AN ABSTRACT OF THE THESIS OF

DONALD ELWIN MOON for the DOCTOR OF EDUCATION
(Name) (Degree)

in EDUCATION presented on ______________
(Major) (Date)

Title: A STUDY OF THE INDUSTRIAL PROCESS OPERATIONS OF SELECTED MANUFACTURING INDUSTRIES WITH IMPLICATIONS FOR THE PLANNING OF INDUSTRIAL ARTS LABORATORIES IN OREGON

Abstract approved: [redacted]
Dr. Pat H. Atteberry

Purpose of the Study

The purpose of this study was to assist the development of an improved industrial arts curriculum and laboratory facilities that reflect the industrial technology. The project attempted to ascertain which of the process operations of the technology may become curricular components in the curriculum. In addition, it attempted to identify the various methods that might be used to perform these process operations in the industrial arts laboratory. To provide information to this end, the investigation sought answers to the following questions:

1. What are the principal process operations of the manufacturing industries that reflect the industrial technology?

2. Does an element of commonality exist between the industrial classifications in the process operations they perform?

3. What methods are employed by the manufacturing industries to perform the process operations?

4. Which of the process operations of industrial technology will become curricular components of the industrial arts curriculum?

5. What type of laboratory facilities will need to be developed for the implementation of the industrial arts curriculum that will reflect the technology?

Procedures

The standard industrial classifications of the U. S. Bureau of the Budget were used as a basis for the selection of the manufacturing industries for the study. The participants in the study were selected from 12 of the 21 standard industrial classifications on the basis of their size, in numbers of employees, and diversity of manufactured products. All were located in the State of Oregon. Five hundred and ninety-nine manufacturing establishments in the twelve standard industrial classifications were contacted by mail. They were requested to complete a questionnaire which listed the principal process operations of the manufacturing industries. Because of the distinct differences in terminology which exist between the graphic arts industries and the other manufacturing industries, two questionnaires were designed. The study participants were asked to indicate: the method used to perform the process operations; when they expected to begin performing the operations, if not doing so now; and what reasons were given for not performing the process operations at all. The questionnaire returns were tabulated by the Oregon State University Computer Center. A summary of the findings is herewith reported.

Selected Findings

1. The operation of offset press printing was performed more often than the operation of letterpress printing by the graphic arts industry.

2. The operations of Intaglio Printing - Gravure and Paint Printing - Silk Screen were performed by relatively few graphic arts establishments.

3. The operations of Screenless Illustration Printing were not being performed by any of the graphic arts establishments reporting.

4. The most representative process operations of the Forming area were: punching, trimming, rolling, cold and hot bending, die pressing, blanking and piercing.

5. The most representative process operations of the Casting and Molding area were: sand casting, permanent mold casting, shell mold casting, plastic molding, injection molding, and contact layup.

6. A degree of specialization in the performance of the process operations was noted. Many of the operations were contracted out to other manufacturing establishments.

7. The principal process operations were more likely to be performed by standard machine methods than by other methods.

8. Although the graphic arts industry was heavily oriented to the use of standard machines to perform the offset press printing operation, many establishments reported using automated machines.

9. Standard machine methods were used extensively to perform the process operations of the Shaping - Cutting area. Automated machines were being used to some degree by the manufacturing industries.

10. In the Assembly area; both hand and standard machine methods were very much in evidence for the performance of the process operations.

11. There is a high degree of commonality existing between the standard Industrial Classifications for the process operations performed in the Forming, Shaping - Cutting, Assembly, and Auxiliary areas.

12. An element of commonality exists in the methods employed to perform the process operations, particularly in hand and standard machine methods.

13. All process operations of the manufacturing industries can be classified under five areas: Forming, Casting - Molding, Shaping - Cutting, Joining, and Auxiliary.

A Study of the Industrial Process Operations of Selected Manufacturing Industries with Implications for the Planning of Industrial Arts Laboratories in Oregon

by

Donald Elwin Moon

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Education

June 1968

APPROVED:

[redacted]

Professor of Education

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[redacted]

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Date thesis is presented April 24, 1968

Typed by Illa W. Atwood for Donald Elwin Moon

ACKNOWLEDGMENT

The writer wishes to express special appreciation to Dr. Pat H. Atteberry, Head of the Department of Industrial Education for his counsel and assistance in the preparation of this report.

Grateful acknowledgment is also made to Dr. William R. Crooks, Dr. Albert L. Leeland, Dr. Ned D. Marksheffel, Dr. Earl E. Smith, and Dr. Franklin R. Zeran for their assistance and advice in the preparation of this report and to Dr. Chester B. Ainsworth for his suggestions during the development of the research problem and design.

Acknowledgment is made to the four hundred and twenty two manufacturing establishments in the State of Oregon who so willingly contributed the information that made this study possible.

The writer also wishes to express his sincere appreciation to his wife and family for their assistance, encouragement and understanding.

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I. INTRODUCTION

Background of the Problem

Schools reflect the society they serve. The rapid advances of industrial technology have had and will continue to have an overwhelming influence on education and society. A technological culture has been created with the development of practical applications, science principles, artistic and applied design principles, and techniques of production. Industrial arts is that part of the educational program which concerns itself largely with preparing individuals to live in a technological culture. This is achieved through a study of industry by providing firsthand manufacturing and service-type experiences in the use of tools, materials and processes. It is necessary to provide facilities in which it is possible to accomplish goals which are not necessarily the accomplishment of simple skills.

Industrial arts does and should continue to derive its subject matter from industry. Industrial arts programs operate in laboratories or shops equipped with the basic industrial materials, machines, and energies of industrial technology. A modern and up-to-date industrial arts program must have laboratory facilities that provide a technological environment representative of modern industry. Provisions must be made for the industrial arts program and supporting facilities to be flexible to accommodate the constantly changing industrial technology.

A review of literature reveals that much concern has been expressed by educators as to what the industrial arts program in a modern high school should be like in the future. These educators hope that the curriculum will provide the educational experiences essential to a good industrial arts program so that it will reflect the technology. In addition, they hope that there will not only be a good program in the areas of drafting, metalworking, and woodworking, but also in electricity-electronics, power mechanics, graphic arts, and the industrial crafts. John L. Feirer (18) gave some indication of the nature of the problem when he wrote that:

> Some idea of what is happening to our industrial education programs at the senior high school level can be gained by studying present-day building reports, which show the school facilities to be built in the next two or three years. In studying these building reports, we find that most high schools are planning for three areas--drafting, metals, and wood. <u>These are the only three being provided for in many new high schools.</u> Only a few new high schools will have space and equipment for electricity-electronics; even fewer will have such areas as power mechanics, graphic arts, and industrial crafts. <u>The high schools being planned today will not be equipped to offer a complete program of industrial education.</u> (18, p. 31)

The areas listed above by Feirer (18) represent those that are traditionally associated with industrial arts. The laboratory facilities for these areas are traditionally equipped with machines and materials commonly associated with the activities of the areas. However, in recent years various writers have described a New Industrial Arts that de-emphasizes the importance of specific areas and puts emphasis on the functional components of industries: materials, processes, products, and people or occupations. Olson (27) in writing about the facilities for the New Industrial Arts, says:

> The new industrial arts facilities provide a laboratory atmosphere within a technological environment. This is in contrast to a workshop or repair shop character.
>
> The laboratory includes facilities representative of basic industrial materials, machines, energies, and principles. This does not necessarily require industrial production machines and equipment, although in certain instances these may be desirable. Rather, it suggests equipment which employs representative industrial principles. A student who understands, for example, an existent basic means for cutting a material will likely understand the application of that process to another material and may be moved to search for a better one. (27, pp. 341-342)

Swanson, Face, and Flug (38), propose "a new program, called American Industry." This title they would assign to displace the name, Industrial Arts (38, p. 18).

Wall (3) in writing about the American Industry, says:

> The proponents advance two objectives for American Industry based on their acceptance of the central purpose of education--"development of the rational powers of man"--expressed by the Educational Policies Commission.

> The two objectives are: (1) to develop an understanding of those concepts which directly apply to industry, and (2) to develop the ability to solve problems related to industry. (3, p. 18)

This statement suggests that the facilities for American Industry could be somewhat like those described by Olson (27) above. In either case, they are describing facilities that must be representative of American technology.

American technology, through advances in automation, is marked by constant change. With the subject matter for industrial arts being derived from industry, this subject matter is then in a state of continual change. Industrial arts programs and supporting facilities should be so flexible that they can easily adapt to the changes. Subject matter and facilities accepted as proper and adequate for industrial arts at the turn of the century are now outmoded. Olson (27) refers to a "technological lag in industrial arts" as being evidenced by today's typical industrial arts programs which have been built largely around materials processing. He further cites woodworking as typical of today's industrial arts, that hand-tool processing is the accepted pattern, and that this kind of activity technologically belonged to the Craft Age, about 1600 A.D. (27, p. 88). Smith (36) reports that the industrial arts programs in Oregon are predominantly oriented to the materials of wood and metal. These programs are not truly representative of American industry in its broadest concepts.

Interpreting American industry involves selecting those elements of technology which are keys to change and growth. Analysis of industry, in the form of process operations, is necessary to ascertain those components which determine the degree to which industrial arts can be more representative of American technology.

Statement of the Problem

The basic problem of this study of curriculum and industrial arts facility modification, which is needed to meet technological changes, has three facets:

1. to identify, in the industries of the State of Oregon, the process operations which lend themselves to instruction in an up-to-date industrial arts laboratory setting;

2. to arrange these process operations into instructional categories;

3. to identify the types of laboratory facilities that will be needed for the implementation of the program.

In order to make basic changes to improve the industrial arts curriculum and its laboratory facilities, it is necessary to obtain information that would:

1. determine the most common industrial process operations that are reflective of the American technology as represented in industries of the State of Oregon.

2. determine the industrial process operations that might be components of the industrial arts curriculum.

3. determine the degree to which there can be more application of the industrial process operations found in Oregon industries to the industrial arts program.

4. determine the type of laboratory facilities necessary in which to teach industrial arts subjects.

5. determine the methods for performing the operations in the industrial arts laboratory setting.

Limitations of the Study

There appears to be two major limitations in this study. The first is: the study is limited to the identification of the industrial process operations commonly found in American technology, as performed by selected manufacturing industries of the State of Oregon. A second limitation is related to the sources from which industrial process operations will be obtained. Not all manufacturing establishments could be represented in this study. Therefore, a sampling of the total list of industries compiled in the 1964 Directory of Oregon Manufacturers and Buyer's Guide was drawn using such limiting factors as number of employees, diversity of products, and usefulness in school curriculum construction.

The manner of selecting participants, the construction of the questionnaire, and the general nature of the study required that basic assumptions be made before the study could be initiated. These basic assumptions were:

1. That these instruments were used by personnel who were competent in recognizing and discussing the process operations in their establishments.

2. That the check list questionnaire was a valid and reliable means of collecting data pertaining to the principal process operations of the manufacturing industries.

Scope of the Study

The participants for this study were drawn from a population of the industries of the State of Oregon. The 1964 Directory of Oregon Manufacturers and Buyer's Guide (29) lists twenty major industrial manufacturing groups and classified them according to the Standard Industrial Classification (S. I. C.) Codes established by the U. S. Bureau of the Budget and published in its Standard Industrial Classifications Manual of 1957 as amended by the Supplement of 1963 (39). Twelve of the 20 industrial manufacturing groups listed in the directory were selected for the study on the basis of their traditional association with industrial arts. The eight industrial manufacturing groups not chosen were more closely associated with other fields of general education, such as: home economics and chemistry, or were considered to be basic manufacturing industries and were not considered appropriate for this study. The criteria used for the final selection of the manufacturing establishments were: size, in terms on numbers employed; and diversity of manufactured products.

Definition of Terms

To facilitate the communication of ideas in this study, it is well to single out certain terms for clarification. The terms related to industrial arts and this study are listed below.

Auxiliary Process Operations: Those operations necessary to insure continuity and completion of the principal process operations, i.e. welding, heat treating, straightening, cleaning, finishing, and shot peening (16, p. 217).

Basic Manufacturing Industries: Industries that produce workable materials from the raw materials, i.e. logging industries, sawmills, planing mills, and blast furnaces.

Basic Process Operations: Basic process operations are sometimes referred to as founding operations. Basic process operations are those which give the material its initial shape or form prior to the process being planned, i.e. lumber from logs; metal from raw materials, including various ores; bar stock and strip stock from the metals.

Industrial Arts: An educational field with subject matter centered in the materials, processes, products, and occupations of industry, and in which the student uses materials, tools, and machines in the solution of problems.

Industrial Arts Laboratory: The terms "shop" and "laboratory" are used synonymously when referring to the industrial arts facility. The statement of William E. Warner (42) pertaining to the term laboratory is accepted by the writer for this study.

> A laboratory shall be thought of not only as a place for making projects but equally as a place for planning, investigating, testing, experimenting, consulting, evaluating. In short, the laboratory shall be thought of as a place for thinking, as well as feeling and doing. (42)

Industrial Education: A generic term applying to all types of education related to industry, including industrial arts education, vocational industrial education (trade and industrial education), and much technical education (6, p. 11).

Major Operations: Those operations performed within the principal process that may be classified either by the manner in which they must be performed or their importance in the sequence (16, p. 209).

Principal Process Operation: Includes all the operations fundamental to the type of manufacturing found in an industry. The principal process operations are classified as follows: (1) Cutting, (2) Forming, (3) Casting and Molding, (4) Assembly (16, p. 203).

Process: A method by which products can be manufactured from raw materials.

Technology: Dewhurst (14) makes the following statement in regards to technology:

> . . . technology consists of accumulated knowledge, techniques and skill, and their application in creating useful goods and services . . . (14, p. 834)

Investigative Procedures

The primary source of data for the study was a questionnaire form (Appendix B, pages 140-145) devised to gather information on the process operations of the manufacturing industries. Two versions of the form were prepared in order to account for the very basic differences in terminology between the graphic arts and the other manufacturing industries. The process operations appearing in the questionnaires were selected after an extensive review of the literature of the various technical subject areas and the literature associated with manufacturing engineering.

The 1964 Directory of Oregon Manufacturers and Buyer's Guide was chosen as the source from which the study participants would be selected. This guide listed all manufacturing establishments by their industrial classifications. An extensive analysis of the manufacturing establishments within these classifications indicated their size, in terms of number of employees, and the products they manufactured. The manufacturing establishments studied qualified for inclusion by virtue of having ten or more employees as well as a degree of diversity in the products they manufactured. In the twelve classifications chosen for the study, there were 1487 manufacturing establishments. Of these, 599 or 40.3 percent were chosen to be participants in the study.

Representatives of the 599 manufacturing establishments, including presidents, owners or general managers, were contacted by mail. They were requested to complete comprehensive questionnaires dealing with the principal process operations of their establishments. They were asked to indicate:

1. if their establishment performed the process operation and by what method;

2. if they did not perform the process operation, when did they expect to begin performing the operation;

3. if they did not expect to perform the principal process operation at all, what was the reason for not doing so?

Four hundred and forty five or 74.2 percent of the manufacturing establishments selected responded by completing the questionnaire. The questionnaires returned were tabulated by the Oregon State University Computer Center. This data will be reported in Chapter IV.

II. REVIEW OF RELATED LITERATURE

Emphasis is given to the relationship of industrial arts to American industry in literature. However, research pertaining to the derivation of industrial arts subject matter from the technology is lacking. The literature reviewed for this study includes comments of authorities which establish that: (1) industrial arts derives its subject matter from industry, (2) an analysis of industry is the fundamental method for identifying and organizing teachable content for an industrial arts curriculum, and (3) specifications for industrial arts laboratory facilities can be drawn from the content of the curriculum.

Industrial Arts Derives Its Subject Matter from Industry

Russian System

The evolution of industrial arts in the United States and its relationship to industry has been recorded historically by Charles A. Bennett (9). He records that it was the Russian system, developed by Victor Della Vos of the Imperial Technical School in Moscow, that influenced such educators as John D. Runkle, President of Massachusetts Institute of Technology, and Calvin M. Woodward, Dean of the polytechnic faculty of Washington University in St. Louis, to advocate a system of training for industry in the public schools of America.

The significance of the Russian system to this study is to be found in its basic purpose: of providing engineers with practical technical training--the belief that the competent engineer needed to know how to use materials, tools, and processes and in its method of using industry as a source for determining the content for the curriculum of the technical school in Moscow.

The Russian system not only influenced industrial education in America but general education as well. Anderson (7) reports that:

> It was Runkle's proclamation of his discovery of the Russian system and his plan for utilizing it, not only in Engineering but also in general education, which marks the beginning of the manual training movement, the first stage in a period of discussion and experimentation in educational handwork which is still running its course. (7, p. 161)

Swedish Sloyd

Bennett (10) further reports that at this same period in history, a program of handwork was being developed in the Scandinavian countries. It had originated with the handwork commonly carried on in the homes where both father and mother instructed the children in the use of tools and materials for the making of useful articles needed by the family. Otto Salomon, an educator, realized the values of such instruction and established an industrial school for boys in Sweden. Later this type of instruction became recognized, by educators of the times, as a form of general education and a system known as Educational Sloyd was established in the schools.

Educational Sloyd was brought to America by Gustof Larssen, a teacher of sloyd in Sweden. The system gained in prominence in America following an exhibit of sloyd projects at the Columbian Exposition in Chicago in 1893 and contributed significantly to the evolution of industrial arts in America.

The importance of the sloyd system to this study is to be found in the three important values that have been contributed to the system. (1) It was concerned with providing individuals with manual skills, so important to that period in history. (2) It derived its content from the home industries, the industrial establishment of the times. (3) It emphasized the project as a means to the learning of the skills. Bennett (10) describes the combining and integrating of the Russian system and the sloyd system that took place.

> It was recognized that by accepting some of the so called principles of the Swedish sloyd, while continuing to apply some fundamental practices of the Russian system and harmonizing these with the best American practice in the use of woodworking tools, Boston has produced an American system of manual training that was pedagogically sound and practical. (10, p. 434)

Manual Training

Manual training is generally considered to have been the first form of organized technical education to be introduced into American public schools. Calvin M. Woodward (44), usually referred to as the father of manual training, in writing about his program says that:

> Our great object is educational; other objects are secondary. That industrial results will surely follow, I have not the least doubt; but they will take care of themselves. Just as a love for the beautiful follows a love for the true, and as the high arts cannot thrive except on the firm foundation of the low ones, so a higher and finer development of all industrial standards is sure to follow a rational study of the underlying principles and methods. (44, p. 229)

In 1886 Woodward (44) made the following statements regarding the value of manual training as related to industry:

> . . . Science and mathematics will profit from a better understanding of forms, materials, and processes, and from the readiness with which their principles may be illustrated.
>
> . . . Correct notions of things, relations, and forces, derived from actual handling and doing, go far toward a just comprehension of language in general; that is, manual training cultivates the mechanical and scientific imagination, and enables one to see the force of metaphors in which physical terms are employed to express metaphysical truths.
>
> . . . It will enable an employer to better estimate the comparative value of unskilled and skilled labor and to exercise a higher consideration for the laboring man.
>
> . . . It will stimulate invention. The age of invention is yet to come and manual training is the very breath of its nostrils.

The relationship of manual training to industry was seen by

Woodward (44) as being a reciprocating situation. Manual training would derive content from industry. Industry would profit through the utilization of persons trained in the program. Both manual training and industry would reap mutual benefits from this association.

Manual training is considered to be the first stage in the progressive development of educational tool instruction as a recognized part of general education.

Manual Arts

Charles A. Bennett (11) has been designated by educators as the "father of manual arts," the title given to the second stage in the evolution of industrial arts. As he wrote about manual arts, he considered the first problem to be that of the selection of the subject matter.

> To find adequate answers one must survey the whole field of the manual arts as applied to industry; he must search out a basis for classification; then he must select fundamental processes in each class. Perhaps no better classification has been suggested than the following:
>
> a. The graphic arts.
> b. The mechanic arts.
> c. The plastic arts.
> d. The textile arts.
> e. The book-making arts.
>
> These five should be found in every course in the manual arts which extends through the elementary school period. (11, pp. 15-16)

The significant value of manual arts to the development of present day industrial arts lies in the fact that this was the first attempt to classify the various fields of industry into instructional areas. At the same time, this brought about the organization of content, derived from industry, for instructional purposes.

Industrial Arts

Industrial arts became the third stage in the evolution of shop work in the public schools and the term is credited to Charles R. Richards (30). As editor of the Manual Training Magazine, published by the Manual Arts Press, Peoria, Illinois, he wrote concerning the need for a new term to describe more adequately the type of activity, which was inadequately called manual training and manual arts. He wrote the following statement in support of the term industrial arts.

> In the hope of enlisting consideration and discussion, the writer proposes the term suggested above: Industrial Art. Such a term indicates a definite field of subject matter. The word Art is inclusive of both the technical and aesthetic elements and the qualifying work points specifically and comprehensively to the special field of our material. (30, p. 33)

Frederick Gordon Bonser (12) is credited with giving depth of meaning to the term industrial arts. Although writing about his concept of industrial arts in the elementary school, he projected a basic definition that has carried over to the high school. The following definition, written by Bonser (12), is one of those that is most often quoted by the various leaders in industrial arts education.

> The industrial arts are those occupations by which changes are made in the forms of materials to increase their values for human usage. As a subject for educative purposes, industrial arts is a study of the changes made by man in the forms of materials to increase their values, and of the problems of life related to those changes. (12, p. 15)

Bonser reinforced this definition by explaining his concept of change when he wrote:

> . . . All of these changes which we make in the forms of materials, that they may be more useful, we call industrial changes. We speak collectively of the occupations devoted to the making of these changes and industries, or industrial arts. The general term manufactures means about the same thing, but industrial arts is preferable as it is more inclusive. (12, p. 3)

The New Industrial Arts and Technology

Delmar W. Olson (28), in his treatis of technology and industrial arts, proposed a New Industrial Arts that would interpret industry more completely and reflect the technology more adequately. The relationship he draws between industrial arts and industry can be seen in his interpretations of the New Industrial Arts.

