TASK INVENTORY FOR TRAINING PROGRAM OF MACHINISTS IN TWO METROPOLITAN AREAS IN OKLAHOMA

By

STEPHEN YAW BEEKO

Bachelor of Science in Mechanical
Engineering Technology
Southern Technical Institute
Marietta, Georgia
1976

Master of Business Administration
Atlanta University
Atlanta, Georgia
1978

Master of Science in Library Science
Atlanta University
Atlanta, Georgia
1979

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF EDUCATION
July, 1982

TASK INVENTORY FOR TRAINING PROGRAM OF MACHINISTS IN TWO METROPOLITAN AREAS IN OKLAHOMA

Thesis Approved:

L Lloyd Wiggins
Thesis Adviser

Lucien Deaggio

William E. Segall

R. W. Tinell

Norman N Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

This study could not have been completed without the assistance and cooperation of many individuals. The author wishes to express his appreciation to the Doctoral Committee: Dr. Lloyd L. Wiggins, committee chairman; Dr. Cecil W. Dugger; Dr. William Segall and Dr. Richard W. Tinnell, for their assistance and encouragement.

The writer, again wishes to recognize and acknowledge his indebtness to Dr. Lloyd Wiggins who not only served as chairman of the author's doctoral committee, but also as his thesis adviser who provided invaluable assistance and suggestions for the preparation of this paper.

Special recognition is given to Dr. William D. Frazier and Mr. James Dunn, State Department of Vocational-Technical Education, Stillwater, Oklahoma for their invaluable assistance.

The author again expresses a deep feeling of gratitude to Dr. Richard Tinnell for his assistance and guidance throughout the study.

Recognition is given to the different typists, notably Kay Porter, for their effort in typing this thesis.

Finally, special gratitude is expressed to my wife, Alice, and children for their understanding, encouragement and many sacrifiees. To my Mother and Father who died, but did not live to see and enjoy the fruits of their dreams, I dedicate this work.

TABLE OF CONTENTS

LIST OF TABLES

Table Page

Table Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

One of the great needs of industry is for well trained workmen who are skillful with their hands and who have the ability to work fast and produce quality industrial products. Machines have paced the progress of civilization and this will remain as true in the future as it has been in the past. Machine tools play an important part in the production of almost all metal production known to man. Glazener (11, p. 103) said, "the machinist and the machine shop are the basis of our industrial production and maintenance." The operating of mills and lathes have been known since ancient times, and today as a result of technology and scientific discovery new machining techniques concepts and principles of metalworking are rapidly evolving. Machines are becoming more complex which will create a need for skilled machinists to keep them running.

It is recognized that the most effective training programs are based on detailed analysis of the job to be performed. Whitehead (27, p. 3) said, "technical education should turn out the pupil with something he knows well and something he can do well." The training needed by machinist must be kept current as a result of technological changes and competency needed by employers. To help guide future machinist training programs and program changes educators must find out the skill level required and how often machinist perform their job by means of task inventory.

Statement of Problem

The problem of this study was to identify tasks performed by machinists which are most suitable for inclusion in a machinist training program.

The problem is complicated because most task lists are likely to contain tasks which although performed on the job are not considered as appropraite for inclusion in the training program.

Those inappropriate tasks may fall into one or more of the following categories:

1. Tasks that are seldom performed by a small proportion of job incumbents.
2. Tasks that are performed not very often on the job.
3. Tasks that need very little or no effort to learn.
4. Tasks that can be best learned on the job.

Purpose of Study

The purpose of this study was to identify the tasks that can be considered as appropriate for inclusion in an instructional program that are performed by job incumbents, adult students in machinist programs, and machinist instructors.

Research Questions

The following research questions were investigated in this study:

1. How often does a machinist do each task on the job?
2. What is the skill level required to do the work well?
3. Are there any significant differences between the mean responses to the tasks performed by job incumbents, adult students and machinist instructors?

Assumptions

For the purpose of this study, the following assumptions were made:

1. The respondents' perceptions of duties and tasks would be alike
2. The instrument is valid because of its prior usage.
3. The job incumbents, adult students and machinist instructors used as a sample were representative of the total population of machinists in the metropolitan areas of Oklahoma City and Tulsa.

Scope and Limitations

The purpose of this study was to identify tasks that could be used as suitable for inclusion in machinist training programs.

1. The research study is limited to skill level related to tasks performed and how often workers perform those tasks.
2. The sample is limited to job incumbents from industries, adult students and machinist instructors from area vocational-technical schools (AVTS), and junior colleges within Oklahoma City and Tulsa metropolitan areas.

Definition of Terms

Certain key words used in the study are defined here to enable accurate communication with the reader.

Duty: It is one of the distinct major activities involved in the work performed by machinist and it is composed of several related tasks. Specific duties used in the study are listed in Table I.

Task: A logically related set of actions required for the completion of job objective.

Task Inventory: An instrument used for conducting occupational surveys. It consists of items of identification and background information and list of appropriate duty and task statements.

Trade: A job requiring great skill and knowledge. Usually two to four years of special training are needed.

Job Incumbents: Workers holding a job in a particular trade or profession.

Metropolitan Area: Includes a central city and the area that surrounds it. The area also includes the entire county in which the city is located.

Labor Force: Includes all persons 16 years of age or over who have civilian job's or are looking for jobs.

Apprentice Training: Training received by an individual to provide him with the necessary skills to become a journeyman. The training is normally administered by a journeyman on the job.

Journeyman: One who has completed an apprentice program successfully and has been accepted into a trade by a specified criterion.

Education: Is a process of providing an individual student with knowledge, skill, competence, and desirable qualities of character and values for his benefit and for the benefit of mankind.

Training: Those activities which are designed to improve performance on the job the employee is presently doing or being taught to do.

Curriculum: All the learning experiences provided by the school.

Area Vocational-Technical School (AVTS): A specialized school serving a school district or districts and used principally for the provision of vocational-technical education to secondary, post-secondary, and adult students and for persons who have academic, socio-economic, or other handicaps who are available for study in preparation for entering

the world of work, or to prepare individuals for enrollment in advanced technical education programs.

Junior college: An institution of higher education which usually offers the first two years of college instructions and frequently grants an associate degree.

Machine Shop Education Program: A program found in an educational institution designed to train persons at the job entry level in the machinist profession.

Vocational Programs: Educational programs, other than academic programs, which deal with both vocational and technical skills designed primarily to prepare the student for an entry-level job.

Vocational Education: A program of instruction which provides persons with skills and knowledge for a specific employment opportunity.

Technical Education: A planned sequence of classroom laboratory experience designed to prepare persons for a cluster of job opportunities in a specialized field in technology. The program of instruction normally includes the study of the underlying sciences and supporting mathematics. Technical education prepares students for occupational areas between the skilled craftsman and the professional person.

Machine Tools: Are large, stationary, power-driven tools that are used to shape or form metal.

Machinist: A machinist is a skilled metal worker who shapes metal parts and other materials by using machine tools and hand tools.

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter describes information from the literature related to the need of a task inventory for training programs; knowledge and skill required by machinists, machining trades and opportunities. Due to rapid innovation in technology, vocational educators are concerned how to keep up with the content of training programs so that graduates will have the work skills and occupational competency needed for employment in the labor market.

The Need For Task Inventories

The committee of National Aid to Vocational Education (22) recognized the need for support of education that would prepare workers for the common occupations. Therefore, there was a great need of providing vocational education for every part of the United States, to supplement apprenticeship training and to meet the increasing demand for trained workers.

Carr (5), the Executive Secretary for the National Education Association, stated that:

> rapid technological change confronts society and the schools with problem which cannot be swept under the rug. For example, how to prepare the new generation for greater excellence in the complex of science and technology (p. 1).

As a result of the rapid technological change, 3 questions arise: (1) why should the schools be concerned with the techonological change,

(2) what possible benefits can come about from the school easing technological change in place, and (3) what is the solution to the school's role in educating students. Blackstone (2) answered the above questions when he stated that:

> Both business and schools have a great stake in improving the quality of workers who enter the business world. Cooperative effort between business and schools will help improve the students effectiveness, and reduce the expense of employing workers and maintaining office training procedures for them. More effective educational programs can come only as we know more about the fact of office employment. We must determine specific demands of business (p. 26).

Curriculum Development in Vocational and Technical Education

Curriculum development in vocational and technical education is needed to furnish teachers with materials that are designed to prepare students for social and economical needs as well as for the necessary skills and related knowledge.

Lawson (15) has summarized the objectives of developing curriculum as follows:

1. Curriculum development must be based on occupational analysis, preparation for entry into the labor market and successful advancement in employment.

2. To aid the student in mastering effectively and efficiently the skills, knowledge, attitude and habit for which education and training are provided (p. 112).

Burt (4) pointed out some complicated factors that may arise in the development of a curriculum for vocational and technical education. He cited as an example, that:

> Job entry requirements may be different for a variety of employers within the same industry, both locally and nationally. Therefore, vocational and technical education must not only determine the job content in terms of skill and knowledge requirement of an occupation, but

> must also rationalize the instructional program to meet the common and current needs of a majority of the employers in the communities (p. 153).

As a result, Dauwalder (8) also stated that:

> Curriula must be developed among job requirements, skills requiremetns, technical and practical knowledge requirements, and must also maintain a general education balance which is flexible and adjustable to changing condition (p. 104).

Course Content and Training Time

Benenati (1) has so succinctly summed up how course content and training time should work together to provide for more efficient program operation so that students are better trained at a lowest cost. He stated that:

> The cost of education is high today, and educators are called upon to be effective, efficient and accountable. To effect those economics the educator should first determine the objective and the scope of the program. . . Once the purpose of the course has been established, conduct a task analysis of the trade to be covered in the course. The course content must determine both the amount of time to be consumed by a course and the way in which that time will be utilized. The proper sequence for making course content and time compatible should therefore be: develop course content; determine how the content should be organized; and allocate the amount of time to be spent on each course component (p. 22).

An approach to identify the curriculum content needed for machinist curriculum development is by task inventory. A task inventory has been explained by Christal (6) as:

> a list of appropriate duty and task statements covering the task performed by worker in an occupational area. It may also contain identification and background information and may be used for collecting occupational information for incumbent workers (p. 95).

The information gathered by using a task inventory technique for occupational analysis has many uses as stated by Fowler and Gauldin (10):

1. To determine what different jobs and tasks exist, their relationship to each other, and what the incumbent of each job is required to do.

2. To determine job differences and relationships to be used in identifying and structuring specific jobs into career fields and career field ladders.

3. To determine training that can be reduced or eliminated. Obsolete subject matter can be identified and removed from an existing curriculum.

4. To determine the critical tasks that should be taught in vocational or technical education programs.

5. To determine the critical tasks that should be included in occupational competency.

6. To serve as a counseling tool and to help students to set realistic perceptions of occupations (p.112).

The task inventory method of job analysis was initially developed for use in the United State Air Force, and has been applied to a number of civilian occupations by various investigators, starting with Morsh (19) and continuing to the most recent by Tinnell (24). The techniques involves:

1. Identifying duties assigned to or expected of an occupational incumbent.

2. Indentifying the tasks which constitute satisfactory performance of the duty.

3. Administering the task inventory to successful job incumbents.

4. Analyzing the incumbent's reports to identify appropriate training experience (p. 12).

Professor Koenigsberger (14) stressed the need to seek to develop and upgrade everyone. He stated that:

> Shortage of manpower was the greater risk in industry in general. It was necessary to start planning now so that the new skills needed in future within the labor force could be developed (p. 135).

Homer (13) listed the following steps which should be considered in the process of planning and directing training programs:

1. Determine the specific skills and abilities required for the desired performance in the job or occupation for which training may be required now and for the forseeable future.

2. Assess the abilities possessed by employees or potential employees as related to the job.

3. From the information obtained in the two previous steps determine precise training requirements for individuals or groups.

4. Assess available training resources.

5. Plan detailed training programs to develop the required skills.

6. Direct and evaluate the training program in operation.

7. Evaluate the results of training through measurement of post-training job performance (p. 5).

Quality Adult Training Programs

The impact of vocational education on the labor market is determined at least partially by program quality. On one level are the quality of training in the local school and the effectiveness of the school in placing graduates in employment related to their training.

Among 14 principles for quality vocational education enunciated by Coe (7) are the following:

1. A quality program is based on an analysis of each occupation to determine what is required to perform as a successful worker in that occupation.

2. A quality program adjusts its curriculum to changing business and industrial conditions, technological change and the requirements of the labor market.

3. A quality program is administered and supervised by personnel who are educated and experienced in vocational education, who understand the needs of pupils and of business and industry and who are able to work effectively with employers, labor, other officials and employment and social agencies.

4. Teachers on a quality program are masters in their occupation and have completed teacher training program where they have learned how to impart their knowledge and skills to pupils (p. 191).

The Vocational Education Amendments of 1968 (9), give emphasis to the important principle of fusing training and work experience for the adult in order to reduce the real barriers between study and the world of work. It was explained that an important effort in such fusion has been labeled cooperative education and describes a joint venture of the educational institution and a cooperating employer.

Boone and Quinn (3, p. 169) also noted that: "The primary mission of adult vocational education is to equip the adult for a more productive life through a process of continual occupational training."

Hill (12) also outlined the following reasons why persons with jobs need training:

1. The complexity of modern work has made work training for many occupations highly desirable.

2. The introduction of new machinery necessitates the training of many workers and thus can only be done on the job.

3. Workers holding jobs need training for more complicated work in the same field if they are to be advanced (pp. 73-74).

Training can be identified in three areas. These are: skills, attitudes and knowledge. All these affect one's job performance. An employer demands certain characteristics in the new worker or graduate. He will certainly expect basic academic education and require a knowledge and skill such as machine operation.

Considerable research has been done however, on the effects of vocational training upon the individual graduate. Numerous follow-up studies have been conducted and Little (16) summarizes these results:

> Despite the inadequacies and deficiencies of the follow-up studies, certain findings seem to constitute a refrain. The Vocational-Technical Education programs are serving important parts of our population in ways that these people would not be helped without them. Those who move directly to jobs from such training have an advantage in earnings, not always great, but still an advantage over their untrained associates. Most persons like their jobs, and the vocationally trained persons are especially prepared. The great majority of vocationally trained high school graduates obtain employment in or near the communities in which they attended school. Graduates obtain their jobs primarily from their own efforts or by the help of friends or relatives; secondary schools, teachers and counselors, are typically not credited with being greatly helpful to students moving to jobs rather than colleges (p. 36).

A variety of programs and institutions provide vocational instruction for people beyond high school age. These include area vocational and technical schools, adult programs in vocational and comprehensive high schools, post-secondary, adult continuing education, college level programs in technical institutes and community colleges, non-profit private trade and business schools, vocational and technical schools operated by industry, organized labor, religious and social organization, and military services. In addition, there are the manpower training programs often conducted in one or another of these institutions.

Knowledge and Skill Required by Machinist

Prosser and Quigley (22) stated that:

> The contribution of science and invention have not only made a tremendous production possible, but in accomplishing it have called increasingly for the systematic training of skilled workers, technicians and leaders. Within recent years the methods used in the shaping of metal by cutting were entirely different fifty years ago from those used today. It has become necessary therefore to equip the learner for jobs or students through organized training (p. 8).

Homer (13) again had this to say:

1. Machinist trade involves specialized knowledge, analytical ability within that specialty and facility in the use of the tools and technique of the specific discipline.

2. Most of the vocational and on-the-job training programs are largely concerned with developing this specialized technical skill (p. 12).

Classification and Opportunities of Machinist Trade

Machining workers make up the largest occupational group in the metal working trade (17). They are generally classified into the following categories:

1. All-round Machinist: is one who set up and operated all the machine tools. He must be able to read blueprints, use precision tools and make adjustments.

2. Tool and Die Makers: They are highly skilled machinists. They design, make and repair the tools, die, fixtures and jigs that are used in the manufacture of all types of production..

3. Machine tool operator: is a semi-skilled person who can operate only one machine or do only a few operations. His job is a routine one.

4. Lay-out men: They are skilled machinist who reads prints and transfer mearsurements to metals. They are the men who set the parts ready to be machined.

5. Set-up men: They are skilled machinist who get the machines for the machine operators. They must be able to sharpen cutting tools, set and adjust the machines and check it to make sure it will make the part exactly as shown on the part.

   Advance jobs in the field include: production foreman; tool/die mold maker; general machinist; maintenance machinist; tape control programmer or self-employed in one of the above fields (p.32).

Activities of the National Tool, Die and Precision Machinery Association (NTDPMA)

Burt (4) summarized the historical activities of the National Tool, Die and precision machinery Association as follows:

> The National Tool, Die and Precision Machinery Association is a national trade association of about 800 member companies. Most of its members belong to local chapters of the association and many of the chapters have active apprenticeship training committees. All the trades such as, die maker, mold maker, tool maker, lathe machinist and other machinists of all categories which the Association is concerned are apprenticeable and most require a four year apprenticeship period of training. In an effort to provide needed manpower, the Association entered into a contract with the U.S. Department of Labor to conduct a national Manpower Development and Training Act program to train and retrain 1200 persons in formal pre-apprenticeship and apprenticeship programs. Under the Manpower Development and Training Act (MDTA) contract as reported by Willian E. Hardman, executive Vice-President of the Association that, the trainee will receive 12 weeks of vocational school instruction in applied mathematics and English, followed by 40 weeks of on-the-job training as pre-apprentice in tool and die shops across the nation.
>
> The local chapters, with the assistance of the Association program administrator, select a local journeyman as an instructor and arrange for his teacher certification, and use of school facilities. The instructor is responsible for the school program during the first twelve weeks. Each trainee is then placed on the job as an apprentice with regular apprentice wages paid by the employer (pp. 488-489).

More formal approaches of training programs are also made by some companies through the development of company training schools. The apprenticeship program to train all-round machinist lasts 3 to 4 years and consists of a combinations of on-the-job, in shop training and considerable related classroom instructions. In shop training, apprenticeship learn chipping, filling, hand tapping, dowel fitting, revitting and the operation of various machine tools. In the classroom, the apprentice studies blue print reading, mechanical drawing, shop mathematics and shop practices.

Machinist Training Program

Machines are becoming more complex which will create a greater need for skilled machinist to keep them running. Many of these machines in

industries are similar to those found in the school shops except that they are larger and more complex. They have many electronic and hydraulic controls. This offers new additional opportunities for better educated machinists in maintenance technology, tape programming, process planning and related work.

The machinists training program is designed to be taught in schools at a vocational level with emphasis on the hands-on operation of metal working equipment and specific skills related to employment in the machine trades.

In the school shop the student will have the opportunities to learn the fundamentals that apply to machine trade. Later, they can master the specific skills by working in the industry. Machinist training and experience enables the machinist to plan and carry through the operations needed in turning our machined products and to switch from one kind of product to another. An experienced machinist is able to plan the cutting and finishing operations in their proper order so he can complete the finish work according to blueprint or written specifictions. He makes standard shop computations relating to dimensions of work, tooling, feeds and speeds of machining. He often uses precision measuring instruments to measure the accuracy of his work. This skilled worker must be able to set up and operate most types of machine tools. The machinist also must know the composition of metals so that he can heat and quench cutting tools and parts to improve machinability. His knowledge enables him to turn a block of metal into an intricate precise part.

A recent article published by the United States Department of Labor (25, p. 3) stated that: "Some 22,000 new machinists and nearly 9,000 tool and die makers will be needed in the U.S. through 1985. Yet the

number of new journeymen for both trades combined total only 5,000 per year."

The existing industries in Tulsa and Oklahoma City metropolitan areas and new industries moving into the state express the need for skilled craftsmen who have the background, knowledge and potential to advance in the machine trades.

Area vocational technical schools and junior colleges serve not only to train but also to retrain individuals who need to improve or advance their specific area of occupation. These instituitions are seen as an effort to deal with local development and the needs of the local economy in a way which provides a supply of skilled manpower for any new type of machine industry that may be coming into the area.

Figure 1 shows the current statistics of opportunities and employment needs of skilled machinists in the machining occupations in the nation.

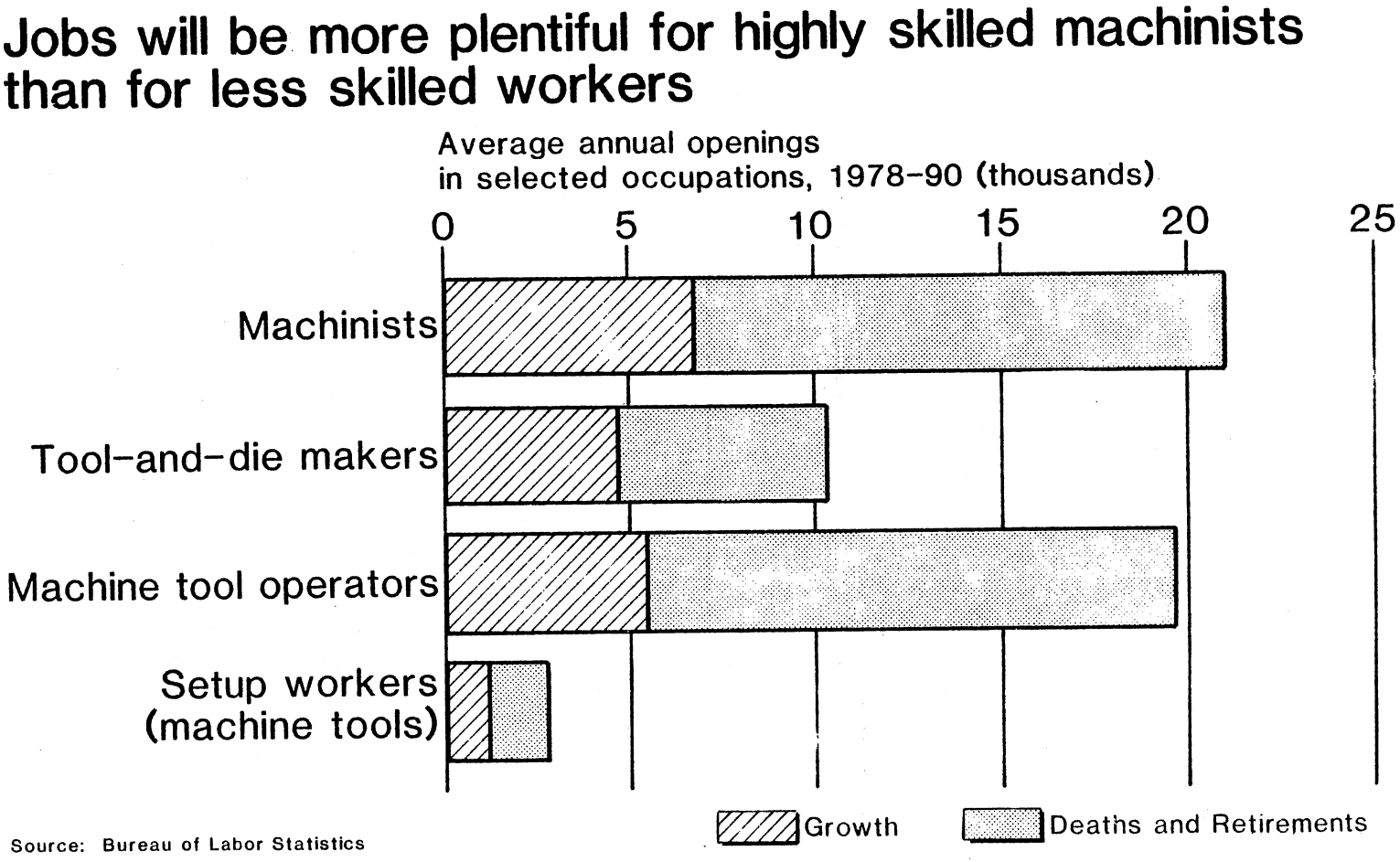


Figure 1. Current Statistics of Employment Needs of Skilled Machinist in the Nation

CHAPTER III

METHOD AND PROCEDURE

Introduction

The study was conducted to provide information on the various functions of machinists with the expectation that if the inappropriate tasks performed by machinists can be identified and removed, the remaining tasks could be used as good choices for inclusion in a machinist instructional training program in Tulsa and Oklahoma City metropolitan areas.

