized in the Dictionary of Occupation Titles (9) as:

   600.280 Machinist's helper
   604.280 Machine tool operator
   600.280 General machinist
   601.280 Tool-and-die maker

2. The study was concerned only with the knowledge, skills, and training required of prospective employees by firms in the Dallas-Fort Worth Metropolitan Area.

Organization of the Study

Chapter I of the study includes an introduction, statement of the problem, purpose of the study, method of procedure, source of data, limitations of the study, organization of the study, definition of terms, and related studies.

Chapter II presents the general qualifications and duties of machinists as indicated by the participating firms.

Chapter III is devoted to the job opportunities for an individual seeking employment in the machinists' trade in one of the four job classifications listed, as well as future employment opportunities in the area.
Chapter IV compares the industrial arts metalworking curriculum with the requirements of the metals industry.

Chapter V consists of a summary, conclusions, and recommendations made in view of the findings of the study.

Definition of Terms

Machinist's Helper, is the occupational title given an employee during the initial training period upon entering the machinist's trade until he becomes proficient in the operation of some particular machine.

Machine Operator, is a person proficient in the operation of only one machine such as a milling machine operator, drill press operator, etc.

General Machinist, is a person with general machine shop experience and is versatile in operating all machines in a machine shop and can perform any bench or floor operation.

Tool-and-Die Maker, is a machinist who is an expert. Generally speaking, his duties involve more delicate craftsmanship and more accurate measurement than those of the general machinist. He is expected to be involved in more mathematical calculations and a more extended use of the various machine tool attachments.

Curriculum, as used in this study, refers to the total offerings provided by the school.

Industrial Arts, as used in this study, refers to that phase of general education that provides the opportunity for students, both boys and girls, to explore the materials, tools, and processes of industry.
Sampling, will refer to the number of firms chosen from various sources that would have likely employed machinists, and in this study includes one hundred twenty-five firms in the Dallas-Fort Worth, Texas, area.

Qualifications, as used in this study, refers to competency in the application of the principles and concepts of metalworking and the use of machinist's tools, equipment, and machinery.

Knowledge and skills, as used in this study, refers to competency in the application of the principles and concepts of metalworking and the use of machinist's tools, equipment, and machinery.

Machine tool, is a metal cutting machine which operates with a power source, such as the lathe, drill press, and the band saw.

The Dallas-Fort Worth, Texas, Area, refers to the cities of Dallas and Fort Worth and their adjacent areas.

Related Studies

Craghead (2) conducted a complete study of the knowledge and skills required of draftsmen in the manufacturing and non-manufacturing firms in the Dallas-Fort Worth, Texas, area. This study indicated that the larger firms that employed more draftsmen used less equipment than the smaller firms that employed fewer draftsmen. Also indicated in this study was the employment demands for trained draftsmen which are steadily increasing.
Wied's (9) study concerned itself with the job prerequisites for female employees in the electronics industry in the Dallas area. The data presented by Wied were collected from information supplied through a sampling of industries and agencies in the Dallas metropolitan area. The data indicated that employment opportunities for female employees in electronics were increasing more rapidly than the number of workers being trained for positions. Wied recommended that young women should be encouraged to take electricity-electronics courses in high school. Further recommendations were that high schools should foster an awareness of the opportunities in the electronics industry for women and that studies in other occupational fields for women be investigated.

Abney's (1) study concerned itself with the duties, opportunities, and requirements of persons who worked with electronic devices in manufacturing industries of the Dallas metropolitan area. Of the persons whose primary work was with electronics, the study indicated that there was a common core of skills and knowledge required of a majority of the workers. The areas of skills and knowledges were electronic circuitry, the industrial uses of electronic units, electronic test equipment, general information relating to industry, and general shop practices.

The study also indicated that job opportunities existed, and that they should double in a three-year period. Job openings are more likely to occur in large manufacturing firms.
The majority of jobs in electronics required at least a high school education. Most openings were restricted to women. Industrial experience was required for employment in many of the jobs. The minimum age of employment for persons working in electronics was eighteen years of age while the preferred age of employment was twenty-five to forty-five years of age. Approximately one-fourth of the job openings were filled through personnel who already worked for the firms, and were closed to outsiders.
CHAPTER BIBLIOGRAPHY


3. Dallas Chamber of Commerce, Manufacturing Firms in Dallas Standard Metropolitan Area with over 25 Employees, Fact Series No. 11, 1969.

4. Dallas Chamber of Commerce, Non-Manufacturing Firms in Dallas County with over 100 Employees, Fact Series A-2, 1969.


CHAPTER II

GENERAL QUALIFICATIONS REQUIRED OF 2,996 MACHINISTS
IN THIRTY-EIGHT PARTICIPATING FIRMS

This chapter will present data indicating general qualifications required of machinists in the Dallas-Fort Worth, Texas, area as indicated by the thirty-eight participating firms. These firms employed 2,996 machinists, and ranged in size from small firms employing only two machinists to one firm which employed 581 machinists.

General Qualifications of Machinists

Table I presents data concerning some general qualifications required by the thirty-eight firms. The data represent the number and percentage of firms and the number and percentage of machinists employed by the firms.