> Industrial arts is one of the practical arts, a form of general education which provided learners with experiences, understandings, and appreciations of materials, tools, machines, processes, and products, and of the occupations incident generally to the manufacturing and mechanical industries. These results are achieved through design, development, and construction of useful products in laboratories or shops, appropriately staffed and equipped, supplemented by study, experiment, invention, investigation, discussions, films, visits, reports, demonstrations and similar activities characteristic of youthful interests and aptitudes in things industrial.
>
> The subject of industrial arts should encompass all

> age and school levels for such purposes as the development of technical, recreational, cultural, and occupational interests and aptitudes, desirable personal-social traits and understandings, and abilities to choose and use industrial products wisely. In general, its purposes are educationally social rather than vocationally economic.
>
> Industrial arts includes such industrial representations as research, design, development, drawing, and construction with materials, tools, machines, and products common to the manufacturing, and service industries, including the field of management. Pupil projects and products are representative of industrialization rather than of handcrafts. (28, p. 75)

American Industry Approach

Face and Flug (17), in developing a new curriculum area for the study of industry, refer to the area as American Industry. This, they project as a possible replacement title for Industrial Arts. The work they have done is in the form of a curriculum project under the sponsorship of Stout State University, U. S. Office of Education, and The Ford Foundation. The project has been under way since 1964. The broad objectives of the American Industry program are: (a) to develop an understanding of those concepts that apply directly to industry and (b) to develop the ability to solve problems related to industry (17, p. 53).

The justification that Face and Flug (17) give to their approach to the project, lies in the following statement:

> The emergence of technology as an even more potent force in the molding of society appears to justify the inclusion of a study of industry in the public school curriculum. The problems of the future are inseparable from increasing industrialization and young people must be led to an adequate understanding of these forces that impinge upon their daily lives. (17, pp. 53-54)

Recorded history, in describing the evolution of industrial arts, has shown a close parallel with the evolution of American industry. As industries grew and became a major influence on our society, the objectives and the interpretations of manual training, manual arts, and industrial arts have changed to meet the challenges of industry and its technology. The major change we find, in recorded history, is that the emphasis has shifted from tools and materials alone to the study of industry, its technology, and its influence on the individuals of our society.

Today industrial arts has been accepted as a part of general education by many educators. Olson (28) in his New Industrial Arts, Face and Flug (17) in their American Industries, point to the need to study industry in its entirety, thereby becoming an important force in the general education of the individual.

In the brochure, Industrial Arts in Education, industrial arts is described as "The study of industrial tools, materials, processes, products, and occupations pursued for general education purposes in shops, laboratories and drafting rooms" (22, p. 3). In A Guide to Improving Instruction in Industrial Arts, industrial arts is defined in the following way:

> The purpose of general education in the United States is to develop common values, skills, understandings, and appreciations based upon the fundamental tenets of democracy. Except for our democratic percepts and structure, the expansion of industrialism,

> supported by science and technology, has been the most pervasive post-Civil War influence on the American way of life. Industrial arts, as a study of industry, falls well within the limits of general education since industry has become the mainspring of our cultural enterprises (5, p. 10).

Ralph Nair (4) further supports industrial arts as an important part of general education with this statement:

> Industrial arts is a subject area defined as dealing with the understanding and interpretation of industrial activity. As an important part of general education, industrial arts is concerned with materials, processes, and products of industry (4, p. 3).

Edgar Hare (19) says:

> Industrial arts programs can make several unique contributions to a curriculum (school program): interest in and understanding of industry and the trades and crafts; exploration of organization, raw materials, processes, products, and occupations of industry; provision for the development of skills, of good craftsmanship and design; preparation for more self-sufficient home living; and provision for integration of a vital portion of man's knowledge and accomplishment (19, p. 53).

In a recent publication, Industrial Arts Education, industrial arts education is described as, ". . .being designed specifically to help prepare individuals for meeting the requirements of a technological culture" (2, p. 3). It further states that, "Industrial arts, as an integral part of the total program of education, provides unique opportunities for students to participate in representative experiences in industrial skills and processes" (2, p. 3).

Four statements of purpose which are unique to industrial arts are set forth in the same publication.

(1) To develop in each student an insight and understanding of industry and its place in our society.

(2) To discover and develop student talents in industrial-technical fields.

(3) To develop problem-solving abilities related to the materials, processes, and products of industry.

(4) To develop in each student skill in the safe use of tools and machines (2, pp. 4-5).

Analysis of Industry is the Fundamental Method for Identifying and Organizing Content for an Industrial Arts Curriculum

The analysis technique is an important means of connecting industrial arts with technological achievement, of making industrial arts practical and thus giving it predictable content.

Bennett (10, p. 46-47), in his conclusions regarding the influence of the Russian system, indicates that the system placed mechanic arts training on a pedagogical level by showing that these arts could be analyzed for their elements, which then could be taught as easily as elements of mathematics, language, and other courses; that the system used for the first time scientific principles in analyzing the mechanic arts and basing courses of instruction on them.

Olson (28), in discussing the influences of manual training on present day industrial arts, states:

> The early manual training emphasized the logical analysis and graded arrangement of tool exercises. As the influences of the science of psychology became increasingly strong in education, attention was turned to the psychological approach. Woodward made a strong point of the natural relationship and interdependency of manual training with the literary, scientific, and mathematical studies. This may have been the origin of the idea for integration of industrial arts with other studies as commonly advocated by today's leaders (28, p. 69).

Charles R. Allen (1), one of the early exponents of analysis as the scientific way to determine what to teach in trade training, wrote:

> Of course, the instructor, knowing his trade, has all these things in his head but until such a "stock taking" is carried out, the instructor is in much the condition of an old-fashioned country store where all sorts of things are in stock but nobody knows just what is in stock. Just as the up-to-date store has an inventory, so the instructor must take an inventory of his stock--what he has to teach (1, pp. 39-40).
>
> Such a stock taking is commonly called analyzing the trade and is the first operation which the instructor must take in laying out a course of instruction (1, pp 42-43).

Allen (1) further defines analyzing the trade as meaning, "simply listing out all the things that the learner must be taught if he is to be taught the complete trade" (1, p. 43). Later he emphasized the importance of analysis when he wrote:

> Getting out a correct and complete analysis and then classifying correctly is the key to the whole problem of getting an effective order of instruction. If the analysis is not complete, the instructor will omit things that the man should be taught if he is to be completely trained (1, p. 46).

Selvidge and Fryklund (33) discussed analysis as it is related to education:

> Modern science is based upon analysis. When confronted with a problem, we immediately set about the task of systematically separating it into its parts and then make a careful examination of each part. Chemistry has taught us how to break down numberless compounds and combine the units into new ways and produce new materials. So, in education, we must analyze our problems into the smaller units in order to classify them and to be able to handle them with greater satisfaction and assurance (33, pp. 60-61).

and,

> An analysis for teaching purposes must list the things one must know and be able to do in order to perform these duties (33, p. 66).

Analysis is a technique by means of which subject matter for industrial arts can be successfully organized. In this study it is thought of as the technique of identifying and listing the elements of the technology, in the form of principal process operations, for instructional purposes. The frequency with which similar elements appear suggests a commonality existing among them. Because they are common, they will become components of subject matter for industrial arts. Silvius and Bohn (35) refer to this analysis technique in the following manner:

> Instructional analysis is the process by which educators study a trade subject such as welding or an industrial arts activity such as plastics and identify the repetitive operations and the informational content to be taught to a learner, whose goal is to become proficient or develop understanding in such a subject or activity. The manipulative phases of industrial education are organized as operations with each operation further broken down by listing procedures and other essential data for teaching purposes (35, p. 192).

Olson (27) refers to the commonality that exists within industries that are analogous, in the following manner:

> When one makes an analysis of two or more industries in search of structure, organization, systems and sequence of operation, personnel staffing, and such, he finds that they have much in common. In fact, there are patterns common to all industries and especially to analagous ones. Manufacturing industries, for example, employ materials, processes, products, power, machines, and people in whatever they produce. All industries have research, engineering, marketing, management, and maintenance divisions. We call such organic divisions <u>functional components</u>. Their identification and derivation result from analysis of industries such as may be pictured in charted organization and in materials handling sequences (27, p. 98).

Industry, itself, has long been a user of the analysis technique to determine the content of on-the-job training programs, production sequence, time and motion study, and quality control. Leonard C. Silvern (34) in describing industrial analysis writes:

> While organization is the structure of a system, analysis is the technique of reducing the whole system to its components while relating the parts to each other and to the whole. In essence, analysis is the mental activity which is later translated to a communication medium such as the written or spoken word. It is breaking down a whole into an organization of parts (34, p. 5).

In describing the use of analysis in a training program, he states:

> An Engineering-Instructor must design a training program. He first lays out the major course, then takes each course and by analysis determines each unit of instruction . . . each unit is further analyzed into sub-units, each sub-unit into lessons (34, p. 6).

This review of literature reveals that: (1) the early exponents of the various forms of industrial education used the analysis technique in search of instructional materials for their curriculum; (2) as industrial technology grew and became a vital factor in our culture, the technique of analysis became more refined; and (3) analysis of industry continues to be the major technique for determining the teachable content of industrial arts.

Relationship of Industrial Concepts to Industrial Arts Programs and Facilities

Traditional Industrial Arts

It may be noted that no studies have been discovered relevant to the problem of arriving at standards for the planning of industrial arts laboratory facilities. This phenomenon may be explained by the traditional manner in which the industrial arts curriculum has been organized, around the materials of industry. The facilities, therefore, have been organized so as to teach about the materials, and the tools and machines related to them; about wood, metal, and drafting. The industrial arts laboratories, often referred to as unit shops, were designated as woodshops, metal shops, and drafting rooms. Only instruction in these related subjects would be taught in the facilities so designated. The curriculum and these shops are representative of the era of manual training, manual arts, and the early years of industrial arts. In these stages of development of present day industrial arts, emphasis was placed first on the instructor (manual training), then the project (manual arts), and in later years, some emphasis for the understanding of industry (industrial arts).

The more recent concepts for the derivation of content for industrial arts, as expressed by Olson (28), Swanson, Face and Flug (38), Maley (26), and others, have industrial arts deriving its goals from the culture; a culture that is influenced by technology.

Much research in industrial arts curriculum development is presently underway. One of the first persons to investigate the relationship of technology to industrial arts was Delmar Olson (28). He identified the functions of industrial arts as being the purposes for which industrial arts is attended. The six functions, also called "Objectives and Guiding Principles," referred to by Olson (28) as being published in the _Ohio High School Standards, Industrial Arts Education for Junior and Senior High Schools_, are (1) the orientation function, (2) the technical function, (3) the avocational function, (4) the consumer function, (5) the social function, and (6) the cultural function. With these functions established as the objectives for industrial arts, Olson (28) proceeds to analyze the industries for subject matter. The guides he employed in the search for this subject matter were: basic materials, processes, products, and occupations. The content of the industries analysis was considered by Olson (28) as representative subject matter, which he referred to as "representative curricular components." Olson (28) would group these components into the subject matter areas of: Transportation, Manufacturing, Construction, Communications, and Power, with much importance being attached to research with its science, experiment, invention, engineering, creation, and development.

The New Industrial Arts and Technology

In writing about the facilities for this type of curriculum, Olson (28) says.

> Two approaches to laboratory planning are implied in the new subject matter: one established laboratories corresponding to the basic industries categories used in this study; the other arranges them by groups of related curricular components. The former appears to be more feasible after numerous trials with the latter; it has the advantage of existent strong organizational structures around which to develop the laboratories.
>
> Because of the nature of the new industrial arts, two interpretations of its housing may be made: the laboratory, and the shop. The term "laboratory" suggests research, experiment, invention, design, and development; "shop" more appropriately refers to manufacturing, services, and recreation. In the laboratory the provision for student searching and experiment is made as appropriate equipment and instruction are brought together. The shop includes facilities for tool and machine processing of materials, for servicing industrial products, and for recreational activities. It is possible that provision for both interpretations may be accounted for in one housing unit. For purposes

> of this study when the term laboratory is used, it is considered inclusive of shop. (28, p. 233)

In another writing, Olson (27) had this to say about the facilities for the "New Industrial Arts."

> The facilities for the new industrial arts may rightly be as new as the curriculum; their specifications will rightly be drawn from within the curriculum. They, too, will reflect technology and all together will provide a technological environment within an educational atmosphere. The new laboratory is more than a rearrangement of the old facilities. It includes representation of technical processes not heretofore commonly found in industrial arts. The issue of unit shop versus general shop is now forever resolved. These have served their day and will no longer be needed. (27, p. 301)

The American Industry Program

Another curriculum proposal in industrial arts is the conceptual approach to teaching about industry. Robert Swanson, Wesley Face, and Eugene Flug (38) at Stout State University, began to experiment with what they have referred to as a radical restructuring of the theoretical orientation of industrial arts. Their new program, called "American Industry," has as its basic objectives the principles as put forth by the Educational Policies Commission; self realization, human relationship, economic efficiency, and civic responsibility. The broad objectives of the American Industry program are:

1. To develop an understanding of those concepts which directly apply to industry.

2. To develop the ability to solve problems related to industry. Swanson, Face, and Flug (38) write:

> Justification for the inclusion of a study of industry in the public schools was seen in the emergence of technology as an even more potent force in the molding of society. The problems of the future are inseparable from increasing industrialization and young people must be led to an adequate understanding of these forces which impinge upon their daily lives. (38, p. 4)

Unlike Olson (28) who attempted to categorize specific industries, materials and occupations into subject matter, Swanson, Face, and Flug (38) are attempting to categorize understandings. They perceive that understandings of concepts derived from the structure of industry would be universally applicable in any specific industry which encompasses it.

The proponents of the American Industries program have not gone far enough in their research or the experimentation with the concept to describe the facilities needed for this program. The comparisons they draw between traditional industrial arts and the American industry may give some clues to their thinking on the subject.

	Traditional Industrial Arts	American Industry
1.	Composed of a detailed study of knowledge concerned with production in specific	Composed of a study of the knowledges contributing to an understanding of the

	industries for pre-vocational or avocational purposes.	total institution of industry for general educational purposes.
2.	The selection of specific industries from among the many possible choices has led to a multiplicity of laboratory and curriculum patterns, making a coherent unified, national program most difficult to achieve.	The identification of a structure composed of underlying concepts should make possible the development of a coherent, unified, national curriculum and the standardization of laboratory facilities.
3.	Pre-selected skills, representative of the industry under study, are identified and serve as the orientation for the course of study.	Concepts serve as the orientation for the course of study. Specific skills are introduced as they become necessary in the activities designed for the development of the concept.
4.	Attempts to duplicate the tools and machines of industry necessary to develop pre-selected skills and specific knowledges.	Makes no attempt to duplicate the tools and machines of industry but utilizes what facilities are needed to develop understandings of concepts. (38, p. 14)

The Experimentation - Research Program

Another proposal for the organization of the content of industrial arts has research and development as its basis. The program that has been proposed is described by Donald Maley (26) when he wrote the following as an introduction to the proposal:

> This article is chiefly devoted to the on-going "Research and Experimentation" programs that were

initiated from the Industrial Education Department of the University of Maryland. It is important to note that the principle emphasis of this article is on the above named program. However, I would like to state that I do not believe that Industrial Arts can fulfill the needs of the great democratic-technological society with any one approach. In this statement I am being consistant in saying that Industrial Arts cannot remain as a partner in a program of modern education as long as it continues to maintain its narrow, limited approach to learning and the needs of persons in such a dynamic society.

. . . In establishing basis for Industrial Arts content, it is imperative that three basic elements be considered with more than the usual lip-service treatment.

1. The content of Industrial Arts must be oriented in the context of society in which it functions--the sociological base.

2. The content of Industrial Arts must be built upon the principles of human understanding and knowledge of the growth and behavior of people--the psychological base.

3. Dr. Walter Waetjen, in a series of lectures on Industrial Arts content and method, has pointed out the existence of biological bases for what is done in the Industrial Arts laboratories. Such elements include the concepts of right dominance, left dominance, and mixed dominance with regard to physical activity and the biological factors influencing motivation and exploration. (26, p. 22)

Beyond the three basic elements that Dr. Maley (26) listed above, he has developed what he refers to as the seven bases upon which the research and experimentation approach to teaching industrial arts are built.

1. The industrial arts program carried out in the public

school should have as its center of focus the development of people.

2. Industrial arts is a phase of general education. Therefore, industrial arts is a study of the problems, products, and processes of industry as well as the occupations and the contributions of those engaged in industry.

3. Industrial arts can be made attractive, meaningful and of value to practically all the school population. Industrial Arts would not be of the same kind for all. The meeting and satisfying of the various individual or group needs of the school population cannot be accomplished through any single process.

4. The selection of content and method grows out of the social context of the society in which industrial arts exists. Essentially, this point centers around the environmental factors that impinge upon the progress of education.

5. Another base upon which such a program is built is related to a concept of the kind of people in the present and future society, since the individual is largely a product of his environment.

6. Science is a very important aspect of industry, its operation, and its interpretation.

7. Identified with the research and experimentation program are, what are described as, sound psychological bases as attested to by experts in the field of human growth and behavior.

Maley (26) does not describe the facilities needed to maintain the research and experimentation programs. The following quote does give some clue as to the type of facilities that probably would be needed for the program:

> A highly successful program has been operating for five years on these bases. It has been a program that started with principles and concepts. It is a program of acceptance in a highly academic environment. It has been

> a program geared to an understanding of the nature and needs of a society, a faith in the capabilities of boys and girls, and a faith in Industrial Arts as a very important part of the total school program. (26, p. 30)

Summary

The information presented in this chapter includes the beliefs of authorities that have written about the industrial arts curriculum. These comments reveal that there is an unanimous agreement that industrial arts derives its subject matter from industry. The techniques of developing this subject matter into the courses of study of the curriculum, vary with the different individuals. One writer, in discussing the problem of improving the curriculum, presented the the challenge for improvement through application of the analysis technique: first, as a means of extending agreement beyond the cover-all name of "industrial arts"; and second, to increase agreement and understanding of the place and purpose of industrial arts in the school curriculum.

While research in curriculum development was reported, the lack of research to relate the industrial arts laboratory facilities to the curriculum, was cited as a reason why the facilities have not changed with the curriculum. Most writers agree that the criteria for the development of industrial arts laboratories can be drawn from within the curriculum. The research that deals with curriculum development has resulted in suggestions of a curriculum designed around technology, around elements of industry, and around research and development. Some writers quoted indicated that as we study these new curricula, some vital questions need to be answered about the facilities needed. The curriculum is only one corner of the triangle. The other two, equally important, are qualified teachers and suitable facilities.

III. PROCEDURES

Introduction

The data for this study were collected by two separate questionnaires. The first was designed to ascertain the principal process operations of the graphic arts industries (graphic arts questionnaire). The second was designed to ascertain the principal process operations of the manufacturing industries, other than graphic arts (manufacturing questionnaire). The study sought to ascertain the degree to which commonality of process operations exists among the various industrial groups. Specifically, the investigation attempts to answer the following questions: (1) Which process operations are being performed by the various industrial establishments and by what method; (2) When do these industrial establishments plan to begin performing the process operation; and (3) What are the reasons for not performing the process operations?

Selection of Study Participants

The 1964 edition of the Directory of Oregon Manufacturers and Buyer's Guide (29), published by the Oregon State Department of Planning and Development, served as the source from which the participants for this study were to be selected. The directory contains information on location, products, and employment figures for approximately 5,000 manufacturing plants in Oregon.

The directory is divided into three major sections: an alphabetical listing of all manufacturers in Oregon, a geographical listing of manufacturing establishments, and a listing of products manufactured in Oregon and the plants that produce them. The section, Product Listing, contained information about the industrial manufacturers that seemed to be most appropriate for the study. It provided complete information as to the name of the company, mailing address, principal company official, principal products manufactured, and number of employees.

The four-digit code numbers under which the Product Listing is organized are the Standard Industrial Classification (S. I. C.) Codes established by the U. S. Bureau of the Budget and published in its Standard Industrial Classifications Manual of 1957 as amended by the Supplement of 1963 (39). These codes were developed in order to promote uniformity and comparability in the presentation of statistical data collected by various agencies of the U. S. Government, state agencies, trade associations, and private research organizations. Accordingly, the codes used in this directory conformed to the industrial classifications used in the U. S. Census of Manufacturers (41). In order to provide a complete listing of different products in Oregon, the directory assigned additional code numbers to the minor products of the manufacturing plants. These are represented by minor Standard Industrial Classification Codes. (See Appendix C.)

With the addition of an identifying number assigned by the investigator, the Standard Industrial Classification Codes became the code numbers for each of the participants.

The first step in the selection of participants for the study was to identify those standard industrial classifications that would be most acceptable for this study. The standard industrial classifications, as listed in the directory, are shown in Table 1. Table 2 lists the criteria which were applied to eliminate certain classifications from this list. The criteria were:

1. The classifications were not represented by manufacturing establishments in Oregon.

2. The classifications were not represented by sufficient numbers of manufacturing establishments, or the establishments listed employed less than ten employees.

3. The classifications were primarily concerned with producing materials from raw materials, i.e. iron from iron ore; lumber from logs.

4. The classifications were more commonly associated with other areas of general education, i.e. home economics and chemistry.

Twelve of the 21 standard industrial classifications displayed

Table 1. Standard Industrial Classifications (S.I.C.).