In order to describe the methods and procedure by which this study was conducted, this chapter was divided into the following sections: (1) sample for the study, (2) development of the instrument, (3) administering the instrument, and (4) tabulation and analysis of data.

Sample for the Study

A review was made of the Oklahoma Directory of Manufacturers and Products (20), Tulsa and Oklahoma City telephone directory, 1981, and a list of schools from the State Department of Vocational and Technical Education, Stillwater, Oklahoma. There were 94 names of industries having machine shops in the director of manufacturers; but when compared with the same names from the telephone directories, only 71 names were found. Apparently the industries had gone out of business or had left the area. Figure 2 is a map of the state of

Oklahoma showing geographical locations of Tulsa and Oklahoma City metropolitan areas this is presented in Appendix D.

The sample for this study consisted of three groups. Group I included 40 job incumbents selected from 20 industries. These 20 industries were determined by the table of random numbers from Runyan and Haber (23). Group II consisted of 40 adult students in machinist programs from two junior colleges and five area vocational and technical schools, and Group III was made up of ten machinist instructors from these institutions. The method derived to obtain representatives of the groups was stratified random sampling which guarantees representation of defined groups in the population (26).

All the educational institutions having machinist training programs in Tulsa and Oklahoma City metropolitan areas were selected for the study since they were few in number. The sample size of the industries was arbitraily limited to 20 industries or 28 percent of the population which was considered valid, and within the time and cost constraints of the investigator. The names of these industries and educational institutions are shown in Appendix D.

Van Dalen (26) author of Understanding Education Research, has this to say regarding sampling: "No specific rules on how to obtain an adequate sample have been formulated, for each situation presents its own problems. If the phenomena under study are homogeneous, a small sample is sufficient" (p. 320).

He goes on to state that:

> Increasing the size of the sample is of little value if units are not chosen in a way that ensures representativeess of the sample. In general, three factors determine the size of an adequate sample: the nature of the population, the type of sampling design, and the degree of precision desired. The researcher gives careful consideration to these factors and then selects the sampling design that will provide the desired precision at minimum cost (p. 320).

Development of Instrument

The instrument used in this study was initially developed by Oklahoma State Tech Machinist Technology Department. The instrument consisted of 11 machinist duties and 320 task statements as shown in Table I.

TABLE I

DUTIES AND THE NUMBER OF TASK STATEMENTS

Number	Machinist Duty	Tasks
1	Materials Machined	20
2	Planning Machine Work	17
3	Performing Mathematical Calculations	55
4	Operating Boring Machine	38
5	Operating Lathes	56
6	Operating Milling Machines	34
7	Operating Power Saws	7
8	Operating Shapers	19
9	Operating Special Machines	28
10	Performing Benchwork	35
11	Doing Paper Work	11
	TOTAL	320

The literature on conducting task inventories suggest that in order to be reasonably comprehensive, an occupational inventory should contain at least 200 and not more than 600 task statements. It was judged by the investigator that the 320 task statements were enough to identify the machinist training programs in Tulsa and Oklahoma City metropolitan areas.

For each of the 320 task statements listed, respondents were asked to answer the following questions by placing a check mark at the

appropriate columns on the rating forms.

1. How often do you really do each of the following.
2. How much skill level was required to do it well?

In order to arrive at an average response for each statement, numerical values were assigned to the response categories as follows: How often: never = 1, rarely = 2, occasionally = 3, frequently = 4; Skill level: low = 0, medium = 2, high = 4.

Administering the Instruments

The machinist instructors and managers from the various machine shops selected from institutions and industries assisted the writer in the distribution and collection of the instruments to adult students and the incumbent workers. The instrument used in this study is shown in Appendix A.

The instrument booklet and cover letters (see Appendix C) were distributed in mid-December, 1981, and all completed instruments were picked up by March, 1982. The total return of the completed inventory booklet were 86 out of 90 submitted or an overall return rate of 95.6 percent.

The information in Table II presents a percentage breakdown of returned responses for each group.

Tabulation and Analysis of Data

Upon return of the instrument the responses were hand tabulated and recorded in groups according to the dependent variables. The mean (average) time and frequency distribution relative to each duty for each group were calculated and ranked. The data was coded and sent to

Oklahoma State University (OSU) computer center to be key punched and programmed. The statistical package of the social sciences (SPSS) was used to perform the descriptive and statistical analysis of the data in this study. The task that most respondents reported performing was ranked first and so on down through the last with task that least number of respondents reported performing being ranked last.

Analysis of variance was used to test for mean differences in the three groups of respondents in their performance of tasks. If there were differences, possible changes in the content of training program could be considered.

According to Popham (21):

> Single classification analysis of variance provides a technique for simultaneously testing whether means of two or more groups are significantly different. The statistical model capitalizes on the integral relationship between the mean and the variance so that by analyzing variance of several groups, conclusions can be drawn regarding the similarity of the means of those groups (p. 176).

Analysis of variance has the advantage of comparing means of many groups in a single statistical test. To determine the accuracy which means are different from which other means, further analysis was performed by utilizing Newman-Keuls' multiple comparison test. Table II presents one-way ANOVA summmary table used in calculation for "F value".

In order to obtain the "F value" by which the research question is addressed, the following quantities are needed.

1. The sums of squares (ss) for the total groups, within the groups, and between groups.

2. The degree of freedom (df) for the within the groups, and between groups.

3. The mean squares for the within groups and between groups.

To determine the precise accuracy of mean difference of the three groups, the following computational formula of Newman-Keuls' test was used.

TABLE II

SUMMARY TABLE: ONE-WAY BETWEEN SUBJECTS ANOVA

Source of Variation	Degree of Freedom	Sum of Squares	Mean Square	F
Factor A	a-1	$SS_A = ET_A^2/N_A - G^2/N$	$MS_A = SS_A/(a-1)$	MS_A/MS_{error}
Error	N-a	$SS_{error} = SS_{total} - SS_a$	$MS_{error} = SS_{error}/(N-a)$	
Total	N-1	$SS_{total} - X^2 - G^2/N$		

Critical value (means) $= 9d\sqrt{MS_{error}/n}$

where d = the number of ordered means spanned by the comparison.

9d is obtained from special table.

n = the number of observations for each mean compared, and

MS_{error} = the appropriate error term from the ANOVA summary table.

The detailed findings of the data are presented in Chapter IV.

CHAPTER IV

RESULTS OF THE STUDY

Introduction

The purpose of this study was to identify the task performed by job incumbents, adult students in machinist program and machinist instructors in their duties, that would serve as a guide for revising and developing future machinist training program or program changes.

Most task lists although performed on the job were not appropriate for inclusion in the training programs. If those inappropriate tasks could be removed what would remain could be used as good choices for inclusion in the program.

Description of Respondents

The job incumbents, adult students in the machinist program and machinist instructors used as samples in this study were considered as representative of the total population of machinist in Oklahoma City and Tulsa metropolitan areas. The respondents were classified as having skills and knowledge relative to job performance in the machining trades.

The job incumbents were employed as machinist in industries. The adult students were selected from classes in area vocational-technical schools (AVTS) and junior colleges in the area, that were held during the evening hours. Many of the students were thought to be part-time

workers. The machinist instructors were experienced workers in their instructional field.

Response Ratings

The information in Table III presents the percentage breakdown of returned responses of the instrument for each group. The total return of the completed instruments was 86 out of 90 distributed for an over all return rate of 95.6 percent.

TABLE III

SAMPLING AND INSTRUMENT RESPONSE

Sample Groups	Sample Size	Number Responding	% Responding
Job Incumbents	40	40	100.0
Adult Students	40	36	90.0
Machinist Instructors	10	10	100.0
TOTAL	90	86	95.6%

Research questions one and two were as follows:

1. How often does a machinist do each task on the job?
2. What is the skill level required to do the work well?

Respondents were asked to complete the instrument shown in Appendix A and to place a check mark at the appropriate column corresponding to each scale on the instrument. Numerical values based on the following possible responses were assigned to question one and two above.

Question 1 (How often): Never=1; Rarely=2; Occasionally=3; Frequently=4.

Question 2 (skill level): Low-0; Medium=2; High=4.

Appendix B shows the mean rating of each of the three groups of respondents. The mean rating was calculated by adding up the total numerical values rated under each scale and divided by the number of respondents in each group. Answers obtained from the mean rating were carried out to one decimal place.

Respondents were also asked to estimate percentage of working time they spent on each of the various duties. The data shown on Table IV were simply the mean time rating for each group of respondents. The percentage mean time rating for each duty was also determined by summing up responses indicated by respondents and then divided by the total number of each group.

TABLE IV

MEAN PERCENT OF TIME FOR EACH DUTY

Duty	Mean Percent of Time Rating JI	AS	MI
1. Operating Lathes	27.5	34.1	25.6
2. Operating Milling Machines	20.7	20.8	18.5
3. Planning Machine Work	11.7	6.7	10.5
4. Doing Paper Work	11.8	5.4	7.4
5. Performing Math Calculations	10.9	6.1	11.0
6. Performing Bench Work	6.3	10.9	8.6
7. Operating Power Saws	5.3	6.3	4.8
8. Operating boring Machines	2.3	3.8	8.1
9. Operating Special Machines	2.3	4.5	1.6
10. Operating Shapers	0.9	0.8	0.1
	99.7	99.4	96.2

From the data it was observed that 48.9 percent of incumbent workers' time, 54.9 percent of adult students' time, and 44.1 percent of machinist instructors time was spent operating lathes and mills. Operating shapers accounted for the least time spent by all respondents.

One-Way Analysis of Variance

The purpose of this section was to analyze the statistical data related to the following research question.

Research Question 3: Are there significant differences in the mean rating of tasks performed by job incumbents, adult students and machinist instructors?

Tables VI through Table XXVI shows the mean rating of responses to each task by each group of respondents, and the result of one-way analysis of variance used to test for the differences of mean rating of responses. Newman-Keuls' multiple comparison test was computed between groups on the same question to find precise accuracy of mean differences among the groups. The .05 level was utilized in determining the significance of all statistical results obtained by one-way ANOVA and Newman-Keuls' multiple comparison test. The purpose of this analysis was to determine differences among the mean ratings of the three groups.

Findings

Table V shows the summary of task statements identified by job incumbents from industries having machine shops, adult students in machinist training program, and machinist instructors from educational institutions with machinist training programs. The Table includes tasks that were considered appropriate for inclusion in the instructional

program and those considered to be deleted, based upon mean rating of 1.4 as selected criteria.

TABLE V

SUMMARY OF TASK STATEMENTS CONSIDERED TO BE INCLUDED OR DELETED FROM MACHINIST INSTRUCTIONAL PROGRAM

Respondents	Task	Task Considered to be included	100%	Task Considered to be deleted	100%
Job Incumbents	320	258	80.63	62	19.38
Adult Students	320	259	80.94	61	19.06
Machinist Instructors	320	270	84.38	50	15.63
Total	960	787	81.98%*	173	18.02%*

*Average

Table VI shows the summary of the mean rating of responses by each group of respondents, and the results of using one-way analysis of variance to determine if there were significant differences among the groups mean. Applying the selected criteria below 1.4 mean rating for a task to be deleted from the instructional program, resulted the removal of task numbers 9, 11, 12, and 14 from the list.

Comparing the groups' mean of individual task performed using one-way analysis of variance, five tasks were found to be significant in both "how often" the tasks were performed and what "skill level" was required to perform the tasks. These five tasks were task numbers; 1,3, 4, 6, and 16.

In Table VII, Newman-Keuls' multiple comparison test was used to

TABLE VI

MATERIALS MACHINED: COMPARING THREE GROUPS' MEAN RATING OF INDIVIDUAL TASK USING ONE-WAY ANALYSIS OF VARIANCE

	TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
		JI	AS	MI	P.	F Value	JI	AS	MI	P.	F Value
1	Aluminum Alloy	3.0	2.9	3.8	0.0230	3.95*	3.1	2.3	3.4	0.0263	3.80*
2	Beryluim Copper	1.5	1.4	1.4	0.6874	0.38	0.9	0.8	1.0	0.8818	0.13
3	Brass	2.9	1.9	2.3	0.0001	15.17*	2.8	1.4	2.0	0.0003	8.90*
4	Bronze	2.5	1.6	1.8	0.0007	7.88*	2.2	1.2	1.8	0.0219	4.00*
5	Carbon Steel	3.4	3.0	3.7	0.1070	2.30	2.9	2.0	3.2	0.0214	4.03*
6	Operating Power Saw	2.9	3.3	1.8	0.0001	11.80*	2.8	1.6	1.0	0.0001	10.37*
7	Operating Shapers	1.9	1.4	1.5	0.0687	2.77	1.4	1.1	1.0	0.6086	0.50
8	Drill Rod	2.2	1.8	2.6	0.0328	3.56*	2.1	1.6	2.2	0.4381	0.83
9	Fiberglass**	1.2	1.3	1.2	0.6807	0.39	0.5	0.6	0.6	0.9011	0.10
10	Flat Ground Stock	2.3	2.2	2.3	0.6915	0.37	2.2	1.6	2.2	0.2418	1.44
11	Lead**	1.3	1.2	1.4	0.6241	0.47	0.6	0.6	1.0	0.5489	0.60
12	Lucite**	1.3	1.2	1.1	0.7553	0.28	0.6	0.4	0.6	0.6917	-.37
13	Magnesium	1.5	1.3	1.3	0.4295	0.85	1.2	1.0	1.2	0.8248	0.19
14	Nulatron**	1.2	1.1	1.1	0.6929	0.37	0.5	0.6	0.6	0.8337	0.18
15	Nylon	2.0	1.5	1.7	0.0326	3.57*	1.8	0.9	1.4	0.0817	2.58
16	Phenolic	2.0	1.3	1.5	0.0008	7.73*	1.8	0.6	1.0	0.0054	5.57*
17	Rubber	1.9	1.2	1.1	0.0007	9.25*	1.2	0.6	0.6	0.1064	2.30
18	Stainless Steel	3.0	2.6	2.7	0.1770	1.77	2.7	2.4	2.8	0.7416	0.30
19	Titanium	1.5	1.3	1.3	0.3946	0.94	0.9	0.9	1.0	0.9799	0.02
20	Wood	1.5	1.6	1.2	0.3712	1.00	1.0	1.2	1.2	0.8137	0.21

*Significant difference, $P < .05$

**Tasks recommended to be deleted from instructional program.

TABLE VII

MATERIALS MACHINED: TASKS IDENTIFIED AS SIGNIFICANTLY DIFFERENT, AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS' ANALYSIS

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE
1* Aluminum alloy	0.0230	Between AS & MI	0.0263	Between MI & AS
3* Brass	0.0001	Between JI & AS	0.0003	Between JI & AS
4* Bronze	0.0007	Between JI & AS	0.0219	Between JI & AS
5* Carbon Steel	------	Between MI & AS	0.0214	Between MI & AS
6* Operating power saw	0.0001	Between JI & MI	0.0001	Between JI & MI
8* Drill rod	0.0328	Between AS & MI	------	Between MI & AS
15* Hylon	0.0326	Between JI & AS	------	Between JI & AS
16* Phenolie	0.0008	Between JI & AS	0.0054	Between JI & AS
17* Rubber	0.0007	Between JI & MI	------	Between JI & AS

*Original task numbers from list of materials machined
AS-Adult Students, JI-Job Incumbents, MI-Machinist Instructors

identify the different combination of groups JI (job incumbents), AS (adult students), and MI (machinist instructors) that contributed most to the significant differences. In Table VII, five tasks were significantly different in both "how often" the tasks were performed and the "skill level" required to perform the tasks. These five tasks were; machining aluminium alloy, machining brass, machining bronze, machining phelonic and operating power saws. Two additional tasks machining drill rod, and machining nylon had significant difference in only "how often" the task was performed. The task machining carbon was significant only in the "skill level" required to perform the task.

The combination groups JI and AS contributed the major difference four times in "how often" the tasks were performed, and five times in the "skill level" required to perform the tasks. The combination groups AS and MI contributed the major difference three times in "how often" the task was performed and three times in the "skill level" required to perform the tasks. The combination groups JI and MI contributed the major difference two times in "how often" the task was performed and once in the "skill level" required to perform the task.

Table VIII deals with planning machine work. Out of the 17 task statements listed in the table, only two tasks were identified as significantly different on both "how often" machinist perform the tasks and the "skill level" required to perform the tasks. These two tasks were task numbers 14 and 17 as listed in the table. The mean ratings of each task on both scales, "how often" and the "skill level" were more than 1.4 as selected criteria chosen. All the tasks should therefore be considered for inclusion in the instructional program.

TABLE VIII

PLANNING MACHINE WORK: COMPARING THREE GROUPS' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

	Task	MEAN RATING HOW OFTEN			ANOVA RESULT HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULT SKILL LEVEL	
		JI	AS	MI	P.	F Value	JI	AS	MI	P.	F Value
1	Calculating dimensions not on print	3.0	3.3	3.6	0.1850	1.72	2.8	3.1	3.2	0.4502	0.81
2	Design special tools and fixtures	2.7	2.5	2.5	0.4432	0.82	2.8	2.6	1.8	0.2468	1.42
3	Determine heat treating requirements	1.8	1.8	2.3	0.2309	1.49	1.2	1.8	1.0	0.2186	1.55
4.	Determine machine o operations	3.1	3.1	3.8	0.2028	1.63	2.9	2.4	3.2	0.2577	1.38
5	Determine properties of materials	1.8	1.9	2.3	0.1898	1.70	1.0	1.7	1.4	0.1485	1.95
6.	Determine Sequence of Machine Operation	3.3	3.1	3.8	0.0536	3.04	2.9	2.2	3.2	0.0566	2.97
7	Make Orthographic drawings of parts	1.8	1.9	2.2	0.4565	0.79	1.1	1.6	0.6	0.1244	2.14
8	Make sketches of parts to be machined	2.6	2.7	3.5	0.0841	2.56	2.1	2.1	2.6	0.5815	0.55
9	Plan for inspection of parts	2.5	2.3	3.2	0.0210	4.06*	2.1	1.8	3.0	0.1106	2.26
10	Plan jogs & fixtures	2.6	2,2	2.5	0.1610	1.87	2.1	2.1	2.2	0.9683	0.03
11	Plan nonstandard tools or cutters	2.4	2.3	2.3	0.8081	0.21	2.1	2.2	2.0	0.9359	0.07
12.	Plan parts or hardware	2.3	1.8	2.4	0.0850	2.54	1.6	1.6	2.0	0.7606	0.27
13	Resolve descrepencies on prints	2.6	2.3	3.1	0.0497	3.12*	2.3	2.1	2.6	0.6756	0.39

TABLE VIII (Continued)

Task	MEAN RATING HOW OFTEN			ANOVA RESULT HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULT SKILL LEVEL	
	JI	AS	MI	P.	F Value	JI	AS	MI	P.	F Value
14 Select appropriate machine job	3.3	2.9	3.8	0.0412	2.32*	3.1	2.2	3.2	0.0127	4.60*
15 Select materials	2.4	2.7	3.3	0.1538	1.92	2.2	1.9	2.6	0.4547	0.80
16 Use handbooks on methods & specs.	2.8	2.5	3.9	0.0007	8.01*	2.4	2.0	3.2	0.0727	2.71
17 Use of standard specs for machine work	3.1	2.7	3.9	0.0032	6.19*	2.9	1.8	3.6	0.0003	0.07*

*Significant difference, $P < .05$

In Table IX, Newman-Keuls' multiple comparison test was used to identify the different combination of groups JI (job incumbents), AS (adult students) and MI (machinist instructors) that contributed most to the significant differences.

Two tasks were identified as significantly different in both "how often" the tasks were performed and the "skill level" required to perform the tasks. These two tasks were; select appropriate machine job, and the use of standard specs for machining work. Three additional tasks planning for inspection of parts, resolving descrepancies on prints, and using handbooks on methods and specs had significant difference in only "how often" the tasks were performed.

The combination groups AS and MI contributed the only major differences, five times in "how often" the task was performed, and five in the "skill level" required to perform the tasks.

Table X is the summary of one-way analysis of variance used to determine if there were significant differences among the group means of responses on performing mathematical calculations.

Performing mathematical calculations are done to support the machine tool operations. In most cases low frequency machine task will be supported with low mean frequency calculations. For example, since pantograph was the least operated along with other special machines (see Table XXI) then task number 39 of Table X can be omitted from machinist instructional program. Tasks numbers 14, 15, 16, 34, and 46 should be considered as inappropriate to be included in a machinist instructional program since these tasks did not meet the selected criteria of 1.4 mean rating.