As shown in Table I, twenty, or 52.6 per cent, of the firms, indicated that they did require previous on-the-job experience as a prerequisite for employment. These twenty firms employed 1,271, or 42.4 per cent, of the machinists included in the study. Nine, or 23.7 per cent, of the firms which employed 1,041, or 34.8 per cent, of the machinists, indicated that they preferred their prospective machinists to have previous on-the-job work experience. Seven, or 18.4 per cent, of the firms that employed 392, or 13.1 per cent, of the machinists indicated
that they desired to employ machinists with previous work experience. Two, or 5.3 per cent, employing 292, or 9.7 per cent, of the machinists, indicated that it did not matter whether or not the prospective employee had previous work experience.

**TABLE I**

**GENERAL QUALIFICATIONS REQUIRED OF 2,996 MACHINISTS IN THIRTY-EIGHT PARTICIPATING FIRMS**

<table>
<thead>
<tr>
<th>QUALIFICATIONS</th>
<th>Machinists</th>
<th>Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Per Cent</td>
</tr>
<tr>
<td>Require that machinists have previous on-the-job experience</td>
<td>1,271</td>
<td>42.4</td>
</tr>
<tr>
<td>Prefer that machinists have previous on-the-job experience</td>
<td>1,041</td>
<td>34.8</td>
</tr>
<tr>
<td>Desire that machinists have previous on-the-job experience</td>
<td>392</td>
<td>13.1</td>
</tr>
<tr>
<td>Does not require machinists have any previous work experience</td>
<td>292</td>
<td>9.7</td>
</tr>
</tbody>
</table>

**Certification Requirements**

Nine, or 23.7 per cent, of the firms indicated that certification was required, and that the employee must attend a ninety-day in-plant certification school. This certification
consisted of specialized training on any one of the four classifications presented in this study. Twenty-nine, or 76.3 per cent, of the firms indicated that no certification was needed by prospective employees for the four job classifications.

**Education Requirements**

Table II indicates the educational level the prospective employee should have attained in order to obtain employment as a machinist in the Dallas-Fort Worth Area, as indicated by the participating firms. The education requirements for machinists varied with the particular type of job skill, and the importance of education requirement varied with the different firms.

The data presented in Table II show that the participating firms did set a definite level of education as being important in hiring machinists. Nineteen, or 50.0 per cent, of the firms indicated that the prospective employee must be a high school graduate. Fifteen, or 39.5 per cent, of the firms required prospective employees to have some high school education. Two firms which employed 280 machinists required their machinists to have vocational school training. These two firms produced precision products.

The larger firms found that there was a noticeable difference between high school and non-high school graduates in respect to the length of time it took each to progress to higher job grades. Also, the larger firms required their machinists to continue their education in the firm's educational assistance programs.
TABLE II
EDUCATIONAL REQUIREMENTS FOR EMPLOYEES PREPARED BY THIRTY-EIGHT FIRMS

<table>
<thead>
<tr>
<th>General Educational Attainments Required</th>
<th>Firms</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Number</td>
</tr>
<tr>
<td>Elementary school</td>
<td>1</td>
</tr>
<tr>
<td>Junior high school</td>
<td>-</td>
</tr>
<tr>
<td>Some high school</td>
<td>15</td>
</tr>
<tr>
<td>High school graduate</td>
<td>19</td>
</tr>
<tr>
<td>Vocational school</td>
<td>2</td>
</tr>
<tr>
<td>Technical school</td>
<td>1</td>
</tr>
<tr>
<td>Some college</td>
<td>-</td>
</tr>
</tbody>
</table>

The personnel administrators of two large firms indicated that the employees with more general education had a better chance to advance to foreman and supervisor than employees with less general education. Thirty-four, or 89.5 per cent, of the firms were cognizant of the fact that the high school graduate was easy to train and could perform a broad range of job skills in less training time than the non-high school graduate.

Technical Knowledge Required

A machinist's trade is a highly specialized area of work in which there have been many new and revolutionary developments. A person entering this trade is expected to have a reasonable amount of technical knowledge. It is necessary for one to become fully aware of the new machinery and the skills required to operate these machines.
The importance of specified related subject matter to the machinist's trade as indicated by the thirty-eight participating firms is shown in Table III. No attempt was made to determine the depth of knowledge necessary, only the breadth. Due to the nature of work done by each firm, the importance of different subject matter varied considerably with the firms. Thirty-four, or 89.5 per cent, of the firms indicated that knowledge of measuring instruments was necessary for prospective machinists. Twenty-one, or 55.3 per cent, indicated that blueprint reading (structural; and machine drafting) was necessary for prospective employees in the machinist's trade. Thirty-six, or 94.7 per cent, of the participating firms indicated that basic mathematics (addition, subtraction, multiplication, and division of whole numbers and fractions) was necessary for prospective machinists. Twenty-nine, or 76.3 per cent, of the firms indicated that the basic functions of trigonometry, plane and solid geometry were necessary related information applicable to the machinist's trade.