Code	
* 19	Ordnance and Accessories
* 20	Food and Kindred Products
* 21	Tobacco Manufacturers
* 22	Textile Mill Products
* 23	Apparel and Other Finished Products
24	Lumber and Wood Products (Except Furniture)
25	Furniture and Fixtures
* 26	Paper and Allied Products
27	Printing and Publishing and Allied Industries
* 28	Chemicals and Allied Products
* 29	Petroleum Refining and Related Industries
30	Rubber and Miscellaneous Plastics Products
* 31	Leather and Leather Products
32	Stone, Clay, and Glass Products
33	Primary Metal Industries
34	Fabricated Metal Products (Not Elsewhere Classified)
35	Machinery, (Except Electrical)
36	Electrical Machinery, Equipment, and Supplies
37	Transportation Equipment
38	Professional, Scientific, and Controlling Instruments; Photographic and Optical Goods; Watches and Clocks
39	Miscellaneous Manufacturing Industries

Note: (*) These Standard Industrial Classifications were not judged to be acceptable to the study (see Table 2).

Number of Standard Industrial Classification Codes Listed	21
Number of Standard Industrial Classification Codes Not Acceptable to the Study	9
Total Number of Standard Industrial Classification Codes Accepted for this Study	12

Table 2. Classified reasons for eliminating certain standard industrial classifications from the original list.

Reason	Number of Standard Industrial Classifications
1. Not represented by manufacturing establishments in Oregon.	1
2. Not represented by sufficient numbers of manufacturing establishments or the establishments listed employed less than ten employees.	1
3. Primarily concerned with producing materials from raw materials.	1
4. More commonly associated with other areas of general education, i.e. home economics and chemistry.	6
TOTAL	9

in Table 1 were considered to be acceptable to the study.

The second step was to analyze the industrial establishments listed under the twelve standard industrial classifications to determine which would be the most appropriate participants. Each individual industrial establishment was analyzed for its size, according to the number of employees, and for the variety of products in their product listing. To delimit the study, it was decided to select those establishments that listed ten or more employees and whose product listing indicated diversity of manufactured products. In addition to these delimiting criteria, those manufacturing establishments which indicated that they were limited to executive offices or auxiliary units where no manufacturing activities took place, were not considered as participants for the study.

A total of 1487 manufacturing industries are listed in the directory under the twelve major Standard Industrial Classifications. From this group of manufacturing industries 599, or 40.4 percent were chosen to be the participants for the study. (See Table 3)

Table 3. Summary of manufacturing establishments selected as participants.

Manufacturing Groups from which Participants were Selected	Number of Manufacturing Establishments Represented	Number of Establishments Selected as Participants
One S.I.C. manufacturing classification - Printing-Publishing and Allied Industries (Representing 13 of 24 minor S.I.C. code titles)	360	103
Eleven S.I.C. manufacturing classifications - other than Printing-Publishing and Allied Industries (Representing 107 of 182 minor S.I.C. code titles)	1127	496
TOTAL	1487	599

Construction of the Questionnaire

Two questionnaires, one for the graphic arts industries and another for the manufacturing industries, other than graphic arts, were developed. An extensive review of the literature was conducted to compile a list of principal process operations common to the manufacturing industries found in the industrial classifications chosen for the study. It was found that the process operations compiled for the graphic arts industries had little, if any similarity, to those of the other manufacturing industries. Thus, a need for two separate questionnaires was established.

The Oregon State University Department of Statistics aided in designing a questionnaire format which was convenient to code and programme for computer tabulation. A check list type of questionnaire was developed.

The graphic arts questionnaire (See Appendix B) had seven sections: I. Relief Printing - Letterpress; II. Plane Printing - Offset; III. Intaglio-Gravure; IV. Paint Printing - Silk Screen; V. Screenless Illustration Printing; VI. Bindery; and VII. Miscellaneous. Each section contained sub-topics of process operations that are commonly associated with that section. There were 14 questions in the questionnaire with 50 principal process operation listings; two pages in length. All of the items listed were designed for simple check mark response.

The principal process operations in the graphic arts questionnaire represented those listed by Karch in Graphic Arts Procedures (24); Hague in Printing and Allied Graphic Arts (20); Jackson in Printing: A Practical Introduction to the Graphic Arts (23); and Cogoli in Photo-Offset Fundamentals (13).

The manufacturing industries questionnaire (See Appendix B) had five sections: I. Forming; II. Casting and Molding; III. Shaping - Cutting; IV. Assembly; and V. Auxiliary. Each section contained sub-topics of process operations that are commonly associated with that section. There were 14 questions in the questionnaire with 153 principal process operations, four pages in length. All of the items listed were designed for simple check mark response.

The principal process operations in the manufacturing questionnaire represented those listed by Eary and Johnson in Process Engineering for Manufacturing (16); by Leach, Morris, and Schrader in Manufacturing Processes and Materials for Engineers (15); by Begeman in Manufacturing Processes (8); by the Plastics Engineering Handbook of the Society of the Plastics Industry, Inc. (37); and by Lindberg in Processes and Materials of Manufacture (25).

The study participants were given ample opportunities to supply additional process operations to the lists on the two questionnaires. None of the respondents availed themselves of this opportunity. This is a possible indication of their belief that the questionnaires were complete with most identifiable process operations.

Questionnaire Returns

According to the procedure described under Selection of Study Participants, the questionnaires were sent to 599 industrial establishments in 12 standard industrial classifications in Oregon. A letter of transmittal which explained the purpose of the study and which requested the cooperation of responsible individuals in the industrial establishments was mailed to the selected participants (See Appendix A). From the first mailing, 316 or 52.75 percent of the questionnaires were returned. A follow-up letter, asking for compliance with the original request, was sent to nonrespondents four weeks after the first mailing (See Appendix A).

Eighty-three or 80.5 percent of the graphic arts establishments and 362 or 72.9 percent of the manufacturing establishments, other than graphic arts, completed the questionnaire (See Table 4 and Appendix D).

Twenty-three of all questionnaires returned were incomplete. Some of these respondents gave reasons for not completing the questionnaires. These incomplete responses were classified according to the reasons given; the results are displayed in Table 5.

Table 4. Summary of respondents.

Manufacturing Groups from which Participants were Selected	Number of Participants Selected	Number of Respondents	Percentage of Respondents
Printing-Publishing and Allied Industries	103	83	80.5
Manufacturing Classifications (other than Printing, Publishing, and Allied Industries)	496	362	72.9
TOTAL	599	445	74.2

Table 5. Classified reasons for incomplete returns.

Reason Given	Graphic Arts	Manufacturing Establishments
1. Removed code numbers from the questionnaire	0	8
2. Company is no longer in business	1	7
3. Company does not do any production	2	1
4. Did not complete the questionnaire as the company was reported through another company	0	4
TOTAL	3	20

A total of 422 or 70.45 percent, of the original 599 participants, are the manufacturing establishments upon which this study was based. The respondents represented all of the 12 major S.I.C. classifications; and 103 or 92.8 percent of the 111 minor S.I.C. classifications selected from the 1964 Directory of Oregon Manufacturers and Buyer's Guide (29). The distribution by major and minor S.I.C. classifications is illustrated in Appendix C.

Analysis of Response

The questionnaires provided only one type of data, objective-quantitative responses. The objective responses were transferred to IBM cards and analyzed, using data processing equipment provided by Oregon State University Department of Statistics. The analysis was limited to the use of descriptive statistics such as numbers and percentages.

Summary

Two separate questionnaires were designed to identify the principal process operations of industry. One for the graphic arts industries (Printing, Publishing, and Allied Industries), and the second one for the manufacturing industries (other than Printing, Publishing, and Allied Industries). This was necessary as the process operations of these two groups of manufacturing industries were found to have little or no similarity between them. The questionnaires were designed for simple check mark response on a multiple-choice basis. This feature was essential because of the nature of the specific questions asked. Also, numerical computation methods were less difficult to perform with such a form for the needed comparative information. Process operations listed in the questionnaire were derived by inspection of the literature.

A total of 599 manufacturing establishments, representing 12 major industrial code classifications and 111 minor industrial code classifications were selected for participation in the study. Four hundred and forty-five manufacturing establishments from 12 major industrial code classifications or 74.2 percent of those selected, responded by completing the questionnaire. Four hundred and twenty-two or 70.45 percent were the manufacturing establishments upon which the study was based.

The analysis and findings, based upon the completed questionnaires, are discussed in Chapter IV of this study.

IV. PRESENTATION OF FINDINGS AND IMPLICATIONS

General Findings

Sample Characteristics

The first task in the analysis was to determine the nature of the sample. By coding the questionnaire, it was possible to determine the extent of the returns in the industrial classifications. Table 6 displays the number and percentage of usable returns which are listed in the various standard industrial classifications. The study sought a broad sampling of the different types of manufacturing establishments so that the results would represent the manufacturing scene in the State of Oregon. While this was not a simple random sampling, each classification was substantially represented.

The employment information was obtained from the 1964 Directory of Oregon Manufacturers and Buyer's Guide (29). As might be expected, a negative exponential distribution was obtained. There were a number of manufacturing establishments of small size, a lesser number of medium size, and a still lesser number of large size. The distribution of the sample manufacturing establishments is shown in Table 7. The information presented here tends to disprove the common belief that the industrial society is composed

Table 6. Usable questionnaire returns from standard industrial classifications.

Major Code	Title	Number of Selected Companies	Number of Usable Returns	Percentage of Usable Returns
24	Lumber and Wood Products (Except Furniture)	64	44	68.7
25	Furniture and Fixtures	25	17	68.0
27	Printing and Publishing and Allied Industries	103	80	77.7
30	Rubber and Miscellaneous Plastic Products	10	6	60.0
32	Stone, Glass, and Glass Products	3	3	100.0
33	Primary Metal Industries	31	24	77.4
34	Fabricated Metal Products, Not Elsewhere Classified	117	82	70.0
35	Machinery (Except Electrical)	119	86	72.2
36	Electrical Machinery Equipment and Supplies	34	25	73.5
37	Transportation Equipment	49	23	46.9
38	Professional, Scientific, and Controlling Instruments: Photographic and Optical Goods; Watches and Clocks	16	12	75.0
39	Miscellaneous Manufacturing Industries	28	20	71.4
	TOTAL	599	422	70.45

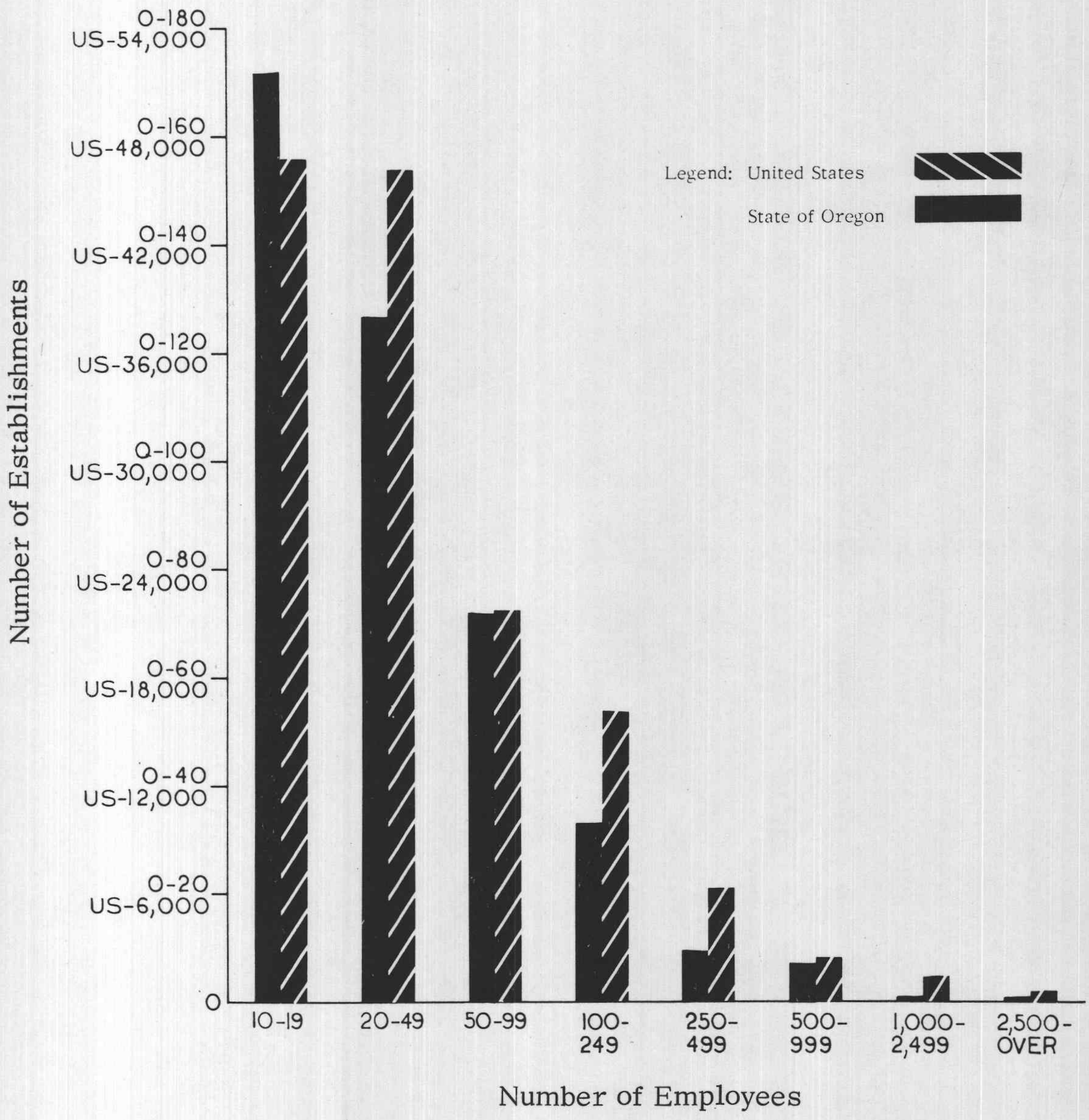
Table 7. Size of responding manufacturing establishments.

	Number of Employees	Number of Companies	Percentage of Companies
1.	10 - 19	172	40.8
2.	20 - 49	127	30.1
3.	50 - 99	72	17.1
4.	100 - 249	33	7.8
5.	250 - 499	9	2.1
6.	500 - 999	7	1.7
7.	1,000 - 2,499	1	.2
8.	2,500 and over	1	.2
	TOTAL	422	100.0

almost entirely of large industrial organizations. Over 70 percent of the responding manufacturing establishments, in the State of Oregon, employed less than 50 employees. This distribution was found to be typical when compared with the distribution on a national basis. (See Figure 1.)

The sample was a large heterogenous group of manufacturing establishments from 12 major standard industrial classification codes of manufacturing industries in the State of Oregon. The relative proportion of the sample companies located within the chosen

Figure 1. Number of Employees in Manufacturing Establishments - United States and State of Oregon Compared



Sources: U. S. Department of Commerce, Bureau of the Census
State of Oregon
Department of Planning and Development

classifications codes was not equal to the proportion of the total number of manufacturing establishments in those standard industrial classification codes. No attempt was made to balance the amount of representation between these classifications, as it would have been irrevelant to the study. However, the distribution of the sample manufacturing establishments, according to establishment employment size, was found to be typical when compared with national figures, and assumed to be reasonable and acceptable for this study. (Figure 1)

Principal Process Operation Analysis - Graphic Arts

Preparation of the Data

The graphic arts questionnaire was designed to identify the principal process operations being employed by industry. These process operations might then be identified as curricular components that could become a part of the industrial arts curriculum. In the questionnaire pertaining to the graphic arts, the process operations were listed in seven general areas of graphic arts activities: (1) relief printing (letterpress), (2) plane printing (offset), (3) intaglio printing (gravure), (4) paint printing (silk screen), (5) screenless illustration printing, (6) bindery, and (7) miscellaneous. (See Appendix B). The manufacturing industries questionnaire listed the process operations in five general areas of manufacturing activities: (1) forming, (2) casting and molding, (3) shaping-cutting, (4) assembly, and (5) auxiliary. Three major questions were asked of all of the respondents: (1) What method is employed to perform the process operation? (2) If not performing the operation now, when do you expect to begin? and (3) What is the reason or reasons for not planning to perform the operation? (See Appendix B)

The methods of performing the operations were listed in four columns: (1) hand methods, (2) standard machine methods (3) automated machine methods, and (4) both hand and machine methods. The respondents were asked to check those methods being employed opposite the principal process operation. A column titled 'not at all' was provided for the respondents if they did not perform the operation at all. In addition, the respondents were asked to indicate their intentions to perform the process operation in the future in one of two columns: (1) one to two years, or (2) three to five years. A 'not at all' column was provided for the respondents to check if they did not plan to do the process operation at all. In addition, the respondents were asked to indicate their reason for not planning to perform the operation in one of five columns: (1) does not apply to the general operation of the establishments, (2) too small (company), (3) too large (operation), (4) too expensive (operation), or (5) contracted out to another establishment. A column was provided for the respondents to supply other reasons for not performing the operation. None of the respondents supplied additional reasons for not performing the operations.

The results provided by the respondents for each of the area classifications are summarily displayed in the tables included in this chapter. Data pertaining to the three major questions are presented separately.

The title of the area classification and the specific question asked of the respondent is given at the top of the table along with the number of establishments which responded in regard to the process operations. A chart of process operations for each of the listed classifications is included.

Interpretation of Data - Graphic Arts

Relief Printing: Letterpress

1. The methods of performing the process operations in the area of Relief Printing are displayed in Table 8. Hand methods were used by 60 to 70 percent of the respondents in performing the operations of layout and plain composition, and by only 20 to 35 percent in proving and imposing. Standard machine methods were used by 27 or 42 percent of the respondents in performing the operations of intertype, linotype, proving, letterpress printing, and die cutting.

Table 8. RELIEF PRINTING: LETTERPRESS - Methods of performing the process operations, percentage of establishments (N = 80)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Layout	65.0			8.75	26.25
Plain Composition (Hand)	70.0				30.0
Hot type composition					
Intertype		27.5	2.5		70.0
Linotype		41.25	13.75		45.0
Monotype		11.25	2.5		86.25
Cold Type Composition	5.0	10.0	6.25	10.0	68.75
Photo Mechanical	2.5	13.75	3.75	2.5	77.5
Proving	23.75	27.5	1.25	13.75	33.75
Imposing	35.0	6.25		5.0	53.75
Letterpress Printing		41.25	8.75	10.0	40.0
Flexographic		1.25		1.25	97.5
Thermography		3.75		1.25	95.0
Die Cutting	1.25	35.0	5.0	3.75	55.0
Embossing	1.25	10.0		1.25	87.5
Stamping Through Gold or Metallic Foil	2.5	2.5			95.0
Blind Stamping		6.25			93.75

Automated machines were used to perform 8 of the 16 operations listed. Although the data shows that standard machine and automated machine methods are used by the respondents, it should be noted that hand methods are used to perform 12 of the 16 operations listed. The number of respondents that do not perform the operations at all are reported in the 'Not at All' column, and vary from 26 to 98 percent. Those operations which had the largest number of respondents in this column were: monotype (86.25 percent), flexographic (97.5 percent), thermography (95 percent), embossing (87.5 percent), stamping through gold or metallic foil (95 percent), and blind stamping (93.75 percent).

2. Table 9 shows when the graphic arts establishments planned to begin performing the operations. A trend toward the expansion of their facilities to include cold type composition and photo mechanical composition seems to be indicated. This growth would be most evident in the next three to five year period. The greatest amount of growth appears to be in the cold type composition operation where a total of 18.75 percent of the respondents indicated their intention to begin performing the operation. A total of 8.75 percent indicated their intention to begin performing the photo mechanical composition operation.

3. Table 10 shows that two reasons were indicated by the respondents most often for not performing the operations: (1) Does

Table 9. RELIEF PRINTING: LETTERPRESS - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Layout			26.25
Plain Composition (Hand)			30.0
Hot Type Composition			
Intertype			70.0
Linotype			45.0
Monotype			86.25
Cold Type Composition	5.0	13.75	50.0
Photo Mechanical	3.75	5.0	68.75
Proving			33.75
Imposing			53.75
Letterpress Printing			40.0
Flexographic			97.5
Thermography		1.25	93.75
Die Cutting			55.0
Embossing			87.5
Stamping Through Gold or Metallic Foil	1.25		93.75
Blind Stamping			93.75

Table 10. RELIEF PRINTING: LETTERPRESS - Reasons for not performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Too Small	Too Large	Too Expensive	Contracted Out	Does Not Apply to General Operation of the Company
Layout				1.25	25.0
Plain Composition (Hand)				1.25	28.75
Hot Type Composition					
Intertype		2.5		2.5	65.0
Linotype		2.5		2.5	40.0
Monotype		1.25	2.5	8.75	77.75
Cold Type Composition			3.75	10.0	35.75
Photo Mechanical			8.75	12.5	47.5
Proving				1.25	32.5
Imposing				1.25	52.5
Letterpress Printing				2.5	37.5
Flexographic	2.5	2.5		6.25	86.25
Thermography	2.5		1.25	17.5	73.75
Die Cutting	1.25			1.25	52.5
Embossing	2.5		1.25	17.5	66.25
Stamping Through Gold or Metallic Foil	1.25		1.25	18.75	73.25
Blind Stamping	1.25		1.25	20.0	71.25

not apply, and (2) Contracted to another company. The latter reason is a probable indication of the importance these operations are to the general operation of those establishments and to the degree to which specialization exists within the industry. The operations of thermography, embossing, stamping through gold and metallic foil, and blind stamping were not performed by many of the respondents as shown in Table 8. However, Table 10 shows that these operations were contracted out most often. Although three to nine percent of the respondents considered cold type composition and photo mechanical composition too expensive, there were 10 to 12.5 percent of the graphic arts establishments that contracted to have these operations performed elsewhere. The number of respondents that replied in the 'Does Not Apply' column gives an indication of the varying degrees of importance the operations have in the graphic arts industry. From the data presented, the least performed operations were: monotype, 77.75 percent; flexographic, 86.25 percent; thermography, 83.75 percent; stamping through gold or metallic foil, 73.25 percent; and blind stamping, 71.25 percent.