Comparing the group means of individual task, there were 17

TABLE IX

PLANNING MACHINE WORK: TASKS IDENTIFIED AS SIGNIFICIANTLY DIFFERENT AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS ' ANALYSIS

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE
9* Plan for inspection of parts	0.0210	Between MI & AS	------	Between MI & AS
13* Resolve descrepencies on prints	0.0497	Between MI & AS	------	Between MI & AS
14* Select appropriate machine for job	0.0412	Between MI & AS	0.0127	Between MI & AS
16* Use handbooks on methods and specs	0.0007	Between MI & AS	------	Between MI & AS
17* use of standard specs for machine work	0.0032	Between MI & AS	0.0003	Between MI & AS

*Original task numbers from list of planning machine work
AS=Adult Students, JI=Job Incumbents, MI=Machinist Instructors

TABLE X

PERFORMING MATHEMATICAL CALCULATIONS: COMPARING THREE GROUPS' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

	TASK	MEAN RATING HOW OFTEN			ANOVA RESULT HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULT SKILL LEVEL	
		JI	AS	MI	P.	F Value	JI	AS	MI	P.	F Value
1	Cal. open & shut height of dies & presses	1.8	1.4	1.4	0.266	1.34	1.1	1.3	0.4	0.2840	1.28
2	Cal. gear tooth & cutter values	1.5	1.7	1.8	0.3765	0.99	0.6	1.8	1.2	0.0010	7.51*
3	Cal. data necessary to measure gear values	1.3	1.4	1.8	0.0129	4.60*	0.3	1.3	1.0	0.0061	5.43*
4	Cal. miniature or micro miniature thread	1.3	1.3	1.5	0.6185	0.48	0.6	1.0	1.0	0.4321	0.85
5	Cal. metric threads values	1.6	1.3	2.0	0.0391	3.37*	0.9	1.1	2.2	0.0434	3.26*
6	Cal. acme threads	2.0	1.9	3.1	0.0001	10.00*	1.6	1.7	3.2	0.0113	4.74*
7	Cal. gearing for hi or low lead attachments	1.6	1.2	1.5	0.1352	2.05	0.9	0.7	1.0	0.7865	0.24
8	Cal. change gearing for a metric thread	1.4	1.2	1.2	0.4158	0.89	0.5	0.7	0.4	0.6319	0.46
9	Cal. buttress thread value	1.3	1.2	1.2	0.3227	1.15	0.6	0.7	0.9	0.6813	0.39
10	Cal. square threads	1.3	1.4	2.1	0.0033	6.14*	0.6	1.0	1.6	0.0788	2.62
11	Cal.. 29° worms	1.4	1.1	1.9	0.0013	7.27*	0.8	0.8	1.4	0.3976	0.93
12	Cal. die clearance value	1.6	1.3	1.3	0.3532	1.05	0.8	1.2	0.4	0.2166	1.56
13	Cal. wide range indexing	1.5	1.5	2.5	0.0028	6.32*	0.8	1.4	2.8	0.0022	6.58*
14	Cal. gear train for fellows gears shaper	1.1	1.1	1.0	0.5960	0.52	0.1	0.9	0.4	0.0066	5.04*
15	Cal. gear train for barber hoober	1.1	1.0	1.0	0.3315	1.12	0.1	0.7	0.4	0.0303	3.65*
16	Cal. astronomical indexing	1.0	1.0	1.2	0.0243	3.92*	0.3	0.7	0.4	0.3954	0.94

TABLE X (Continued)

	TASK	MEAN RATING HOW OFTEN JI	AS	MI	ANOVA RESULT HOW OFTEN P.	F. Value	MEAN RATING SKILL LEVEL JI	AS	MI	ANOVA RESULT SKILL LEVEL P.	F Value
17	Cal. multiple lead threads (ext&int)	1.7	1.5	2.4	0.0027	6.37*	1.0	1.3	2.2	0.0983	2.39
18	Cal unified threads (ext) special	2.0	1.8	3.4	0.0002	9.40*	1.5	1.2	3.0	0.0079	5.13*
19	Cal. unified threads (int) special	2.0	1.7	3.4	0.0001	10.92*	1.5	1.3	3.0	0.0116	4.70*
20	Cal. offset on jig borer rotary-tilt table	1.3	1.5	2.0	0.0059	5.48*	0.4	1.3	1.6	0.0034	6.09*
21	Cal. material strength	1.5	1.6	1.5	0.7696	0.26	0.7	1.4	0.6	0.0620	2.88
22	Cal. clearance, relief & rake of tools	2.3	2.5	3.3	0.0492	3.13*	1.8	1.7	2.8	0.1441	1.98
23	Cal. machine time for production of parts	2.7	2.3	2.9	0.1172	2.20	2.3	1.4	2.2	0.0506	2.09
24	Cal. bend radii & allowances (sheet metal)	1.6	1.4	1.2	0.2846	1.28	0.6	1.1	0.6	0.2658	1.35
25	Cal. linear indexing	1.4	1.5	2.0	0.1559	1.90	0.5	1.4	1.8	0.0083	5.08*
26	Cal. pipe thread values (ext & int)	1.8	1.6	2.3	0.0670	2.80	1.1	1.2	1.6	0.5696	0.57
27	Cal. degree indexing	2.2	1.9	3.2	0.0042	5.87*	1.9	1.4	3.0	0.0349	3.50*
28	Cal.. spring value	1.4	1.3	1.4	0.8381	0.18	0.6	1.0	0.4	0.3176	1.16
29	Cal. plain indexing	2.0	1.6	3.5	0.0001	15.03*	1.4	1.1	3.0	0.0031	6.18*
30	Cal. unified threads (int) standard	2.3	2.1	3.6	0.0008	7.77*	1.8	1.4	3.0	0.0265	3.80*
31	Cal. tolerances or allowances	2.9	2.8	3.5	0.1720	1.80	2.5	2.1	3.2	0.1017	2.35
32	Cal. Unified threads (ext) standard	2.4	2.1	3.6	0.0007	7.98*	1.7	1.3	3.0	0.0157	4.37*

TABLE X (Continued)

	TASK	MEAN RATING HOW OFTEN JI	AS	MI	ANOVA RESULT HOW OFTEN P.	F Value	MEAN RATING SKILL LEVEL JI	AS	MI	ANOVE RESULT SKILL LEVEL P.	F Value
33	Cal. dimensions of key-seats, etc.	2.7	2.0	3.0	0.0010	7.55 *	2.2	1.5	2.8	0.0358	3.47 *
34	Cal. dimensions of parts from blueprints	3.3	2.9	3.8	0.0347	3.51 *	2.8	1.8	3.2	0.0053	5.59 *
35	Cal. plating allowance	1.9	1.8	1.5	0.4592	0.79	1.3	1.3	0.8	0.6744	0.40
36	Cal. shrinkage factor	2.2	1.6	1.7	0.0067	5.35 *	1.5	1.3	0.6	0.3625	1.03
37	Cal. hole coordinates for jig borer	1.6	1.7	2.2	0.2079	1.60	0.7	1.3	1.4	0.1444	1.98
38	Cal. raw stock sizes	2.6	2.5	3.3	0.0563	2.99	2.5	1.4	2.6	0.0100	4.87 *
39	Cal. template ratios for pantograph	1.1	1.3	1.1	0.3377	1.10	0.3	0.9	0.4	0.0477	3.16 *
40	Cal. machine speeds & feeds	3.4	3.4	4.0	0.1605	1.87	2.9	2.6	3.2	0.3530	1.05
41	Cal. grind allowance on finished parts	2.8	2.7	2.7	0.9624	0.04	2.4	1.9	2.6	0.2586	1.37
42	Cal. stock utilization in machine work	2.6	2.2	2.8	0.1303	2.09	2.2	1.6	2.2	0.2468	1.42
43	Cal. micrometer reading	3.1	3.1	4.0	0.0767	2.65	2.5	2.2	3.4	0.1552	1.91
44	Cal. roughing & finishing depth of cuts	3.5	3.3	4.0	0.0445	2.32 *	3.1	2.3	3.6	0.0163	4.33 *
45	Cal. shrink factors for ceramics	1.0	1.3	1.0	0.0057	5.53 *	0.1	1.2	0.4	0.0002	9.41 *
46	Cal. compaction ratio for isostatic pressing	1.1	1.1	1.0	0.4508	0.81	0.1	0.9	0.0	0.0045	5.77 *
47	Cal. compaction ratio for conv. pressing	1.5	1.2	1.0	0.0660	2.82	0.7	1.2	0.0	0.0465	3.18 *
48	Convert to metric measurements	1.8	1.7	2.1	0.4024	0.92	0.9	1.0	1.4	0.5894	0.53

TABLE X (Continued)

	TASK	MEAN RATING HOW OFTEN JI	AS	MI	ANOVA RESULT HOW OFTEN P.	F Value	MEAN RATING SKILL LEVEL JI	AS	MI	ANOVA RESULT SKILL LEVEL P.	F Value
49	Make trig calculation for compound angles	2.4	2.2	3.2	0.0330	3.56 *	1.6	1.9	2.8	0.1088	2.28
50	Make calculations for cam milling	1.4	1.5	1.3	0.8953	0.11	0.6	1.2	0.4	0.0943	2.43
51	Make trig calculations for helices of leads	1.4	1.3	1.9	0.0965	2.41	0.7	1.1	0.8	0.4038	0.92
52	Make trig calculations for lead alternative on lathe	1.4	1.4	2.0	0.0751	2.68	0.6	1.2	1.2	0.1062	2.30
53	Make trig calculations for tapers	2.4	2.2	3.6	0.0022	6.63 *	1.7	1.8	3.2	0.0256	2.83 *
54	Make trig calculations for sinebar or sineplate	1.9	1.8	2.5	0.0800	2.61	1.2	1.5	2.0	0.3232	1.14
55	Make trig calculations for necessary dimensions	2.2	2.3	3.8	0.0025	6.49 *	1.4	1.6	3.4	0.0023	6.54 *

*Significant difference, $p < .05$

significantly different task numbers; 3, 5, 6, 13, 18, 19, 20, 27, 29, 30, 32, 33, 34, 44, 45, 53, and 55.

In Table XI, Newman-Keuls' multiple comparison test was used to identify the different combination of groups JI (job incumbents), AS (adult students), MI (machinist instructors) that contributed most to the significant differences. In Table XI, 17 tasks were significantly different in both "how often" the task was performed and the "skill level" required to perform the tasks. These 17 tasks were: 3, 5, 6, 13, 18, 19, 20, 27, 29, 30, 32, 33, 34, 44, 45, 53, and 55. Seven additional tasks, calculate square threads calculate 29' worms, calculate astronomical indexing, claculate multiple lead thread (external and internal), calculate clearance relief and rake of tools, calculate shrinkage factor and make trig. calculation for compound angle had significance difference in only "how often" the tasks were performed. The tasks, calculate gear tooth and cutter values, calculate gear train for fellows geers, calcualte gear train for barber hoober, calculate linear indexing calculate raw stock sizes, calculate template ratios for pantograph, calculate template ratios for isostatic pressing and calculate compaction ratio for conventional pressing were significant only in the "skill level" required to perform the tasks.

The combination groups JI and AS contributed the major difference one only in "how often" the task was performed, and seven times in the "skill level" required to perform the tasks. The combination groups AS and MI contributed the major difference 21 times in "how often" the tasks were performed and 13 times in the "skill level" required to perform the tasks. The combination groups JI and MI contributed the major difference, 10 times in "how often" the tasks were performed and 12

TABLE XI

PERFORMING MATH CALCULATIONS: TASKS IDENTIFIED AS SIGNIFICANTLY DIFFERENT, AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS' ANALYSIS

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE
2* Cal.gear tooth & cutter values	------	Between MI & JI	0.0010	Between AS & JI
3* Cal.data necessary to measure gear values	0.0129	Between MI & JI	0.0061	Between AS & JI
5* Cal.metric thread values	0.0391	Between MI & AS	0.0434	Between MI & JI
6* Cal.acme threads	0.0001	Between MI & AS	0.0113	Between MI & JI
10* Cal.square threads	0.0033	Between MI & JI	------	Between MI & JI
11* Cal.29' worms	0.0013	Between MI & AS	------	Between MI & JI
13* Cal.wide range indexing	0.0028	Between MI & JI	0.0022	Between MI & JI
14* Cal.gear train for fellows gears	------	Between AS & MI	0.0066	Between AS & JI
15* Cal.gear train for barber hooker	------	Between JI & MI	0.0303	Between AS & JI
16* Cal.astronomical indexing	0.0243	Between MI & JI	------	Between AS & JI
17* Cal.multiple lead thread (ext. & int.)	0.0027	Between MI & AS	------	Between MI & JI
18* Cal.unified thread (ext) special	0.0002	Between MI & AS	0.0079	Between MI & AS
19* Cal.unified thread (int) special	0.0001	Between MI & AS	0.0116	Between MI & AS
20* Cal.offset on jig borer	0.0059	Between MI & JI	0.0034	Between MI & JI
22* Cal.clearance, relief & rake of tools	0.0492	Between MI & JI	------	Between MI & AS
27* Cal.degree indexing	0.0042	Between MI & AS	0.0349	Between MI & AS
29* Cal.plain indexing	0.0001	Between MI & AS	0.0031	Between MI & AS

TABLE XI (Continued)

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE
25* Cal. linear indexing	------	Between MI & JI	0.0083	Between MI & JI
30* Cal. unified threads (int) standard	0.0008	Between MI & AS	0.0265	Between MI & AS
32* Cal. unified threads (ext) standard	0.0007	Between MI & AS	0.0157	Between MI & AS
33* Cal. dimensions of keyseats etc.	0.0010	Between MI & AS	0.0358	Between MI & AS
34* Cal. dimensions of parts from blue prints	0.0347	Between MI & AS	0.0053	Between MI & AS
36* Cal. shrinkage factor	0.0067	Between JI & AS	------	Between JI & MI
38* Cal. raw stock sizes	------	Between MI & AS	0.0100	Between MI & AS
39* Cal. template ratios for pantograph	------	Between AS & MI	0.0477	Between AS & JI
44* Cal. roughing & finishing depth of cuts	0.0445	Between MI & AS	0.0163	Between MI & AS
45* Cal. shrink factors for ceramics	0.0057	Between AS & MI	0.0002	Between AS & JI
46* Cal. compaction ratio for isostatic prg.	-----	Between AS & MI	0.0045	Between AS & MI
47* Cal. compaction ratio for conv. pressing	-----	Between JI & MI	0.0465	Between AS & MI
49* Make trig. calculation for compound ang.	0.0330	Between MI & AS	------	Between MI & JI
53* Make trig cal. for tapers	0.0022	Between MI & AS	0.0256	Between MI & JI
55* Make trig cal for necessary dimt.	0.0025	Between MI & AS	0.0023	Between MI & JI

*Original task numbers from list of performing math. calculations
AS-Adult Students, JI-Job Incumbents, MI-Machinist Instructors

times in the "skill level" required to perform the tasks.

In Table XII, one-way analysis of variance used to determine significant difference among the group means, showed that there was only one significant difference in both "how often" the task was performed, and the "skill level" required to perform the tasks. The task identified, was to perform facing operations on vertical boring machines which should be included in the instructional program since the mean rating by individual groups was above 1.4 as selected criteria.

In Table XIII, Newman-Keuls' mutliple Comparison test was used to identify the different combination of groups JI (job incumbents), AS (adult students), MI (machinist instructors) that contributed most to the significant differences. In Table XIII, one task was significantly different in both "how often" the task was performed and the "skill level" required to perform the task. The task was: perfoming boring operations on vertical boring machines (VBM). Three additional tasks, perform flat ribbing operation on horizontal boring machine (HBM), perform thread chasing operation on HBM, and perform precision reaming operation had significant difference in only the "skill level" required to perform the tasks.

The combination groups JI and AS contributed the major difference two times in "how often" the tasks were performed and one only in the "skill level" required to perform the task. The combination groups AS and MI contributed the major difference two times in "how often" the task were performed and three times in the "skill level" required to perform the tasks.

TABLE XII

OPERATING BORING MACHINES: COMPARING THREE GROUPS' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

	TASK	MEAN RATING HOW OFTEN			ANOVA RESULT HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULT SKILL LEVEL	
		JI	AS	MI	P.	F Value	JI	AS	MI	P.	F Value
1	Perform boring & drilling operations on HBM	2.1	1.8	1.6	0.3461	1.08	1.5	1.2	0.2	0.0712	2.73
2	Perform flat ribbing operations on HBM	1.2	1.5	1.4	0.1689	1.83	0.3	0.9	0.2	0.0181	4.21*
3	Perform operation using digital readouts	1.5	1.4	2.0	0.1059	2.32	0.9	0.9	1.0	0.9431	0.06
4	Perform operations using rules	2.2	1.8	1.7	0.1588	1.89	1.5	0.9	0.4	0.1091	2.28
5	Use boring heads on HBM	2.1	1.9	1.6	0.3872	0.96	1.5	1.1	0.6	0.2646	1.35
6	Perform operations using end measures	2.0	1.9	2.0	0.5931	0.37	1.4	1.1	0.8	0.5526	0.60
7	Perform thread chasing operation on HBM	1.3	1.5	1.2	0.4354	0.84	0.5	1.1	0.0	0.0157	4.37*
8	Select & set feeds & speeds for HBM	2.3	2.0	1.9	0.3902	0.95	1.6	1.3	1.2	0.6546	0.43
9	Select coolant, cutting oil, or compound for HBM	2.0	1.9	1.5	0.4873	0.73	1.3	0.8	0.2	0.0588	2.93
10	Use angle plates on HBM	1.7	1.6	1.5	0.7901	0.24	1.2	0.8	0.2	0.1429	1.99
11	Use alignment head for dividing head on HBM	1.5	1.6	1.5	0.9980	0.00	0.7	0.9	0.6	0.6438	0.44
12	Use auxiliary spindle on HBM	1.3	1.3	1.4	0.8002	0.22	0.5	0.6	0.2	0.6462	0.44
13	Use boring head on HBM	1.9	1.7	1.7	0.4581	0.79	1.4	0.9	0.6	0.2046	1.62
14	Use dividing head on HBM	1.6	1.6	1.4	0.8975	0.11	0.9	1.2	0.2	0.1787	1.76

TABLE XII (Continued)

TASK	MEAN RATING HOW OFTEN			ANOVA RATING HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RATING SKILL LEVEL	
	JI	AS	MI	P.	F Value	JI	AS	MI	P.	F Value
15. Use long boring bar on HBM	1.9	1.5	1.5	0.1236	2.5	1.4	0.8	0.4	0.0877	2.51
16. Use right angle head on HBM	1.4	1.4	1.4	1.0000	0.00	0.9	0.8	0.2	0.3866	0.96
17. Use rotab on HBM	1.3	1.1	1.5	0.1171	2.21	0.5	0.6	0.2	0.6061	0.50
18. Use rotary tables on HBM	1.6	1.5	1.5	0.6863	0.38	1.1	0.9	0.2	0.2856	1.27
19. Use Rusnok head on HBM	2.2	1.2	1.4	0.5585	0.59	0.1	0.5	0.2	0.0993	2.38
20. Use short boring bar on HBM	1.2	1.8	1.6	0.2202	1.55	1.6	1.1	0.4	0.0864	2.52
21. Use support ring for spindle on HBM	1.4	1.5	1.6	0.6244	0.47	0.5	0.8	0.4	0.4516	0.80
22. Use vertical spindle head on HBM	1.5	1.5	1.4	0.9394	0.06	0.9	0.7	0.4	0.6571	0.42
23. Perform boring operations on VBM	2.2	1.9	2.3	0.1446	1.99	1.5	1.1	1.4	0.5203	0.66
24. Perform contour turning operations on VBM	1.6	1.6	1.7	0.7142	0.34	0.9	1.0	0.8	0.9336	0.07
25. Perform facing operations on VBM	2.2	1.9	2.4	0.1174	2.21	1.5	1.2	1.8	0.5901	0.53
26. Perform operations on VBM using side head	1.6	1.3	1.4	0.3012	1.22	0.9	0.5	0.2	0.1622	1.86
27. Perform facing operations on VBM	2.2	1.6	2.6	0.0037	6.11*	1.5	0.7	2.0	0.0259	3.82*
28. Perform operations using turrer	1.6	1.4	1.6	0.2596	1.38	0.8	0.6	0.6	0.8587	0.15
29. Perform operations on VBM using post chucks	1.4	1.5	1.5	0.7338	0.31	0.7	0.9	0.6	0.7262	0.32
30. Perform turning operation on VBM	1.5	1.6	1.6	0.8694	0.14	0.8	0.9	0.8	0.8137	0.21

TABLE XII (Continued)

	TASK	MEAN RATING HOW OFTEN JI	AS	MI	ANOVA RESULT HOW OFTEN P.	F Value	MEAN RATING SKILL LEVEL JI	AS	MI	ANOVA RESULT SKILL LEVEL P.	F Value
31	Perform operations with raising	1.6	1.5	1.4	0.8110	0.21	0.8	0.6	0.4	0.6188	0.48
32	Select & set feed & speed controls on VBM	2.2	1.9	2.2	0.2104	1.60	1.3	0.8	0.4	0.2950	1.24
33	Select coolant, or compound for VBM	1.9	1.7	2.1	0.3143	1.18	1.2	0.8	1.4	0.3959	0.94
34	Align jig borer attachments & accessories	1.3	2.0	1.7	0.0652	2.85	0.5	1.2	1.0	0.0914	2.46
35	Perform precision boring operations, etc.	1.3	1.7	1.7	0.4425	0.83	0.5	1.2	1.0	0.1116	2.25
36	Perform precision drilling operations, etc.	1.3	1.7	1.8	0.3169	1.17	0.5	1.2	1.0	0.0893	2.49
37	Perform precision reaming operations, etc.	1.3	1.8	1.7	0.2367	1.48	0.5	1.2	0.6	0.0446	3.23*
38	Set up & align work pieces for jib borer	1.3	1.9	1.7	0.1924	1.69	0.5	1.1	1.0	0.1568	1.89

*Significance difference, $p < .05$.

TABLE XIII

OPERATING BORING MACHINES: TASKS IDENTIFIED AS SIGNIFICANTLY DIFFERENT, AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS' ANALYSIS

	SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE
2*	Performing flat ribbing operation on HBM	------	Between AS & JI	0.0181	Between AS & MI
7*	Perform thread chasing operat. on HBM	------	Between AS & MI	0.0157	Between AS & MI
27*	Perform facing operat. on VBM	0.0037	Between MI & AS	0.0259	Between MI & AS
37*	Perform precision reaming operat. etc.	------	Between AS & JI	0.0446	Between AS & JI

*Original task numbers from list of operating boring machines
AS-Adult Students, JI-Job Incumbents, MI-Machinist Instructors

In Table XIV, one-way analysis of variance used to determine significant difference among the group means, showed that there were six significant differences out of 56 task statements associated with operating lathes. These differences were identified on both scales; "how often" machinist perform the tasks and the "skill level" required to perform the tasks. The mean rating response for each task obtained by all groups were more than 1.4 as selected criteria.

In Table XV, Newman-Keuls' multiple comparison test was used to identify the different combination of groups JI (job incumbents), AS (adult students), and MI (machinist instructor) that contributed most to the significant differences. In Table XV, six tasks were significantly different in both "how often" the tasks were performed and the "skill level" required to perform the tasks. These six tasks were: center part in four jaw chuck counterface and countersink holes with lathe, cut external threads unified, knurl. set up and use steady rest and turn shoulders or corners. Sixteen additional tasks; align tail stock, cut external threads-acme, cut external threads-metric, cut external threads-square, cut external tapered surface, cut inside threads-acme, cut inside threads-multiple, cut inside threads-metric, cut internal tapered surfaces, cut inside threads-unified, cut left hand threads, inspect lathes for safety operation, set up material in 5-C collect, turn grooves, and turn parts between centers had significance difference in only "how often" the tasks were performed. The tasks, center drill and drill holes, center part in 6 jaw chuck, mount and turn soft jaws, ream holes, and select and attach tool holders were significant only in the "skill level" required to perform the tasks.