Each firm indicated that prospective machinists are required to have a knowledge of the operation of the equipment and machinery utilized by the different firms according to job classification. Table IV shows data that indicate use of machinery of the thirty-eight firms by 2,996 machinists. As shown in Table IV, six, or 15.8 per cent, of the machinists operated the vertical jig bore machine. The horizontal jig bore was operated by ten, or 26.3 per cent, of the machinists.
TABLE III

IMPORTANCE PLACED ON RELATED SUBJECT MATTER FOR MACHINISTS BY THE THIRTY-EIGHT PARTICIPATING FIRMS

<table>
<thead>
<tr>
<th>Study Area</th>
<th>Necessary</th>
<th>Per cent</th>
<th>Desirable</th>
<th>Per cent</th>
<th>Unnecessary</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knowledge of measuring instruments..........</td>
<td>34</td>
<td>89.5</td>
<td>4</td>
<td>10.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. Structural drafting and blueprint reading...</td>
<td>21</td>
<td>55.2</td>
<td>2</td>
<td>5.3</td>
<td>15</td>
<td>39.5</td>
</tr>
<tr>
<td>3. Addition and subtraction of whole numbers...</td>
<td>36</td>
<td>94.7</td>
<td>2</td>
<td>5.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4. Machine drafting and blueprint reading.....</td>
<td>21</td>
<td>55.2</td>
<td>2</td>
<td>5.3</td>
<td>15</td>
<td>39.5</td>
</tr>
<tr>
<td>5. Multiplication and division of whole numbers.</td>
<td>36</td>
<td>94.7</td>
<td>2</td>
<td>5.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Addition and subtraction of fractions.......</td>
<td>36</td>
<td>94.7</td>
<td>1</td>
<td>5.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Multiplication and division of fractions...</td>
<td>36</td>
<td>94.7</td>
<td>1</td>
<td>2.6</td>
<td>1</td>
<td>2.6</td>
</tr>
<tr>
<td>8. Basic trigonometry..........................</td>
<td>29</td>
<td>76.3</td>
<td>7</td>
<td>18.4</td>
<td>2</td>
<td>5.3</td>
</tr>
<tr>
<td>9. Plane geometry.............................</td>
<td>29</td>
<td>76.3</td>
<td>7</td>
<td>18.4</td>
<td>2</td>
<td>5.3</td>
</tr>
<tr>
<td>10. Solid geometry............................</td>
<td>29</td>
<td>76.3</td>
<td>7</td>
<td>18.4</td>
<td>2</td>
<td>5.3</td>
</tr>
<tr>
<td>11. Basic metallurgy...........................</td>
<td>-</td>
<td>-</td>
<td>27</td>
<td>71.1</td>
<td>11</td>
<td>23.9</td>
</tr>
<tr>
<td>12. Strength and stress of materials..........</td>
<td>-</td>
<td>-</td>
<td>7</td>
<td>18.4</td>
<td>31</td>
<td>81.6</td>
</tr>
<tr>
<td>13. Industrial and shop safety..................</td>
<td>38</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The vertical milling machine was operated by thirty-two, or 84.2 per cent, while twenty-nine, or 76.3 per cent, operated the horizontal milling machine. Machinists in all thirty-eight, or 100.0 per cent, of the participating firms
used the drill press and the lathe. The surface grinder was used by machinists in thirty-seven, or 97.4 per cent, of the firms. Machinists in twenty-seven, or 71.1 per cent, of the participating firms use the O. D. (outside diameter) grinder while machinists in only five, or 13.1 per cent, of the firms used the I. D. (inside diameter) and the centerless grinders.

TABLE IV
MACHINES USED BY MACHINISTS IN THE THIRTY-EIGHT PARTICIPATING FIRMS

<table>
<thead>
<tr>
<th>Types of Machinery Used</th>
<th>Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
</tr>
<tr>
<td>1. Jig bore (vertical)</td>
<td>6</td>
</tr>
<tr>
<td>2. Jig bore (horizontal)</td>
<td>10</td>
</tr>
<tr>
<td>3. Milling machine (vertical)</td>
<td>32</td>
</tr>
<tr>
<td>4. Milling machine (horizontal)</td>
<td>29</td>
</tr>
<tr>
<td>5. Drill press</td>
<td>38</td>
</tr>
<tr>
<td>6. Lathe</td>
<td>38</td>
</tr>
<tr>
<td>7. Surface grinder</td>
<td>37</td>
</tr>
<tr>
<td>8. O. D. grinder</td>
<td>27</td>
</tr>
<tr>
<td>9. I. D. grinder</td>
<td>5</td>
</tr>
<tr>
<td>10. Tool grinder</td>
<td>12</td>
</tr>
<tr>
<td>11. Centerless grinder</td>
<td>5</td>
</tr>
<tr>
<td>12. Overhead crane or heavy duty hoists</td>
<td>2</td>
</tr>
<tr>
<td>13. Jig and fixtures</td>
<td>27</td>
</tr>
<tr>
<td>14. Planing machine</td>
<td>23</td>
</tr>
</tbody>
</table>

The tool grinder was reported to be used by machinists in twelve, or 31.6 per cent, of the participating firms. Overhead cranes or heavy duty hoists were used by machinists in two, or 5.3 per cent, of the firms. Jigs and fixtures were
used by machinists in twenty-seven, or 97.4 per cent, of the participating firms. The planing machine was reported to be used by machinists in twenty-three, or 60.5 per cent, of the thirty-eight participating firms.