Plane Printing: Offset

1. The methods of performing the process operations in Plane Printing - Offset, are shown in Table 11. Layout operation is shown to be performed by hand methods by 56.25 percent. Standard

Table 11. PLANE PRINTING: OFFSET - Methods of performing the process operations, percentages of establishments. (N = 80)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Layout	56.25			5.0	38.75
Photo Copying	6.25	31.25	1.25	7.5	53.75
Plate Making	10.0	37.5	3.75	11.25	37.5
Color Separation	5.0	11.25	1.75	5.0	77.5
Offset Press Printing		45.0	17.5	2.5	35.0

machine methods were used most often in the performance of all of the other operations, with offset press printing having the largest number of respondents (45 percent). In addition, this is the process operation where the greatest number of respondents used automated machinery. Photo copying and plate making are represented in all categories of methods with a strong indication for the use of both hand and machine methods. The number of respondents that did not perform the operations at all are reported in the 'Not at All' column. The operation of color separation had the largest number of responses in this column (77.5 percent). However, Tables 12 and 13 tend to emphasize the importance the graphic arts industry gives to this operation.

Table 12. PLANE PRINTING: OFFSET - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Layout			38.75
Photo Copying	1.25	1.25	51.25
Plate Making			37.5
Color Separation	2.5	5.0	70.0
Offset Press Printing		1.25	33.75

Table 13. PLANE PRINTING: OFFSET - Reasons for not performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Too Small	Too Large	Too Expensive	Contracted Out	Does Not Apply to General Operation of the Company
Layout				1.25	37.5
Photo Copying				8.75	42.5
Plate Making				2.5	35.0
Color Separation			2.5	18.75	48.75
Offset Press Printing				1.25	32.5

2. Plans to begin the performance of the process operations, as shown in Table 12, were not reported to any great extent. Evidence indicates that the process operations of color separation will probably show minor growth (2.5 percent) in the next one to two year period with greater growth (5 percent) taking place in the next three to five year period. This would be considered as a trend for expansion within the industry and could possibly influence the selection of color separation as a curricular component in the graphic arts curriculum.

3. Table 13 shows reasons for not performing the process operations. From 32 to 49 percent of the respondents indicated that they did not perform and did not plan to perform the process operations as they did not apply to the general operation of their establishments. Color separation was contracted to other establishments by 18.75 percent of the respondents while 8.75 percent contracted to have photo copying done elsewhere.

Intaglio Printing: Gravure

1. The methods of performing the process operations in Intaglio Printing are displayed in Table 14. None of the operations were performed by hand methods. However, all of the operations were performed, to some degree, by both hand and machine methods. Photoengraving was the operation performed most often by standard

Table 14. INTAGLIO PRINTING: GRAVURE - Methods of performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Copper Plate Engraving		1.25		2.5	96.25
Line Engraving		2.5	1.25	2.5	93.75
Photoengraving		5.0	3.75	2.5	88.75
Etching		2.5		2.5	95.0
Dry Point				1.25	98.75

machines (5.0 percent), and by automated machines (3.75 percent). The responses in the 'Not at All' column indicate the extent to which the operations are not performed by the respondents. However, Table 16 will show that the industry does consider some of the operations important. This will be shown by the number of respondents that contracted to have the operations performed elsewhere.

2. As shown by Table 15, none of the respondents had any plans to perform the process operations in the Intaglio Printing area.

3. The reasons for not performing the process operations in Intaglio Printing are reported in Table 16. Less than two percent of the respondents indicated that their companies were too small, or

Table 15. INTAGLIO PRINTING: GRAVURE - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Copper Plate Engraving			96.25
Line Engraving			93.75
Photoengraving			88.75
Etching			95.0
Dry Point			98.75

Table 16. INTAGLIO PRINTING: GRAVURE - Reasons for not performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Too Small	Too Large	Too Expensive	Contracted Out	Does Not Apply to General Operation of the Company
Copper Plate Engraving	1.25		1.25	11.25	82.5
Line Engraving	1.25		1.25	11.25	80.0
Photoengraving	1.25		1.25	11.25	75.0
Etching	1.25		1.25	7.5	85.0
Dry Point	1.25		1.25	6.25	90.0

that the operation was too expensive to be performed by them. From 6 to 12 percent of the respondents did indicate that they contracted out each of the operations. From 75 to 90 percent indicated that the operations did not apply to the general operation of their establishments. The data which is shown in Tables 14 and 16 are a probable indication of the degree of specialization that exists in the graphic arts industry for Intaglio Printing.

Paint Printing: Silk Screen

1. The methods for performing the process operations in the Paint Printing: Silk Screen area are displayed in Table 17 where the respondents indicated that they performed all of the operations using hand methods. None of the respondents indicated that they performed any of the operations using standard or automated machine methods. One operation, that of Tusche, was not performed by any of the respondents. The percentage of respondents performing any operations in this area of activity was relatively small being less than four percent.

2. Only one of the process operations, that of photographic silk screen, showed any indication of further development, then only in the next three to five year period and by only 1.25 percent of the respondents (Table 18). From the evidence presented, this area does not appear to be one that will be expanded by the industry

Table 17. PAINT PRINTING: SILK SCREEN - Methods of performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Layout	3.75				96.25
Photographic	1.25			1.25	97.5
Stencil (Hand Cut)	3.75				96.25
Tusche					100.00
Decalomania	2.5				97.5

Table 18. PAINT PRINTING: SILK SCREEN - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Layout			96.25
Photographic		1.25	96.25
Stencil (Hand Cut)			96.25
Tusche			100.0
Decalomania			97.5

in the one to five year period.

3. Table 19 shows that the most common reason given by the respondents for not planning to perform an operation was: the operations did not apply to the general operation of the establishment. Although 96 to 100 percent of the respondents reported in Table 17 that they did not perform the operations at all, 12 to 15 percent have now indicated that they did contract each of the operations to other companies. This is a probable indication of the degree of specialization that exists within the graphic arts industry for Paint Printing: Silk Screen.

Table 19. PAINT PRINTING: SILK SCREEN - Reasons for not performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Too Small	Too Large	Too Expensive	Contracted Out	Does Not Apply to General Operation of the Company
Layout			1.25	13.75	81.25
Photographic			1.25	15.0	80.0
Stencil (Hand Cut)			1.25	12.5	81.5
Tusche	1.25		1.25	13.75	83.75
Decalomania			1.25	15.0	81.25

Screenless Illustration Printing

1. The methods of performing the process operations are displayed in Table 20. None of the respondents indicated that they performed any of the process operations in this area.

2. The plans of the respondents to begin performing the process operations in Screenless Illustration Printing are reported in Table 21. There appears to be a slight indication of the industry beginning to perform the process operations in the next three to five year period, but by less than two percent of the respondents.

3. Ninety percent of the respondents indicated that the screenless illustration printing operations did not apply to their general production activities (Table 22). Seven and one-half percent of the respondents indicated that they contracted each of the operations to other establishments.

Bindery

1. The methods of performing the process operations in Bindery are reported in Table 23. The respondents indicated that hand operation methods were used to perform 10 of the 14 process operations listed. In addition, they reported using both hand and machine methods in 13 of the 14 operations. The operation of collating was performed most often by hand methods (27.5 percent).

Table 20. SCREENLESS ILLUSTRATION PRINTING - Methods of performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Photogelatin					100.0
Collotype					100.0

Table 21. SCREENLESS ILLUSTRATION PRINTING - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Photogelatin		1.25	98.75
Collotype		1.25	98.75

Table 22. SCREENLESS ILLUSTRATION PRINTING - Reasons for not performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Too Small	Too Large	Too Expensive	Contracted Out	Does Not Apply to General Operation of the Company
Photogelatin			1.25	7.5	90.0
Collotype			1.25	7.5	90.0

Table 23. BINDERY - Methods of performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Cutting	1.25	51.25	7.5	5.0	35.0
Drilling		53.75	2.5	5.0	38.75
Punching		52.5	2.5	5.0	40.0
Perforating		50.0	7.5	3.75	38.75
Folding	2.5	48.75	5.0	6.25	37.5
Collating	27.5	21.25	7.5	8.75	35.0
Stapling	1.25	48.75	5.0	7.5	37.5
Side Wire Binding	1.25	43.75	1.25	2.5	51.25
Saddle Wire Binding		42.5	6.25	5.0	46.25
Sewn Soft Cover	1.25	6.25	1.25		91.25
Sewn Case--Bound	2.5	2.5		1.25	93.75
Loose-leaf Binding	7.5	15.0		5.0	72.5
Plastic Binding	3.75	22.5		8.75	65.0
Spiral Binding	1.25	3.75		2.5	92.5

All of the process operations were reported as being performed by standard machine methods while 10 of the 14 operations were performed by the use of automated machines. Sewn soft cover, sewn case--bound, and spiral binding were performed the least often of all the process operations, less than a total of 10 percent of all respondents.

2. It is evident from the data collected that the industry in general does not plan expansion of facilities to perform the bindery operations (Table 24). Exceptions to this can be found in the operations of Plastic Binding and Spiral Binding, where 1.25 percent indicated that these operations would be added in the next three to five year period.

3. Several reasons were reported for not performing the process operations in the bindery area, in addition to the 'Does not Apply' reason (Table 25). The most notable of these was the 'Contracted Out' reason which was reported for all of the operations listed. The operations of sewn soft cover, sewn case--bound, and spiral binding, which were reported as being performed by less than a total of nine percent of all respondents reporting in Table 23, were among those which were most often contracted out to other companies (23 to 27 percent). The operations pertaining to the actual binding of materials were indicated as being too expensive or too large by only 1.25 percent of the respondents.

Table 24. BINDERY - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Cutting			35.0
Drilling			38.75
Punching			40.0
Perforating			38.75
Folding			37.5
Collating			35.0
Stapling			37.5
Side Wire Binding			51.25
Saddle Wire Binding			46.25
Sewn Soft Cover			91.25
Sewn Case--Bound			93.75
Loose-leaf Binding			72.5
Plastic Binding		1.25	63.75
Spiral Binding		1.25	91.25

Table 25. BINDERY - Reasons for not performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Too Small	Too Large	Too Expen-sive	Con-tracted Out	Does Not Apply to General Operation of the Company
Cutting				1.25	33.75
Drilling				2.5	36.25
Punching				1.25	38.75
Perforating				1.25	37.5
Folding				2.5	35.0
Collating				1.25	33.75
Stapling				1.25	36.25
Side Wire Binding			1.25	3.75	46.25
Saddle Wire Binding			1.25	2.5	42.5
Sewn Soft Cover		1.25	1.25	26.25	62.5
Sewn Case--Bound		1.25	1.25	26.25	65.0
Loose-leaf Binding		1.25	1.25	16.25	53.75
Plastic Binding		1.25	1.25	11.25	51.25
Spiral Binding			1.25	23.75	67.5

Miscellaneous

1. The methods of performing the process operations in this miscellaneous area are reported in Table 26. The operations included in this area may be referred to as auxiliary type operations that could possibly have been listed with some of the other areas. They represent rather specialized types of operations, and are performed by relatively few companies. The postage meter operation is performed by all methods, with standard machines being used by 17.5 percent of the respondents. As reported in the 'Not at All' column, the rubber stamp making and tickometer operations were not performed by any of the reporting establishments.

Table 26. MISCELLANEOUS - Methods of performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Xerography		1.25		1.25	97.5
Rubber Stamp Making					100.0
Postage Meter	5.0	17.5	2.5	6.25	68.75
Tickometer					100.0

2. The evidence does not indicate that there will be much expansion in the industry to include these process operations (Table 27). Rubber Stamp Making is the one operation which the respondents planned to begin performing in the one to five year period and then by only a total of 2.5 percent.

3. Table 28 shows that 60 to 90 percent of the respondents indicated that these operations did not apply to their general production activities. However, rubber stamp making was contracted out by 26.5 percent and xerography by 12.5 percent of the respondents.

General Curricular Component Observations for the Graphic Arts Curriculum

The general conclusions to be drawn from the response are these: Standard machine methods were used predominantly to perform the principal process operations. Automated machine methods were more often found in the areas of Relief Printing, Plane Printing, and Bindery than in the areas of Intaglio, Paint, and Screenless Painting, and the miscellaneous grouping. There is evidence that the industry intends to expand its operations in the area of Relief Printing and Plane Printing, specifically in the cold type composition, photo mechanical composition, and color separation operations. The process operations in the areas of Paint Printing (Silk Screen) and Screenless Illustration Printing were not being performed by many

Table 27. MISCELLANEOUS - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Xerography	1.25		96.25
Rubber Stamp Making	1.25	1.25	97.5
Postage Meter			68.75
Tickometer			100.0

Table 28. MISCELLANEOUS - Reasons for not performing the process operations, percentage of establishments. (N = 80)

Principal Process Operation	Too Small	Too Large	Too Expen-sive	Con-tracted Out	Does Not Apply to General Operation of the Company
Xerography	1.25		1.25	12.5	82.5
Rubber Stamp Making			1.25	26.25	70.0
Postage Meter			2.5	6.25	60.0
Tickometer	1.25		1.25	6.25	91.25

establishments. Therefore, this evidence indicates that these are the least desirable areas to be considered when selecting the curricular components for the graphic arts curriculum. All of the process operations were contracted out, to some degree, to other establishments in the graphic arts industry. Table 7 shows that there were a large percentage of small establishments participating in the study (88 percent with less than 100 employees). When this information is combined with the evidence that the establishments contracted out the performance of all process operations, the conclusion is supported that there is a high degree of specialization in the graphic arts industry. In addition, this would support the conclusion that even though the operations were contracted out, someone must be trained to perform the operations. Facilities should then be provided in the graphic arts laboratories for the performance of the more prominent of the process operations to be included as curricular components. Those less prominent process operations should be included as curricular components and presented as related information or topics for research and experimentation. Although this study excluded graphic arts establishments with less than ten employees, further investigation may reveal that it is these establishments that specialize in the performance of certain process operations in the graphic arts industry.

Interpretation of Data - Manufacturing Industries

1. Table 29 shows that all of the process operations in the Forming area were being performed by some method. The findings indicate that hand methods were used to perform 22 of the 43 operations, while 35 of them were performed by a combination of hand and machine methods. All of the operations were performed by standard machines, while 27 of the 43 were being performed by automated machines. However, there were less than four percent of the respondents using automated machines to perform the operations. The operations performed most often by hand methods were those of cold bending (4.4 percent), hot bending (5.3 percent), and welding - pipe (5.6 percent). These same operations were among those most often performed by the respondents in the 'Both Hand and Machine Method' column. The operations most often performed by standard machine methods were: punching (22.8 percent), trimming (17.8 percent), rolling (14 percent), cold bending (19.3 percent), flanging (9 percent), die pressing (12 percent), piercing (9.9 percent), blanking (13.2 percent), and welding - pipe (9.4 percent).

2. The study participants indicated that they intended to begin performing 34 of the 43 process operations in the next one to five year period (Table 30). However, the expansion of facilities to perform the operations, as indicated by the numbers of respondents,

Table 29. FORMING-Methods of performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Forging	2.1	3.8		2.3	91.8
Extruding		1.5	1.2	.6	96.7
Punching	1.8	22.8	3.2	10.8	61.4
Trimming	2.9	17.8	2.1	12.9	64.3
Drawing					
Box Drawing		2.9	.3		96.8
Panel Drawing		3.5	.6	.6	95.3
Cupping		4.4		.6	95.0
Redrawing		2.6			97.4
Reverse Redrawing		1.5			98.5
Rolling	2.9	14.0	1.5	5.6	76.0
Forming					
Cold Bending	4.4	19.3	2.1	14.6	59.6
Hot Bending	5.3	5.9	.9	7.0	80.9
Flanging	.9	9.0	1.2	4.7	84.2
Corrugating		4.4	.3	1.5	93.8
Beading	1.2	5.0	1.2	1.5	91.0
Ribbing	.6	3.8	.3	1.2	94.1
Curling		3.8	.6	.9	94.7
Hemming		5.3		3.8	90.9
Seaming	.6	5.6	1.5	3.5	88.8
Bulging	.6	2.9		1.2	95.3
Embossing		4.7	.9	1.8	92.6
Slip Forming	.6	1.2		.9	97.3
Plug and Ring		2.3		1.2	96.5
Die Pressing		12.0	.3	3.2	84.5
Stretch Forming	.9	3.2		1.5	94.4
Creasing	.6	4.4		1.5	93.5
Draping		1.5	.3		98.2
Differentials in Air Pressures					
Vacuum Forming		2.3	1.2	.6	95.9
Compressed Air Forming		2.3	.3	.3	97.1
Vacuum Drawing		.6			99.4
Blowing into Mold		.3			99.7
Pressure Blowing in Free Space		.6	.3		99.1
Coining		4.1	.9	1.2	93.8
Swaging	1.2	6.7	.9	3.5	87.7
Spinning (Cold)	.6	4.4	.6	1.5	92.9
Spinning (Hot)		1.2	.6	.6	97.6
Piercing	.6	9.9	1.2	4.1	84.2
Blanking	.6	13.2	1.8	2.9	81.5
Welding (Pipe)	5.6	9.4	.9	6.4	77.7
Squeezing (Cold)	.6	3.8		1.5	94.1
Squeezing (Hot)	.9	2.3		.9	95.9
Veneering (Hand Forming)	.6	.9		1.2	97.3
Blow Die		.6			99.4

Table 30. FORMING-When the establishments plan to begin performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Forging			91.8
Extruding	.9	.3	95.5
Punching	1.8	.9	58.7
Trimming	.9		63.4
Drawing			
Box Drawing	.3	.3	96.2
Panel Drawing	.3	.3	94.7
Cupping	.3	.6	94.1
Redrawing	.6	.3	96.5
Reverse Redrawing	.6	.3	97.6
Rolling	1.2	.3	74.5
Forming			
Cold Bending	1.2	.6	57.8
Hot Bending	.3	.3	80.3
Flanging	.9		83.3
Corrugating			93.8
Beading	.3	.6	90.2
Ribbing	.3	.3	93.5
Curling	.3	.3	94.1
Hemming			90.9
Seaming	.3		83.5
Bulging			95.3
Embossing	.3		93.3
Slip Forming		.3	97.0
Plug and Ring			96.5
Die Pressing	.9		83.6
Stretch Forming			94.4
Creasing	.6		92.9
Draping	.3		97.9
Differentials in Air Pressures			
Vacuum Forming	.3	1.2	94.4
Compressed Air Forming	.3	.6	96.2
Vacuum Drawing		.6	98.8
Blowing into Mold	.6	.3	98.8
Pressure Blowing in Free Space		.3	98.8
Coining	.3		93.5
Swaging	.3	.6	86.8
Spinning (Cold)			92.9
Spinning (Hot)	.3		97.3
Piercing	.6	.3	83.3
Blanking	.9	.6	80.0
Welding (Pipe)			77.7
Squeezing (Cold)	.3	.3	93.5
Squeezing (Hot)			95.4
Veneering (Hand Forming)		.3	97.0
Blow Die		.	99.4

never amounted to more than a total of 2.7 percent for any operation. The findings indicate a very limited amount of expansion of these operations within the industries.

3. From 56 to 98.5 percent of the study participants reported that the process operations in the Forming area did not apply to the general operation of their establishments (Table 31). However, all of the process operations were contracted out to other manufacturing establishments. Those reported most often under the 'Contracted Out' reason were: forging (5.8 percent), extruding (6.4 percent), cold spinning (3.8 percent), and swaging (3.2 percent).

Casting and Molding

1. The area of casting and molding did not have a high representation in numbers of responses for any process operation, as evidenced by the high percentages in the 'Not at All' column (Table 32). Less than a total of 10 percent of the respondents gave any indication of performing the operations. However, the findings revealed that all of the 23 process operations were being performed by some method: four by hand methods; 22 by standard machine methods; 15 by automated machine methods; and 19 by both hand and machine methods. The most often performed operations were those of: sand casting, permanent mold casting, shell mold casting, plastic molding, injection molding, and contact layup.