TABLE XIV

OPERATING LATHES: COMPARING THREE GROUPS' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
1 Align tailstock center	2.8	2.8	3.8	0.0032	6.18*	2.7	2.5	3.0	0.6087	0.50
2 Bore holes on a lathe	3.4	3.4	4.0	0.0719	2.72	2.9	2.4	3.4	0.1152	2.22
3 Center drill and drill hole	3.4	3.4	4.0	0.1328	2.07	2.9	2.3	3.6	0.0398	3.35*
4 Center part in 4 jaw chuck	3.1	2.7	3.7	0.0113	4.74*	2.8	2.1	3.4	0.0358	3.47*
5 Center part in 6 jaw chuck	1.8	1.4	1.5	0.0894	2.49	1.9	1.2	0.6	0.0461	3.19*
6 Counterface & counter sink holes with lathe	3.1	2.8	3.5	0.0320	3.59*	2.9	1.7	3.2	0.0043	5.83*
7 Cut external threads, acme	2.7	2.3	3.2	0.0073	5.23*	2.3	2.1	2.8	0.5223	0.65
8 Cut external threads, buttress	1.9	1.9	1.6	0.7002	0.36	1.0	1.7	0.8	0.0696	2.75
9 Cut external threads, metric	1.8	1.4	2.1	0.0173	4.28*	1.4	1.3	1.4	0.9497	0.05
10 Cut external threads, multiple	1.8	1.9	2.7	0.0089	5.02*	1.2	1.8	2.2	0.1563	1.90
11 Cut external threads, pipe	2.2	2.0	2.6	0.1378	2.03	1.6	1.7	2.0	0.7996	0.22
12 Cut external threads, square	1.8	1.5	2.3	0.0286	3.72*	1.2	1.3	1.8	0.5541	0.59
13 Cut external tapered surfaces	2.8	2.4	3.6	0.0003	9.07*	2.4	2.2	3.2	0.2190	1.55
14 Cut external threads, unified	2.4	2.6	3.8	0.0022	6.63*	1.9	2.1	3.4	0.0314	3.61*
15 Cut inside threads, acme	2.3	1.7	2.4	0.0039	5.96*	2.1	1.6	2.0	0.4485	0.81
16 Cut inside threads, buttress	1.6	1.6	1.5	0.9290	0.07	1.1	1.4	0.8	0.4117	0.90
17 Cut inside threads, pipe	1.9	1.7	2.4	0.0503	3.11	1.4	1.5	1.6	0.8831	0.12

TABLE XIV (Continued)

TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
18 Cut inside threads, multiple	1.6	1.5	2.3	0.0163	4.35*	1.2	1.4	1.8	0.5896	0.53
19 Cut inside threads, square	1.5	1.4	1.9	0.1353	2.05	1.1	1.2	1.0	0.8741	0.13
20 Cut inside threads, metric	1.6	1.3	2.1	0.0137	4.54*	1.3	1.1	1.4	0.8037	0.22
21 Cut internal tapered surfaces	2.5	2.1	3.1	0.0057	5.52*	2.2	1.8	2.6	0.3713	1.00
22 Cut inside threads, unified	2.4	2.1	3.4	0.0010	7.57*	1.9	1.6	2.8	0.1389	2.02
23 Cut left hand theads	2.2	1.9	2.7	0.0441	3.25*	1.9	1.5	2.2	0.3910	0.95
24 Cut off or part finish work	3.0	3.0	3.7	0.1291	2.10	2.7	2.4	3.4	0.1996	1.64
25 Cut worm for worm gear assemblies	1.3	1.3	1.4	0.6939	0.37	0.7	0.9	0.4	0.5341	0.63
26 Inspect lethes for safety operations	2.9	2.9	4.0	0.0138	4.52*	2.6	1.9	3.4	0.0319	3.59*
27 Knurl	2.5	2.9	3.9	0.0003	9.10*	2.4	2.3	3.6	0.0402	3.34*
28 Mount and turn soft jaws	2.9	2.6	2.6	0.3403	1.09	2.7	1.7	1.8	0.0235	3.93*
29 Perform contour turning operations	2.3	2.6	2.8	0.2909	1.26	1.9	2.2	2.2	0.6044	0.51
30 Perform tapping operations	2.9	3.0	3.3	0.7924	0.23	2.8	2.2	2.8	0.2983	1.23
31 Perform threading opertions with a dil	2.6	2.7	2.9	0.8693	0.14	2.5	1.9	2.6	0.2236	1.53
32 Ream holes	2.9	2.9	3.7	0.0515	3.08	2.9	2.1	3.2	0.0416	3.31*
33 Rough and finish outside diameters	3.5	3.6	4.0	0.4134	0.89	2.9	2.6	3.6	0.1270	2.12
34 Select and attach lathe attachments	3.3	3.2	3.9	0.1534	1.92	2.8	2.2	3.4	0.0624	2.87
35 Select and attach lathe fixtures	3.1	3.3	3.2	0.8387	0.18	2.7	2.1	2.8	0.1758	1.78
36 Select and attach tool holders	3.3	3.4	4.0	0.1351	2.05	2.9	2.2	3.6	0.0230	3.95*

TABLE XIV (Continued)

TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
37 Select collant, etc. for late	3.1	2.9	3.6	0.2461	1.43	2.4	1.9	3.0	0.1452	1.98
38 Select and set speeds & feeds for lathe	3.5	2.6	4.0	0.2947	1.24	2.7	2.7	3.6	0.1981	1.65
39 Set up and use faceplate for lathe	2.6	2.4	3.1	0.1189	2.19	2.5	2.0	3.0	0.1584	1.88
40 Set up and use follower rest	2.2	2.1	2.8	0.1842	1.73	2.1	1.6	2.6	0.1260	2.12
41 Set up and use mandrels	2.2	2.4	2.7	0.5882	0.53	2.1	1.8	2.2	0.7066	0.35
42 Set up and use steady rest	3.0	2.2	3.0	0.0004	8.69*	2.6	1.6	2.6	0.0233	3.94*
43 Set up and material in 5-c collect	2.2	2.1	3.1	0.0155	4.40*	1.9	1.3	2.8	0.0605	2.90
44 Set up and use material in 3 jaw universal chuck	3.4	3.5	3.9	0.3694	1.01	2.9	2.2	3.4	0.0518	3.07
45 Set up material in 115 collect	1.5	1.4	1.3	0.8805	0.13	0.7	1.2	0.4	0.1963	1.66
46 Set up material in rubber-sleeve collect	1.5	1.3	1.7	0.3503	1.06	1.1	0.8	1.4	0.5735	0.56
47 Set up toolpost grinder	2.2	1.9	1.7	0.2761	1.31	2.2	1.6	1.0	0.0960	2.41
48 Set up material in 215 collect	1.4	1.3	1.3	0.9327	0.07	0.6	1.0	0.6	0.3620	1.03
49 Turn angular forms	2.3	2.5	3.2	0.1164	2.21	2.1	2.1	2.8	0.4598	0.78
50 Turn grooves	3.2	2.9	3.6	0.0470	3.17*	2.8	2.2	3.2	0.1066	2.30
51 Turn long small diameters	2.7	2.9	3.2	0.2819	1.29	2.5	2.5	3.0	0.5592	0.59
52 Turn long small diameter using box tool	1.9	1.9	2.0	0.8338	0.18	1.1	1.5	1.2	0.4301	0.85
53 Turn posts between centers	2.6	2.6	3.6	0.0102	4.86*	2.4	2.2	3.4	0.0991	2.38
54 Turn shoulders or corners	3.3	3.1	4.0	0.0263	3.81*	2.8	2.1	3.4	0.0270	3.77*
55 Use form tools for lathe	2.9	2.9	3.2	0.7288	0.32	2.6	2.3	2.8	0.6148	0.49
56 Wing spring on lathe	1.5	1.6	1.4	0.8084	0.21	0.7	2.1	0.6	0.2491	1.41

TABLE XV

OPERATING LATHE: TASKS IDENTIFIED AS SIGNIFICANTLY DIFFERENT AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS ' ANALYSIS

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE
1* Align tailstock center	0.0032	Between MI & AS	------	Between MI & AS
3* Center drill and drill holes	------	Between MI & AS	0.0398	Between MI & AS
4* Center part in 4 jam chuck	0.0113	Between MI & AS	0.0358	Between MI & AS
5* Center part in 6 jam chuck	------	Between JI & AS	0.0461	Between JI & MI
6* Counterface & countersink holes with lathe	0.0320	Between MI & AS	0.0043	Between MI & AS
7* Cut external threads, acme	0.0073	Between MI & AS	------	Between MI & AS
9* Cut external threads, metric	0.0173	Between MI & AS	------	Between JI & AS
10* Cut external threads, multiple	0.0089	Between MI & JI	------	Between MI & JI
12* Cut external threads, square	0.0286	Between MI & AS	------	Between MI & JI
13* Cut tapered threads, surfaces	0.0003	Between MI & AS	------	Between MI & AS
14* Cut external threads, unified	0.0022	Between MI & AS	0.0314	Between MI & JI
15* Cut inside threads, acme	0.0039	Between MI & AS	------	Between JI & AS

TABLE XV (Continued)

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE
18* Cut inside threads multiple	0.0163	Between MI & AS	------	Between MI & JI
20* Cut inside threads metric	0.0137	Between MI & AS	------	Between MI & AS
21* Cut internal trapered surfaces	0.0057	Between MI & AS	------	Between MI & AS
22* Cut inside-threads unified	0.0010	Between MI & AS	------	Between MI & AS
23* Cut left hand threads	0.0441	Between MI & AS	------	Between MI & AS
26* Inspect lathes for safety operation	0.0138	Between MI & AS	------	Between MI & AS
27* Knurl	0.0003	Between MI & AS	0.0402	Between MI & AS
28* Mount and turn soft jaws	------	Between MI & AS	0.0235	Between JI & AS
32* Ream Holes	------	Between MI & AS	0.0416	Between MI & AS
36* Select and attach tool holders	------	Between MI & AS	0.0230	Between MI & AS
42* Set up and use steady rest	0.0004	Between MI & AS	0.0333	Between MI & AS
43* Set up material in 5-c collect	0.0155	Between MI & AS	------	Between MI & AS
50* Turn grooves	0.0470	Between MI & AS	------	Between MI & AS
53* Turn parts between centers	0.0102	Between MI & AS	------	Between MI & AS
54* Turn Shoulder or corners	0.0263	Between MI & AS	0.0270	Between MI & AS

*Original task numbers from list of operating lathes
AS-Adult Students, JI-Job Incumbents, MI-Machinist Instructors

Combination groups JI and AS contributed the major difference two times in "how often" the tasks were performed, and three times in "skill level" required to perform the tasks. The combination groups JI and MI contributed the major difference four times in "how often" the tasks were performed, and five times in the "skill level" required to perform the tasks.

Table XVI shows the mean rating of individual task associated with operating milling machines. Task responses rated above a mean of 1.4 was considered for inclusion in a machinist instructional program. Milling machine was observed to be one of the most used machine tools as responded by job incumbents, adult students and machinist instructors.

One-way analysis of variance was used to determine the significant difference among the group means. There were four tasks identified as significantly different among the group means on both scales; "how often" the task was performed, and the "skill level" required to perform the task. These four tasks were numbers 11, 19, 20, and 22 as listed in the table.

In Table XVII, Newman-Keuls' multiple comparison test was used to identify the different combination of groups JI (job incumbents), AS (adult students), and MI (machinist instructors) that contributed most to the significant differences.

In Table XVII, four tasks were significantly different in both "how often" the tasks were performed and the "skill level" required to perform the tasks. These four tasks were: mill angles, mill horizontal plane surfaces, mill vertical plane surfaces and perform climb cut milling operations. Fourteen additional tasks, align milling machine accessories, align milling machine attachments, align milling machine

TABLE XVI

OPERATING MILLING MACHINES: COMPARING THREE GROUPS ' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
1 Align milling machine accessories	3.1	3.0	4.0	0.0201	4.11*	2.6	2.4	3.4	0.1917	1.69
2 Align milling machine attachments	2.9	2.9	4.0	0.0072	5.26*	2.6	2.3	3.4	0.1268	2.12
3 Align milling machine cutting tools	3.0	3.1	4.0	0.0340	3.53*	2.6	2.3	3.4	0.1157	2.21
4 Align milling machine fixtures	3.2	3.0	4.0	0.0209	4.06*	2.7	2.3	3.4	0.1023	2.34
5 Bore holes	3.1	2.7	3.6	0.0097	4.91*	2.6	2.1	3.2	0.0861	2.53
6 Brouch slots groves with stationary spindle	2.0	1.8	1.6	0.3074	1.20	1.7	1.4	1.4	0.6990	0.36
7 Clean and lubricate milling machine	2.8	3.2	3.4	0.4755	0.75	2.4	2.0	3.2	0.1605	1.87
8 Drill holes on milling machine	3.3	3.2	3.7	0.1973	1.66	2.8	2.1	3.6	0.0124	4.64*
9 fly cut on milling machine	3.2	2.7	3.6	0.0094	4.46*	2.6	2.2	3.4	0.0859	2.53
10 Inspect machine for safe operat. conditions	2.9	2.9	3.7	0.1376	2.03	2.5	2.1	3.4	0.0910	2.47
11 Mill angles	2.9	2.6	3.6	0.0153	4.41*	2.5	1.9	3.4	0.0264	3.80*
12 Mill compound angles	2.5	2.0	2.8	0.0122	4.66*	2.1	1.8	2.2	0.7462	0.29
13 Mill curves or radil	2.5	2.3	3.2	0.0343	3.52*	2.2	1.8	3.0	0.1665	1.83
14 Mill cylindrical work	2.4	1.9	3.0	0.0076	5.19*	2.0	1.3	2.6	0.0632	2.86
15 Mill dovetails	1.9	1.7	2.2	0.1248	2.14	1.6	1.2	1.8	0.4073	0.91
16 Mill external seats, slots or groves	2.8	2.3	3.1	0.0098	4.90*	2.6	1.8	2.8	0.0536	3.03

TABLE XVI (Continued)

TASK	MEAN RATING HOW OFTEN JI	AS	MI	ANOVA RESULTS HOW OFTEN P.	F VALUE	MEAN RATING SKILL LEVEL JI	AS	MI	ANOVA RESULTS SKILL LEVEL P.	F VALUE
17 Mill gears	1.8	1.3	2.2	0.0013	7.20*	1.4	0.9	1.0	0.5543	0.59
18 Mill helices	1.3	1.3	1.4	0.6610	0.42	0.7	0.9	0.6	0.7328	0.31
19 Mill horizontal plane surfaces	2.9	2.5	3.8	0.0027	6.38*	2.6	1.8	3.2	0.0320	3.59*
20 Mill vertical plane surfaces	2.8	2.4	3.7	0.0071	5.26*	2.5	1.8	3.0	0.0490	3.13*
21 Clperate die mill	1.5	1.3	1.3	0.3665	1.02	0.7	0.9	0.2	0.3906	0.95
22 Perform climb cut milling operations	2.6	2.1	3.3	0.0046	5.77*	1.7	1.3	3.0	0.0151	4.41*
23 Perform indexing oper'ts. with collect blocks	1.7	1.8	1.7	0.9931	0.01	1.1	1.4	1.2	0.5992	0.52*
24 Perform indexing oper'ts. with dividing head	2.7	2.0	3.4	0.0001	10.84*	2.2	1.8	3.0	0.1090	2.28
25 perform indexing oper'ts. with rotary table	2.7	1.9	3.3	0.0001	12.36*	2.3	1.7	2.8	0.1129	2.24
26 Perform sawing and/or parting operations	2.3	1.9	2.7	0.0394	3.37*	2.1	1.8	1.6	0.6432	0.44
27 Perform straddle or gang milling operations	2.1	1.8	2.2	0.1040	2.33	1.5	1.6	1.2	0.8203	0.20
28 Ream holes on milling machine	2.9	2.4	3.4	0.0039	5.96*	2.5	1.8	2.8	0.1046	2.32
29 Select and set speeds & feeds for milling work	3.3	3.3	4.0	0.1344	2.06	2.7	2.3	3.6	0.0563	2.98
30 Select coolant, oils or compound for milling work	2.7	2.8	3.7	0.0949	2.43	2.1	1.8	3.0	0.1652	1.84
31 Sharpen single point cutting tool	2.9	2.8	3.6	0.0998	2.37	2.7	2.0	3.0	0.1150	2.22
32 Set up and align sire plate or table	2.4	2.1	2.0	0.2092	1.60	2.2	1.7	1.4	0.2811	1.29
33 Set up and align work	3.2	3.1	4.0	0.0535	3.04	2.8	2.2	3.4	0.0543	3.02
34 use cherring attachment	1.3	1.4	1.1	0.6655	0.41	0.6	0.8	0.2	0.3543	1.05

TABLE XVII

OPERATING MILLING MACHINES: TASKS IDENTIFIED AS SIGNIFICANTLY DIFFERENT, AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS' ANALYSIS

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE
1* Align milling machine accessories	0.0201	Between MI & AS	------	Between MI & AS
2* Align milling machine attachments	0.0072	Between MI & AS	------	Between MI & AS
3* Align milling machine cutting tools	0.0340	Between MI & AS	------	Between MI & AS
4* Align milling machine fixtures	0.0209	Between MI & AS	------	Between MI & AS
5* Bore holes	0.0097	Between MI & AS	------	Between MI & AS
8* Drill holes on milling machine	------	Between MI & AS	0.0124	Between MI & AS
9* Fly cut on milling machine	0.0094	Between MI & AS	------	Between MI & AS
11* Mill angles	0.0153	Between MI & AS	0.0264	Between MI & AS
12* Mill compound angles	0.0122	Between MI & AS	------	Between MI & AS
13* Mill curves or radil	0.0343	Between MI & AS	------	Between MI & AS
14* Mill cylindrical work	0.0076	Between MI & AS	------	Between MI & AS
16* Mill external seats, slots or groves	0.0098	Between MI & AS	------	Between MI & AS
17* Mill gears	0.0013	Between MI & AS	------	Between JI & AS
19* Mill horizontal plane surfaces	0.0027	Between MI & AS	0.0320	Between MI & AS
20* Mill vertical plane surfaces	0.0071	Between MI & AS	0.0490	Between MI & AS
22* Perform climb cut milling operations	0.0046	Between MI & AS	0.0151	Between MI & AS

TABLE XVII (Continued)

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE
24* Perform indexing oper 'ts. with dividing head	0.0001	Between MI & AS	------	Between MI & AS
25* Perform indexing oper 'ts. with rotary table	0.0001	Between MI & AS	------	Between MI & AS
26* Perform sawing and/or parting operations	0.0394	Between MI & AS	------	Between MI & AS
28* Ream holes on milling machine	0.0039	Between MI & AS	------	Between MI & AS

*Original task numbers from list of operating milling machines
AS-Adult Students, JI-Job Incumbents, MI-Machinist Instructors

cutting tools, align milling machine fixtures, bore holes, fly cut on milling machines mill compound angles, mill curve or radii, mill cylindrical work, mill external seats, slots or grooves, mill gears, perform indexing operations with dwindling head, perform indexing operations with rotary table, perform carving and parting operations and ream holes on milling machines. The task, drill holes on milling machines was significant only in the "skill level" required to perform the task.

The combination groups JI and AS contributed the major difference one time only in "skill level" required to perform the task. The combination groups AS and MI contributed the major difference 20 times in "how often" the tasks were performed and 18 times in the "skill level" required to perform the tasks. The combination groups JI and MI contributed the major difference one only in the "skill level" required to perform the task.

In Table XVIII, the mean rating of task statements associated with operating power saws by job incumbents, adult students, and machinist instructors were above the mean of 1.4 rating used as selected criteria. One-way analysis of variance was used to determine the significant differences among the group means. Three tasks were identified as significantly different in both "how often" tasks were performed and the "skill level" required to perform the tasks. These three tasks were; task numbers 1, 2, and 3 as shown in the table. One task was identified as significantly different only in "how often" the task was performed.

In Table XIX, Newman-Keuls' multiple comparison test was used to identify the different combination of groups JI (job incumbents) AS (adult students) and MI (machinist instructors) that contriubted most to the significant differences.

TABLE XVIII

OPERATING POWER SAWS: COMPARING THREE GROUPS ' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
1 Clean and lubricate power saw	2.2	2.6	3.8	0.0012	7.30*	1.9	1.6	3.2	0.0254	3.84*
2 inspect power saw for safety operation	2.7	2.7	4.0	0.0036	6.03*	2.2	1.7	3.6	0.0085	5.05*
3 Remove, weld or replace saw blades	2.6	2.9	3.8	0.0236	3.93*	2.4	2.1	3.6	0.0378	3.41*
4 Apply coolants for sawing	2.6	2.8	3.7	0.0489	3.14*	2.0	1.6	3.0	0.0779	2.63
5 Set up and perform angular sawing opert.	2.4	2.3	2.9	0.0608	2.91	2.1	1.8	2.4	0.5706	0.56
6 Set up and perform contour sawing opert.	1.9	2.2	3.1	0.0512	3.09	1.5	1.6	2.6	0.1855	1.72
7 Set up and perform straight sawing opert.	2.8	3.2	3.9	0.0561	2.99	2.3	2.0	3.4	0.0557	2.99

*-Significant difference, P<.05

In Table XIX, three tasks were significantly different in both "how often" the tasks were performed and the "skill level" required to perform the tasks. These three tasks were: clean and lubricate power saws, inspect power saws for saftey operations and remove, weld, or replace saw blades. One additonal task, apply coolant for sawing had significant difference in only "how often" the task was performed.

The combination groups AS and MI contriubted the major difference two times in "how often" the tasks were performed and four times in the "skill level: required to perform the tasks. The combination groups JI and MI contributed the major difference two times in "how often" the tasks were performed.

In Table XX, there was no significant difference among the group means after using one-way analysis of variance to determine the differences. Out of 17 task statements associated with operating shapers, the following tasks were rated high (mean of 1.4 or more) by each group of respondents to be considered for inclusion in an instructional program.

1. Task numbers 8 and 18 were rated by job incumbents.

2. Task numbers 1, 2, 3, 4, 6, 9, 10, 12, 15, 16, and 19 by adult students.

3. Task numbers 1, 2, 3, 4, 8, 11, 12, 15, 18, and 19 by machinist instructors.

In Table XXI, operating special machines has the following classifications and task numbers (see Appendix B).