Table V presents data on general shop practices required in the thirty-eight firms involving 2,996 machinists. The shop practice required most frequently by all of the thirty-eight participating firms was the use of basic hand tools. Blueprint reading by machinists was required by thirty-seven, or 97.4 per cent, of the participating firms. Twenty-one, or 55.3 per cent, of the firms required machinists to be familiar with basic drafting practices. Sixteen, or 42.1 per cent, of the firms reported that they required their machinists to be familiar with the techniques of precision measurement. Thirty-two, or 84.2 per cent, of the firms required machinists to do basic sheet-metal work.

TABLE V
GENERAL SHOP PRACTICES REQUIRED OF THE MACHINISTS IN THE THIRTY-EIGHT PARTICIPATING FIRMS

<table>
<thead>
<tr>
<th>General Shop Practices Required</th>
<th>Firms</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Per Cent</td>
</tr>
<tr>
<td>1. Use of basic hand tools</td>
<td>38</td>
<td>100.0</td>
</tr>
<tr>
<td>2. Blueprint reading</td>
<td>37</td>
<td>97.4</td>
</tr>
<tr>
<td>3. Basic drafting practices</td>
<td>21</td>
<td>55.3</td>
</tr>
<tr>
<td>4. Techniques of precision</td>
<td>16</td>
<td>42.1</td>
</tr>
<tr>
<td>measurement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Basic sheet metal work</td>
<td>32</td>
<td>84.2</td>
</tr>
</tbody>
</table>
Age Requirements

In the Dallas-Fort Worth Metropolitan Area, age did not seem to be a crucial factor in the employment of machinists, as age requirements vary with different firms. Table VI indicates the age requirement set by the thirty-eight participating firms. The larger firm employing over one hundred machinists did not indicate a critical preference as to age, while the firms, employing twenty-five or less, did indicate age preference for machinists. They preferred to have machinists between twenty-five and thirty-five years of age. The age range from eighteen to twenty-one was specified as a minimum age requirement by the thirty-eight participating firms.

TABLE VI

AGE REQUIREMENTS FOR MACHINISTS OF FIRMS
IN THE DALLAS METROPOLITAN AREA

<table>
<thead>
<tr>
<th>Age</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Preferred</th>
<th>Per Cent of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>23</td>
<td>23</td>
<td>5</td>
<td>60.2</td>
</tr>
<tr>
<td>19</td>
<td>8</td>
<td></td>
<td></td>
<td>21.1</td>
</tr>
<tr>
<td>20</td>
<td>4</td>
<td></td>
<td></td>
<td>10.5</td>
</tr>
<tr>
<td>21</td>
<td>3</td>
<td></td>
<td></td>
<td>7.9</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td>13.2</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>12</td>
<td>15</td>
<td>31.6</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td>6</td>
<td>39.5</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td>15.8</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>8</td>
<td></td>
<td>21.1</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td>11</td>
<td></td>
<td>23.9</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td>12</td>
<td></td>
<td>31.6</td>
</tr>
<tr>
<td>65</td>
<td></td>
<td>7</td>
<td></td>
<td>18.4</td>
</tr>
</tbody>
</table>
Twenty-three, or 60.2 per cent, of the firms preferred to hire prospective machinists at the age of eighteen. Ages fifty-five and sixty were reported as being the maximum ages most often considered when hiring machinists. Seven firms reported that their maximum age of employment was sixty-five.
CHAPTER III

JOB OPPORTUNITIES FOR PERSONS SEEKING EMPLOYMENT
AS MACHINISTS IN THE DALLAS-FORT WORTH AREA

The rapid growth in the metals industry has brought about many changes in the job opportunities for a person who might be interested in the machinist's trade. The total number of persons employed in the metals industry as machinists (skilled and semi-skilled) in the Dallas-Fort Worth Area is 8,212, which is 65.7 per cent of the projected number by 1975 (1, pp. 19-22).

Since 1965 the various metal products firms, both large and small, have continued to grow and prosper. As indicated in Metro Dallas Man Power Outlook to 1975, by 1975 the Dallas-Fort Worth Area will provide 25 per cent of the state's metal manufacturing and fabrication output (1). Data obtained from the questionnaire, for this chapter, attempts to answer some questions pertaining to persons seeking employment as machinists in the Dallas-Fort Worth Area.

Admission Tests

Some types of admission tests were given to the majority of machinists working in the thirty-eight participating firms. Presented in Table VII are the per cent and number of firms administering the various types of tests used. The most
common tests used were skill, practical, and physical examination. Twenty-one, or 55.3 per cent, of the firms indicated that they required skill tests for all four selected job classifications. Twenty-seven, or 72.1 per cent, of the firms required practical tests.