Table 31. FORMING-Reasons for not performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Too Small	Too Large	Too Expensive	Contracted Out	Does Not Apply to General Operation of the Company
Forging		.3		5.8	84.5
Extruding	.3	.3	.9	6.4	87.6
Punching	.3			1.5	56.9
Trimming			.3	1.8	61.3
Drawing					
Box Drawing			.3	.9	95.0
Panel Drawing				.9	93.8
Cupping				1.5	92.6
Redrawing				1.2	95.3
Reverse Redrawing				.6	97.0
Rolling				2.3	72.2
Forming					
Cold Bending				1.5	56.3
Hot Bending				1.2	79.1
Flanging				1.8	81.5
Corrugating		.3		2.1	91.4
Beading				1.2	89.0
Ribbing				1.2	92.3
Curling				.9	93.2
Hemming				1.2	89.7
Seaming				1.2	82.3
Bulging				.6	94.7
Embossing				2.1	91.2
Slip Forming		.3	.3	.9	95.5
Plug and Ring				.6	95.9
Die Pressing				2.1	81.5
Stretch Forming				1.5	92.9
Creasing				.9	92.0
Draping				.9	97.0
Differentials in Air Pressures					
Vacuum Forming		.3	.6	.6	92.9
Compressed Air Forming		.3	.6	.3	95.0
Vacuum Drawing		.3	.6	.6	97.3
Blowing into Mold		.3	.6	.3	97.6
Pressure Blowing in Free Space			.3	.3	98.2
Coining				2.1	91.4
Swaging		.3	.3	3.2	83.0
Spinning (Cold)				3.8	89.1
Spinning (Hot)				2.6	94.7
Piercing				1.8	81.5
Blanking				2.9	77.1
Welding (Pipe)				1.2	76.5
Squeezing (Cold)			.3	.6	92.6
Squeezing (Hot)				.3	95.1
Veneering (Hand Forming)			.6	.6	95.8
Blow Die			.3	.6	98.5

Table 32. CASTING AND MOLDING - Methods of performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Casting					
Sand Casting	.9	2.1	.6	4.7	91.7
Permanent Mold Casting	.3	.6	.6	2.9	95.6
Shell Mold Casting	.6	1.5	1.2	2.1	95.6
Precision Investment Casting		.3		2.1	97.6
Centrifugal Casting		1.5	.3	.9	97.3
Die Casting		1.5	.9	.3	97.3
Plastic Molding		3.2	.3	2.3	94.2
Embedding		1.2			98.8
Powdered Metal Molding		.3			99.7
Pressure Molding					
Die Casting		1.2	.6	.3	97.9
Compression Molding		1.8	.3	.6	97.3
Transfer Molding		.3	.3	.9	98.5
Laminating		.9		1.2	97.9
Injection Molding		2.1	.9	.9	96.1
Extruding		.6	.6	.3	98.5
Preforming		.3	.3	.3	99.1
Compacting		.3	.3	.6	98.8
Cold Molding		.3	.3	.6	98.8
Reinforced Plastic Molding					
Contact Layup	2.1	.6		1.2	96.1
Vacuum Bag Molding		.3		.3	99.4
Expanded Bag Molding		.3			99.7
Matched Metal Molding		.3		.6	99.1
Preform Molding			.3		99.7

2. Table 33 shows that the participants planned to begin performing 16 of the 23 process operations in the next one to five years. A total of 1.2 percent of the manufacturing establishments will probably begin performing the operations of permanent mold casting, shell mold casting, centrifugal casting, die casting, plastic molding, and injection molding in this same period.

3. Table 34 reveals the reasons for not performing the process operations. The majority of the respondents, 81 to 98.2 percent, indicated that the operations did not apply to the general operation of their establishments. All of the operations were contracted out to other companies. The more prominent ones were: sand casting (9.9 percent), die casting (8.2 percent), permanent mold casting (7.9 percent), shell mold casting (6.4 percent), precision investment casting (5.6 percent), centrifugal casting (5.6 percent), plastic molding (5.6 percent), and pressure molding--die casting (5.3 percent).

Shaping and Cutting

1. The methods of performing process operations of the Shaping - Cutting area are reported in Table 35. The data shows that the operations are performed rather extensively by the respondents using machine methods in preference to hand methods. Standard machines are used to perform all of the operations listed. The

Table 33. CASTING AND MOLDING - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	One to Two Years	Three of Five Years	Not at All
Casting			
Sand Casting	.6		91.1
Permanent Mold Casting	1.2		94.4
Shell Mold Casting	.9	.3	94.4
Precision Investment Casting	.6		97.0
Centrifugal Casting	.6	.6	96.1
Die Casting	.6	.6	96.1
Plastic Molding	.6	.6	93.0
Embedding			98.8
Powdered Metal Molding			99.7
Pressure Molding			
Die Casting	.3	.3	97.3
Compression Molding	.3	.6	96.4
Transfer Molding		.6	97.9
Laminating			97.9
Injection Molding	.6	.6	94.9
Extruding		.3	98.2
Preforming			99.1
Compacting			98.8
Cold Molding			98.8
Reinforced Plastic Molding			
Contact Layup	.3		95.8
Vacuum Bag Molding	.3	.3	98.8
Expanded Bag Molding			99.7
Matched Metal Molding	.3	.3	98.5
Preform Molding	.3		99.4

Table 34. CASTING AND MOLDING - Reasons for not performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Too Small	Too Large	Too Expen-sive	Con-tracted Out	Does Not Apply to General Operation of the Company
Casting					
Sand Casting				9.9	81.2
Permanent Mold Casting			.3	7.9	86.9
Shell Mold Casting			.3	6.4	87.7
Precision Investment Casting	.3		.3	5.6	90.8
Centrifugal Casting			1.2	5.6	89.3
Die Casting	.3		.3	8.2	86.3
Plastic Molding				5.6	87.4
Embedding				2.3	96.5
Powdered Metal Molding			.3	3.8	95.6
Pressure Molding					
Die Casting				5.3	92.0
Compression Molding				2.3	94.1
Transfer Molding				2.1	95.8
Laminating				2.3	95.6
Injection Molding				3.5	91.4
Extruding				3.8	94.4
Preforming				1.5	97.6
Compacting				1.5	97.3
Cold Molding				1.5	97.3
Reinforced Plastic Molding					
Contact Layup				1.8	94.0
Vacuum Bag Molding				1.8	97.0
Expanded Bag Molding				1.5	98.2
Matched Metal Molding				1.2	97.3
Preform Molding				1.2	98.2

Table 35. SHAPING -- CUTTING - Methods of performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Presswork (Chip-less Shaping)					
Cutoff	.6	23.4	1.8	6.7	67.5
Piercing		18.7	1.5	3.2	76.6
Punching	.9	26.0	1.8	3.8	67.5
Blanking	.3	17.5	2.0	3.8	76.4
Parting	.6	14.3	1.2	2.6	81.3
Trimming	.6	21.6	2.0	6.1	69.7
Notching	1.2	20.2	1.5	5.0	72.1
Lancing		7.0	.9	1.8	90.3
Perforating	.6	10.8	1.5	2.0	85.1
Shearing	1.5	22.5	2.0	5.8	68.2
Shaving		7.3	1.2	2.0	89.5
Machine (Cutting)					
Turning		35.0	5.5	5.5	54.0
Drilling		42.7	6.4	12.6	38.3
Counterboring		36.5	3.5	7.3	52.7
Countersinking		37.4	4.7	11.4	46.5
Fly Cutting		24.9	.9	5.8	68.4
Milling		30.9	2.9	5.3	60.9
Shaping		26.9	2.6	4.7	65.8
Planing		19.0	2.3	2.9	75.8
Cutoff	.6	22.5	1.5	4.9	70.5
Broaching		5.5	.3	2.0	92.2
Grinding		11.1	1.5	5.3	82.1
Honing	.3	12.6	.3	4.7	82.1
Sawing	.9	39.2	3.5	9.6	46.8
Routing		21.3	.6	3.5	74.6
Engraving		4.4		.6	95.0
Sanding	3.2	25.4	2.6		68.8
Filing	16.1	12.3	.3	10.2	59.1
Tapping--Threading	3.8	22.5	2.9	15.8	25.0

percentage of responses in this performance category varies from a low of 4.5 percent for engraving to 42.7 percent for drilling. However, further examination of this column shows that only four of the 29 operations; lancing, shaving, broaching, and engraving, were performed by less than 10 percent of the respondents. In addition, 17 of the operations were performed by more than 20 percent of the respondents using standard machine methods. Automated machines were used to perform 28 of the 29 operations. Turning (5.5 percent), drilling (6.4 percent), counter boring (3.5 percent), and countersinking (4.7 percent) were those most often performed using automated machines. Hand operations alone were only used in 14 operations, while both hand and machine methods were used in 28 of the 29 operations.

2. It was found that the manufacturing establishments would begin to perform all of the process operations in the one to five year period (Table 36). More establishments indicated their intentions to begin performing the operations in the three to five year period than would in the one to two year period. The percentage of the establishments beginning to perform any of the operations is relatively small, being less than a total of three percent.

3. Table 37 shows the reasons why the manufacturing establishments do not perform the process operations. The establishments contracted out 26 of the 29 operations to other companies, by

Table 36. SHAPING -- CUTTING - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Presswork (Chipless Shaping)			
Cutoff	.3	.9	66.3
Piercing	.3	1.2	75.1
Punching	.6	1.5	65.4
Blanking	.3	1.5	74.6
Parting	.3	.3	80.7
Trimming	.3	.9	68.5
Notching		.9	71.2
Lancing		.3	90.0
Perforating		.6	84.5
Shearing	.9	.6	67.0
Shaving		.3	89.2
Machine (Cutting)			
Turning	.3	.9	52.8
Drilling		.3	38.0
Counterboring		.3	52.4
Countersinking		.3	46.2
Fly Cutting		.6	67.8
Milling	.3	.9	59.7
Shaping	.3	.9	64.6
Planing	.9	.6	74.3
Cutoff	.6	.3	69.3
Broaching		.3	91.9
Grinding	.3	2.0	79.8
Honing	.6		81.5
Sawing		.3	46.0
Routing		.3	74.3
Engraving		.6	94.4
Sanding		.6	68.2
Filing	.3		58.8
Tapping--Threading		.9	24.1

Table 37. SHAPING -- CUTTING - Reasons for not performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Too Small	Too Large	Too Expen-sive	Con-tracted Out	Does Not Apply to General Operation of the Company
Presswork (Chipless Shaping)					
Cutoff				2.3	64.0
Piercing				1.8	73.3
Punching	.3			1.5	63.6
Blanking			.3	2.3	72.0
Parting			.3	1.8	78.6
Trimming			.3	1.8	66.4
Notching			.3	1.8	69.1
Lancing				1.5	88.5
Perforating				2.6	81.9
Shearing		.3		2.0	64.7
Shaving				1.5	87.7
Machine (Cutting)					
Turning				.6	52.2
Drilling					38.0
Counterboring				.6	51.8
Countersinking					46.2
Fly Cutting				1.2	66.6
Milling				1.2	66.6
Shaping	.3		.3	3.2	60.8
Planing			.6	1.2	72.5
Cutoff				.6	68.7
Broaching			.3	2.6	89.0
Grinding				.3	79.5
Honing				2.9	78.6
Sawing					46.0
Routing				2.0	72.3
Engraving	.6			5.5	88.3
Sanding	.3			.9	67.0
Filing				.6	58.2
Tapping--Threading	.3			.6	23.2

varying degrees. The process operation of engraving, which was reported in Table 35 as being performed by only a total of five percent of the respondents, is contracted out most often by 5.5 percent. 'Does Not Apply to the General Operation of the Company' was the most often reported reason for not performing the operations.

Assembly

1. The methods of performing the process operations in the Assembly area are reported in Table 38. With the exception of friction welding, which was not performed by any of the respondents, the process operations were performed mainly by hand and standard machines. Hand methods were used to perform 21 of the 23 operations. In the permanent joining category, the operations performed most often by this method were: welding - oxygen-acetylene (14.9 percent), soldering - soft (13.7 percent), soldering - hard (11.4 percent), and brazing (17.8 percent). In the mechanical assembly category, all of the operations were performed by hand by more than 14 percent of the respondents. Standard machines were used to perform 22 of the 23 operations, with the operations of welding - oxygen-actylene (19.0 percent), welding - resistance (16.4 percent), soldering - hard (10.5 percent), brazing (11.4 percent), press fitting (12.5 percent), and riveting (13.7 percent) being performed most often. Although most of the activity for the performance of the operations

Table 38. ASSEMBLY - Methods of performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand and Machine Methods	Not at All
Joining (Permanent)					
Welding (Forge)	1.8	2.6	.6	2.0	93.0
Welding (Oxy.-Acet.)	14.9	19.0	1.2	8.2	56.7
Welding (Resistance)	4.7	16.4	1.5	6.1	71.3
Welding (Inert Gas)	6.4	9.9	3.8	7.0	72.9
Welding (Atomic Hydrogen)		2.3	.6	2.6	94.5
Welding (Fusion)	3.5	4.1	1.2	3.8	87.4
Soldering (Soft)	13.7	8.5	1.8	5.5	70.5
Soldering (Hard)	11.4	10.5	1.5	3.8	72.8
Brazing	17.8	11.4	.9	4.7	65.2
Gluing (Pressure)	7.0	7.9	.9	3.8	80.4
Gluing (Heating)	1.2	4.1	.3	1.2	93.2
Gluing (Resistance)	.6	6.4	.6		92.4
Cementing	7.0	3.5		2.9	86.6
Press Fitting	5.2	12.6	.6	4.7	76.9
Shrink Fitting	6.1	7.6	.6	4.1	81.6
Plastic Welding					
Heated Tool Welding	2.0	2.6		.9	94.5
Hot Gas Welding	.6	1.2		.3	97.9
Friction Welding					100.0
Assembly (Mechanical)					
Riveting	14.6	13.7	.9	13.2	57.6
Screws (Self-Tapping)	17.3	9.9	.3	10.2	62.3
Screws (Machine)	21.1	9.4	.3	11.1	58.1
Screws (Wood)	16.1	4.4	.3	5.5	73.7
Nails	16.6	3.8	1.5	5.8	72.3

was centered in hand and standard machine methods, automated machines were used in 19 of the 23 operations. This method was used most often by the establishments to perform the welding and soldering operations in the permanent joining category and nailing in the mechanical assembly category. The manufacturing establishments reported that they used both hand and machine methods to perform 22 of the 23 operations with the largest concentration of activity centered in the individual operations of the mechanical assembly category.

2. Table 39 shows when the respondents plan to begin performing 16 of the 23 assembly operations. The percentage of respondents that will begin these operations is relatively small; from 0.3 to 2.8 percent. The data shows that more companies will begin performing the various welding operations, exclusive of forge welding, in the three to five year period than in the one to two year period.

3. The reasons for not performing the various assembly operations are shown in Table 40. Relatively small numbers, from 0.3 to 3.5 percent of the respondents, contracted 16 of the 23 operations to other establishments. Welding - inert gas (3.5 percent) and welding - atomic hydrogen (2.0 percent) are the two operations contracted out most often. The 'Does Not Apply' column shows that 55

Table 39. ASSEMBLY - When the establishments plan to begin performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Joining (Permanent)			
Welding (Forge)			93.3
Welding (Oxy.-Acet.)	.3	.6	55.8
Welding (Resistance)	.3	1.8	69.2
Welding (Inert Gas)	1.2	1.8	69.8
Welding (Atomic Hydrogen)	.3	1.5	92.7
Welding (Fusion)		2.8	84.6
Soldering (Soft)		.3	70.2
Soldering (Hard)		.3	72.5
Brazing		.3	64.9
Gluing (Pressure)	.3		80.1
Gluing (Heating)	.3		92.9
Gluing (Resistance)	.3		92.1
Cementing	.6		86.0
Press Fitting			76.9
Shrink Fitting			81.6
Plastic Welding			
Heated Tool Welding	.9		93.6
Hot Gas Welding	.3	.3	97.3
Friction Welding	.6	.3	99.1
Assembly (Mechanical)			
Riveting			57.6
Screws (Self-Tapping)			62.3
Screws (Machine)			58.1
Screws (Wood)	.3		73.4
Nails			72.3

Table 40. ASSEMBLY - Reasons for not performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Too Small	Too Large	Too Expen-sive	Con-tracted Out	Does Not Apply to General Operation of the Company
Joining (Permanent)					
Welding (Forge)			.6	.6	92.1
Welding (Oxy.-Acet.)					55.8
Welding (Resist-ance)			.3	.9	68.0
Welding (Inert Gas)	.3			3.5	66.0
Welding (Atmoic Hydrogen)	.3			2.0	90.4
Welding (Fusion)	.3		.3	.9	83.1
Soldering (Soft)				.3	69.9
Soldering (Hard)				.3	72.2
Brazing				.6	64.3
Gluing (Pressure)				.3	79.8
Gluing (Heating)				.3	92.6
Gluing (Resistance)				.3	91.8
Cementing					86.0
Press Fitting				.6	76.3
Shrink Fitting				.6	81.0
Plastic Welding					
Heated Tool Welding			.3	.6	92.7
Hot Gas Welding			.3	.9	96.4
Friction Welding		.3	.3	.6	97.9
Assembly (Mechanical)					
Riveting			.6		57.0
Screws (Self-Tapping)			.3		62.0
Screws (Machine)			.3		57.8
Screws (Wood)					73.4
Nails		.3			72.0

to 98 percent of the establishments do not consider the operations to be a part of their general operation.

Auxiliary

1. The auxiliary area included those process operations which were not directly related to the basic construction of the product, but were necessary to the completion of the product. Table 41 shows that hand methods were used in 28 of the 35 operations, while a combination of hand and machine methods were used in 34 of the operations. The operations most often performed by hand methods were: welding (7.6 percent), straightening (7.6 percent), washing (15.8 percent), degreasing (8.8 percent), deburring (10.2 percent), and painting (12.9 percent). These operations were also among those that were performed most often by both hand and machine methods. Standard machines were used to perform all of the operations and automated machines were used in 24 of the 35 operations. However, less than three percent of the respondents used automated machines to perform the operations. From the 'Not at All' column it can be observed that the least performed operations are sintering (98.2 percent), planishing (98.2 percent), and ashing (99.4 percent). It can also be observed that the most often performed operations are those of welding (37.6 percent), degreasing (33.3 percent), deburring (37.7 percent), and painting (38 percent).

Table 41. AUXILIARY-Methods of performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Hand Methods	Standard Machine Methods	Automated Machine Methods	Both Hand And Machine Methods	Not at All
Welding	7.6	17.5	2.9	9.6	62.4
Metallizing		3.8		2.0	94.2
Heat Treating					
Flame Hardening	2.6	3.8	.3	1.8	91.5
Induction Hardening		2.9	.9	1.2	95.0
Carburizing	.9	4.9	.3	1.2	92.7
Nitriding	.9	.9		.6	97.6
Annealing	3.2	8.8	.3	2.9	84.8
Tempering	4.1	8.5	.3	3.2	83.9
Drawing	3.5	7.3	.3	1.8	87.4
Aging	2.6	2.9		.6	93.7
Bluing	.6	2.9	.3	.6	95.6
Normalizing	2.6	8.2	.6	1.8	86.8
Stress Relieving	3.2	10.2	.3	2.9	83.4
Sintering		1.2		.6	98.2
Straightening	7.6	10.2	.6	9.9	71.7
Cleaning					
Washing	15.8	6.7	.6	9.9	90.1
Degreasing	8.8	12.9	.9	10.5	66.7
Blasting	5.0	9.4	.3	4.4	80.9
Tumbling	2.3	10.8	.3	5.0	81.6
Pickling	2.9	3.8	.3	2.3	90.7
Finishing					
Deburring	10.2	12.3	.6	14.6	62.3
Painting	12.9	16.1	.3	18.7	62.0
Plating	2.0	5.3	.3	3.2	89.2
Buffing	5.8	8.2	.3	9.4	76.3
Polishing	4.4	8.2		10.2	77.2
Shot Peening		3.2	.3	.9	95.6
Baking					
Drying		9.6	1.8	3.5	85.1
Curing		6.1	.9	2.9	90.1
Surface Treating					
Blasting	2.9	8.2	.3	2.9	85.7
Polishing	4.1	7.3		6.1	82.5
Buffing	4.1	7.0		5.6	83.3
Brushing	3.2	6.1		3.2	87.5
Peening	1.5	3.5		.9	94.1
Planishing	.6	.9		.3	98.2
Ashing		.6			99.4

2. Although the data presented in Table 42 indicates some degree of expansion in 28 of the 35 operations, the percentage of respondents in either the one to two year or the three to five year periods was not over a total of 2.5 percent for any operation.

3. Table 43 shows that the 'Does Not Apply' reason was the most often reported reason for not performing the operations (from 60 to 94 percent of the respondents). However, all of the 34 operations were 'Contracted Out' (from 0.3 to 14.6 percent). The plating operation was contracted out by 14.6 percent of the respondents.

General Curricular Component Observations of the Manufacturing Industries for the Industrial Arts Curriculum

The general conclusions to be drawn from the response are these: All of the process operations, with the exception of the preform molding process operation of the casting and molding area, were being performed by standard machine methods. This method was used extensively in the performance of the operations in the Shaping - Cutting area. The respondents reported performing the process operations by both hand and machine methods. However, only in the performance of the process operations of the Assembly and Auxiliary areas were the use of hand or a combination of hand and machine methods much in evidence. Automated machines were used in all areas but were more evident in the areas of Forming and

Table 42. AUXILIARY-When the establishments plan to begin performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	One to Two Years	Three to Five Years	Not at All
Welding	.6		61.8
Metallizing	.3	.3	93.6
Heat Treating			
Flame Hardening	.6	.3	90.6
Induction Hardening	.9	.3	93.8
Carburizing			92.7
Nitriding			97.6
Annealing	.9	.3	83.6
Tempering	.3	.3	83.3
Drawing		.3	87.1
Aging		.3	93.6
Bluing		.3	95.3
Normalizing	.3		86.5
Stress Relieving	.3		83.1
Sintering			98.2
Straightening	.3		71.4
Cleaning			
Washing			90.1
Degreasing	1.5	.9	64.5
Blasting	.3	.9	79.7
Tumbling	.6	.3	80.7
Pickling	.3	.6	89.8
Finishing			
Deburring		.6	61.7
Painting	.6	.3	51.1
Plating	.6		88.6
Buffing	.6	.3	75.4
Polishing	.3	.3	76.6
Shot Peening	.3	.9	94.4
Baking			
Drying	.3	.6	84.2
Curing		.6	89.5
Surface Treating			
Blasting		.9	84.8
Polishing		.3	82.2
Buffing		.3	83.0
Brushing			87.5
Peening		.3	93.8
Planishing			98.5
Ashing			99.4

Table 43. AUXILIARY-Reasons for not performing the process operations, percentage of establishments. (N = 342)

Principal Process Operation	Too Small	Too Large	Too Expensive	Contracted Out	Does Not Apply to General Operation of the Company
Welding				.3	61.5
Metallizing	.3		.3	4.4	92.6
Heat Treating					
Flame Hardening				8.2	82.4
Induction Hardening			.6	7.3	85.9
Carburizing			.3	7.9	84.5
Nitriding			.3	6.4	90.9
Annealing				7.0	76.6
Tempering				7.9	75.4
Drawing				6.8	80.3
Aging				5.0	86.6
Bluing				5.6	89.7
Normalizing				5.8	80.7
Stress Relieving				6.4	76.7
Sintering			.3	4.1	93.8
Straightening	.3			1.8	69.3
Cleaning					
Washing				.9	89.2
Degreasing				1.5	63.0
Blasting	.3			7.0	72.4
Tumbling				4.7	76.0
Pickling	.3			5.6	83.9
Finishing					
Deburring				.6	61.1
Painting				1.8	49.3
Plating	.3			14.6	73.7
Buffing	.3			5.8	69.3
Polishing	.3			6.1	70.5
Shot Peening	.6			3.8	90.0
Baking					
Drying	.3		.6	1.8	81.5
Curing	.3		.3	1.8	87.1
Surface Treating					
Blasting				5.8	79.0
Polishing				3.8	79.2
Brushing				2.0	85.5
Peening				2.0	91.8
Planishing				1.8	96.1
Ashing				1.5	97.9

Shaping - Cutting. Only minor expansion of the industry to include some of the process operations in their manufacturing activities was evident. Nearly all of the process operations were contracted out to other establishments. This was generally noted throughout all of the areas of process operations, and would seem to indicate the degree to which the manufacturing establishments rely upon each other for the performance of the operations necessary for the completion of their product. Further investigation may reveal that manufacturing establishments with fewer than ten employees specialize in the performance of certain process operations. These establishments were not included in this study.