1. Operating gear hobber (task number 1-4).

2. Operating pantograph (task numbers 5-13).

3. Operating electrical discharge machines EDM (task numbers, 14-18).

TABLE XIX

OPERATING POWER SAWS: TASKS IDENTIFIED AS SIGNIFICANTLY DIFFERENT, AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS ' ANALYSIS

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K ' ANALY. GROUP DIFFERENCE
1* Clean and lubricate power saws	0.0012	Between MI & JI	0.0254	Between MI & AS
2* Inspect power saws for safty operit.	0.0036	Between MI & AS	0.0085	Between MI & AS
3* Apply coolant for sawing	0.0236	Between MI & JI	0.0378	Between MI & AS
4* Remove, weld or replace saw blades	0.0489	Between MI & AS	------	Between MI & AS

*Original task numbers from list of operating power saws
AS-Adult Students, JI-Job Incumbents, MI-Machinist Instructors

TABLE XX

OPERATING SHAPERS: COMPARING THREE GROUPS' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
1 Align shaper attachments	1.3	1.4	1.5	0.6172	0.49	0.6	0.6	0.2	0.6234	0.48
2 Aligh shaper fixtures	1.3	1.4	1.5	0.7396	0.30	0.6	0.6	0.2	0.6234	0.48
3 Align shaper tools	1.3	1.5	1.5	0.5303	0.64	0.6	0.8	0.2	0.4446	0.82
4 Clean & lubricate shapers	1.2	1.4	1.5	0.0977	2.42	0.3	0.6	0.2	0.2718	1.32
5 Cut off or part with shapers	1.2	1.2	1.2	0.8067	0.22	0.5	0.4	0.0	0.4842	0.73
6 Finish angular work on shaper	1.3	1.4	1.2	0.8911	0.12	0.7	0.6	0.0	0.2884	1.26
7 Finish ext. keyseats or grooves on shaper	1.2	1.3	1.0	0.4651	0.78	0.5	0.4	0.0	0.3815	0.97
8 Finish horizontal surfaces on the shaper	1.4	1.4	1.5	0.7897	0.24	0.7	0.6	0.2	0.4875	0.72
9 Finish irregular work on the shaper	1.3	1.4	1.1	0.7222	0.33	0.5	0.6	0.0	0.3539	1.05
10 Finish irregular work on the shaper	1.3	1.3	1.2	0.9807	0.02	0.6	0.6	0.0	0.3502	1.06
11 Finish vertical surfaces on the shaper	1.2	1.3	1.4	0.7285	0.32	0.6	0.7	0.2	0.5653	0.57
12 Inspect shapers for safety operation	1.2	1.4	1.5	0.3586	1.04	0.5	0.4	0.2	0.7559	0.28
13 Knurl a flat surface on the shaper	1.0	1.0	1.0	0.7064	0.35	0.2	0.2	0.0	0.7160	0.34
14 Perform rotary shaping	1.0	1.0	1.0	0.6445	0.44	0.2	0.3	0.0	0.4612	0.78

TABLE XX (Continued)

TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
	JI	AS	MI	p.	F VALUE	JI	AS	MI	P.	F VALUE
15 Select and set speeds and feeds of shapers	1.3	1.4	1.5	0.6609	0.42	0.6	0.7	0.2	0.5435	0.61
16 Select cutting oils for shaper work	1.2	1.4	1.2	0.5314	0.64	0.4	0.5	0.0	0.4196	0.88
17 Shape internal gears	1.1	1.0	1.0	0.3000	1.23	0.2	0.4	0.0	0.3854	0.96
18 Sharpen cutting tools for shapers	1.4	1.3	1.5	0.6586	0.42	0.8	0.7	0.2	0.5013	0.70
19 Set up and align work	1.3	1.5	1.5	0.7265	0.32	0.8	0.7	0.2	0.4618	0.78

TABLE XXI

OPERATING SPECIAL MACHINES: COMPARING THREE GROUPS' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
1 Align machine attachments for gear hobber	1.1	1.1	1.0	0.6936	0.37	0.3	0.4	0.0	0.3395	1.09
2 Perform gear generating operations	1.1	1.1	1.0	0.7632	0.27	0.3	0.4	0.0	0.3809	0.98
3 Select & install gear trains	1.3	1.2	1.0	0.5743	0.67	0.4	0.5	0.0	0.4493	0.81
4 Set up & align gear blank	1.3	1.0	1.0	0.2429	1.45	0.4	0.5	0.0	0.5115	0.68
5 Adjust linkage per ratio	1.0	1.1	1.0	0.4285	0.86	0.2	0.5	0.0	0.1566	1.90
6 Do profile work on pantograph	1.1	1.2	1.0	0.4879	0.73	0.1	0.5	0.0	0.0751	2.67
7 Do three dimensional on pantograph	1.0	0.2	1.0	0.1689	1.84	0.0	0.5	0.0	0.0174	4.26*
8 Drill & counter bore holes	1.0	1.1	1.0	0.2675	1.35	0.1	0.4	0.0	0.1652	1.84
9 Engrave a scale on pantograph	1.0	1.1	1.0	0.1160	2.24	0.1	0.5	0.0	0.0394	0.36*
10 Graduate a scale on pantograph	1.0	1.1	1.0	0.1160	2.24	0.1	0.5	0.0	0.0394	3.36*
11 Select & set speeds on cutter	1.0	1.1	1.0	0.7272	0.32	0.2	0.4	0.0	0.1985	1.65
12 Sharpen engraving tools	1.0	1.1	1.0	0.6512	0.43	0.2	0.5	0.0	0.1566	1.90
13 Set up & al ign work piece	1.1	1.1	1.0	0.4879	0.73	0.1	0.5	0.0	0.1016	2.35
14 Align machine attachments etc.	1.3	1.3	1.3	0.8085	0.21	0.7	0.7	0.4	0.8046	0.22
15 Align tool head with work	1.4	1.3	1.3	0.8112	0.21	0.7	0.7	0.4	0.8046	0.22
16 Fabricate tools for EDM	1.3	1.2	1.3	0.6714	0.40	0.6	0.6	0.4	0.9011	0.10

TABLE XXI (Continued)

TASK	MEAN RATING HOW OFTEN			ANOVA RESULTS HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULTS SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
17 Perform machining operatings on EDM	1.2	1.2	1.3	0.6375	0.45	0.6	0.7	0.4	0.8589	0.15
18 Set up & adjust machine controls	1.4	1.3	1.3	0.6580	0.42	0.8	0.7	0.4	0.7891	0.24
19 Set up, align and operate sander	2.0	2.2	2.0	0.9370	0.07	1.5	1.2	1.4	0.7627	0.27
20 Grind internal and exterior surfaces	2.4	2.8	2.4	0.6169	0.49	2.2	2.6	1.6	0.2524	1.40
21 Plain and form grind	2.3	2.6	2.6	0.3275	1.13	21.	2.4	2.0	0.7411	0.30
22 Mount workpiece in machine	1.9	2.3	3.3	0.0025	6.50*	1.1	1.6	3.0	0.0101	4.86*
23 Operate NC machines	1.9	2.2	3.3	0.0015	7.14*	1.1	1.7	3.0	0.0103	4.84*
24 Punch program tape	1.8	1.7	3.3	0.0001	12.07*	0.9	1.2	3.0	0.0020	6.71*
25 Set up and adjust machine controls	1.9	2.1	3.2	0.0033	6.18*	1.2	1.7	2.8	0.0365	3.45*
26 Select appropriate tools and fixtures	1.9	2.0	3.2	0.0027	6.43*	1.2	1.4	2.8	0.0350	3.49*
27 Test and debug programs	2.0	2.0	3.1	0.0107	4.83*	1.2	1.8	2.6	0.0728	2.71
28 Write machine tool programs	1.9	1.9	2.9	0.0102	4.89*	1.0	1.6	2.6	0.0401	3.34*

*Significance difference, $p < .05$

4. Operating sanders (task number 19).

5. Operating grinders (task numbers 20-21).

6. Operating numerically controlled machine tools (task numbers 22-28).

To determine a task to be considred for inclusion in an instructional program, was based on 1.4 mean rating as selected criteria. The highest mean rating of each task from these special machines were among the operating of sanders, grinders and the numerically controlled machine tools as listed above by all respondents. Comparing the group means by using one-way analysis of variance, six tasks from numerically controlled machine tools were identified as significantly different on both "how often" the task was performed, and the "skill level" required to perform the task. These six tasks were numbers; 22, 23, 24, 25, 26, and 28.

In Table XXII, Newman-Keuls' multiple comparison test was used to identify the different combination of groups. JI (job incumbents), AS (adult students) and MI (machinist instructors) that contributed most to the significant differences.

In Table XXII, six tasks were significantly different in both "how often" the task was performed and the "skill level" required to perform the tasks. These tasks were: mount work piece in machine, operate numerically controlled machine punch program tape, set up and adjust machine controls, select appropriate tools and fixtures and write machine tool programs. Three additional tasks, do three dimensional on pantograph, engrave a scale on pantograph, and graduate a scale on pantograph had significance difference in only "how often" the task was performed. The task; test, and debug programs was significant only in the skill level required to perform the task.

TABLE XXII

OPERATING SPECIAL MACHINES: TASKS IDENTIFIED AS SIGNIFICANTLY DIFFERENT AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KAULS' ANALYSIS

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE
7* Do three dimensional on pantograph	------	Between AS & MI	0.0174	Between AS & MI
9* Engrave a scale on pantograph	------	Between AS & MI	0.0394	Between AS & MI
10* Graduate a scale on pantograph	------	Between AS & MI	0.0394	Between AS & MI
22* Mount work piece on machine	0.0025	Between MI & JI	0.0101	Between MI & JI
23* Operate NC machine	0.0015	Between MI & JI	0.0103	Between MI & JI
24* Punch program tape	0.0001	Between MI & AS	0.0020	Between MI & JI
25* Set up and adjust machine controls	0.0033	Between MI & JI	0.0365	Between MI & JI
26* Select appropriate tools and fixtures	0.0027	Between MI & AS	0.0350	Between MI & JI
27*.Test and debug programs	0.0107	Between MI & AS	------	Between MI & JI
28* Write machine tool programs	0.0102	Between MI & AS	0.0401	Between MI & JI

*Original task numbers from list of operating special machines
JI-Job Incumbent, AS-Adult Students, MI-Machinist Instructors

The combination groups AS and MI contributed the major difference seven times in "how often" the tasks were performed and three times in the "skill level" required to perform the task. The combination groups JI and MI contributed the major difference three times in "how often" the tasks were preformed, and seven times in the "skill level" required to perform the task.

Table XXIII shows the list and mean ratings of task statements associated with bench work and the results of one-way analysis of variance which was used to determine if there were significant differences among the group means. The mean ratings of responses by each group on "how foten" machinist perform those tasks, met the selected criteria of 1.4 mean rating for inclusion in the instructional program.

Four tasks had significant difference among the group means in both "how often" machinist perform the task and the "skill level" required to perform the tasks.

In Table XXIV, Newman-Keuls' multiple comparison test was used to identify the different combinations of groups JI (job incumbents), AS (adult students) and MI (machinist instructors) that contributed most to the significant differences.

In Table XXIV, three tasks were significantly different in both "how often" the task was performed and the "skill level" required to perform the tasks. These three tasks were: install helecoils and other threaded inserts, inspect work area for safety, and clean up adjacent work areas. Five additional tasks, clean floors, hand sharper or hone cutting tools with stone, install bushing and other non-threaded inserts, perform functional try out of rig, and use a hand broach had significant difference in only "how often" the tasks was performed. The tasks; cut threads with hand taps and dies, dispose the trash oily waste material,

TABLE XXIII

PERFORMING BENCH WORK: COMPARING THREE GROUPS' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

TASK	MEAN RATING HOW OFTEN			ANOVA RESULT HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULT SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
1. Bench check mechanical components	2.5	2.7	3.1	0.5010	0.70	1.9	2.3	2.2	0.6581	0.42
2 Clean floors	2.7	2.3	3.9	0.0012	7.28*	2.2	1.7	3.4	0.0345	3.51*
3 Clean, prepare mechanical components	2.5	2.9	3.1	0.3319	1.12	1.9	1.9	2.8	0.2683	1.34
4 Cut materials with hand hacksaw	2.6	2.9	3.0	0.7849	0.24	2.4	1.7	2.4	0.1354	2.05
5 Cut threads with hand taps and dies	2.9	3.1	3.4	0.1898	1.70	2.8	1.7	3.0	0.0066	5.34*
6 Disassemble and/or assemble parts	2.7	2.9	3.1	0.8557	0.16	2.4	2.0	2.6	0.4797	0.74
7 Dispose of scrap metal, chips, or shavings	2.7	3.2	3.7	0.6321	1.26	2.3	1.6	3.0	0.0551	3.00
8 Dispose of trash or oily waste material	2.6	3.1	3.9	0.4057	0.48	2.3	1.4	3.6	0.0018	6.80*
9 Hand file a template	2.4	2.4	2.3	0.8140	0.21	2.0	1.8	1.8	0.9017	0.10
10 Hand file radii	2.7	2.7	3.0	0.6512	0.43	2.3	2.0	2.8	0.3852	0.97
11 Hand lap or hone surfaces	2.4	2.4	2.3	0.7925	0.23	1.9	1.9	1.2	0.4230	0.87
12 Hand scrape bearing surfaces	1.8	2.0	1.6	0.6833	0.38	1.1	1.4	0.8	0.4513	0.80
13 Hand sharpen or hone cutting tools with stone	2.8	2.5	3.3	0.0087	5.04*	2.6	1.9	2.6	0.1393	2.02
14 Install bushings & other non-threaded inserts	2.8	2.3	2.3	0.0397	3.36*	2.4	1.6	1.8	0.1225	2.15
15 Install helocoils & other threaded inserts	2.4	1.9	2.0	0.0216	4.03*	2.3	1.2	1.8	0.0319	3.59*

TABLE XXIII (Continued)

TASK	MEAN RATING HOW OFTEN			ANOVA RESULT HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULT SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
16 Lay out a rough casting	2.4	1.9	2.0	0.0609	2.90	1.8	1.3	1.4	0.5720	0.65
17 Perform deburring operations	2.9	2.9	3.7	0.0816	2.59	2.7	1.3	3.4	0.0001	10.10*
18 Perform functional try out of jigs, etc.	2.8	2.3	2.1	0.0380	3.41*	2.4	1.7	1.4	0.1414	2.00
19 Perform general layout work	2.8	2.9	3.6	0.1354	2.05	2.5	3.3	3.2	0.2049	1.62
20 Perform spring winding on bench	1.5	1.6	1.5	0.9967	0.00	0.6	1.0	0.4	0.2837	1.28
21 Inspect work area for safety	1.5	2.9	4.0	0.0029	6.29*	1.9	1.7	3.4	0.0158	4.36*
22 Clean up adjacent work areas	2.6	2.5	3.6	0.0202	4.10*	2.2	1.2	3.2	0.0015	7.04*
23 Press green ceramics from powder	1.2	1.4	1.4	0.4573	0.79	0.1	0.7	0.4	0.0579	2.95
24 Ream holes with hand reamers	2.3	2.4	2.8	0.2755	1.31	2.2	1.8	2.0	0.6468	0.44
25 Remove or install pins	2.8	2.7	2.7	0.5517	0.60	2.4	1.7	2.0	0.2156	1.56
26 Remove/replace gears, pulleys etc.	2.6	2.4	2.8	0.1238	2.15	2.4	1.7	2.0	0.1848	1.72
27 Rework threads with thread files	2.6	2.4	3.0	0.1105	2.27	2.4	1.6	2.4	0.0716	2.72
28 Rough & finish surfaces with hand files	2.5	2.6	3.1	0.4930	0.81	2.0	1.8	2.4	0.6349	0.46
29 Silver Solder	1.9	1.9	1.4	0.2984	1.23	1.4	1.5	0.0	0.0294	3.68*
30 Straighten misc. parts	2.5	2.4	1.7	0.1443	1.99	2.2	1.7	0.4	0.0086	5.04*
31 Use a hand broach	2.3	1.9	1.3	0.0105	4.84*	1.8	1.3	0.4	0.0638	2.85
32 Use hand grinder	2.6	2.7	2.3	0 0401	2.2 *	2.5	1.6	1.4	0.0404	3.34*
33 Work mat. with hanner, etc.	2.5	3.1	3.0	0.6919	0.37	2.0	2.0	2.6	0.6142	0.49
34 Silt Solder	1.9	2.2	1.6	0.3646	1.02	1.3	1.7	0.8	0.2001	1.64
35 Work materials with portable hand drill	2.7	2.7	2.5	0.5925	0.53	2.6	1.9	1.8	0.1220	2.10

*Significance difference, $p < .05$

TABLE XXIV

PERFORMING BENCH WORK: TASKS IDENTIFIED AS SIGNIFICANTLY DIFFERENT, AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS' ANALYSIS

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE
2* Clear floors	0.0012	Between MI & JI	------	Between MI & AS
5* Cut threads with hand taps & dies	------	Between MI & AS	0.0066	Between MI & AS
8* Dispose the trash oily waste material	------	Between MI & JI	0.0018	Between MI & AS
13* Hand sharpen or hone cutting tools with stone	0.0087	Between MI & AS	------	Between JI & AS
14* Install bushing & other non-thread inserts	0.0397	Between JI & AS	------	Between JI & AS
15* Install helecoils & other threaded inserts	0.0216	Between JI & AS	0.0319	Between JI & AS
17* Perform deburring operations	------	Between MI & AS	0.0001	Between MI & AS
18* Perform functional try out of jig, etc.	0.0380	Between JI & MI	1----	Between JI & MI
21* Inspect work area for safety	0.0029	Between MI & JI	0.0158	Between MI & AS
22* Clean up adjacent work area	0.0202	Between MI & AS	0.0015	Between MI & AS
29* Silver solder	------	Between JI & MI	0.0294	Between AS & MI
30* Straighten misc. parts	------	Between AS & MI	0.0086	Between AS & MI
31* Use a hand broach	0.0105	Between JI & MI	------	Between JI & MI
32* Use hand grinder	------	Between JI & MI	0.0401	Between JI & MI

*Original task numbers from list of performing bench work.
JI-Job Incumbent, AS-Adult Students, MI-Machinist Instructors

perform deburring operations, silver solder, straighten miscellaneous parts, and use hand grinder were significant only in the "skill level" required to perform the tasks.

The combination groups JI and AS contributed the major difference two times in "how often" the tasks were performed, and three times in the "skill level" required to perform the tasks. The combination groups AS and MI contributed the major differecne five times in "how often" the tasks were performed and seven times in the "skill level" required to perform the task. The combination groups JI and MI contributed the major difference seven times in "how often" in the "skill level" required to perfrom the task.

In Table XXV, the mean rating of task statements associated with "doing paper work" by job incumbents, adult students, and machinist instructors were above the selected criteria (mean of 1.4). The high response rating shows that all task statements were appropriate for inclusion in a machinist instructional program as determined by mean of 1.4 rating.

There were three significant differences among the group means on "how often" tasks were performed. These three tasks were: drawing sketches, study reports on mateirals and supervise and evaluate other personal work.

In Table XXVI, Newman-Keuls' multiple comparison test used to identify the different combination of groups JI (job incumbents), AS (adult students), MI (machinist instructors) that contributed most to the significant differences in doing paper work; drawing sketches, study reports on materials and supervise and evaluate other persons work had significant difference only in "how often" the tasks were performed.

TABLE XXV

DOING PAPER WORK: COMPARING THREE GROUPS' MEAN RATING OF INDIVIDUAL TASK, USING ONE-WAY ANALYSIS OF VARIANCE

TASK	MEAN RATING HOW OFTEN			ANOVA RESULT HOW OFTEN		MEAN RATING SKILL LEVEL			ANOVA RESULT SKILL LEVEL	
	JI	AS	MI	P.	F VALUE	JI	AS	MI	P.	F VALUE
1 Draft correspondence or reports	1.9	2.0	2.9	0.0788	2.63	1.2	1.4	1.6	0.6559	0.42
2 Drawing sketches	2.6	2.8	3.0	0.0256	3.65*	2.0	2.2	2.6	0.4954	0.71
3 Maintain work records, etc.	2.6	2.3	2.0	0.0642	2.85	1.9	1.3	1.8	0.3066	1.20
4 Order & receive stock, materials, etc.	2.3	2.2	2.6	0.3596	1.04	1.7	1.2	0.8	0.1820	1.74
5 Plan work for other persons	2.7	2.3	2.7	0.0817	2.59	1.9	1.8	1.0	0.2862	1.27
6.Review inspection report	1.9	1.9	2.7	0.6580	0.42	1.7	1.3	1.2	0.6097	0.50
7 Scheduling work other than machine work	2.3	2.1	2.2	0.1533	1.92	1.6	1.3	1.6	0.8240	0.19
8 Spend time with consultants	1.9	1.8	2.6	0.6894	0.37	1.4	1.4	1.4	0.9995	0.00
9 Study reports on materials	1.9	1.9	2.7	0.0344	3.52*	1.2	1.2	1.8	0.4864	0.73
10 Prepare cost estimates for projects	2.3	1.9	1.9	0.0508	3.10	1.5	1.4	1.8	0.7885	0.24
11 Supervise & evaluate other persons work	2.5	1.9	2.6	0.0082	5.13*	1.9	1.3	2.0	0.3116	1.18

*Significant difference, $p < .05$

TABLE XXVI

DOING PAPER WORK: TASKS IDENTIFIED AS SIGNIFICANTLY DIFFERENT, AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS' ANALYSIS

SIGNIFICANT TASKS	ANOVA RESULT HOW OFTEN (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE	ANOVA RESULT SKILL LEVEL (.05 LEVEL)	NEWMAN-K' ANALY. GROUP DIFFERENCE
2* Drawing sketches	0.0256	Between MI & AS	------	Between MI & JI
10* Study reports on materials	0 0344	Between MI & AS	------	Between MI & JI
11* Supervise and evaluate other persons work	0.0082	Between JI & AS	-----	Between MI & AS

*Original Task numbers from list of doing paper work
JI-Job Incumbent, AS-Adult Students, MI-Machinist INstructors

The combination groups AS and MI contributed the major difference two times in "how often" the tasks were performed and once in the "skill level" required to perform the task. The combination groups JI and MI contributed the major difference two times in the "skill level" required to perform the tasks.

Table XXVII shows 10 duties performed by machinists. The mean percent of time rating was ranked, and operating lathes and milling machines were identified as the most machine tools used by job incumbents, adult students, and machinist instructors. Comparing the groups' mean of individual duty performed using one-way analysis of variance, three duties were found to be significantly different in performing thier duties. These were: performing mathematical calcualtions, operating milling machines, and operating power saws.

Newman-Keuls' multiple comparison test was used to identify the different combinations of groups JI (job incumbents), AS (adult students) MI (machinist instructors) that contributed most to the significant differences. The combination groups, JI and AS contributed the major difference once in operating shapers. The combination groups, AS and MI contributed the major difference six times in performing duties associated with; operating lathes, operating milling machines, planning machine work, doing paper work, performing math calculations, and operating boring machines. The combination groups JI and MI contributed the major difference three times in performing duties associated with; performing bench work, operating power saws and operating special machines.

TABLE XXVII

DUTIES PERFORMED BY MACHINIST: COMPARING THREE GROUPS' MEAN PERCENT OF TIME RATING, USING ONE-WAY ANALYSIS OF VARIANCE AND IDENTIFICATION OF GROUPS CAUSING DIFFERENCES AS DETERMINED BY THE USE OF NEWMAN-KEULS' ANALYSIS

DUTIES	MEAN PERCENT TIME RATING			ANOVA RESULT		NEWMAN-K' ANALYSIS GROUP DIFFERENCE
	JI	AS	MI	P.	F VALUE	
1. Operating Lathes	27.5	34.1	25.6	0.0739	2.69	Between AS & MI
2. Operating Milling Machines	20.7	20.8	18.5	0.0081	5.12*	Between AS & MI
3. Planning Machine Work	11.7	6.7	10.5	0.0771	2.64	Between AS & MI
4. Doing Paper Work	11.8	5.4	7.4	0.3276	1.13	Between AS & MI
5. Performing Math Calculations	10.9	6.1	11.0	0.0109	4.77*	Between AS & MI
6. Performing Bench Work	6.3	10.9	8.6	0.8583	0.15	Between JI & MI
7. Operating Power Saws	5.3	6.3	4.8	0.0102	4.85*	Between JI & MI
8. Operating Burring Machines	2.3	3.8	8.1	0.8681	0.14	Between AS & MI
9. Operating Special Machines	2.3	4.5	1.6	0.2047	1.62	Between JI & MI
10. Operating Shapers	0.9	0.8	0.1	0.7231	0.33	Between JI & AS

*Significant Difference, $p < .05$
JI-Job Incumbents, AS-Adult Students, MI Machinist Instructors

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of the study was to identify tasks performed by job incumbents, adult students and machinist instructors that can be considered for inclusion in machinist instructional programs.

An approach to identify the tasks needed for instructional program was determined by using task inventory method of job analysis. To fulfill the purpose of the study, the following questions were asked:

1. "How often" does a machinist perform the task?
2. What "skill level" was required to do the task?
3. Are there significant differences between the mean responses of the task performed by job incumbents, adult students and machinist instructors?

Respondents in this study comprised 40 job incumbents from 20 industries having machine shops; 40 adult students in a machinist program and 10 machinist instructors selected from educational institutions having machinist training program in Oklahoma City and Tulsa metropolitan areas. The instrument consisted of 11 machinist duties and 320 task statements. To decide whether a task should be considered for inclusion in a machinist instructional program, a selected criteria of 1.4 or more mean rating of responses was chosen.

One-way analysis of variance was used to determine if there were significant differences among the group means only. When significance was observed, further analysis was conducted to determine precisely which groups combination caused the differences by using Newman-Keuls' multiple comparison test. The .05 level of probability was set as the standard for significance.

Percent mean time rating was calculated and ranked for each duty. Operating lathes and milling machines were identified as taking 48.9 percent of job incumbents' time, 54.1 percent of adult students' time, and 44.1 percent of machinist instructors' time in performing their duties. Eighty-eight tasks out of 320 or 27.5 percent on "how often" tasks were performed and 57 tasks or 17.0 percent on "skill level" required to perform the tasks were identified as significantly different among the group means.

Operating of shapers, gear hobber and pantograph were considered not appropriate for inclusion in machinist instructional programs since they did not meet the selected criteria of 1.4 mean rating.