TABLE VII

TYPES OF ADMISSION TESTS ADMINISTERED TO MACHINISTS
BY THIRTY-EIGHT PARTICIPATING FIRMS

<table>
<thead>
<tr>
<th>Types of Admission Tests</th>
<th>Firms</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Per Cent</td>
</tr>
<tr>
<td>Skills Test</td>
<td>21</td>
<td>55.3</td>
</tr>
<tr>
<td>Practical Test</td>
<td>27</td>
<td>72.1</td>
</tr>
<tr>
<td>Standardized Test</td>
<td>6</td>
<td>15.8</td>
</tr>
<tr>
<td>Oral Test</td>
<td>11</td>
<td>28.9</td>
</tr>
<tr>
<td>Physical Examination</td>
<td>38</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Twenty-seven firms developed and administered some form of a practical test. All participating firms required each prospective employee to have a physical examination. Six of the firms required a ninety-day training school, and upon successful completion of the training the employees were then given a standardized test, and offered a position in one of the four job classifications used in this study. The standardized tests used differed with each firm because of the nature of work done by each firm. The standardized tests used were developed by The American Society of Mechanical Engineers or the individual firms themselves.
Since many firms required a personal interview, the question often arose as to how much emphasis the firm placed on personal interview when hiring a person in the machinist's trade. The answer to the question is illustrated in Table VIII.

**TABLE VIII**

**EMPHASIS PLACED ON PERSONAL INTERVIEWS BY THE THIRTY-EIGHT PARTICIPATING FIRMS**

<table>
<thead>
<tr>
<th>Emphasis Placed on Personal Interviews</th>
<th>Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
</tr>
<tr>
<td>From 0 to 25 per cent</td>
<td>10</td>
</tr>
<tr>
<td>From 26 to 50 per cent</td>
<td>19</td>
</tr>
<tr>
<td>From 51 to 75 per cent</td>
<td>6</td>
</tr>
<tr>
<td>From 76 to 100 per cent</td>
<td>3</td>
</tr>
</tbody>
</table>

Ten, or 26.3 per cent, of the participating firms indicated that emphasis placed on personal interviews was from 0 to 25 per cent, while nineteen, or 50.0 per cent, reported that they placed from 26 to 50 per cent on personal interviews. This was due to the fact that those personnel administrators worked for large firms which have well-established and time-tested employment policies. As shown, admission was not entirely based upon personal interviews.

**Current Employment**

The study concentrated on four specific job classifications of machinists who work in the metal manufacturing
industries in the Dallas-Fort Worth Area. These job classifications were machinist helpers, machine tool operators, general machinists, and tool-and-die makers.

Thirty-eight firms selected for use in this study made up a combination of small firms with twenty-five or less employees and large firms with over one hundred. The job classifications selected were common to both small and large firms. All thirty-eight firms were engaged in the manufacture or fabrication of specific products.

### TABLE IX

**NUMBER OF MACHINISTS CURRENTLY EMPLOYED IN THE THIRTY-EIGHT PARTICIPATING FIRMS ACCORDING TO JOB CLASSIFICATION WITH PROJECTION TO 1975**

<table>
<thead>
<tr>
<th>Job Classification</th>
<th>Present Machinists</th>
<th>Projected 5-year Increase</th>
<th>Projected Total 1975</th>
<th>Per Cent of Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinist Helper</td>
<td>231</td>
<td>763</td>
<td>994</td>
<td>330.3</td>
</tr>
<tr>
<td>Machine Tool Operator</td>
<td>1,993</td>
<td>5,683</td>
<td>7,676</td>
<td>285.1</td>
</tr>
<tr>
<td>General Machinist</td>
<td>526</td>
<td>1,921</td>
<td>2,447</td>
<td>365.2</td>
</tr>
<tr>
<td>Tool-and-Die-Maker</td>
<td>246</td>
<td>772</td>
<td>918</td>
<td>313.8</td>
</tr>
</tbody>
</table>

The number and per cent of machinists in the four job classifications are presented in Table IX. Also shown in this table is the projected growth pattern to 1975. The total number of machinists employed by the thirty-eight participating firms was 2,996. These machinists were divided into the different job classifications as follows: 231 machinist helpers, 1,993 machine tool operators, 526 general
machinists, and 246 tool-and-die makers.

According to estimates made by the Dallas Chamber of Commerce and Texas Employment Commission, there were over 328 firms engaged in the business of manufacturing and fabrication of metal products in the Dallas Metropolitan Area in September, 1968 (2). Most of the firms represented in this study employed seventy-five or fewer machinists. Thirty-four, or 89.5 per cent, of the participating firms reported that they anticipated a growth pattern that should double their number of machinists within the next five years.
CHAPTER BIBLIOGRAPHY


CHAPTER IV

COMPARISON OF INDUSTRIAL ARTS METALWORKING CURRICULUM
TO REQUIREMENTS OF MACHINIST IN INDUSTRY

The data presented in this chapter give a comparison of the courses offered in metalworking in the public schools with the employment requirements of the prospective machinist by the metalworking firms.

Curriculum Offering in High School
Metalworking Courses

Industrial arts is a general education subject area which is designed to prepare youth for effective living in our industrial society (1, p. 140). Courses in industrial arts are based on technology. The learning experiences include a study of industrial processes and the capability to work with common tools and materials of industry. The students are taught safe work habits and to develop skill and pride in craftsmanship. Industrial arts courses help students select occupations in which they would like to work.