Analysis of the Standard Industrial Classifications, the Principal Process Operations They Performed, and the Methods They Employed

The study attempted to identify the principal process operations of the manufacturing industries. In addition, it attempted to determine if any elements of commonality existed between the industrial classifications in the performance of the process operations. With the accumulation of this information the curricular components of the industrial arts curriculum could be established.

It has been established previously that there are five general areas of manufacturing activities: (1) Forming, (2) Casting and Molding, (3) Shaping - Cutting, (4) Assembly, and (5) Auxiliary.

Figure 2 through 6 show the degree to which commonality does exist between the 11 standard industrial classifications used in this study. The findings for each of the areas will be discussed separately in the following paragraphs.

1. The manufacturing area of Forming contained 43 principal process operations, some of which were grouped under sub-headings related to the general topic of Forming. Figure 2 is an analysis of the methods employed by the manufacturing establishments in the industrial classifications to perform the process operations. The information presented implies that there is some degree of commonality existing between all of the standard industrial classifications for the performance of the process operations. The exception is S. I. C. 32 - Stone, Clay and Glass products where no activity was reported by its respondents. In addition, some degree of commonality does exist in the methods employed to perform the process operation. For example, the process operation of 'Rolling' is performed by 7 of the 11 standard industrial classifications. The operation is performed using hand or standard machine methods by all of them. This evidence of an element of commonality existing between the standard industrial classifications will assist in the selection of the curricular components for the industrial arts curriculum.

2. As shown in Figure 3, there is a relatively small amount

Figure 2. FORMING: Analysis of methods employed to perform the process operations.

Standard Industrial Classifications \ Principal Process Operations	Forging	Extruding	Punching	Trimming	Drawing Operations: Box Drawing	Drawing Operations: Panel Drawing	Drawing Operations: Cupping	Drawing Operations: Redrawing	Drawing Operations: Reverse Redrawing	Rolling	Forming Operations: Cold Bending	Forming Operations: Hot Bending	Forming Operations: Flanging	Forming Operations: Corrugating	Forming Operations: Beading	Forming Operations: Ribbing	Forming Operations: Curling	Forming Operations: Hemming	Forming Operations: Seaming	Forming Operations: Bulging	Forming Operations: Embossing	Forming Operations: Slip Forming	Forming Operations: Plug and Ring	Forming Operations: Die Pressing	Forming Operations: Stretch Forming	Forming Operations: Creasing	Forming Operations: Draping
24 Lumber and Wood Products		3, 4	2	2, 4							2			4	2	3					3						
25 Furniture and Fixtures			2, 4	2							1, 2, 4	4					2		2		2	2				2	
30 Rubber and Misc. Plastics Products		3	3	3, 4		3, 4				3				3													
32 Stone, clay, and Glass Products																											
33 Primary Metal Industries	2, 4		2, 3	2, 3, 4						2, 4	2, 3	2, 4	2	2	2	2	2	2	2	2			4	2		2	
34 Fabricated Metal Products	1, 2, 4	2	2, 3, 4	1, 2, 3, 4	2, 3	2, 4	2	2	2	1, 2, 3, 4	1, 2, 3, 4	1, 2, 3, 4	1, 2, 3, 4	2, 4	1, 2, 4	2, 4	2, 3, 4	2, 4	2, 3, 4	2, 4	2, 3, 4	2, 3, 4	2, 4	2, 3, 4	2, 4	2, 4	2
35 Machinery	1, 2, 4	4	1, 2, 3, 4	1, 2, 4	2	2	2, 4	2	2	1, 2, 4	1, 2, 3, 4	1, 2, 3, 4	1, 2, 4	2, 4	1, 2, 4	1, 2	2	2, 4	1, 2, 4	2, 4	2	1	2	2, 4	1, 4	2	2
36 Electrical Machinery		3	2, 3, 4	2, 3, 4	2	2, 3	2, 4	2		1, 2, 4	1, 2, 4	2, 4	2, 4	2	2, 3	2	2, 3, 4	2, 4	2, 4	2, 4	2, 4	2	2	2, 4	2	1, 2, 4	2
37 Transportation Equipment	1		2, 3	1, 2, 4	2	2	2			1, 2, 4	1, 2, 4	1, 4	2	2		1		2		1, 2				2, 4	2, 4	1	
38 Prof., Sci., and Controlling Inst.	1	2	2, 4	1, 2, 4		2	2	2	2	1, 2	1, 2, 4	1, 2	2	2	2	4	2	2	2, 3	1	1, 4		4	2, 4	1, 2	2	
39 Misc. Manufacturing Industries		4	1, 2, 3, 4	1, 2, 3, 4						1, 2, 4	1, 2, 4	1	4	4		4		4	1, 2, 4		2	2	2	2	1, 4		3

Method of Performing Operation

1. Hand Method
2. Standard Machine Method
3. Automated Machine Method
4. Both Hand and Machine Method

Figure 2. (continued) FORMING: Analysis of methods employed to perform the process operations.

Principal Process Operations: Differentials in Air Pressures

Standard Industrial Classifications	Vacuum Forming 1	2	3	4	Compressed Air Forming 1	2	3	4	Vacuum Drawing 1	2	3	4	Blowing into Mold 1	2	3	4	Pressure Blowing 1	2	3	4
24 Lumber and Wood Products			●			●														
25 Furniture and Fixtures																				
30 Rubber and Misc. Plastics Products																				
32 Stone, clay, and Glass Products																				
33 Primary Metal Industries						●	●							●					●	
34 Fabricated Metal Products		●				●				●										
35 Machinery		●		●		●		●		●										
36 Electrical Machinery		●		●																
37 Transportation Equipment		●				●														
38 Prof., Sci., and Controlling Inst.		●							●											
39 Misc. Manufacturing Industries		●	●			●												●		

Standard Industrial Classifications	Coining 1	2	3	4	Swaging 1	2	3	4	Spinning (Cold) 1	2	3	4	Spinning (Hot) 1	2	3	4
24 Lumber and Wood Products										●						
25 Furniture and Fixtures																
30 Rubber and Misc. Plastics Products																
32 Stone, clay, and Glass Products																
33 Primary Metal Industries		●				●		●		●						
34 Fabricated Metal Products		●	●			●	●	●		●	●	●		●		●
35 Machinery		●		●	●	●		●	●	●		●		●		●
36 Electrical Machinery		●	●	●		●	●	●		●	●	●			●	
37 Transportation Equipment					●				●	●				●		
38 Prof., Sci., and Controlling Inst.		●		●	●	●		●				●				
39 Misc. Manufacturing Industries						●										

Standard Industrial Classifications	Piercing 1	2	3	4	Blanking 1	2	3	4	Welding (Pipe) 1	2	3	4	Squeezing (Cold) 1	2	3	4
24 Lumber and Wood Products		●				●										
25 Furniture and Fixtures		●				●										
30 Rubber and Misc. Plastics Products																
32 Stone, clay, and Glass Products																
33 Primary Metal Industries		●		●		●	●		●		●	●		●		
34 Fabricated Metal Products		●	●	●		●	●	●	●	●	●	●	●	●		●
35 Machinery		●		●	●	●		●	●	●		●	●	●		●
36 Electrical Machinery		●	●	●		●	●	●	●	●		●		●		●
37 Transportation Equipment	●	●				●			●	●		●				
38 Prof., Sci., and Controlling Inst.		●		●		●		●	●	●						
39 Misc. Manufacturing Industries	●	●			●	●			●	●		●				

Standard Industrial Classifications	Squeezing (Hot) 1	2	3	4	Veneering (Hand Forming) 1	2	3	4	Blow Die 1	2	3	4
24 Lumber and Wood Products												
25 Furniture and Fixtures						●						
30 Rubber and Misc. Plastics Products												
32 Stone, clay, and Glass Products												
33 Primary Metal Industries		●										
34 Fabricated Metal Products	●	●		●				●				
35 Machinery	●	●		●	●	●		●		●		
36 Electrical Machinery												
37 Transportation Equipment												
38 Prof., Sci., and Controlling Inst.												
39 Misc. Manufacturing Industries												

Method of Performing Operation

1. Hand Method
2. Standard Machine Method
3. Automated Machine Method
4. Both Hand and Machine Method

Figure 3. CASTING and MOLDING: Analysis of methods employed to perform the process operations.

Principal Process Operations — Casting Operations

Standard Industrial Classifications	Sand Casting				Permanent Mold Casting				Shell Mold Casting				Prec. Investment Casting				Centrifugal Casting				Die Casting				Plastic Molding				Embedding				Powdered Metal Molding			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products																																				
25 Furniture and Fixtures																																				
30 Rubber and Misc. Plastics Products					●				●																	●		●								
32 Stone, clay, and Glass Products																										●				●						
33 Primary Metal Industries		●	●	●				●		●	●	●				●		●	●	●		●														
34 Fabricated Metal Products	●	●		●		●	●			●	●							●				●	●													
35 Machinery	●	●		●		●		●		●		●		●		●		●		●		●		●		●								●		
36 Electrical Machinery				●			●																			●	●	●		●						
37 Transportation Equipment																						●				●		●								
38 Prof., Sci., and Controlling Inst.									●							●							●			●		●								
39 Misc. Manufacturing Industries								●															●			●		●		●						

Principal Process Operations — Pressure Molding Operations

Standard Industrial Classifications	Die Casting				Compression Molding				Transfer Molding				Laminating				Injection Molding				Extruding				Preforming				Compacting				Cold Molding			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products																●							●													
25 Furniture and Fixtures																																				
30 Rubber and Misc. Plastics Products																		●	●																	
32 Stone, clay, and Glass Products														●		●																				
33 Primary Metal Industries		●				●																								●		●				
34 Fabricated Metal Products			●	●				●				●				●		●		●				●		●		●				●				●
35 Machinery		●																				●												●		
36 Electrical Machinery			●				●	●			●	●						●	●	●			●				●			●					●	
37 Transportation Equipment		●				●				●				●		●						●														
38 Prof., Sci., and Controlling Inst.						●						●		●					●																	
39 Misc. Manufacturing Industries																		●																		

Principal Process Operations — Reinforced Plastic Molding Operations

Standard Industrial Classifications	Contact Layup				Vacuum Bag Molding				Expanded Bag Molding				Matched Metal Molding				Preform Molding			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products																				
25 Furniture and Fixtures																				
30 Rubber and Misc. Plastics Products	●															●			●	
32 Stone, clay, and Glass Products	●			●																
33 Primary Metal Industries																				
34 Fabricated Metal Products				●																
35 Machinery	●	●		●																
36 Electrical Machinery																				
37 Transportation Equipment	●			●						●				●						
38 Prof., Sci., and Controlling Inst.	●					●														
39 Misc. Manufacturing Industries																				

Method of Performing Operation

1. Hand Method
2. Standard Machine Method
3. Automated Machine Method
4. Both Hand and Machine Method

of manufacturing activity in the Casting and Molding area. However, a degree of commonality does exist between 10 of the 11 standard industrial classifications for the performance of a majority of the process operations. Casting operations were somewhat limited to performance by the standard industrial classifications of Primary Metal Industries, Fabricated Metal Products and Machinery.

3. The manufacturing area of Shaping - Cutting was previously reported as having a large percentage of manufacturing establishments performing the various process operations. As shown in Figure 4, there was much manufacturing activity within all of the standard industrial classifications except S.I.C. 32 - Stone, Clay and Glass Products. This additional information supports all of the process operations as curricular components since a high degree of commonality is indicated for the performance of the operations. Further analysis reveals that standard machine methods were used predominantly by all of the standard industrial classifications for a large majority of the operations. Table 35 showed the number of manufacturing establishments that performed the operations using standard and automated machine methods. With this high degree of commonality existing between the industrial classifications and the large numbers using these methods to perform the operations, standard and automated machine methods could be employed to perform the process operations selected as curricular components.

Figure 4. SHAPING---CUTTING: Analysis of methods employed to perform the process operations.

Presswork (Chipless Shaping) Operations — methods marked (1–4)

Standard Industrial Classifications	Cutoff	Piercing	Punching	Blanking	Parting	Trimming	Notching	Lancing	Perforating	Shearing	Shaving
24 Lumber and Wood Products	1, 2, 3, 4	2	2, 4	2, 3, 4	2	1, 2, 3, 4	1, 2, 4	2	2	2	2
25 Furniture and Fixtures	2	2	2, 3	2		2	2		2	2	2
30 Rubber and Misc. Plastics Products	3	3	3	3	3	3	3		3	3	
32 Stone, clay, and Glass Products											
33 Primary Metal Industries	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4	2	2	2	2, 4	2, 4
34 Fabricated Metal Products	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	1, 2, 3, 4	2, 3, 4
35 Machinery	1, 2, 4	2, 4	1, 2, 4	1, 2, 4	1, 2, 4	1, 2, 4	1, 2, 4	2, 4	1, 2, 4	1, 2, 4	2, 4
36 Electrical Machinery	2, 3, 4	2, 3, 4	1, 2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	1, 2, 3, 4	2, 3, 4	2, 3, 4	1, 2, 3, 4	2
37 Transportation Equipment	2, 4	2	2	2, 4	1, 2	2, 3	1, 2, 4	2, 4	2	1, 2, 4	2, 3, 4
38 Prof., Sci., and Controlling Inst.	2, 4	2, 4	2, 4	2, 4	2	2, 4	2, 4	2	2, 3	2, 3, 4	2
39 Misc. Manufacturing Industries	2, 4	2	2	2	2	2	2, 4		1	1, 2, 4	2

Machining (Cutting) Operations — methods marked (1–4)

Standard Industrial Classifications	Turning	Drilling	Counterboring	Countersinking	Fly Cutting	Milling	Shaping	Planing	Cutoff
24 Lumber and Wood Products	2, 3	2, 3, 4	2, 3, 4	2, 4	2	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4
25 Furniture and Fixtures	2, 3	2, 3, 4	2, 3, 4	2, 3, 4		2	2, 4	2	1, 2
30 Rubber and Misc. Plastics Products	2, 3	2, 3	3	3	3	3	3		4
32 Stone, clay, and Glass Products									
33 Primary Metal Industries	2, 3, 4	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4	2, 3, 4	1, 2, 3, 4
34 Fabricated Metal Products	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 4	2, 3, 4	2, 3, 4	2, 4	2, 4
35 Machinery	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 4	2, 3, 4	2, 3, 4	2	2, 4
36 Electrical Machinery	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3	3	2, 3, 4
37 Transportation Equipment	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3, 4	2, 3	2, 3	2	2, 4
38 Prof., Sci., and Controlling Inst.	2, 4	2, 4	2, 4	2, 4	2, 4	2, 4	2	2	2
39 Misc. Manufacturing Industries	2, 3	2, 4	2	2	2	2	2, 4	2	2, 3

Standard Industrial Classifications	Broaching	Grinding	Honing	Sawing	Routing	Engraving	Sanding	Filing	Tapping--Threading
24 Lumber and Wood Products		2, 4		2, 3, 4	2, 3, 4		1, 2, 3, 4	1, 2, 4	2, 4
25 Furniture and Fixtures				2, 3	2, 3		1, 2, 3, 4	1, 4	
30 Rubber and Misc. Plastics Products			2	3, 4	2		2	2	3
32 Stone, clay, and Glass Products									
33 Primary Metal Industries	2	2	2, 4	2, 3, 4	2, 4	2	2	1, 2, 4	2, 3, 4
34 Fabricated Metal Products	2, 4	2, 3, 4	2, 4	1, 2, 3, 4	2, 4	2, 4	1, 2, 3, 4	1, 2, 4	1, 2, 3, 4
35 Machinery	2, 4	2, 4	2, 4	1, 2, 3, 4	2, 4	2, 4	1, 2, 4	1, 2, 4	1, 2, 3, 4
36 Electrical Machinery	2, 3, 4	2, 3, 4	2, 3	2, 3, 4	2, 3	2	2, 3, 4	1, 2, 3, 4	1, 2, 3, 4
37 Transportation Equipment	2, 4	2, 4	1, 2, 4	2, 4	2, 4	2	1, 2, 4	1, 2, 4	1, 2, 3, 4
38 Prof., Sci., and Controlling Inst.	2	4	2, 4	2, 4	2		1, 2	1, 2, 4	1, 2, 4
39 Misc. Manufacturing Industries		2, 3, 4	2	2	2		2, 4	1, 2	1, 2, 4

Method of Performing Operation

1. Hand Method
2. Standard Machine Method
3. Automated Machine Method
4. Both Hand and Machine Method

4. The Assembly area of manufacturing activity was represented by 23 principal process operations, all of which were performed to some degree by the manufacturing establishments (Figure 5). Seven of the 11 standard industrial classifications indicated that their production activities included all of the principal process operations by a variety of methods. Three of the four remaining standard industrial classifications performed 20 to the 23 process operations by fewer methods. Classification 32 - Stone, Clay, and Glass Products did not perform any operations. A degree of commonality does exist within the standard industrial classifications for the performance of the process operations in the Assembly area. This information provides additional assistance in the selection of curricular components.

5. Figure 6 represents the variety of process operations performed by the manufacturing industries in the Auxiliary area, as well as the methods used. All of the 35 process operations listed are performed by the manufacturing establishments of the standard industrial classifications. There is a high degree of commonality existing in the performance of the process operations in seven of the 11 standard industrial classifications and to a lesser degree in three of the remaining four. Hand methods and standard machine methods were used most often by the majority of the standard industrial classifications. Automated machines are not used as often in the

Figure 5. ASSEMBLY: Analysis of methods employed to perform the process operations.

Joining (Permanent) Operations

Standard Industrial Classifications / Principal Process Operations	Welding (Forge)				Welding (Oxy.-Acet.)				Welding (Resistance)				Welding (Inert Gas)				Welding (Atomic Hydrogen)				Welding (Fusion)			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products					●	●								●								●		
25 Furniture and Fixtures						●				●				●										
30 Rubber and Misc. Plastics Products																						●		
32 Stone, clay, and Glass Products																								
33 Primary Metal Industries			●	●	●	●		●	●	●	●	●	●	●	●	●				●	●	●		●
34 Fabricated Metal Products		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●
35 Machinery	●	●		●	●	●		●	●	●		●	●	●	●	●		●	●	●	●	●		●
36 Electrical Machinery					●	●		●	●	●			●		●	●		●		●	●	●		●
37 Transportation Equipment	●				●	●	●	●	●	●	●	●	●	●	●	●			●			●	●	
38 Prof., Sci., and Controlling Inst.		●			●	●				●		●	●		●			●			●		●	
39 Misc. Manufacturing Industries					●	●	●			●		●												

Standard Industrial Classifications / Principal Process Operations	Soldering (Soft)				Soldering (Hard)				Brazing				Gluing (Pressure)				Gluing (Heating)				Gluing (Resistance)			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products		●								●			●	●	●	●		●		●		●	●	
25 Furniture and Fixtures													●	●	●	●		●		●		●	●	
30 Rubber and Misc. Plastics Products		●				●				●				●										
32 Stone, clay, and Glass Products																								
33 Primary Metal Industries	●			●	●			●	●	●		●				●								
34 Fabricated Metal Products	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●							
35 Machinery	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●		
36 Electrical Machinery	●	●		●	●	●		●	●	●			●			●	●							
37 Transportation Equipment	●	●	●		●	●	●		●	●			●											
38 Prof., Sci., and Controlling Inst.	●	●		●	●	●		●	●	●			●	●				●			●	●		
39 Misc. Manufacturing Industries	●	●				●			●				●	●				●		●		●		

Joining (Permanent) Operations (continued) and Plastics Welding

Standard Industrial Classifications / Principal Process Operations	Cementing				Press Fitting				Shrink Fitting				Heated Tool Welding (Plastics Welding)				Hot Gas Welding (Plastics Welding)				Friction Welding (Plastics Welding)			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products				●						●								●						
25 Furniture and Fixtures	●																							
30 Rubber and Misc. Plastics Products		●				●				●				●										
32 Stone, clay, and Glass Products																								
33 Primary Metal Industries				●	●	●	●		●	●		●		●										
34 Fabricated Metal Products	●	●		●	●	●		●	●	●		●	●			●		●		●				
35 Machinery	●	●		●	●	●		●	●	●	●	●	●	●		●		●		●	●	●		
36 Electrical Machinery	●			●	●	●		●	●				●	●			●							
37 Transportation Equipment	●	●			●	●	●		●	●	●		●											
38 Prof., Sci., and Controlling Inst.	●	●		●	●	●		●	●	●			●	●		●		●		●		●		●
39 Misc. Manufacturing Industries	●					●							●	●			●				●			

Assembly (Mechanical) Operations

Standard Industrial Classifications / Principal Process Operations	Riveting				Screws (Self-Tapping)				Screws (Machine)				Screws (Wood)				Nails			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products	●	●		●		●							●	●		●	●	●	●	●
25 Furniture and Fixtures		●			●	●				●			●	●	●		●	●	●	
30 Rubber and Misc. Plastics Products			●	●			●				●			●						
32 Stone, clay, and Glass Products																				
33 Primary Metal Industries		●	●	●	●	●		●	●			●	●			●	●			●
34 Fabricated Metal Products	●	●	●	●	●	●		●	●	●		●	●			●	●	●		●
35 Machinery	●	●		●	●	●		●	●	●		●	●	●		●	●	●		●
36 Electrical Machinery	●	●		●	●	●		●	●	●		●	●			●	●			●
37 Transportation Equipment	●	●		●	●	●			●	●			●	●			●	●		
38 Prof., Sci., and Controlling Inst.	●			●	●			●	●			●	●			●	●			
39 Misc. Manufacturing Industries	●	●		●	●			●	●			●	●	●		●	●			●

Method of Performing Operation

1. Hand Method
2. Standard Machine Method
3. Automated Machine Method
4. Both Hand and Machine Method

Figure 6. AUXILIARY: Analysis of methods employed to perform the process operations.