Based upon a mean rating of 1.4 or more as selected criteria, 262 task statements or 81.98 percent out of 320 tasks were identified as appropriate for inclusion in machinist instructional program. Fifty-eight tasks statements or 18.02 percent were identified to be deleted from the instructional program.

Conclusion

Information from this study may be used to help guide future machinist training programs. Quality training program is based on careful analysis of occupation to insure that no task that is highly important

to the job is removed from instructional program due to low mean rating by respondents.

Some tasks, although performed on the job were often not considered appropriate to be included in the instructional program due to the following reasons; 1. tasks that were performed infrequently, 2. tasks that required little effort to learn and 3. tasks that could be best learned on the job. If these inappropriate tasks could be removed what would remain could be considered for inclusion in a machinist instructional program.

This study shows that machine tools and duties performed by adult students and machinist instructors in the educational institutions having machinist program and the method of work compared with job incumbents in industries with machine shops were almost the same as a result of responses provided.

Although different machinist may have different functions especially different companies, the task lists and rating developed in this study seemed to be reasonably respresentative.

Recommendations

The investigator makes the following recommendations:

1. Educators should not regard low mean rating of tasks as of no value. Tasks with low mean rating should be considered carefully before removal from instructional program, to insure that no task that is highly important to the job is removed simply because it was not performed frequently.

2. The machinist instructor should serve as a liasion between the school and the industry to help students attain job skill and related knowledge.

3. Findings of this study should be made available to educators who are concerned in revising and developing machinist training programs.

4. It is highly recommended that a similar study be made about machinists' competency in the use of numerically controlled machine tools, and computer programming.

SELECTED BIBLIOGRAPHY

1. Benenati, Carl G. "Course Content and Training Time". Technical Education News, Vol. 30, No. 1 (Oct.-Nov., 1976), p. 22.

2. Blackstone, Bruce I. "Automation". Office Executive, Vol. 25 (June, 1960), p. 26.

3. Boone, Edgar J. "Vocational Education". Yearbook of Agriculture 1971. Washington, D.C.: U.S. Government Printing Office, 1971.

4. Burt, Samuel M. Industry and Vocational Technical Education. New York: McGraw-Hill Book Company, 1967.

5. Carr, William G. NEA News. Washington, D.C.: National Education Association, 1961.

6. Christal, Raymond E. Experience in the Collection Analysis and Reporting of Occupation Data in the United States Air Forces. Lackland Air Force Base, Texas: Air Force Human Resources Laboratory, 1973.

7. Coe, Burr D. "What is Quality Vocational Education?" In Gordon F. Law (Ed.), Current Concepts in Vocational Education, New Brunswick, New Jersey: Rutgers University, 1974.

8. Dauwalder, Donald E. Education and Training for Technical Occupation. Los Angeles, California: Los Angeles City Junior College District, 1961.

9. Evans, R.N. Methodological Study for Determining the Task Content of Dental Auxiliary Education Programs. Washington D.C.: Project Report, Office of Special Programs, Bureau of Health Manpower Education, National Institute of Health, 1973.

10. Fowler, H. and Gaudin, G. A Consortium to Determine and Provide Performance-Based Vocational Education Students. Columbus, Ohio: The Center for Vocational and Technical Education, 1970.

11. Glazener, Everett R. Education for a Changing World of Work. Washington D.C.: U.S. Government Printing Press, 1963.

12. Hill, Frank Ernest. Training for the Job. New York: American Association for Adult Education, 1940.

13. Homer, Rose C. The Development and Supervision of Training Program. Chicago: American Technical Society, 1974.

14. Koenigsberger, F. "Education and Training for the Metal Worker of 1980. Washington, D.C.: OECD Publications Center, Final Report, 1960.

15. Lawson, Milton E. Teaching Related Subject and Industrial and Technical Education. Columbus, Ohio: Bell and Howell Company, 1972.

16. Little, Kenneth J. Review and Synthesis of Research on Placement and Follow-up of Vocational Education Students. Columbus, Ohio: The Center for Vocational and Technical Education, 1970.

17. "Machinist". Chronicle Occupational Brief, D.O.T. 600. Moravia, New York: Chronicle Guidance, Inc., 1980.

18. Miller, Arron J. "Why Vocational Education". (Report to the State Vocational Education Conference, June, 1973) Stillwater, Oklahoma: State Vocational Education Department, 1973.

19. Morsh, J. Job Analysis in the United States Air Force. Lackland Air Force Base Texas: Personnel Research Laboratory, Wright Air Development Division, 1961.

20. Oklahoma Directory of Manufacturers and Products. Oklahoma City: Oklahoma Industrial Development Department, 1980.

21. Popham W. James and Sirotnik, Kenneth A. Educational Statistic Use and Interpretation. New York: Harper and Row Publisher, 1973.

22. Prosser, Charles A. and Quigley Thomas H. Vocational Education in a Democracy. Chicago: American Technical Society, (1949).

23. Runyan, Richard P. and Haber, Audray. General Statistics. Reading, Massachusetts: Addison - Wesley Publishing Company, 1967.

24. Tinnell, Richard W. "A Task Inventory of Technical Teachers in Oklahoma". (Unpub. Ed. D. dissertation, Oklahoma State University, 1975).

25. "The Shortage of Skilled Workers". Update, Vol. 4, No. 2 (October, 1981), p. 3.

26. Van Dalen, Deubold B. Understanding Educational Research. New York: McGraw-Hill Book Company, 1973.

27. Whitehead, Alfred Horth. The Aim of Education and Other Essays. London: London University Press, 1929.

APPENDIX A

DATA COLLECTION INSTRUMENT

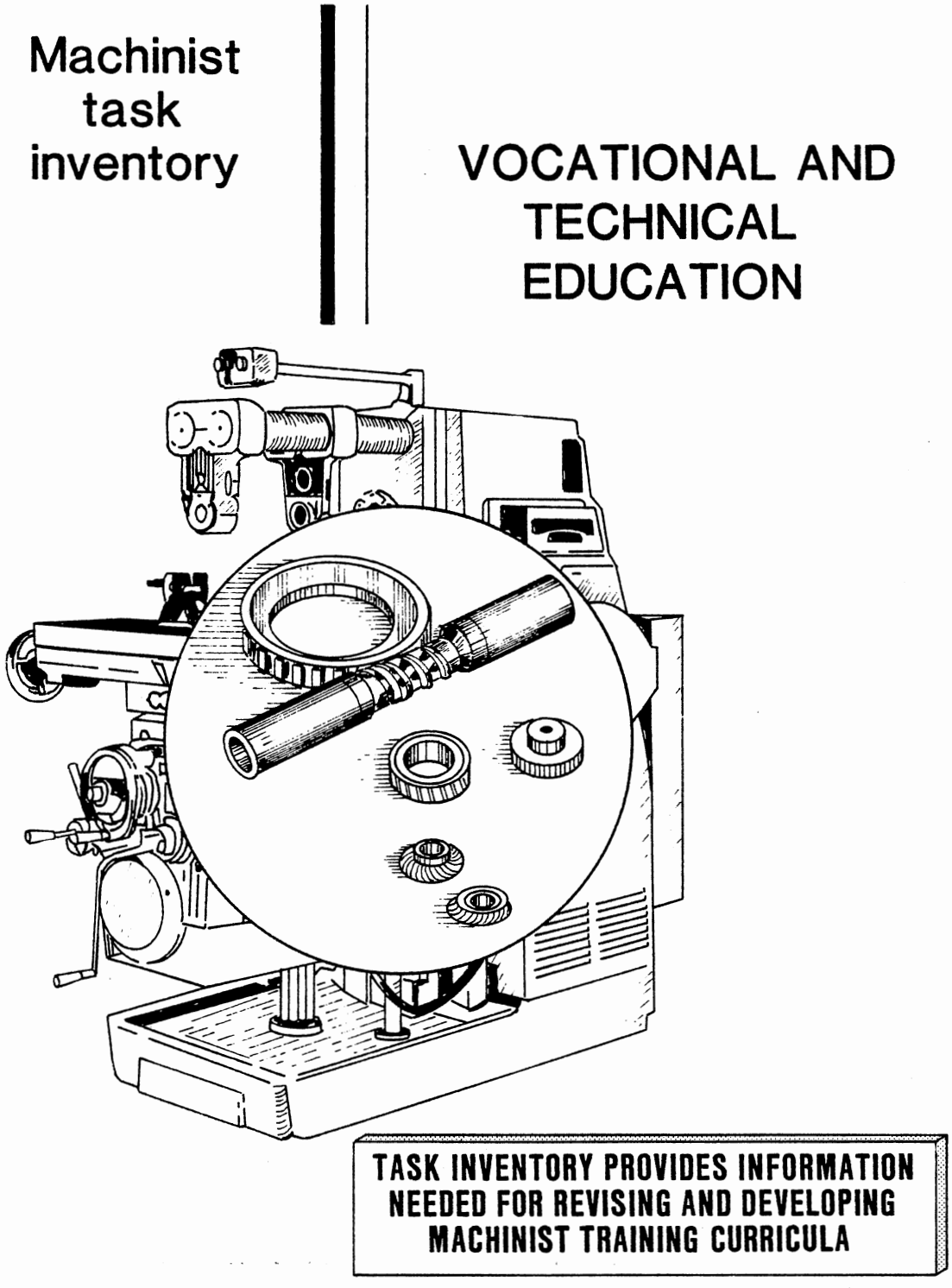


Figure 2. Example of Machine Tools and Machine Products

INSTRUCTIONS FOR COMPLETING THE TASK INVENTORY OF MACHINIST

1. Completing the task inventory is very easy, and it requires about one-half hour to do.

2. In completing the task inventory you are to respond in terms of your present regular job.

3. Fill in the task inventory background information. Be sure you provide all information asked for.

4. Read each task statement under every duty in the inventory. As you read, place a check mark (✓) in the check column beside each task you do.

5. At the end of each section write in any task you do which are not listed. Lastly, please return the whole booklet to your instructory/manager promptly.

Estimate the percentage of time that you spend on the average (say in the last year) in each of the following job activities.

	% of Time
1. Planning machine work	
2. Performing mathematical calculations	
3. Operating boring machines (HBM, VBM, Jig Borer)	
4. Operating lathes	
5. Operating milling machines	
6. Operating power saws	
7. Operating shapers	
8. Operating special machines (gear hobber, EDM, etc.)	
9. Performing benchwork	
10. Doing paper work	
List and rate other activities that you perform	100%

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY -

B. MATERIALS MACHINED

- TASK -

	Check How Often you Do It on the Job				Check the Skill Level Required to do It Well		
	Never	Rarely	Occasionally	Frequently	Low	Medium	High
1. Aluminum alloy						*	
2. Beryllium copper							
3. Brass							
4. Bronze							
5. Carbon stell							
6. Cast iron							
7. Copper							
8. Drill rod							
9. Fiberglass							
10. Flat ground stock							
11. Lead							
12. Lucite							
13. Magnesium							
14. Nylatron							
15. Nylon							
16. Phenolic							
17. Rubber							
18. Stainless steel							
19. Titanium							
20. Wood							
List and rate other materials that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY -

C. PLANNING MACHINE WORK

- TASK -

	Check How Often you Do It on the Job				Check the Skill Level Required to do it Well		
	Never	Rarely	Occasionally	Frequently	Low	Medium	High
1. Calculating dimensions not on print						*	
2. Design special tools and fixtures							
3. Determine heat treating requirements							
4. Determine machining operations for a single part							
5. Determine properties of materials							
6. Determine sequence of machining operations							
7. Make orthographic drawings of parts							
8. Make sketches of parts to be machined							
9. Plan for inspection of parts							
10. Plan jigs or fixtures							
11. Plan nonstandard tools or cutters							
12. Plan parts or hardware							
13. Resolve discrepancies on prints							
14. Select appropriate machine for job							
15. Select materials							
16. Use handbooks, etc., on methods and specs							
17. Use of standards and specs for machine work							
List and rate other planning activities that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY -

D. PERFORMING MATHEMATICAL CALCULATIONS

- TASK -

		Check How Often you Do It on the Job				Check the Skill Level Required to do It Well		
		Never	Rarely	Occasionally	Frequently	Low	Medium	High
1.	Calculate open and shut height of dies and presses							
2.	Calculate gear tooth and cutter values							
3.	Calculate data necessary to measure gear values							
4.	Calculate miniature or micro miniature threads							
5.	Calculate metric thread values							
6.	Calculate acme threads							
7.	Calculate gearing for hi or lo lead attachments							
8.	Calculate change gearing for a metric thread							
9.	Calculate Buttress thread values							
10.	Calculate square threads							
11.	Calculate 29° worms							
12.	Calculate die clearance values							
13.	Calculate wide range indexing							
14.	Calculate gear train for Fellows gear shaper							
15.	Calculate gear train for Barber Coleman gear hobber							
16.	Calculate astronomical indexing							
17.	Calculate multiple lead threads (external & internal)							
18.	Calculate unified threads (external, special)							
19.	Calculate unified threads (internal, special)							
20.	Calculate offset on jig borer rotary-tilt table							
21.	Calculate material strength							
22.	Calculate clearance, relief, and rake of tools							
23.	Calculate machine time for production of parts							
24.	Calculate bend radii and allowances (sheet metal)							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY - / - TASK -	Check How Often you Do It on the Job: Never	Rarely	Occasionally	Frequently	Check the Skill Level Required to do it Well: Low	Medium	High
D. PERFORMING MATHEMATICAL CALCULATIONS (Con't)							
25. Calculate linear indexing							
26. Calculate dipe thread values (external & internal)							
27. Calculate degree indexing							
28. Calculate spring values							
29. Calculate plain indexing							
30. Calculate unified threads (internal, standard)							
31. Calculate tolerances or allowances							
32. Calculate unified threads (external, standard)							
33. Calculate dimensions of keyseats, slots or grooves							
34. Calculate dimensions of parts from blueprints							
35. Calculate plating allowance							
36. Calculate shrinkage factor							
37. Calculate hole coordinates for jig borer							
38. Calculate raw stock sizes							
39. Calculate template ratios for pantograph							
40. Calculate machine speeds and feeds							
41. Calculate grind allowance on finished parts							
42. Calculate stock utilization in machine work							
43. Calculate micrometer readings							
44. Calculate roughing and finishing depth of cuts							
45. Calculate shrink factors for ceramics							
46. Calculate compaction ratio for isostatic pressing							
47. Calculate compaction ratio for conventional pressing							
48. Convert to metric measurements							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY - / - TASK -	Check How Often you Do It on the Job: Never	Rarely	Occasionally	Frequently	Check the Skill Level Required to do it Well: Low	Medium	High
D. PERFORMING MATHEMATICAL CALCULATIONS (Con't)							
49. Make trig calculations for compounded angles							
50. Make calculations for cam milling							
51. Make trig calculations for helices or leads							
52. Make trig calculations for lead alternation on lathe							
53. Make trig calculations for tapers							
54. Make trig calculations for sinebar or sineplate							
55. Make trig calculations for necessary dimensions							
List and rate other calculations that you teach							
E. OPERATING MILLING MACHINES							
1. Align milling machine accessory							
2. Align milling machine attachments							
3. Align milling machine cutting tools							
4. Align milling machine fixtures							
5. Bore holes							
6. Broach slots and grooves with stationary spindle							
7. Clean and lubricate milling machines							
8. Drill holes on milling machine							
9. Fly cut on milling machine							
10. Inspect machine for safe operating conditions							
11. Mill angles							
12. Mill compound angles							
13. Mill curves or radii							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then → Check How Often you Do It on the Job

And → Check the Skill Level Required to do it Well

- DUTY -

E. OPERATING MILLING MACHINES (Con't)

- TASK -

	Never	Rarely	Occasionally	Frequently	Low	Medium	High
14. Mill cylindrical work						*	
15. Mill dovetails							
16. Mill external seats, slots, or grooves							
17. Mill gears							
18. Mill helices							
19. Mill horizontal plane surfaces							
20. Mill vertical plane surfaces							
21. Operate die mill							
22. Perform climb cut milling operations							
23. Perform indexing operations with collet blocks							
24. Perform indexing operations with dividing head							
25. Perform indexing operations with rotary table							
26. Perform sawing and/or parting operations							
27. Perform straddle or gang milling operations							
28. Ream holes on milling machine							
29. Select and set speeds and feeds for milling work							
30. Select coolants, oils, or compounds for milling							
31. Select, shape, sharpen single point cutting tool							
32. Set up and align sine plate or table							
33. Set up and align work							
34. Use cherrying attachment							
List and rate other milling operations that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY -

F. OPERATING BORING MACHINES

- TASK -

OPERATING HORIZONTAL BORING MILLS (HBM)

		Check How Often you Do It on the Job				Check the Skill Level Required to do it Well		
		Never	Rarely	Occasionally	Frequently	Low	Medium	High
1.	Perform boring and drilling operations on HBM							
2.	Perform flat ribbing operation on HBM							
3.	Perform operation using digital readouts on HBM							
4.	Perform operations using rules							
5.	Use boring head on HBM							
6.	Perform operations using and measures							
7.	Perform thread chasing operation on HBM							
8.	Select and set feeds and speeds for HBM							
9.	Select Coolant, cutting oil, or compound for HBM							
10.	Use angle plates on HBM							
11.	Use alignment head for dividing head on HBM							
12.	Use auxiliary spindle on HBM							
13.	Use boring head on HBM							
14.	Use dividing head on HBM							
15.	Use long boring bar on HBM							
16.	Use right angle head on HBM							
17.	Use Rotab on HBM							
18.	Use rotary tables on HBM							
19.	Use Rusnok head on HBM							
20.	Use short boring bar on HBM							
21.	Use support ring for spindle on HBM							
22.	Use vertical spindle head on HBM							
	List and rate other HBM operations that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

	Check How Often you Do It on the Job				Check the Skill Level Required to do it Well		
	Never	Rarely	Occasionally	Frequently	Low	Medium	High
- DUTY -							
F. OPERATING BORING MACHINES (Con't)							
- TASK -							
OPERATING VERTICAL BORING MILLS (VBM)							
1. Perform boring operations on VBM							
2. Perform contour turning operations on VBM							
3. Perform facing operations on VBM							
4. Perform operation on VBM using side head							
5. Perform facing operations on VBM							
6. Perform operations using Turret							
7. Perform operation on VBM using post chucks							
8. Perform turning operations on VBM							
9. Perform operations with raising or lowering of rail							
10. Select and set feed and speed controls on VBM							
11. Select coolant, cutting oil, or compound for VBM							
List and rate any other VBM operations that you teach							
OPERATING JIG BORER							
1. Align jig borer attachments and accessories							
2. Perform precision boring operations on the jig borer							
3. Perform precision drilling operations on jig borer							
4. Perform precision reaming operations on jig borer							
5. Set up and align work pieces for jig borer							
List and rate other jig borer operations that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then → And →

- DUTY -

G. OPERATING LATHES

- TASK -

	Check How Often you Do It on the Job				Check the Skill Level Required to do it Well		
	Never	Rarely	Occasionally	Frequently	Low	Medium	High
1. Align tailstock center							
2. Bore holes on a lathe							
3. Center drill and drill holes							
4. Center part in 4 jaw chuck							
5. Center part in 6 jaw chuck							
6. Counterface or counterink holes with lathe							
7. Cut external threads, acme							
8. Cut external threads, Buttress							
9. Cut external threads, metric							
10. Cut external threads, multiple							
11. Cut external threads, pipe							
12. Cut external threads, square							
13. Cut external tapered surfaces							
14. Cut external threads, unified							
15. Cut inside threads, acme							
16. Cut inside threads, Buttress							
17. Cut inside threads, pipe							
18. Cut inside threads, multiple							
19. Cut inside threads, square							
20. Cut inside threads, metric							
21. Cut internal tapered surfaces							
22. Cut inside threads, unified							
23. Cut left hand threads							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then → And →

- DUTY - / - TASK -	Check How Often you Do It on the Job: Never	Rarely	Occasionally	Frequently	Check the Skill Level Required to do it Well: Low	Medium	High
G. OPERATING LATHES (Con't)							
24. Cut off or part finished work							
25. Cut worm for worm gear assemblies							
26. Inspect lathes for safe operating conditions							
27. Knurl							
28. Mount and turn soft jaws							
29. Perform contour turning operations							
30. Perform tapping operations							
31. Perform threading operations with a die							
32. Ream holes							
33. Rough and finish outside diameters							
34. Select and attach lathe attachments							
35. Select and attach lathe fixtures							
36. Select and attach tool holders							
37. Select coolant, cutting oil, compound for lathe							
38. Select and set speeds and feeds for lathe							
39. Set up and use faceplate for lathe							
40. Set up and use follower rest							
41. Set up and use mandrels							
42. Set up and use steady rest							
43. Set up material in 5-C collet							
44. Set up material in 3 jaw universal chuck							
45. Set up material in 115 collet							
46. Set up material in rubber-sleeve collect							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time. Then And

- DUTY - / - TASK -	Check How Often you Do It on the Job: Never	Rarely	Occassionally	Frequently	Check the Skill Level Required to do it Well: Low	Medium	High
G. OPERATING LATHES (Con't)							
47. Set up toolpost grinder							
48. Set up material in 215 collet							
49. Turn angular forms							
50. Turn grooves							
51. Turn long small diameters							
52. Turn long small diameters using box tool							
53. Turn parts between centers							
54. Turn shoulders or corners							
55. Use form tools for lathe							
56. Wind springs on lathe							
List and rate other lathe operations that you teach							
H. OPERATING POWER SAWS							
1. Clean and lubricate power saws							
2. Inspect power saws for safe operating conditions							
3. Remove, weld, or replace saw blades							
4. Select/apply coolants or cutting oils for sawing							
5. Set up and perform angular sawing operations							
6. Set and perform contour sawing operations							
7. Set up and perform straight sawing operations							
List and rate other power saw operations that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY -

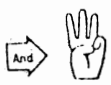
I. OPERATING SHAPERS

- TASK -

		Check How Often you Do It on the Job				Check the Skill Level Required to do it Well		
		Never	Rarely	Occasionally	Frequently	Low	Medium	High
1.	Align shaper attachments							
2.	Align shaper fixtures							
3.	Align shaper tools							
4.	Clean and lubricate shapers							
5.	Cut off or part with shaper							
6.	Finish angular work on the shaper							
7.	Finish external keyseats or grooves on shaper							
8.	Finish horizontal surfaces on the shaper							
9.	Finish internal keyseats or grooves on shaper							
10.	Finish irregular work on the shaper							
11.	Finish vertical surfaces on the shaper							
12.	Inspect shapers for safe operating conditions							
13.	Knurl a flat surface on the shaper							
14.	Perform rotary shaping							
15.	Select and set speeds and feeds of shapers							
16.	Select coolants or cutting oils for shaper work							
17.	Shape internal gears							
18.	Select, shape, sharpen cutting tools for shapers							
19.	Set up and align work							
	List and rate other shaper operations that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.