The metalworking curriculum is taught in courses at three levels of difficulty and complexity. The first level is introductory metalworking. Introductory metalworking is a study of two or more areas of the metalworking industries, selected from bench metalworking, sheet metalworking, and
founding (1, p. 153). The second level is general metalworking. General metalworking is a study of four or more of the metalworking areas, selected from art metalworking, forging, founding, sheet metalworking, metal spinning, bench metalworking, and machine metalworking (1, p. 154). The third level is machine metalworking I and II. Machine metalworking is designed to introduce students to the type of work done by machinists. Students in machine metalworking I and II should also develop some degree of technical skill in the operation of basic machine tools and an understanding of machine tool design principles.

The Texas Education Agency gives the following course description of machine metalworking or the machinists courses:

Instruction is given on the engine lathe, milling machine, drill press, surface grinding machine, tool grinder, and shaper. Skill is developed by constructing useful projects which require multiple operations on several machines. As skill projects require accurate and precise work and opportunities are afforded to use machinery handbooks. Instruction in blueprint reading includes interpreting drafting symbols, tolerances, dimensions, conventional representations, interpreting notes and work orders. Sketching is also taught (1, p. 155).

The Texas Education Agency provides schools throughout the state with an option to offer the following number of units in machine metalworking: one-half unit, one unit, one and one-half units, and two units. The recommended grade level of the course is grades 10 through 12.

Courses offered in the public schools are generally called basic machinists courses and are not designed to produce
machinists. These courses are not vocational in nature, and should not be confused with vocational education. The student can by taking these courses find out if he is suited for work in the machinist’s trade, and determine if he wishes to become a machinist specialist or engineer. Machine metalworking offers superb exploration and pre-vocational training for students interested in entering the metals industry as prospective machinists.

Course Offerings Compared to Requirements of Machinists in Industry

From an analysis of the machine metalworking curriculum in the public schools and the knowledge and skills requirement of the four job classifications surveyed in this study, it would seem that the machine metalworking curriculum in the public schools of Texas is meeting the basic requirements of industry in providing the type of pre-vocational training needed by high school students wishing to enter the metal industry as machinists.

The machinists in each job classification studied were required to possess a broad knowledge of the machinist’s trade. Machinists in most cases were required to be proficient in the use of most power machinery, jigs and fixtures, measuring instruments, blueprint reading, and mathematics. The machinists were also required to possess a general knowledge of sheet metalwork, the use of basic hand tools, and basic drafting practices.
It would appear as though the existing machine metal-working curriculum offered in the public schools of Texas is meeting, if not exceeding, these basic requirements set forth by industry by machinists in the Dallas-Fort Worth Area. Like any other general education course, industrial arts cannot meet in every detail the exact requirements set by the various areas of the industrial market.
CHAPTER BIBLIOGRAPHY

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS
AND RECOMMENDATIONS

Summary

This study was conducted to collect data concerning knowledge and skills required of machinists in the Dallas-Fort Worth Area. These machinists were of four job classifications which were machinist's helper, machine tool operator, general machinists, and tool-and-die makers.

In order to gather the data needed for the study, first a sampling of 125 firms, within the Dallas-Fort Worth Area, was taken, and the firms were sent a letter inquiring whether or not they employed machinists, and a post card to be returned indicating whether they employed machinists, and if so, whether or not they would participate in the study. Of the 125 firms contacted, 82 returned the enclosed post card. Fifty-one of the 82 indicated that they did employ machinists and would participate in the study by completing and returning a questionnaire. Thirty-eight firms did participate in the study.

A questionnaire was designed to gather data concerning aspects of the knowledge and skills required of machinists. The personnel directors completed the questionnaires, indicating
what they considered to be important qualifications for persons entering the machinist's trade.

Information and data needed for the study were secured, and the study is organized as follows: Chapter I of the study includes an introduction, statement of the problem, purpose of the study, method of procedure, source of data, limitations of the study, organization of the study, definitions of terms, and a brief summary of three related studies. Chapter II presents the general qualifications and duties of machinists as indicated by the thirty-eight participating firms in the Dallas-Fort Worth Area. Chapter III is devoted to the job opportunities for an individual seeking employment in the machinist's trade in one of the four job classifications listed, as well as future employment opportunities in the areas. Chapter IV shows the machine metalworking curriculum for industrial arts as presented by the Texas Education Agency. It also compares that curriculum with the employment requirement of the metal industry, to determine if the curriculum meets the needs of prospective employees in the Dallas-Fort Worth Area.

Findings

When data from the questionnaires and personal interviews were tabulated and studied, they revealed a definite pattern with respect to the knowledge and skills required of machinists. To study the qualifications and general duties required of machinists, they were grouped according to job
classification, as follows: machinist's helpers, machine tool operators, general machinists, and tool-and-die makers. The anticipated five-year needs for the firms were 994 machinist's helpers, 5,683 machine tool operators, 1,921 general machinists, and 772 tool-and-die makers. The personnel department was responsible for the employment of the machinists.