Standard Industrial Classifications	Welding				Metallizing				Flame Hardening				Induction Hardening				Carburizing				Nitriding			
									Heat Treating Operations															
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products																								
25 Furniture and Fixtures		●																						
30 Rubber and Misc. Plastics Products		●																						
32 Stone, clay, and Glass Products																								
33 Primary Metal Industries	●	●	●	●				●		●		●								●				●
34 Fabricated Metal Products	●	●	●	●		●		●		●		●		●	●	●		●		●	●	●		
35 Machinery	●	●	●	●		●		●	●	●	●	●		●	●	●	●	●	●	●	●	●		●
36 Electrical Machinery	●	●		●				●	●	●						●	●	●			●			
37 Transportation Equipment	●	●	●	●		●				●				●				●						
38 Prof., Sci., and Controlling Inst.	●	●							●							●								
39 Misc. Manufacturing Industries	●	●		●																				

Standard Industrial Classifications	Annealing				Tempering				Drawing				Aging				Bluing				Normalizing			
	Heat Treating Operations																							
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products																								
25 Furniture and Fixtures																								
30 Rubber and Misc. Plastics Products																								
32 Stone, clay, and Glass Products																								
33 Primary Metal Industries	●	●		●	●	●		●	●	●		●	●	●		●		●			●	●		
34 Fabricated Metal Products	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●		●	●	●	●	●	●	●
35 Machinery	●	●		●	●	●		●	●	●		●	●	●			●	●			●	●		●
36 Electrical Machinery	●	●			●	●		●	●	●		●	●				●	●			●	●		
37 Transportation Equipment		●				●				●				●								●		
38 Prof., Sci., and Controlling Inst.	●			●	●			●	●			●		●								●		
39 Misc. Manufacturing Industries		●				●																		

Standard Industrial Classifications	Stress Relieving				Sintering				Straightening				Washing				Degreasing				Blasting			
	Heat Treating Operations												Cleaning Operations											
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products														●										
25 Furniture and Fixtures																								
30 Rubber and Misc. Plastics Products										●								●						
32 Stone, clay, and Glass Products																								
33 Primary Metal Industries	●	●		●		●		●	●	●		●	●	●		●	●	●		●	●	●		●
34 Fabricated Metal Products	●	●	●	●				●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●
35 Machinery	●	●		●		●			●	●		●	●	●		●	●	●		●	●	●		●
36 Electrical Machinery	●	●				●			●	●		●	●	●	●	●	●	●		●	●	●		●
37 Transportation Equipment	●	●				●			●	●		●	●	●		●	●	●		●	●	●		●
38 Prof., Sci., and Controlling Inst.		●		●					●			●	●			●	●			●		●		
39 Misc. Manufacturing Industries		●							●	●			●			●	●	●		●	●			

Standard Industrial Classifications	Tumbling				Pickling				Deburring				Painting				Plating				Buffing			
	Cleaning Operations								Finishing Operations															
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products													●	●		●		●				●		
25 Furniture and Fixtures														●										
30 Rubber and Misc. Plastics Products										●				●								●		
32 Stone, clay, and Glass Products																								
33 Primary Metal Industries	●	●		●	●	●		●	●	●	●	●	●	●	●	●		●				●		●
34 Fabricated Metal Products	●	●	●	●	●	●		●	●	●		●	●	●		●	●	●	●	●	●	●	●	●
35 Machinery	●	●		●	●	●	●	●	●	●	●	●	●	●		●		●		●	●	●		●
36 Electrical Machinery		●		●	●	●			●	●		●	●	●		●	●	●		●	●	●		●
37 Transportation Equipment	●	●		●	●	●			●	●			●	●		●		●			●	●		●
38 Prof., Sci., and Controlling Inst.	●	●		●					●	●		●		●		●				●	●	●		●
39 Misc. Manufacturing Industries	●	●		●	●	●			●	●			●	●		●		●			●	●		●

Standard Industrial Classifications	Polishing				Shot Peening				Drying				Curing				Blasting				Polishing			
	Finishing Operations								Baking Operations								Surface Treating Operations							
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products				●						●	●				●	●					●			
25 Furniture and Fixtures																								
30 Rubber and Misc. Plastics Products		●								●				●	●	●						●		
32 Stone, clay, and Glass Products																								
33 Primary Metal Industries		●		●		●		●		●	●	●		●		●		●		●		●		●
34 Fabricated Metal Products	●	●		●		●	●			●	●	●		●		●	●	●	●	●	●	●		●
35 Machinery	●	●		●				●		●		●		●		●	●	●		●	●	●		●
36 Electrical Machinery		●		●						●	●	●		●		●	●	●		●	●	●		
37 Transportation Equipment	●	●		●		●				●				●			●	●		●	●	●		●
38 Prof., Sci., and Controlling Inst.	●	●		●						●		●		●		●		●				●		●
39 Misc. Manufacturing Industries	●	●		●		●				●		●		●								●		●

Standard Industrial Classifications	Buffing				Brushing				Peening				Plainshing				Ashing			
	Surface Treating Operations																			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
24 Lumber and Wood Products		●																		
25 Furniture and Fixtures																				
30 Rubber and Misc. Plastics Products		●				●														
32 Stone, clay, and Glass Products																				
33 Primary Metal Industries	●	●		●	●	●		●		●				●						
34 Fabricated Metal Products	●	●		●	●	●		●	●	●		●	●	●				●		
35 Machinery	●	●		●	●	●		●	●	●		●								
36 Electrical Machinery	●	●		●	●	●														
37 Transportation Equipment	●	●				●				●				●						
38 Prof., Sci., and Controlling Inst.		●		●		●				●				●				●		
39 Misc. Manufacturing Industries		●		●		●		●												

Method of Performing Operation

1. Hand Method
2. Standard Machine Method
3. Automated Machine Method
4. Both Hand and Machine Method

performance of the process operations in this area as they were in other areas of manufacturing activity. The extent to which hand and standard machine methods may be used to perform the curricular components in the industrial arts laboratory is indicated by the extent to which they appear in this figure.

Curricular Components Identified

Since no reports of studies of this nature have been discovered by the investigator, no precise criteria could be established for the selection of the curricular components. The choosing of these curricular components and the method or methods by which they could be performed was accomplished by examining the data presented in Tables 8 through 43 and Figures 2 through 6, with the final selection of the curricular components being based on such factors as:

1. the extent to which the process operations were being performed by the respondents;

2. the extent to which the respondents would possibly begin to perform the process operations in the one to five year period;

3. the extent to which the process operations were contracted out to other manufacturing establishments by the respondents;

4. the extent to which the process operations were being performed by the various methods; and

5. the extent to which there was evidence of commonality

existing between the various Standard Industrial Classifications for the performance of the process operations and the methods used.

Graphic Arts Curriculum

The process operations that are suggested as curricular components of the graphic arts curriculum are listed in Table 44. The suggested method or methods to be used to perform these process operations in the graphic arts laboratory, are also indicated in the table.

Industrial Arts Curriculum

The process operations that are suggested as curricular components of the industrial arts curriculum are listed in Table 45. The suggested method or methods to be used to perform these process operations in the industrial arts laboratory, are also indicated in the table.

Summary

The findings revealed that the graphic arts establishments performed a variety of process operations, most of which were performed using standard machine methods. The process operations of the Screenless Illustration Printing area were not performed by any of the respondents. The activity of the graphic arts establishments

Table 44. Curricular components for the Graphic Arts; with suggested methods for performing them.

Curricular Components	Suggested Methods					Suggested as Topics for Research and Experimentation
	Hand	Standard Machine	Automated Machine	Both Hand and Machine	Not at All	
A. Relief Printing: Letterpress						
1. Layout	X					
2. Plain Composition	X					
3. Hot Type Composition						
a. Intertype		X				
b. Linotype		X	X			
c. Monotype					X	X
4. Cold Type Composition		X	X	X		
5. Photo Mechanical		X				
6. Proving	X	X		X		
7. Imposing	X	X				
8. Letterpress Printing		X	X	X		
9. Flexographic					X	X
10. Thermography					X	X
11. Die Cutting		X				
12. Embossing					X	X
13. Stamping through Gold or Metallic Foil					X	X
14. Blind Stamping					X	X
B. Plane Printing: Offset						
1. Layout	X					
2. Photo Copying		X				
3. Plate Making	X	X		X		
4. Color Separation		X				
5. Offset Press Printing		X	X			
C. Intaglio Printing: Gravure						
1. Copper Plate Engraving					X	X
2. Line Engraving					X	X
3. Photoengraving		X				
4. Etching					X	X
5. Dry Point					X	X

Table 44 (continued)

Curricular Components	Suggested Methods: Hand	Standard Machine	Automated Machine	Both Hand and Machine	Not at All	Suggested as Topics for Research and Experimentation
D. Paint Printing: Silk Screen						
1. Layout	X					
2. Photographic	X			X		
3. Stencil (Hand Cut)	X					
4. Tusche					X	X
5. Decalomania	X					
E. Screenless Illustration Printing						
1. Photogelatin					X	X
2. Collotype					X	X
F. Bindery						
1. Cutting		X				
2. Drilling		X				
3. Punching		X				
4. Perforating		X				
5. Folding	X	X				
6. Collating	X	X				
7. Stapling		X				
8. Side Wire Binding		X				
9. Saddle Wire Binding		X				
10. Sewn Soft Cover		X				
11. Sewn Case - Bound	X	X				
12. Loose-Leaf Binding	X	X				
13. Plastic Binding		X		X		
14. Spiral Binding		X		X		
G. Miscellaneous						
1. Xerography					X	X
2. Rubber Stamp Making		X				
3. Postage Meter		X				
4. Tickometer					X	X

Table 45. Curricular components for Industrial Arts; with suggested methods for performing them.

Curricular Components	Suggested Methods: Hand	Standard Machine	Automated Machine	Both Hand and Machine	Not at All	Suggested as Topics for Research and Experimentation
A. Forming						
1. Forging					X	X
2. Extruding					X	X
3. Punching		X		X		
4. Trimming		X		X		
5. Drawing						
a. Box Drawing					X	X
b. Panel Drawing					X	X
c. Cupping					X	X
d. Redrawing					X	X
e. Reverse Redrawing					X	X
6. Rolling		X				
7. Forming						
a. Cold Bending	X	X		X		
b. Hot Bending	X	X		X		
c. Flanging		X				
d. Corrugating					X	X
e. Beading					X	X
f. Ribbing					X	X
g. Curling					X	X
h. Hemming					X	X
i. Seaming		X		X		
j. Bulging					X	X
k. Embossing					X	X
l. Slip Forming					X	X
m. Plug and Ring					X	X
n. Die Pressing		X				

Table 45 (continued)

Curricular Components	Suggested Methods: Hand	Standard Machine	Automated Machine	Both Hand and Machine	Not at All	Suggested as Topics for Research and Experimentation
o. Stretch Forming					X	X
p. Creasing					X	X
q. Draping					X	X
8. Differentials in Air Pressures						
a. Vacuum Forming					X	X
b. Compressed Air Forming					X	X
c. Vacuum Drawing					X	X
d. Blowing into Mold					X	X
e. Pressure Blowing in Free Space					X	X
9. Coining					X	X
10. Swaging					X	X
11. Spinning (Cold)					X	X
12. Spinning (Hot)					X	X
13. Piercing		X				
14. Blanking		X				
15. Welding (Pipe)	X	X		X		
16. Squeezing (Cold)					X	X
17. Squeezing (Hot)					X	X
18. Veneering (Hand Forming)					X	X
19. Blow Die					X	X
B. Casting and Molding						
1. Casting						
a. Sand Casting		X		X		
b. Permanent Mold Casting				X		
c. Shell Mold Casting				X		
d. Precision Investment Casting					X	X
e. Centrifugal Casting		X				

Table 45 (continued)

Curricular Components	Suggested Methods: Hand	Standard Machine	Automated Machine	Both Hand and Machine	Not at All	Suggested as Topics for Research and Experimentation
f. Die Casting		X				
g. Plastic Molding		X		X		
h. Embedding					X	X
i. Powdered Metal Molding					X	X
2. Pressure Molding						
a. Die Casting					X	X
b. Compression Molding					X	X
c. Transfer Molding					X	X
d. Laminating					X	X
e. Injection Molding		X				
f. Extruding					X	X
g. Preforming					X	X
h. Compacting					X	X
i. Cold Molding					X	X
3. Reinforced Plastic Molding						
a. Contact Layup					X	X
b. Vacuum Bag Molding					X	X
c. Expanded Bag Molding					X	X
d. Matched Metal Molding					X	X
e. Preform Molding					X	X
C. Shaping - Cutting						
1. Presswork (Chipless Shaping)						
a. Cutoff		X		X		
b. Piercing		X				
c. Punching		X				
d. Blanking		X				
e. Parting		X				
f. Trimming		X		X		
g. Notching		X		X		

Table 45 (continued)

Curricular Components	Suggested Methods: Hand	Standard Machine	Automated Machine	Both Hand and Machine	Not at All	Suggested as Topics for Research and Experimentation
h. Lancing					X	X
i. Perforating		X				
j. Shearing		X		X		
k. Shaving					X	X
2. Machining (Cutting)						
a. Turning		X	X	X		
b. Drilling		X	X	X		
c. Counterboring		X		X		
d. Countersinking		X		X		
e. Fly Cutting		X		X		
f. Milling		X		X		
g. Shaping		X				
h. Planing		X				
i. Cutoff		X		X		
j. Broaching					X	X
k. Grinding		X		X		
l. Honing		X		X		
m. Sawing		X		X		
n. Routing		X				
o. Engraving					X	X
p. Sanding	X	X				
q. Filing	X	X		X		
r. Tapping - Threading	X	X		X		
D. <u>Assembly</u>						
1. Joining (Permanent)						
a. Welding (Forge)					X	X
b. Welding (Oxy.-Acet.)	X	X		X		
c. Welding (Resistance)	X	X		X		
d. Welding (Inert Gas)	X	X	X	X		

Table 45 (continued)

Curricular Components	Suggested Methods					Suggested as Topics for Research and Experimentation
	Hand	Standard Machine	Automated Machine	Both Hand and Machine	Not at All	
e. Welding (Atomic Hydrogen)					X	X
f. Welding (Fusion)	X	X		X		
g. Soldering (Soft)	X	X		X		
h. Soldering (Hard)	X	X		X		
i. Brazing	X	X		X		
j. Gluing (Pressure)	X	X		X		
k. Gluing (Heating)					X	X
l. Gluing (Resistance)		X				
m. Cementing	X	X				
n. Press Fitting	X	X		X		
o. Shrink Fitting	X	X		X		
p. Plastic Welding						
1) Heated Tool Welding					X	X
2) Hot Gas Welding					X	X
3) Friction Welding					X	X
2. Assembly (Mechanical)						
a. Riveting	X	X		X		
b. Screws (Self-Tapping)	X	X		X		
c. Screws (Machine)	X	X		X		
d. Screws (Wood)	X	X		X		
e. Nails	X	X		X		
E. Auxiliary						
1. Welding	X	X		X		
2. Metallizing					X	X
3. Heat Treating						
a. Flame Hardening		X				
b. Induction Hardening		X				
c. Carburizing		X				
d. Nitriding					X	X
e. Annealling	X	X		X		
f. Tempering	X	X				
g. Drawing	X	X				
h. Aging	X	X				

Table 45 (continued)

Curricular Components	Suggested Methods					Suggested as Topics for Research and Experimentation
	Hand	Standard Machine	Automated Machine	Both Hand and Machine	Not at All	
i. Bluing		X				
j. Normalizing	X	X				
k. Stress Relieving	X	X		X		
l. Sintering					X	X
4. Straightening	X	X		X		
5. Cleaning						
a. Washing	X	X		X		
b. Degreasing	X	X		X		
c. Blasting	X	X		X		
d. Tumbling		X				
e. Pickling	X	X				
6. Finishing						
a. Deburring	X	X		X		
b. Painting	X	X		X		
c. Plating		X		X		
d. Buffing	X	X		X		
e. Polishing	X	X		X		
7. Shot Peening		X				
8. Baking						
a. Drying		X				
b. Curing		X				
9. Surface Treating						
a. Blasting		X				
b. Polishing	X	X		X		
c. Buffing	X	X		X		
d. Brushing	X	X		X		
e. Peening		X				
f. Planishing					X	X
g. Ashing					X	X

seemed to be primarily concerned with the areas of Relief Printing (Letterpress), Plane Printing (Offset), and Bindery. Graphic arts establishments that did not perform the operations sometimes contracted with other establishments to have the operations performed for them. This phenomenon seemed to suggest that a degree of specialization existed within the industry for the performance of certain process operations. It may also suggest that the graphic arts establishments rely upon each other for the performance of the process operations. The curricular components for the graphic arts, and the methods for performing them, were selected after a careful analysis of the data presented.

An analysis of the data pertaining to the manufacturing industries revealed the principal process operations and the methods used to perform them. Hand methods were used to perform many of the operations. However, standard and automated machines were used extensively. This would seem to suggest that hand methods should be employed in the performance of certain operations in the industrial arts laboratory, but standard or automated machines may be used to supplement hand methods now being employed. Further investigation is needed to determine if standard or automated machine methods may eventually eliminate hand methods in the performance of certain process operations.

The possibility that an element of commonality may exist between the Standard Industrial Classifications, for the process operations performed and the methods of performing them, was explored by comparison charts. An analysis of these charts established that a degree of commonality does exist between the various classifications. This information was used, along with other data presented, to select the curricular components of the industrial arts curriculum and to suggest methods of performing them in the industrial arts laboratory.

V. SUMMARY AND CONCLUSIONS

The Problem

The basic objectives of the study were to determine the principal process operations being performed by present day industrial technology; to ascertain which of these principal process operations may be considered to be curricular components in an industrial arts curriculum that would reflect the technology; and to ascertain the methods to be employed for the performance of the principal process operations in the industrial arts curriculum. For lack of record of previous research on this topic, the study became primarily exploratory in nature.

Questions which were focused to obtain information relative to the selection of process operations as curricular components and the methods for performing them, were the following:

1. What are the principal process operations that are reflective of the American technology as represented in industries of the State of Oregon?

2. What methods do the industrial technology employ to perform these operations?

3. Do the manufacturing establishments plan to begin to perform the process operations in a one to five year period?

4. What reasons do the manufacturing establishments give for not planning to perform the process operations?

Findings

The findings of the study are detailed in Chapter IV, Presentation of Findings and Implications, and are summarized here into three classifications: (1) Principal process operations performed by manufacturing industries; (2) Methods of performing the process; and (3) The commonality that exists between the standard industrial classifications and the principal process operations they perform.

(1) The results of the study suggest that:

a. In the Relief Printing area; layout, plain composition, linotype, proving, imposing, and letterpress printing were the process operations performed most often.

b. In the Relief Printing area; flexographic, thermography, stamping through gold or metallic foil, and blind stamping were the least performed process operations.

c. In the Plane Printing area; the process operations of offset press printing, and plate making were the most performed process operations.

d. In the Plane Printing area; color separation was the least performed operation.

e. The operation of offset press printing was performed more often than the operation of letterpress printing by the graphic arts industry.

f. In the Intaglio Printing - Gravure area; relatively few establishments performed any of the process operations.

g. In the Paint Printing - Silk Screen area; only minor activity for the performance of the operations was reported by the respondents.

h. In the Paint Printing - Silk Screen area; the process operation of tusche was not performed by any of the respondents.

i. In the Screenless Illustration Printing area; none of the process operations were being performed by the respondents.

j. In the Bindery area; sewn soft cover, sewn case - bound, and spiral binding were the least performed of the process operations.

k. In the Miscellaneous area; postage meter was the most often performed process operation.

l. The process operations of punching, trimming, rolling, cold and hot bending, die pressing, blanking, and piercing were most representative of the Forming area of manufacturing activities.

m. The process operations of the Casting and Molding area were not performed by many manufacturing establishments. Most representative of this area of activity were the operations of: sand casting, permanent mold casting, shell mold casting, plastic molding, injection molding, and contact layup.

n. In the Shaping - Cutting area; the process operations that showed the least amount of activity were those of: lancing, shaving, broaching, and engraving.

o. Brazing, soldering, pressure gluing, and various welding operations in the Assembly area were the basic means of joining materials permanently by the manufacturing industries.

p. Friction welding was not performed by any of the respondents.

q. Welding, straightening, degreasing, blasting, deburring, painting, and buffing operations were most representative of the Auxiliary area of activity.

r. The manufacturing establishments contracted out operations to other manufacturing establishments indicating that there was a certain amount of specialization within the manufacturing industries.