- DUTY - / - TASK -	Check How Often you Do It on the Job: Never	Rarely	Occasionally	Frequently	Check the Skill Level Required to do it Well: Low	Medium	High
J. OPERATING SPECIAL MACHINES							
OPERATING GEAR HOBBER							
1. Align machine attachments for gear hobber							
2. Perform gear generating operations							
3. Select and install gear trains							
4. Set up and align gear blank							
List and rate other hobber operations that you teach							
OPERATE PANTOGRAPH							
1. Adjust linkage per ratio							
2. Do profile work on Pantograph							
3. Do tree-dimensional on Pantograph							
4. Drill and counter bore holes							
5. Engrave a scale on Pantograph							
6. Graduate a scale on Pantograph							
7. Select and set speed of cutter							
8. Select, shape, or sharpen engraving tools							
9. Set up and align work piece							
List and rate other Pantograph operations that you teach							
OPERATING SANDERS							
1. Set up, align and operate sander							
List and rate other sanding operations that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY -

J. OPERATING SPECIAL MACHINES (Con't)

- TASK -

	Check How Often you Do It on the Job				Check the Skill Level Required to do it Well		
	Never	Rarely	Occasionally	Frequently	Low	Medium	High
OPERATE ELECTRICAL DISCHARGE MACHINE (EDM)							
1. Align machine attachments, fixtures, accessories							
2. Align tool head with work							
3. Fabricate tools for EDM							
4. Perform machining operations on EDM							
5. Set up and adjust machine controls							
List and rate other EDM operations that you teach							
OPERATING GRINDERS							
1. Grind internal and external surfaces							
2. Plain and form grind							
List and rate other grinding operations that you teach							
OPERATING NUMERICALLY CONTROLLED MACHINE TOOLS							
1. Mount workpiece in machine							
2. Operate NC machines							
3. Punch program tape							
4. Set up/adjust machine controls							
5. Select appropriate tools and fixtures							
6. Test and debug programs							
7. Write machine tool programs							
List and rate other NC operations that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then → And →

- DUTY -

K. PERFORMING BENCHWORK

- TASK -

		Check How Often you Do It on the Job				Check the Skill Level Required to do it Well		
		Never	Rarely	Occasionally	Frequently	Low	Medium	High
1.	Bench check mechanical components (assemblies)							
2.	Clean floors							
3.	Clean/prepare mechanical components (assemblies)							
4.	Cut materials with hand hacksaw							
5.	Cut threads with hand taps and dies							
6.	Disassemble and/or assemble parts							
7.	Dispose of scrap metal, chips, or shavings							
8.	Dispose of trash or oily waste material							
9.	Hand file a template							
10.	Hand file radii							
11.	Hand lap or hone surfaces							
12.	Hand scrape bearing surfaces							
13.	Hand sharpen or hone cutting tools with stones							
14.	Install bushings and other non-threaded inserts							
15.	Install helicoils and other threaded inserts							
16.	Lay out a rough casting							
17.	Perform deburring operations							
18.	Perform functional try out of jigs, dies, fixtures							
19.	Perform general layout work							
20.	Perform spring winding on bench							
21.	Prepare, clean, or inspect work area for safety							
22.	Clean up adjacent work areas							
23.	Press green ceramics from powder							
24.	Ream holes with hand reamers							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY -

K. PERFORMING BENCHWORK (Con't)

- TASK -

	Check How Often you Do It on the Job				Check the Skill Level Required to do it Well		
	Never	Rarely	Occasionally	Frequently	Low	Medium	High
25. Remove or install pins							
26. Remove/replace gears, pulleys, wheels, etc.							
27. Rework threads with thread files							
28. Rough and finish surfaces with hand files							
29. Silver solder							
30. Soft solder							
31. Straighten miscellaneous parts							
32. Use a hand broach							
33. Use hand grinder							
34. Work materials with hammer, punches, or chisels							
35. Work materials with portable hand drill							
List and rate other benchwork operations that you teach							

MACHINIST TASK INVENTORY

Consider each of the following job tasks one at a time.

Then

And

- DUTY -

L. DOING PAPERWORK

- TASK -

		Check How Often you Do It on the Job				Check the Skill Level Required to do it Well		
		Never	Rarely	Occasionally	Frequently	Low	Medium	High
1.	Draft correspondence or reports							
2.	Drawing sketches							
3.	Maintain work records and other paperwork							
4.	Order and receive stock, material and supplies							
5.	Plan work for other people							
6.	Prepare cost estimates for projects							
7.	Review inspection reports							
8.	Scheduling work other than machine work							
9.	Spend time with consultants							
10.	Study reports on materials							
11.	Supervise and evaluate other people's work							
	List and rate other paperwork that you teach							

APPENDIX B

MEAN (AVERAGE) RATING FOR EACH TASK

MEAN (AVERAGE) RATING FOR EACH TASK PERFORMED

A mean rating is shown for each group (JI = Job incumbents, AS = Adult students, MI = Machinist instructors) on each item rated.

A. BASIC TIME ALLOCATIONS. Please estimate the percentage of time that you spent on the average (say in the last year) in each of the following job activities.

	MEAN PERCENTAGE OF TIME RATING		
	JI	AS	MI
1. Planning machine work	11.7	6.7	10.5
2. Performing math calculations	10.9	6.1	11.0
3. Operating boring machine	2.3	3.8	8.1
4. Operating lathes	27.5	34.1	25.6
5. Operating milling machines	20.7	20.8	18.5
6. Operating power saws	5.3	6.3	4.8
7. Operating shapers	0.9	0.8	0.1
8. Operating special machines	2.3	4.5	1.6
9. Performing bench work	6.3	10.9	8.6
10. Doing paper work	11.8	5.4	7.4

B. MATERIALS MACHINED. About how often do you really do each of the following? How much skill level is required to do it well?

	HOW OFTEN			SKILL LEVEL		
	JI	AS	MI	JI	AS	MI
1. Aluminum alloy	3.0	2.9	3.8	3.1	2.3	3.4
2. Berylium copper	1.5	1.4	1.4	0.9	0.8	1.0
3. Brass	2.9	1.9	2.3	2.8	1.4	2.0
4. Bronze	2.5	1.6	1.8	2.2	1.2	1.8
5. Carbon steel	3.4	3.0	3.7	2.9	2.0	3.2
6. Operating power saws	2.9	2.2	1.8	2.8	1.6	1.0
7. Operating shapers	1.9	1.4	1.5	1.4	1.1	1.0
8. Drill rod	2.2	1.8	2.6	2.1	1.6	2.2
9. Fiberglass	1.2	1.3	1.2	0.5	0.6	0.6
10. Flat ground stock	2.3	2.2	2.3	2.2	1.6	2.2
11. Lead	1.3	1.2	1.4	0.6	0.6	1.0
12. Lucite	1.3	1.2	1.1	0.6	0.4	0.6
13. Magnesium	1.5	1.3	1.3	1.2	1.0	1.2
14. Nylatron	1.2	1.1	1.1	0.5	0.6	0.6
15. Nylon	2.0	1.5	1.7	1.8	0.9	1.4
16. Phenolic	2.0	1.3	1.5	1.8	0.6	1.0
17. Rubber	1.9	1.2	1.1	1.2	0.6	0.6
18. Stainless steel	3.0	2.6	2.7	2.7	2.4	2.8
19. Titanium	1.5	1.3	1.3	0.9	0.9	1.0
20. Wood	1.5	1.6	1.2	1.0	1.2	1.2

C. PLANNING MACHINE WORK	HOW OFTEN			SKILL LEVEL		
	JI	AS	MI	JI	AS	MI
1. Calculating dimensions not on print	3.0	3.3	3.6	2.8	3.1	3.2
2. Design special tools and fixtures	2.7	2.5	2.5	2.8	2.6	1.8
3. Determine heat treating requirements	1.8	1.8	2.3	1.2	1.8	1.0
4. Determine machining operations for a single part	3.1	3.1	3.8	2.9	2.4	3.2
5. Determine properties of materials	1.8	1.9	2.3	1.0	1.7	1.4
6. Determine sequence of machining operations	3.3	3.1	3.8	2.9	2.2	3.2
7. Make orthographic drawings of parts	1.8	1.9	2.2	1.1	1.6	0.6
8. Make sketches of parts to be machined	2.6	2.7	3.5	2.1	2.1	2.6
9. Plan for inspection of parts	2.5	2.3	3.2	2.1	1.8	3.0
10. Plan jigs or fixtures	2.6	2.2	2.5	2.1	2.1	2.2
11. Plan nonstandard tools or cutters	2.4	2.3	2.3	2.1	2.2	2.0
12. Plan parts or hardware	2.3	1.8	2.4	1.6	1.6	2.0
13. Resolve discrepancies on prints	2.6	2.3	3.1	2.3	2.1	2.6
14. Select appropriate machine job	3.3	2.9	3.8	3.1	2.2	3.2
15. Select materials	2.4	2.7	3.3	2.2	1.9	2.6
16. Use handbooks etc. on methods and specs	2.8	2.5	3.9	2.4	2.0	3.2
17. Use of standard and specs for machine work	3.1	2.7	3.9	2.9	1.8	3.6

D. PERFORMING MATHEMATICAL CALCULATIONS						
1. Cal. opent and shut height of dies and presses	1.8	1.4	1.4	1.1	1.3	0.4
2. Calculate gear tooth and cutter values	1.5	1.7	1.8	0.6	1.8	1.2
3. Calculate data necessary to measure gear values	1.3	1.4	1.8	0.3	1.3	1.0
4. Calculate miniature or micro miniature threads	1.3	1.3	1.5	0.6	1.0	1.0
5. Calculate metric threads values	1.6	1.3	2.0	0.9	1.1	2.2
6. Calculate acme threads	2.0	1.9	3.1	1.6	1.7	3.2
7. Calculate gearing fo hi lo lead attachments	1.6	1.2	1.5	0.9	0.7	1.0
8. Calculate change gearing for a metric thread	1.4	1.2	1.2	0.5	0.7	0.4
9. Calculate Buttress thread values	1.3	1.2	1.2	0.6	0.7	0.9
10. Calculate square threads	1.3	1.4	2.1	0.6	1.0	1.6
11. Calculate 29° worms	1.4	1.1	1.9	0.8	0.8	1.4
12. Calculate die clearance values	1.6	1.3	1.3	0.8	1.2	0.4
13. Calculate wide range indexing	1.5	1.5	2.5	0.8	1.4	2.8
14. Calculate gear train for Fellows gears shaper	1.1	1.1	1.0	0.1	0.9	0.4
15. Cal. gear train for Barber coleman gear hobber	1.1	1.0	1.0	0.1	0.7	0.4
16. Calculate astronomical indexing	1.0	1.0	1.2	0.3	0.7	0.4
17. Calculate multiple lead threads (ext. & int.)	1.7	1.5	2.4	1.0	1.3	2.2
18. Calculate unified threads (external, special)	2.0	1.8	3.4	1.5	1.2	3.0
19. Calculate unified threads (internal, special)	2.0	1.7	3.4	1.5	1.3	3.0
20. Calculate offset on jig borer rotary-tilt table	1.3	1.5	2.0	0.4	1.3	1.6
21. Calculate material strenght	1.5	1.6	1.5	0.7	1.4	0.6
22. Calculate clearance, relief, and rake of tools	2.3	2.5	3.3	1.8	1.7	2.8
23. Calculate machine time for production of parts	2.7	2.3	2.9	2.3	1.4	2.2
24. Calculate bend radii and allowances (sheet metal)	1.6	1.4	1.2	0.6	1.1	0.6
25. Calculate linear indexing	1.4	1.5	2.0	0.5	1.4	1.8

D. PERFORMING MATHEMATICAL CALCULATIONS con't	HOW OFTEN			SKILL LEVEL		
	JI	AS	MI	JI	AS	MI
26. Calculate pipe thread values	1.8	1.6	2.3	1.1	1.2	1.6
27. Calculate degree indexing	2.2	1.9	3.2	1.9	1.4	3.0
28. Calculate spring values	1.4	1.3	1.4	0.6	1.0	0.4
29. Calculate plain indexing	2.0	1.6	3.5	1.4	1.1	3.0
30. Calculate unified threads	2.3	2.1	3.6	1.8	1.4	3.0
31. Calculate tolerances or allowances	2.9	2.8	3.5	2.5	2.1	3.2
32. Calculate unified threads	2.4	2.1	3.6	1.7	1.3	3.0
33. Calculate dimensions of keyseats, etc.	2.7	2.0	3.0	2.2	1.5	2.8
34. Cal. dimensions of parts from blueprints	3.3	2.9	3.8	2.8	1.8	3.2
35. Calculate plating allowance	1.9	1.8	1.5	1.3	1.3	0.8
36. Calculate shrinkage factor	2.2	1.6	1.7	1.5	1.3	0.6
37. Calculate hole coordinates for jig borer	1.6	1.7	2.2	0.7	1.3	1.4
38. Calculate raw stock sizes	2.6	2.5	3.3	2.5	1.4	2.6
39. Calculate template ratios for pantograph	1.1	1.3	1.1	0.3	0.9	0.4
40. Calculate machine speeds and feeds	3.4	3.4	4.0	2.9	2.6	3.2
41. Calculate grind allowance on finished parts	2.8	2.7	2.7	2.4	1.9	2.6
42. Calculate stock utilization in machine work	2.6	2.2	2.8	2.2	1.6	2.2
43. Calculate micrometer readings	3.1	3.1	4.0	2.5	2.2	3.4
44. Cal. roughing and finishing depth of cuts	3.5	3.3	4.0	3.1	2.3	3.6
45. Calculate shrink factors for ceramics	1.0	1.3	1.0	0.1	1.2	0.4
46. Cal. compaction ratio for isostatic pressing	1.1	1.1	1.0	0.1	0.9	0.0
47. Cal. compaction ratio for conv. pressing	1.5	1.2	1.0	0.7	1.2	0.0
48. Convert to metric measurements	1.8	1.7	2.1	0.9	1.0	1.4
49. Make trig cal. for compounded angles	2.4	2.2	3.2	1.6	1.9	2.8
50. Make calculations for cam milling	1.4	1.5	1.3	0.6	1.2	0.4
51. Make trig cal. for helices of leads	1.4	1.3	1.9	0.7	1.1	0.8
52. Make trig cal. for lead alternation on lathe	1.4	1.4	2.0	0.6	1.2	1.2
53. Make trig calculations for tapers	2.4	2.2	3.6	1.7	1.8	3.2
54. Make trig calculations for sinebar or sineplate	1.9	1.8	2.6	1.2	1.5	2.0
55. Make trig calculations for necessary dimensions	2.2	2.3	3.8	1.4	1.6	3.4
E. OPERATING BORING MACHINES						
OPERATING HORIZONTAL BORING MILLS (HBM)						
1. Perform boring and drilling operations on HBM	2.1	1.8	1.6	1.5	1.2	0.2
2. Perform flat ribbing operations on HBM	1.2	1.5	1.4	0.3	0.9	0.2
3. Perform operation using digital readouts on HBM	1.5	1.4	2.0	0.9	0.9	1.0
4. Perform operations using rules	2.2	1.8	1.7	1.5	0.9	0.4
5. Use boring head on HBM	2.1	1.9	1.6	1.5	1.1	0.6
6. Perform operations using end measures	2.0	1.9	2.0	1.4	1.1	0.8
7. Perform thread chasing operation on HBM	1.3	1.5	1.2	0.5	1.1	0.0
8. Select and set feeds and speeds for HBM	2.3	2.0	1.9	1.6	1.3	1.2
9. Select coolant, cutting oil, or compound for HBM	2.0	1.9	1.5	1.3	0.8	0.2
10. Use angle plates on HBM	1.7	1.6	1.5	1.2	0.8	0.2
11. Use alignment head for dividing head on HBM	1.5	1.6	1.5	0.7	0.9	0.6
12. Use auxiliary spindle on HBM	1.3	1.3	1.4	0.5	0.6	0.2
13. Use boring head on HBM	1.9	1.7	1.7	1.4	0.9	0.6

OPERATING HORIZONTAL BORING MILLS (HBM) con't	HOW OFTEN			SKILL LEVEL		
	JI	AS	MI	JI	AS	MI
14. Use dividing head on HBM	1.6	1.6	1.4	0.9	1.2	0.2
15. Use long boring bar on HBM	1.9	1.5	1.5	1.4	0.8	0.4
16. Use right angle head on HBM	1.4	1.4	1.4	0.9	0.8	0.2
17. Use Rotab on HBM	1.3	1.1	1.5	0.5	0.6	0.2
18. Use rotary tables on HBM	1.6	1.5	1.5	1.1	0.9	0.2
19. Use Rusnok bead on HBM	2.2	1.2	1.4	0.1	0.5	0.2
20. Use short boring bar on HBM	1.2	1.8	1.6	1.6	1.1	0.4
21. Use support ring for spindle on HBM	1.4	1.5	1.6	0.5	0.8	0.4
22. Use vertical spindle head on HBM	1.5	1.5	1.4	0.9	0.7	0.4
OPERATING VERTICAL BORING MILLS (VBM)						
23. Perform boring operations on VBM	2.2	1.9	2.3	1.5	1.1	1.4
24. Perform contour turning operations on VBM	1.6	1.6	1.7	0.9	1.0	0.8
25. Perform facing operations on VBM	2.2	1.9	2.4	1.5	1.2	1.8
26. Perform operation on VBM using side head	1.6	1.3	1.4	0.9	0.5	0.2
27. Perform facing operations on VBM	2.2	1.6	2.6	1.5	0.7	2.0
28. Perform operations using Turrer	1.6	1.4	1.6	0.8	0.6	0.6
29. Perform operation on VBM using post chucks	1.4	1.5	1.5	0.7	0.9	0.6
30. Perform turning operation on VBM	1.5	1.6	1.6	0.8	0.9	0.8
31. Perform operations with raising	1.6	1.5	1.4	0.8	0.6	0.4
32. Select and set feed and speed controls on VBM	2.2	1.9	2.2	1.3	0.8	0.4
33. Select coolant, etc. or compound for VBM	1.9	1.7	2.1	1.3	0.8	1.4
OPERATING JIG BORER						
34. Align jig borer attachements and accessories	1.3	2.0	1.7	0.5	1.2	1.0
35. Perform precision boring operations etc.	1.3	1.7	1.7	0.5	1.2	1.0
36. Perform precision drilling operations etc.	1.3	1.7	1.8	0.5	1.2	1.0
37. Perform precision reaming operations etc.	1.3	1.8	1.7	0.5	1.2	0.6
38. Set up and align work pieces for jig borer	1.3	1.9	1.7	0.5	1.1	1.0
F. OPERATING LATHES						
1. Align tailstock center	2.8	2.8	3.8	2.7	2.5	3.0
2. Bore holes on a lathe	3.4	3.4	4.0	2.9	2.4	3.4
3. Center drill and drill holes	3.4	3.4	4.0	2.9	2.3	3.6
4. Center part in 4 haw chuck	3.1	2.7	3.7	2.8	2.1	3.4
5. Center part in 6 jaw chuck	1.8	1.4	1.5	1.9	1.2	0.6
6. Counterface of contersink holes with lathe	3.1	2.8	3.5	2.8	1.7	3.2
7. Cut external threads, acme	2.7	2.3	3.2	2.3	2.1	2.8
8. Cut external threads, Buttress	1.9	1.9	1.6	1.0	1.7	0.8
9. Cut external threads, metric	1.8	1.4	2.1	1.4	1.3	1.4
10. Cut external threads, multiple	1.8	1.9	2.7	1.2	1.8	2.2

F. OPERATING LATHES con't	HOW OFTEN			SKILL LEVEL		
	JI	AS	MI	JI	AS	MI
11. Cut external threads, pipe	2.2	2.0	2.6	1.6	1.7	2.0
12. Cut external threads, square	1.8	1.5	2.3	1.2	1.3	1.8
13. Cut external tapered surfaces	2.8	2.4	3.6	2.4	2.2	3.2
14. Cut external threads, unified	2.4	2.6	3.8	1.9	2.1	3.4
15. Cut inside threads, acme	2.3	1.7	2.4	2.1	1.6	2.0
16. Cut inside threads, Buttress	1.6	1.6	1.5	1.1	1.4	0.8
17. Cut inside threads, pipe	1.9	1.7	2.4	1.4	1.5	1.6
18. Cut inside threads, multiple	1.6	1.5	2.3	1.2	1.4	1.8
19. Cut inside threads, square	1.5	1.4	1.9	1.1	1.2	1.0
20. Cut inside threads, metric	1.6	1.3	2.1	1.3	1.1	1.4
21. Cut internal tapered surfaces	2.5	2.1	3.1	2.2	1.8	2.6
22. Cut inside threads, unified	2.4	2.1	3.4	1.9	1.6	2.8
23. Cut left hand threads	2.2	1.9	2.7	1.9	1.5	2.2
24. Cut off or part finished work	3.0	3.0	3.7	2.7	2.4	3.4
25. Cut worm for worm gear assemblies	1.3	1.3	1.4	0.7	0.9	0.4
26. Inspect lathes for safety operation	2.9	2.9	4.0	2.6	1.9	3.4
27. Knurl	2.5	2.9	3.9	2.4	2.3	3.6
28. Mount and turn soft jaws	2.9	2.6	2.6	2.7	1.7	1.8
29. Perform contour turning operations	2.3	2.6	2.8	1.9	2.2	2.2
30. Perform tapping operation	2.9	3.0	3.3	2.8	2.2	2.8
31. Perform threading operations with a die	2.6	2.7	2.9	2.5	1.9	2.6
32. Ream holes	2.9	2.9	3.7	2.9	2.1	3.2
33. Rough and finish outside diameters	3.5	3.6	4.0	2.9	2.6	3.6
34. Select and attach lathe attachments	3.3	3.2	3.9	2.8	2.2	3.4
35. Select and attach lathe fixtures	3.1	3.3	3.2	2.7	2.1	2.8
36. Select and attach tool holders	3.3	3.4	4.0	2.9	2.2	3.6
37. Select coolant, etc. for lathe	3.1	2.9	3.6	2.4	1.9	3.0
38. Select and set speeds and feeds for lathe	3.5	2.6	4.0	2.7	2.7	3.6
39. Set up and use faceplate for lathe	2.6	2.4	3.1	2.5	2.0	3.0
40. Set up and use follower rest	2.2	2.1	2.8	2.1	1.6	2.6
41. Set up and use mandrels	2.2	2.4	2.7	2.1	1.8	2.2
42. Set up and use steady rest	3.0	2.2	3.0	2.6	1.6	2.6
43. Set up material in 5-C collet	2.2	2.1	3.1	1.9	1.3	2.8
44. Set up material in 3 jaw universal chuck	3.4	3.5	3.9	2.9	2.2	3.4
45. Set up material in 115 collet	1.5	1.4	1.3	0.7	1.2	0.4
46. Set up material in rubber-sleeve collect	1.5	1.3	1.7	1.1	0.8	1.4
47. Set up toolpost grinder	2.2	1.9	1.7	2.2	1.6	1.0
48. Set up material in 215 collet	1.4	1.3	1.3	0.6	1.0	0.6
49. Turn angular forms	2.3	2.5	3.2	2.1	2.1	2.8
50. Turn grooves	3.2	2.9	3.6	2.8	2.2	3.2
51. Turn long small diameters	2.7	2.9	3.2	2.5	2.5	3.0
52. Turn long small diameters using box tool	1.9	1.9	2.0	1.1	1.5	1.2
53. Turn parts between centers	2.6	2.6	3.6	2.4	2.2	3.4
54. Turn shoulders or corners	3.3	3.1	4.0	2.8	2.1	3.4
55. Use form tools for lathe	2.9	2.9	3.2	2.6	2.3	2.8
56. Wing springs on lathe	1.5	1.6	1.4	0.7	2.1	0.6