Admission tests were administered by all the firms. The most important tests were the practical test, skills test, and physical examination. Twenty, or 52.6 per cent, of the firms indicated that they did require previous on-the-job experience. Twenty-nine, or 76.3 per cent, of the firms indicated that no certification was needed by prospective employees to enter the machinist's trade. The age requirements for persons entering the machinist's trade ranged from a minimum age of eighteen to a maximum age of sixty-five. Some participating firms indicated that they were concerned with ability and not age of prospective employees. Nineteen, or 50.0 per cent, of the participating firms indicated that personal interviews constituted from 26 to 50 per cent of the basis for employment.

Nineteen firms indicated that their prospective employees must have a high school education, while the others only indicated that the prospective employee should have some high school training. The high school curriculum in Texas offers a wide variety of experiences in the machine metalworking area. The following courses or subject matter were found to be of
extreme importance as basic knowledge for prospective machinists: use of basic hand tools, blueprint reading, basic drafting practices, techniques of precision measurement, basic sheet metalworking, shop and industrial safety. The equipment and machinery used by machinists in the establishments participating in this study were the vertical and horizontal jig bore, vertical and horizontal milling machine, drill press, lathe, surfacer, O. D., I. D., tool and centerless grinder, overhead crane, jig and fixtures, and the planing machine. These machines were used rather extensively by the firms. Both the large and small diversified firms in the Dalla-Fort Worth Area are in great need of machinists in each of the job classifications surveyed in this study.

Conclusions

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

1. Persons who take machine metalworking in high school have a better understanding of industry and should be better satisfied with the job.

2. Employment opportunities do exist for a wide range of age groups of machinists.

3. An abundance of machine metalworking training and general education of individual can receive, increases his chances of obtaining a better position in the machinist's trade.

4. The basic metalworking curriculum offered in the public schools of Texas can be of great benefit to many
young persons as an introduction to a possible vocation upon graduation from high school.

5. The employee who has taken machine metalworking courses will probably spend less time in in-service training and will qualify for a job requiring more skills.

Recommendations

The following recommendations are made in view of the findings in this study:

1. In programs designed to explore machine metalworking, emphasis should be placed upon an understanding of skills involved in the use of the various machines.

2. Emphasis should be placed upon learning to read working blueprints in programs designed to explore machine metalworking.

3. Students should acquire an understanding of the machine shop processes and their applications to industry.

4. Students in machine metalworking courses should acquire an understanding of precision measuring instruments.

5. High schools should foster an awareness among students of the opportunities in the metal industry.

6. Students should be encouraged to take metalworking courses in high school.

7. Similar studies in other occupational field for prospective employees may be investigated.

8. Future studies of machinists, with specific regard to the Dallas-Fort Worth Metropolitan Area, should be conducted.
periodically in order to maintain current and up-to-date information for use in reviewing and revising programs designed to explore the machinist's trade.
APPENDIX A

LETTERS OF INQUIRY
LETTER OF INQUIRY

Attention: Director of Personnel

Dear Sir:

At present I am engaged in a Master's degree program in the area of industrial arts at North Texas State University. For my research problem, I plan to conduct a study to identify the job skills and knowledge of a machinist seeking employment and employed in the Dallas-Fort Worth Area. The main purpose of this study is to obtain concrete data for developing up-to-date and effective instructional programs in our educational institutions.

Enclosed is a stamped, self-addressed card inquiring whether your company employs machinists, and if so, whether you would participate in this study by completing and returning a questionnaire that would be mailed to you on a future date.

If you do not employ machinists, please indicate this, and return the card to me so that I may remove your name from the mailing list of selected firms to be included in this study. If you do employ machinists, please return the card so that I will know whether you will participate in the study.

All data and information will be treated in a confidential manner, and the names of individuals and firms will not be revealed in the study.

Your cooperation will be greatly appreciated.

Sincerely,

Larry E. Mosby
Graduate Student
Company Name __________________________________________
Company Address _______________________________________
     City ____________ Zip Code ____________

This company employs machinists...Yes ( )
    No ( )

If your company does employ machinists:

We would be willing to participate in
    this study by completing and returning a questionnaire. ( )

We would not be willing to participate.
    ( )

Signature: ____________________________________________
APPENDIX B
INFORMATION FORM
March 9, 1970

Director of Personnel

Dear Sir:

On February 20, I mailed to you a letter inquiring if your firm employed machinists, and if so, whether or not you would participate in a study designed to determine the knowledge and skills you consider important for your machinists to possess. Thank you for returning the card indicating that you do employ machinists and that you would participate in the study by completing and returning a questionnaire.

Enclosed you will find a questionnaire and a return envelope. Please complete the questionnaire and return it as soon as possible.

Thank you for your willingness to cooperate.

Sincerely,

Larry E. Mosby
Graduate Student

Approved and sponsored by:

A. Frank Nelson
Professor of Industrial Arts

LEM/fdm

Enclosure
QUESTIONNAIRE
A STUDY OF THE KNOWLEDGE AND SKILLS REQUIRED OF MACHINISTS IN THE DALLAS-FORT WORTH AREA

Directions: Please supply the information requested by checking (✓) the appropriate response or by writing the information in the blanks. Please answer all questions.

Name of firm: ________________________

Principal product(s) or type of product(s) of your firm:

1. How many machinists do you employ at this location? __________

2. Of the job classifications listed below, which ones are represented in your firm?

   ( ) Machinist's helper
   ( ) Machine tool operator
   ( ) General machinist
   ( ) Tool-and-die maker

3. Of the job classifications represented in your firm, how many are employed in each classification?

   a. _______ Machinist's helper
   b. _______ Machine tool operator
   c. _______ General machinist
   d. _______ Tool-and-die maker

4. Do you anticipate an increase in the number of machinists that you will employ in the next five years? Yes ( ) No ( )

5. What are the age requirements for a person entering industry as a machinist? Minimum age ______ Maximum age ______ Preferred age ______

6. Is certification required of a person entering the machinist's trade in your firm? Yes ( ) No ( )
7. What types of admission tests are administered to a prospective employee entering industry as a machinist?
   a. ( ) Skills test
   b. ( ) Practical test
   c. ( ) Standardized test
   d. ( ) Oral test
   e. ( ) Physical examination
   f. ( ) Other (please specify)

8. What per cent of emphasis placed on personal interviews?
   ( ) 0 - 25%
   ( ) 26 - 50%
   ( ) 51 - 75%
   ( ) 76 - 100%

9. Are in-service training programs conducted in your firm for a person entering as a machinist? Yes ( ) No ( )
   a. ( ) On-the-job training program
   b. ( ) Apprenticeship program
   c. ( ) Classroom instruction
   d. ( ) Tuition assisted evening classes
   e. ( ) Other (please specify)

10. Is previous on-the-job experience as a machinist a requirement for employment as a machinist with your firm? Yes ( )
    No ( ) If the answer is no, is previous experience
   a. ( ) Desired
   b. ( ) Preferred
   c. ( ) Does not matter

11. Which one of the following general educational attainments does your firm require of a person entering the machinist trade?
   a. ( ) Elementary
   b. ( ) Junior high school
   c. ( ) Some high school
   d. ( ) High school graduate
   e. ( ) Vocational school
   f. ( ) Technical school
   g. ( ) Some college
   h. ( ) Other (please specify)
12. Do you consider one specific area of education (other than machine shop), such as mathematics or physics, to be important as part of the machinist's background. Yes ( ) No ( ) If so, what specific area? ________________

13. Please check (✓) the appropriate box to show the importance of the subject to the machinists you employ.

<table>
<thead>
<tr>
<th>Area of Study</th>
<th>Necessary</th>
<th>Desirable</th>
<th>Unnecessary</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Knowledge of measuring instruments..............</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Structural drafting and blueprint reading....</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Machine drafting and blueprint reading........</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Addition and subtraction of whole numbers.....</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Multiplication and division of whole numbers...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F. Addition and subtraction of fractions..........</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. Multiplication and division of fractions......</td>
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</tr>
<tr>
<td>H. Basic trigonometry functions...................</td>
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<td></td>
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</tr>
<tr>
<td>I. Plane geometry functions......................</td>
<td></td>
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</tr>
<tr>
<td>J. Solid geometry functions......................</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>K. Basic metallurgy..............................</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>L. Strength and stress of materials..............</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. Shop and industrial safety....................</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>N. Others:.......................................</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

______________________________
14. A knowledge of what type machinery is required by your firm of a person entering the machinists' trade?

   a. ( ) Jig bore (vertical)
   b. ( ) Horizontal jig bore
   c. ( ) Milling machine (vertical)
   d. ( ) Horizontal milling machine
   e. ( ) Drill press
   f. ( ) Lathes
   g. ( ) Surface grinder
   h. ( ) O. D. Grinder
   i. ( ) I. D. Grinder
   j. ( ) Tool grinder
   k. ( ) Centerless grinder
   l. ( ) Overhead crane and/or heavy duty hoists
   m. ( ) Jigs and fixtures
   n. ( ) Planing machines

15. A knowledge of what type general shop practices is required by your firm of a person entering the machinists' trade?

   a. ( ) Use of basic hand tools
   b. ( ) Blueprint reading
   c. ( ) Basic drafting practices
   d. ( ) Techniques of precision measurement
   e. ( ) Basic sheet metal work
   f. ( ) Other (please specify)

16. In your opinion how can the high school metal courses aid prospective machinist employees in the various job classifications?

   a. Reduces time spent in in-service training program.

   ( ) Yes
   ( ) Sometimes
   ( ) No

   b. Familiarizes with general aspects of the machinists' trade.

   ( ) Yes
   ( ) Sometimes
   ( ) No
c. Eliminate early termination with job.

( ) Yes
( ) Sometimes
( ) No

17. Additional Comments:

Thank you for your courtesy in completing this form.
APPENDIX C

FOLLOW-UP LETTER
FOLLOW-UP LETTER

March 31, 1970

Director of Personnel

Dear Sir:

On March 9, I mailed to you a questionnaire regarding machinists employed by your company which you agreed to complete and return. As of this date, I have not received your copy.

Would you please fill out and return the questionnaire to me as soon as possible. If you find that you cannot locate it or that it has been misplaced, please advise and I will be glad to forward another copy to you. If you have returned the questionnaire and I have not yet received it, thank you for your promptness.

Your cooperation in this study is very much appreciated.

Sincerely,

Larry E. Mosby
Graduate Student

Approved and sponsored by:

A. Frank Nelson
Professor of Industrial Arts

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