G. OPERATING MILLING MACHINES	HOW OFTEN			SKILL LEVEL		
	JI	AS	MI	JI	AS	MI
1. Align milling machine accessories	3.1	3.0	4.0	2.6	2.4	3.4
2. Align milling machine attachments	2.9	2.9	4.0	2.6	2.3	3.4
3. Align milling machine cutting tools	3.0	3.1	4.0	2.6	2.3	3.4
4. Align milling machine fixtures	3.2	3.0	4.0	2.7	2.3	3.4
5. Bore holes	3.1	2.7	3.6	2.6	2.1	3.2
6. Broach slots and grooves with stationary spindle	2.0	1.8	1.6	1.7	1.4	1.4
7. Clean and lubricate milling machines	2.8	3.2	3.4	2.4	2.0	3.2
8. Drill holes on milling machine	3.3	3.2	3.7	2.8	2.1	3.6
9. Fly cut on milling machine	3.2	2.7	3.6	2.6	2.2	3.4
10. Inspect machine for safe operating conditions	2.9	2.9	3.7	2.5	2.1	3.4
11. Mill angles	2.9	2.6	3.6	2.5	1.9	3.4
12. Mill compound angles	2.5	2.0	2.8	2.1	1.8	2.2
13. Mill curves or radii	2.5	2.3	3.2	2.0	1.8	3.0
14. Mill cylindrical work	2.4	1.9	3.0	2.0	1.3	2.6
15. Mill devetails	1.9	1.7	2.2	1.6	1.2	1.8
16. Mill external seats, slots, or grooves	2.8	2.3	3.1	2.6	1.8	2.8
17. Mill gears	1.8	1.3	2.2	1.4	0.9	1.0
18. Mill helices	1.3	1.3	1.4	0.7	0.9	0.6
19. Mill horizontal plane surfaces	2.9	2.5	3.8	2.6	1.8	3.2
20. Mill vertical plane surfaces	2.8	2.4	3.7	2.5	1.8	3.0
21. Operate die mill	1.5	1.3	1.3	0.7	0.9	0.2
22. Perform climb cut milling operations	2.6	2.1	3.3	1.7	1.3	3.0
23. Perform indexing oper'ts with collet blocks	1.7	1.8	1.7	1.1	1.4	1.2
24. Perform indexing oper'ts with dividing head	2.7	2.0	3.4	2.2	1.8	3.0
25. Perform indexing oper'ts with rotary table	2.7	1.9	3.3	2.3	1.7	2.8
26. Perform sawing and/or parting operations	2.3	1.9	2.7	2.1	1.8	1.6
27. Perform straddle or gang milling operations	2.1	1.8	2.2	1.5	1.6	1.2
28. Ream holes on milling machine	2.9	2.4	3.4	2.5	1.8	2.8
29. Select and set speeds and feeds for milling work	3.3	3.3	4.0	2.7	2.3	3.6
30. Select coolants, oils, or compound for milling	2.7	2.8	3.7	2.1	1.8	3.0
31. Sharpen single point cutting tool	2.9	2.8	3.6	2.7	2.0	3.0
32. Set up and align sine plate or table	2.4	2.1	2.0	2.2	1.7	1.4
33. Set up and align work	3.2	3.1	4.0	2.8	2.2	3.4
34. Use cherrying attachment	1.3	1.4	1.1	0.6	0.8	0.2
H. OPERATING POWER SAWS						
1. Clean and lubricate power saws	2.2	2.6	3.8	1.9	1.6	3.2
2. Inspect power saws for safety operation	2.7	2.7	4.0	2.2	1.7	3.6
3. Remove, weld, or replace saw blades	2.6	2.9	3.8	2.4	2.1	3.6
4. Apply coolants for sawing	2.6	2.8	3.7	2.0	1.6	3.0
5. Set up and perform angular sawing operation	2.4	2.3	2.9	2.1	1.8	2.4
6. Set up and perform contour sawing operations	1.9	2.2	3.1	1.5	1.6	2.6
7. Set up and perform straight sawing operations	2.8	3.2	3.9	2.3	2.0	3.4

I. OPERATING SHAPERS	HOW OFTEN			SKILL LEVEL		
	JI	AS	MI	JI	AS	MI
1. Align shaper attachments	1.3	1.4	1.5	0.6	0.6	0.2
2. Align shaper fixtures	1.3	1.4	1.5	0.6	0.6	0.2
3. Align shaper tools	1.3	1.5	1.5	0.6	0.8	0.2
4. Clean and lubricate shapers	1.2	1.4	1.5	0.3	0.6	0.2
5. Cut off or part with shaper	1.2	1.2	1.2	0.5	0.4	0.0
6. Finish angular work on the shaper	1.3	1.4	1.2	0.7	0.6	0.0
7. Finish ext. keyseats or grooves on shaper	1.2	1.3	1.0	0.5	0.4	0.0
8. Finish horizontal surfaces on the shaper	1.4	1.4	1.5	0.7	0.6	0.2
9. Finish int. keyseats or grooves on shaper	1.3	1.4	1.1	0.5	0.6	0.0
10. Finish irregular work on the shaper	1.3	1.3	1.2	0.6	0.6	0.0
11. Finish vertical surfaces on the shaper	1.2	1.3	1.4	0.6	0.7	0.2
12. Inspect shapers for safety operation	1.2	1.4	1.5	0.5	0.4	0.2
13. Knurl a flat surface on the shaper	1.0	1.0	1.1	0.2	0.2	0.0
14. Perform rotary shaping	1.1	1.0	1.0	0.2	0.3	0.0
15. Select and set speeds and feeds of shapers	1.3	1.4	1.5	0.6	0.7	0.2
16. Select cutting oils for shaper work	1.2	1.4	1.2	0.4	0.5	0.0
17. Shape internal gears	1.1	1.0	1.0	0.2	0.4	0.0
18. Sharpen cutting tools for shapers	1.4	1.3	1.5	0.8	0.7	0.2
19. Set up and align work	1.3	1.5	1.5	0.8	0.7	0.2
J. OPERATING SPECIAL MACHINES						
OPERATING GEAR HOBBER						
1. Align machine attachments for gear hobber	1.1	1.1	1.0	0.3	0.4	0.0
2. Perform gear generating operations	1.1	1.1	1.0	0.3	0.4	0.0
3. Select and install gear trains	1.3	1.2	1.0	0.4	0.5	0.0
4. Set up and align gear blank	1.3	1.0	1.0	0.4	0.5	0.0
OPERATE PANTOGRAPH						
5. Adjust linkage per ratio	1.0	1.1	1.0	0.2	0.5	0.0
6. Do profile work on Pantograph	1.1	1.2	1.0	0.1	0.5	0.0
7. Do three-dimensional on Pantograph	1.0	1.2	1.0	0.0	0.5	0.0
8. Drill and counter bore holes	1.0	1.1	1.0	0.1	0.4	0.0
9. Engrave a scale on Pantograph	1.0	1.1	1.0	0.1	0.5	0.0
10. Graduate a scale on Pantograph	1.0	1.1	1.0	0.1	0.5	0.0
11. Select and set speeds on cutter	1.0	1.1	1.0	0.2	0.4	0.0
12. Sharpen engraving tools	1.0	1.1	1.0	0.2	0.5	0.0
13. Set up and align work piece	1.1	1.1	1.0	0.1	0.5	0.0
OPERATE ELECTRICAL DISCHARGE MACHINE (EDM)						
14. Align machine attachments, etc.	1.3	1.3	1.3	0.7	0.7	0.4
15. Align tool head with work	1.4	1.3	1.3	0.7	0.7	0.4
16. Fabricate tools for EDM	1.3	1.2	1.3	0.6	0.6	0.4
17. Perform machining operations on EDM	1.2	1.2	1.3	0.6	0.7	0.4
18. Set up and adjust machine controls	1.4	1.3	1.3	0.8	0.7	0.4

J. OPERATING SPECIAL MACHINES con't	HOW OFTEN			SKILL LEVEL		
OPERATING SANDERS	JI	AS	MI	JI	AS	MI
19. Set up, align and operate sander	2.0	2.2	2.0	1.5	1.2	1.4
OPERATING GRINDERS						
20. Grind internal and ext. surfaces	2.4	2.8	2.4	2.2	2.6	1.6
21. Plain and form grind	2.3	2.6	2.6	2.1	2.4	2.0
OPERATING NUMERICALLY CONTROLLED MACHINE TOOLS						
22. Mount workpiece in machine	1.9	2.3	3.3	1.1	1.6	3.0
23. Operate NC machines	1.9	2.2	3.3	1.1	1.7	3.0
24. Punch program tape	1.8	1.7	3.3	0.9	1.2	3.0
25. Set/up adjust machine controls	1.9	2.1	3.2	1.2	1.7	2.8
26. Select appropriate tools and fixtures	1.9	2.0	3.2	1.2	1.4	2.8
27. Test and debug programs	2.0	2.0	3.1	1.2	1.8	2.6
28. Write machine tool programs	1.9	1.9	2.9	1.0	1.6	2.6
K. PERFORMING BENCHWORK						
1. Bench check mechanical components	2.5	2.7	3.1	1.9	2.3	2.2
2. Clean floors	2.7	2.3	3.9	2.2	1.7	3.4
3. Clean/prepare mechanical components	2.5	2.9	3.1	1.9	1.9	2.8
4. Cut materials with hand hacksaw	2.6	2.9	3.0	2.4	1.7	2.4
5. Cut threads with hand taps and dies	2.9	3.1	3.4	2.8	1.7	3.0
6. Disassemble and/or assemble parts	2.7	2.9	3.1	2.4	2.0	2.6
7. Dispose of scrap metal, chips, or shavings	2.7	3.2	3.7	2.3	1.6	3.0
8. Dispose of trash or oily waste material	2.6	3.1	3.9	2.3	1.4	3.6
9. Hand file a template	2.4	2.4	2.3	2.0	1.8	1.8
10. Hand file radii	2.7	2.7	3.0	2.3	2.0	2.8
11. Hand lap or hone surfaces	2.4	2.4	2.3	1.9	1.9	1.2
12. Hand scrape bearing surfaces	1.8	2.0	1.6	1.1	1.4	0.8
13. Hand sharpen or hone cutting tools with stones	2.8	2.5	3.3	2.6	1.9	2.6
14. Install bushings and other non-threaded inserts	2.8	2.3	2.3	2.4	1.6	1.8
15. Install helecoils and other threaded inserts	2.4	1.9	2.0	2.3	1.2	1.8
16. Lay out a rough casting	2.4	1.9	2.2	1.8	1.3	1.4
17. Perform deburring operations	2.9	2.9	3.7	2.7	1.3	3.4
18. Perform functional try out of jigs, etc.	2.8	2.3	2.1	2.4	1.7	1.4
19. Perform general layout work	2.8	2.9	3.6	2.5	2.2	3.2
20. Perform spring winding on bench	1.5	1.6	1.5	0.6	1.0	0.4
21. Inspect work area for safety	1.5	2.9	4.0	1.9	1.7	3.4
22. Clean up adjacent work areas	2.6	2.5	3.6	2.2	1.2	3.2
23. Press green ceramics from powder	1.2	1.4	1.4	0.1	0.7	0.4
24. Ream holes with hand reamers	2.3	2.4	2.8	2.2	1.8	2.0
25. Remove or install pins	2.8	2.7	2.7	2.4	1.7	2.0

K. PERFORMING BENCHWORK con't	HOW OFTEN			SKILL LEVEL		
	JI	AS	MI	JI	AS	MI
26. Remove/replace gears, pulleys, etc.	2.6	2.4	2.8	2.4	1.7	2.0
27. Rework threads with thread files	2.6	2.4	3.0	2.4	1.6	2.4
28. Rough and finish surfaces with hand files	2.5	2.6	3.1	2.0	1.8	2.4
29. Silver solder	1.9	1.9	1.4	1.4	1.5	0.0
30. Soft solder	1.9	2.2	1.6	1.3	1.7	0.8
31. Straighten miscellaneous parts	2.5	2.4	1.7	2.2	1.7	0.4
32. Use a hand broach	2.3	1.9	1.3	1.8	1.3	0.4
33. Use hand grinder	2.6	2.7	2.3	2.5	1.6	1.4
34. Work materials with hammer, etc.	2.5	3.1	3.0	2.0	2.0	2.6
35. Work materials with portable hand drill	2.7	2.7	2.5	2.6	1.9	1.8
L. DOING PAPER WORK						
1. Draft correspondance or reports	1.9	2.0	2.9	1.2	1.4	1.6
2. Drawing sketches	2.6	2.8	3.0	2.0	2.2	2.6
3. Maintain work records etc.	2.6	2.3	2.0	1.9	1.3	1.8
4. Order and receive stock, material and etc.	2.3	2.2	2.6	1.7	1.2	0.8
5. Plan work for other persons	2.7	2.3	2.7	1.9	1.8	1.0
6. Prepare cost estimates for projects	2.3	1.9	1.8	1.5	1.4	1.8
7. Review inspection reports	1.9	1.9	2.7	1.7	1.3	1.2
8. Scheduling work other than machine work	2.3	2.1	2.2	1.6	1.3	1.6
9. Spend time with consultants	1.9	1.8	2.6	1.4	1.4	1.4
10. Study reports on materials	1.9	1.9	2.7	1.2	1.2	1.8
11. Supervise and evaluate other persons work	2.5	1.9	2.6	1.9	1.3	2.0

APPENDIX C

TRANSMITTAL LETTERS

Stephen Y. Beeko
36-5 South University Place
Stillwater, OK 74074

December 11, 1981

Dear Machinist Instructor:

I need your help. I am conducting a study in an area that when completed will be helpful to you as educator training people to work in the machine shop. I am attempting to validate a complete list of duties and tasks performed by machinists.

What I am asking for is less than one-half hour of your time to complete one of the enclosed task inventory booklets. I should be very grateful if you would also help me by distributing the remaining booklets to four of your adult students in your class for completion. When they are completed, let the student return the booklets to you. I shall come by in a week's time to collect them.

I realize that I am asking a lot from you and your students, but hopefully when completed the data provided will help increase relevance in training programs and efficiency of graduates who enter the world of work.

Copies of the research findings will be available. Complete the attached form if you would like to have a copy.

Your participation in this project is greatly appreciated.

Thank you.

Sincerely,

Stephen Y. Beeko

Dr. Lloyd Wiggins
Chairman of Committee

Occupational and Adult Education
Oklahoma State University
Stillwater, OK 74078

To: Stephen Y. Beeko
(Graduate Student)

REQUEST FOR RESEARCH FINDINGS

(Task Inventory for Training
Program of Machinists in
Oklahoma)

a. Name _____
First Middle Initial Last

b. School/Business Address: _____

_____

_____

c. Telephone: (___) _____
area code

Stephen Y. Beeko
36-5 South University Place
Stillwater, OK 74074

December 11, 1981

Dear Manager:

I need your help. I am conducting a study in an area that when completed will be helpful to you as an owner or manager of a machine shop employing persons to work in this area. I am attempting to validate a complete list of duties and tasks performed by machinist in Tulsa and Oklahoma City metropolitan areas.

Please give the enclosed task inventory booklets to two of your machinists to complete them. I realize that I am taking much of your precious time, but hopefully when completed the data provided will help increase relevance in training programs, efficiency and productivity of machinist in Oklahoma.

Copies of the research findings will be available. Complete the attached form if you would like to have a copy.

Your participation in this project is greatly appreciated.

Thank you.

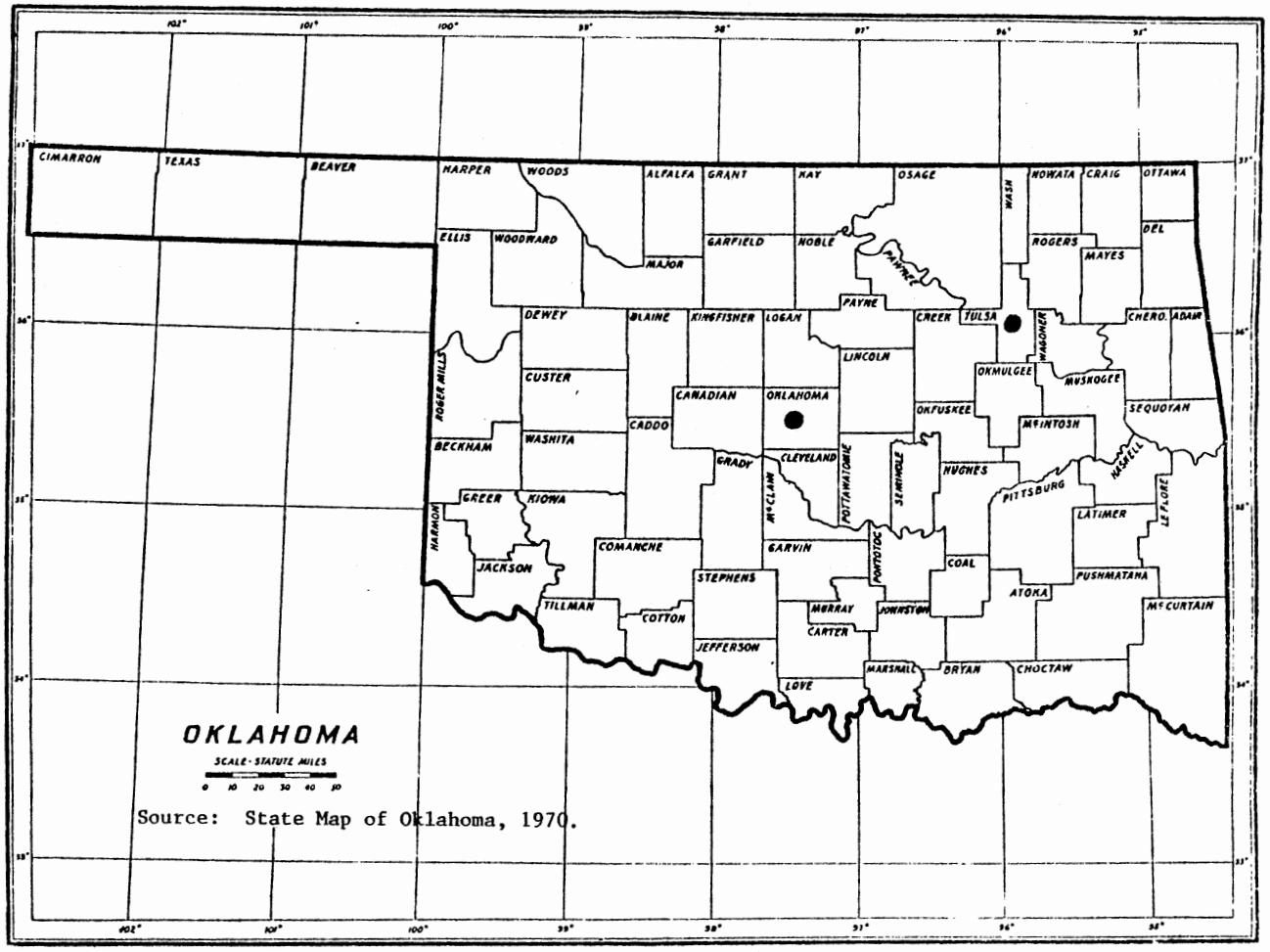
Sincerely,

Stephen Y. Beeko

Dr. Lloyd Wiggins
Chairman of Committee

APPENDIX D

NAMES AND ADDRESSES OF SCHOOLS AND INDUSTRIES



Source: State Map of Oklahoma, 1970.

Figure 3. Map of Oklahoma Showing Geographical Locations of Tulsa and Oklahoma City Metropolitan Areas

SELECTED SCHOOLS AND COLLEGES (HAVING MACHINE SHOPS)
USED IN THIS STUDY FROM TULSA & OKLA. CITY
METROPOLITAN AREAS

1. Moore-Norman
   Area Vo-Tech. School
   4701 12th Ave. N.W.
   Norman, OK 73069

2. Canadian Valley
   Area Vo-Tech. School
   P.O. Box 579
   El-Reno, OK 73086

3. Foster-Estes AVTS
   4901 South Bryant
   Oklahoma City, OK 73109

4. Tulsa County AVTS
   Memorial Ave. Campus
   Tulsa, OK 74145

5. Tulsa County AVTS
   Peoria Ave. Site
   Tulsa, OK 74106

6. S. Oklahoma City Junior College
   7777 S. May
   Oklahoma City, OK 74159

7. Tulsa Junior College
   3727 East Apache
   Tulsa, OK 74119

SELECTED INDUSTRIES (HAVING MACHINE SHOPS) USED
IN THIS STUDY FORM OKLAHOMA CITY METRO. AREA

1. City Auto Parts & Machine Shop
   31 N.E. 10th Street
   Oklahoma City, OK 73105

2. Industries Machine Co.
   1546 W. Reno
   Oklahoma City, OK

3. Phil Good Products, Inc.
   3500 West Reno Ave.
   Oklahoma City, OK 73107

4. K & F Machine & Mfg. Co.
   1500 S.E. 89th St.
   Oklahoma City, OK 73109

5. Four J. Machine Co.
   3013 S. High
   Oklahoma City, OK 73124

6. Olive Machine Works, Inc.
   1807 N.W. 5th
   Oklahoma City, OK 73106

7. Bishop Machine & Mfg., Inc.
   4213 S. Robinson
   Oklahoma City, OK 73109

8. McPherson Machine Shop
   I-35 & Highway 9 West
   Oklahoma City, OK

9. C.M.I. Corporation (MFG. Div.)
   Interstate 40 & Morgan Rd.
   Oklahoma City, OK 74101

10. Magnetic Peripheral Inc.
    Control Data Corporation
    10321 West Reno Ave.
    Oklahoma City, OK 73112

SELECTED INDUSTRIES (HAVING MACHINE SHOPS) USED
IN THIS STUDY FROM TULSA METROPOLITAN AREA

1. Dieco Mfg.
   15715 E. Pine
   Tulsa, OK

2. P.S.M./Precision Speciality Inc.
   14310 E. Marshall
   Tulsa, OK

3. Hampton Industries, Inc.
   5341 E. Independence
   Tulsa, OK

4. Sooner Mfg. Co.
   1515 East 7th St.
   Tulsa, OK 74120

5. Ken S. Machine Shop
   5933 East 12th St.
   Tulsa, OK 74127

6. Lafayette Mfg. Inc.
   830 North Atlanta
   Tulsa, OK 74110

7. Cline Machine Inc.
   25 N. Lawton
   Tulsa, OK 74127

8. Sawyer mfg. Co.
   1031 North Columbia Place
   Tulsa, OK

9. Interstate Tool & Mfg. Inc.
   1044 N. Columbia Place
   Tulsa, OK 74150

10. HcElroy Mfg. Co.
    833 N. Tuston
    Tulsa, OK 74112

VITA

Stephen Yaw Beeko

Candidate for the Degree of

Doctor of Education

Thesis: TASK INVENTORY FOR TRAINING PROGRAM OF MACHINISTS IN TWO METROPOLITAN AREAS IN OKLAHOMA

Major Field: Occupational and Adult Education

Biographical:

Personal Data: Born in Mampong-Ashanti, Ghana, December 26, 1946; the son of Yaw Beeko and Yaa Maanu.

Education: Attended Presbyterrian Middle School, Mampong-Ashanti; Winneba Teacher Training College, 1951-1952; Handicraft Teachers College, 1960-1962; received Bachelor of Mechanical Engineering Technology degree from Southern Technical Institute in June, 1976; received Master of Business Administration degree in June, 1978 and Master of Science in Library Science degree from Atlanta University, Atlanta, Georgia in August, 1979; completed the requirements for Doctor of Education degree at Oklahoma State University in July, 1982.

Professional Experience: Technical instructor at Kumasi Technical Institute 1962-1970; Supervisor for night shift, Precision Plastic Industry, Marietta, Georgia, 1975-1978.

Leadership Activities: Member of American Vocation Association; Society for Mechnaical Engineers; American Education Research Association; Vice-President, Student Chapter of Lions Club, School of Technology Marietta, Georgia 1974-1975; Distinguished Military Student Army R.O.T.C., 1974; Who's Who in American Universities and Colleges, 1975.