(2) The findings in the study also suggested that:

a. The principal process operations were more likely to be performed by standard machine methods than by any other method.

b. In the Relief Printing - Letterpress area; hand methods were used most often in the performance of the operations of layout, plain composition, and imposing.

c. Automated machines were used more often in the linotype, cold type composition, and letterpress printing operations than in any of the other Relief Printing operations.

d. In the Plane Printing - Offset area; hand methods were used most often in the performance of the layout operation.

e. While the graphic arts industry was heavily oriented to the use of standard machines to perform the offset press printing operation, automated machines were very much in evidence.

f. The process operations of the Paint Printing - Silk Screen area were by hand methods.

g. In the Bindery area; the process operation of collating was performed using hand operations more often than standard machines.

h. In the performance of the principal process operations of the Forming area, standard machine methods were preferred over hand methods by the manufacturing establishments.

i. In the Shaping - Cutting area; filing is performed more often using hand methods than by machine methods.

j. Standard machine and automated machine methods were used most often in the performance of the Shaping - Cutting operations.

k. In the Assembly area; both hand and standard machine methods were very much in evidence for the performance of the process operations.

l. Both hand and standard machine methods were used to perform the process operations of the Auxiliary area.

(3) The analysis of the standard industrial classifications for elements of commonality in the process operations they perform suggested that:

a. There is a high degree of commonality existing between the standard industrial classifications for the process operations performed in the Forming, Shaping - Cutting, Assembly, and Auxiliary areas.

b. A lesser degree of commonality exists in the manufacturing area of Casting and Molding.

c. An element of commonality exists in the methods employed to perform the process operations, particularly in the hand and standard machine methods.

Conclusions

From the findings of this study the following conclusions are drawn:

1. The technological phase of the industrial arts curriculum should not only be oriented to the materials of industry but also to the technological concepts which are related to the process operations of industrial technology.

2. The technological concepts upon which the industrial arts curriculum should be based are to be found in the principal process operations of the Forming, Casting and Molding,

Shaping by Cutting, Assembly, and Auxiliary areas of industrial activity.

3. The industrial arts laboratory should be designed to permit the application of these technological concepts.

4. The laboratory facilities for industrial arts should be designed to provide a learning environment in which the understandings and applications of the principals of commonality can be implemented with all materials, processes and energies of the technologies represented in this study.

5. The curriculum and the laboratory facilities for industrial arts should have a multi-range of activities and be so flexible that they can readily change to keep pace with a changing technology.

6. The graphic arts should be represented principally by elements of the Relief Printing-Letterpress, Plane Printing-Offset, Paint Printing - Silk Screen, and Bindery area.

Recommendations for Implementation

1. It is recommended that industrial arts departments and individual instructors compare the elements of their curriculum with the curriculum components identified in this study.

2. It is recommended that industrial arts departments and individual instructors compare the methods they now use to perform the process operations in their curriculum with those methods identified in this study.

3. It is recommended that the curricular components identified in this study be considered as elements of the industrial arts curriculum that will reflect the technology.

4. It is recommended that the industrial arts laboratories be provided with equipment that will enable the process operations to be performed in the manner that the manufacturing industries are most likely to use.

5. It is recommended that the industrial arts laboratories be designed to provide for a multi-range of activities involving the use of a wide range of materials, and processes.

Discussion

The traditional industrial arts curriculum and the shops in which the curriculum has been implemented have been organized primarily around the materials of industry. That is to say: woodworking has been taught in the wood shop; metalworking in the metal shop; and ceramics in the ceramic shop. This curricular orientation has led to a lag in curricular change causing industrial arts programs to become outmoded and no longer reflective of the industrial technology.

The up-to-date industrial arts curriculum, which will reflect the technology, should be organized to include five basic technological concept areas. These areas are: (1) Forming, (2) Casting and Molding, (3) Shaping by Cutting, (4) Assembly, and (5) Auxiliary. The understanding and the application of the concepts, represented in these five areas, would permit their application to all materials found in the technology whether they be wood, metal, plastic-synthetic, ceramic, or other materials. For example: it is necessary to understand and be able to apply the concepts of forming to the forming of wood into shapes for the construction of furniture; the forming of metal for auto bodies; the forming of various synthetics for boats; or the forming of ceramics for the utilities found in the home.

The materials of industry were not used as a basis for this study. It was concerned with the problem of ascertaining which principal process operations of industrial technology might be considered as curricular components for an optimum industrial arts curriculum. Although the Standard Industrial Classifications chosen for the study do reflect various material categories, the respondents recorded only the process operations they performed and made no mention of the materials used. These responses were grouped under the concept areas of Forming, Casting and Molding, Shaping by Cutting, Assembly, and Auxiliary. The element of commonality of process operations which was found to exist within the various Standard Industrial Classifications would support the conclusion that these concepts were applied to all of the materials of the technology.

The industrial arts laboratory facilities for the implementation of this curriculum must be designed to provide a learning environment in which the understandings and applications of the technological concepts and the principles of commonality can be implemented. This would preclude the orientation of facilities to materials, machines or project activities. The industrial arts laboratory should be designed as a multi-purpose facility. It would allow for the study and application of these concepts to all materials through the performance of process operations identified as curricular components. The equipment should reflect the methods employed by the technology to perform the process operations. In addition, the facilities should be so flexible that they can be readily changed to keep pace with a changing technology.

Recommendations for Further Study

The following suggestions might profitably be made subject for further investigation:

1. A study to determine the extent to which certain process operations are being discontinued by the manufacturing industries in favor of newer process operations.

2. A study to determine the extent to which the manufacturing industries are eliminating hand and standard machine methods and are re-tooling to meet the demands for automation.

3. A study to determine the kinds, sizes, designs, and cost of equipment that would be needed to perform some of the process operations identified in this study.

4. A study to determine if an element of commonality exists between the process operations of the graphic arts industry and those of the manufacturing industries.

5. A comprehensive study to determine the principal process operations of the manufacturing industries in various sections of the United States; correlated to obtain the total perspective of the industrial technology.

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APPENDICES

APPENDIX A

OREGON STATE UNIVERSITY CORVALLIS, OREGON 97331

SCHOOL OF EDUCATION

Department of
INDUSTRIAL EDUCATION
Industrial-Arts Education
Industrial-Vocational Education

Your company is one of a select group, representing Oregon Manufacturers, that has been selected to study the technological change that has taken place in American industry. In industrial arts education we are deeply concerned that the industrial arts curriculum in the teacher training institutions and in the public schools be as reflective of today's technology as is possible. Reflecting technology involves selecting the elements which are keys to change and growth.

The Industrial Arts Department at Oregon State University is proposing to study American industry to determine the operations and processes of industry, and the degree they influence the planning of industrial arts laboratory facilities. Ultimately industry will benefit from our findings as this information will be utilized to train the young industrial workers of the future.

Your reply and opinions are important to this research and will be held strictly confidential. Individual companies will not be identified in the main body of this study.

Since this questionnaire is being sent to a select group, your support is urgently needed if we are to make a successful study. Please return the copy of the questionnaire in the enclosed self-addressed stamped envelope as soon as possible. Thank you for your cooperation.

Sincerely,

Donald E. Moon, Instructor
Industrial Arts Department

Research Advisor
Dr. F. R. Zeran, Dean
School of Education
Oregon State University
Corvallis, Oregon

OREGON STATE UNIVERSITY
CORVALLIS, OREGON 97331
SCHOOL OF EDUCATION
Department of
INDUSTRIAL EDUCATION
Industrial-Arts Education
Industrial-Vocational Education

March 25, 1965

Dear Sir:

A short time ago we mailed you a questionnaire asking you to check a list of process operations and indicate which of those you are performing at the present time and in what fashion, and those which you intend, or do not intend, to perform in the future. As we explained, we need this information in order to do a better job of interpreting industry, and the planning of the industrial arts curriculum and laboratory facilities of the public schools in the State of Oregon. If you have already returned the questionnaire to Oregon State University, please ignore this letter.

Just in case you misplaced the original questionnaire, we ask your cooperation in filling in the enclosed copy and returning it to us at your earliest convenience.

The questionnaires were sent to a small but carefully selected "sample" of the manufacturing industries of Oregon, and the accuracy of our findings depends upon obtaining the response of each industry in the "sample" group.

For your convenience in replying, another stamped, self-addressed envelope is enclosed.

As we in the Industrial Education Department at Oregon State University have a real need for this information, we hope that we may count on your cooperation.

Many thanks.

Sincerely yours,

Donald E. Moon, Instructor
Industrial Education Department

DEM:jlh

APPENDIX B

STRICTLY CONFIDENTIAL   STUDY NO._________

DETERMINING THE PRINCIPAL PROCESS OPERATIONS OF INDUSTRY

INDUSTRIAL INFORMATION:

Standard Industrial Classification Codes have been established by the U. S. Bureau of the Budget for all manufacturing establishments. Please check the exact classification that identifies your establishment.

_____ 24 Lumber and Wood Products (Except Furniture)
_____ 25 Furniture and Fixtures
_____ 30 Rubber and Miscellaneous Plastics Products
_____ 32 Stone, Clay, and Glass Products
_____ 33 Primary Metal Industries
_____ 34 Fabricated Metal Products (Not Elsewhere Classified)
_____ 35 Machinery (Except Electrical)
_____ 36 Electrical Machinery, Equipment and Supplies
_____ 37 Transportation Equipment
_____ 38 Professional, Scientific, and Controlling Instruments: Photographic and Optical Goods; Watches and Clocks
_____ 39 Miscellaneous Manufacturing Industries

INSTRUCTIONS:

1. Indicate which of the following process operations are being performed by your establishment through the application of
   a. hand methods,
   b. standard machine methods,
   c. automated machine methods,
   d. both hand and machine methods, or
   e. not at all.

2. If you are not performing the process operation at this time, indicate if you plan to do so within a period of
   a. one to two years,
   b. three to five years, or
   c. not at all.

3. If you do not plan to perform the operation at all, indicate the reason or reasons why:
   a. Does not apply.
   b. Too small.
   c. Too large.
   d. Too expensive.
   e. Contracted to another company.
   f. Other reason (State the reason).

4. After you have completed the questionnaire, return it to Oregon State University in the addressed-stamped envelope which has been provided for your convenience.

   Thank you for your cooperation.

Check the method being employed to perform the process operation.						If not performing the process now, when do you expect to begin?			Check the reason or reasons for not planning to perform the operation.					
Hand methods	Standard machine methods	Automated machine methods	Both hand and machine methods	Not at all	PRINCIPAL PROCESS OPERATION	One to two years	Three to five years	Not at all	Does not apply	Too small	Too large	Too expensive	Contracted out	Other reason
					I. FORMING									
					1. Forging									
					2. Extruding									
					3. Punching									
					4. Trimming									
					5. Drawing									
					a. Box Drawing									
					b. Panel Drawing									
					c. Cupping									
					d. Redrawing									
					e. Reverse Redrawing									
					6. Rolling									
					7. Forming									
					a. Cold Bending									
					b. Hot Bending									
					c. Flanging									
					d. Corrugating									
					e. Beading									
					f. Ribbing									
					g. Curling									
					h. Hemming									
					i. Seaming									
					j. Bulging									
					k. Embossing									
					l. Slip Forming									
					m. Plug and Ring									
					n. Die Pressing									
					o. Stretch Forming									
					p. Creasing									
					q. Draping									
					8. Differentials in Air Pressures									
					a. Vacuum Forming									
					b. Compressed Air Forming									
					c. Vacuum Drawing									
					d. Blowing Into Mold									
					e. Pressure Blowing in Free Space									
					9. Coining									
					10. Swaging									
					11. Spinning (Cold)									
					12. Spinning (Hot)									
					13. Piercing									
					14. Blanking									
					15. Welding (Pipe)									
					16. Squeezing (Cold)									
					17. Squeezing (Hot)									
					18. Veneering (Hand Forming)									
					19. Blow Die									
					20. Others									
					a.									
					b.									
					c.									
					II. CASTING AND MOLDING									
					1. Casting									
					a. Sand Casting									
					b. Permanent Mold Casting									
					c. Shell Mold Casting									
					d. Precision Investment Casting									
					e. Centrifugal Casting									
					f. Die Casting									
					g. Plastic Molding									
					h. Embedding									
					i. Powdered Metal Molding									

Check the method being employed to perform the process operation.						If not performing the process now, when do you expect to begin?			Check the reason or reasons for not planning to perform the operation.					
Hand methods	Standard machine methods	Automated machine methods	Both hand and machine methods	Not at all	PRINCIPAL PROCESS OPERATION	One to two years	Three to five years	Not at all	Does not apply	Too small	Too large	Too expensive	Contracted out	Other reason
					II. CASTING AND MOLDING (CONTINUED)									
					2. Pressure Molding									
					a. Die Casting									
					b. Compression Molding									
					c. Transfer Molding									
					d. Laminating									
					e. Injection Molding									
					f. Extruding									
					g. Preforming									
					h. Compacting									
					i. Cold Molding									
					3. Reinforced Plastic Molding									
					a. Contact Layup									
					b. Vacuum Bag Molding									
					c. Expanded Bag Molding									
					d. Matched Metal Molding									
					e. Preform Molding									
					4. Other									
					a.									
					b.									
					III. SHAPING--CUTTING									
					1. Presswork (Chipless Shaping)									
					a. Cutoff									
					b. Piercing									
					c. Punching									
					d. Blanking									
					e. Parting									
					f. Trimming									
					g. Notching									
					h. Lancing									
					i. Perforating									
					j. Shearing									
					k. Shaving									
					2. Machining (Cutting)									
					a. Turning									
					b. Drilling									
					c. Counterboring									
					d. Countersinking									
					e. Fly Cutting									
					f. Milling									
					g. Shaping									
					h. Planing									
					i. Cutoff									
					j. Broaching									
					k. Grinding									
					l. Honing									
					m. Sawing									
					n. Routing									
					o. Engraving									
					p. Sanding									
					q. Filing									
					r. Tapping--Threading									
					3. Other									
					a.									
					b.									
					IV. ASSEMBLY									
					1. Joining (Permanent)									
					a. Welding (Forge)									
					b. Welding (Oxy.-Acet.)									
					c. Welding (Resistance)									
					d. Welding (Inert Gas)									
					e. Welding (Atomic Hydrogen)									
					f. Welding (Fusion)									
					g. Soldering (Soft)									
					h. Soldering (Hard)									

Check the method being employed to perform the process operation.						If not performing the process now, when do you expect to begin?			Check the reason or reasons for not planning to perform the operation.					
Hand Methods	Standard machine methods	Automated machine methods	Both hand and machine methods	Not at all	PRINCIPAL PROCESS OPERATION	One to two years	Three to five years	Not at all	Does not apply	Too small	Too large	Too expensive	Contracted out	Other reason
					1. Joining (Permanent) - Cont.									
					i. Brazing									
					j. Gluing (Pressure)									
					k. Gluing (Heating)									
					l. Gluing (Resistance)									
					m. Cementing									
					n. Press Fitting									
					o. Shrink Fitting									
					p. Plastic Welding									
					1) Heated Tool Welding									
					2) Hot Gas Welding									
					3) Friction Welding									
					q. Other									
					1)									
					2)									
					2. Assembly (Mechanical)									
					a. Riveting									
					b. Screws (Self-Tapping)									
					c. Screws (Machine)									
					d. Screws (Wood)									
					e. Nails									
					f. Others									
					1)									
					2)									
					V. AUXILIARY									
					1. Welding									
					2. Metallizing									
					3. Heat Treating									
					a. Flame Hardening									
					b. Induction Hardening									
					c. Carburizing									
					d. Nitriding									
					e. Annealling									
					f. Tempering									
					g. Drawing									
					h. Aging									
					i. Bluing									
					j. Normalizing									
					k. Stress Relieving									
					l. Sintering									
					4. Straightening									
					5. Cleaning									
					a. Washing									
					b. Degreasing									
					c. Blasting									
					d. Tumbling									
					e. Pickling									
					6. Finishing									
					a. Deburring									
					b. Painting									
					c. Plating									
					d. Buffing									
					e. Polishing									
					7. Shot Peening									
					8. Baking									
					a. Drying									
					b. Curing									
					9. Surface Treating									
					a. Blasting									
					b. Polishing									
					c. Buffing									
					d. Brushing									
					e. Peening									
					f. Planishing									
					g. Ashing									
					9. Other									
					a.									
					b.									

STRICTLY CONFIDENTIAL STUDY NO._______

DETERMINING THE PRINCIPAL PROCESS OPERATIONS

OF THE

GRAPHIC ARTS

INSTRUCTIONS:

1. Indicate which of the following process operations are being performed by your establishment through the application of
   a. hand methods,
   b. standard machine methods,
   c. automated machine methods,
   d. both hand and machine methods, or
   e. not at all
2. If you are not performing the process operation at this time, indicate if you plan to do so within a period of
   a. one to two years,
   b. three to five years, or
   c. not at all.
3. If you do not plan to perform the operation at all, indicate the reason or reasons why:
   a. Does not apply.
   b. Too small.
   c. Too large.
   d. Too expensive.
   e. Contracted to another company.
   f. Other reason (state the reason).
4. After you have completed the questionaire, return it to Oregon State University in the addressed-stamped envelope which has been provided for your convenience.

Thank you for your cooperation.

Check the method being employed to perform the process operation.						If not performing the process now, when do you expect to begin?			Check the reason or reasons for not planning to perform the operation.					
Hand Methods	Standard machine methods	Automated machine methods	Both hand and machine methods	Not at all	PRINCIPAL PROCESS OPERATION	One to two years	Three to five years	Not at all	Does not apply	Too small	Too large	Too expensive	Contracted out	Other reason
					I. RELIEF PRINTING: LETTERPRESS									
					A. Layout									
					B. Composition									
					1. Plain Composition (Hand)									
					2. Hot Type Composition									
					a. Intertype									
					b. Linotype									
					c. Monotype									
					d.									
					e.									
					3. Cold Type Composition									
					4. Photo Mechanical									
					C. Proving									
					D. Imposing									
					E. Letterpress Printing									
					1. Flexographic									
					2. Thermography									
					3. Die Cutting									
					4. Other									
					a.									
					b.									
					F. Embossing									
					G. Stamping Through Gold or Metallic Foil									
					H. Blind Stamping									
					I. Other									
					1.									
					2.									
					3.									
					II. PLANE PRINTING: OFFSET									
					A. Layout									
					B. Photo Copying									
					C. Plate Making									
					D. Color Separation									
					E. Offset Press Printing									
					F. Other									
					1.									
					2.									
					3.									

Check the method being employed to perform the process operation.						If not performing the process now, when do you expect to begin?			Check the reason or reasons for not planning to perform the operation.					
Hand methods	Standard machine methods	Automated machine methods	Both hand and machine methods	Not at all	PRINCIPAL PROCESS OPERATION	One to two years	Three to five years	Not at all	Does not apply	Too small	Too large	Too expensive	Contracted out	Other reason
					III. INTAGLIO PRINTING: GRAVURE									
					A. Copper Plate Engraving									
					B. Line Engraving									
					D. Photoengraving									
					E. Etching									
					F. Dry Point									
					G. Other									
					1.									
					2.									
					3.									
					IV. PAINT PRINTING: SILK SCREEN									
					A. Layout									
					B. Photographic									
					C. Stencil (Hand Cut)									
					D. Tusche									
					E. Decalomania									
					F. Other									
					1.									
					2.									
					3.									
					V. SCREENLESS ILLUSTRATION PRINTING									
					A. Photogelatin									
					B. Collotype									
					C. Other									
					1.									
					2.									
					3.									
					VI. BINDERY									
					A. Cutting									
					B. Drilling									
					C. Punching									
					D. Perforating									
					E. Folding									
					F. Collating									
					G. Stapling									
					H. Side Wire Binding									
					I. Saddle Wire Binding									
					J. Sewn Soft Cover									
					K. Sewn Case--Bound									
					L. Loose-Leaf Binding									
					M. Mechanical Binding									
					1. Plastic Binding									
					2. Spiral Binding									
					N. Other									
					1.									
					2.									
					3.									
					VII. MISCELLANEOUS									
					A. Xerography									
					B. Rubber Stamp Making									
					C. Postage Meter									
					D. Tickometer									
					E. Other									
					1.									
					2.									
					3.									

APPENDIX C

STANDARD INDUSTRIAL CLASSIFICATIONS:
NUMBER OF MANUFACTURING ESTABLISHMENTS;
NUMBER OF PARTICIPANTS CHOSEN; AND THE
PERCENTAGE OF PARTICIPANTS RESPONDING.

Major Code	Minor Code	Title	Number of manufacturing establishments	Number of establishments chosen as participants	Number of establishments responding	Total percentage of respondents
24		Lumber and Wood Products (Except Furniture)	172	64	45	70
	26	Hardwood Dimension and Flooring Mills	12	5	4	
	31	Millwork Plants	68	35	19	
	33	Prefabricated	26	12	11	
	99	Wood Products Not Elsewhere Classified	66	12	11	
25		Furniture and Fixtures	54	25	17	68
	11	Wood Household Furniture, Except Upholstered	20	8	6	
	12	Wood Household Furniture, Upholstered	14	7	5	
	14	Metal Household Furniture	1	1	0	
	41	Wood Partitions, Shelving, Lockers and Office and Store Furniture	8	4	2	
	42	Metal Partitions, Shelving, Lockers and Office and Store Furniture	3	2	1	
	91	Venetian Blinds and Shades	8	3	3	

Major Code	Minor Code	Title	Number of manufacturing establishments	Number of establishments chosen as participants	Number of establishments responding	Total percentage of respondents
27		Printing and Publishing and Allied Industries	360	103	83	79
	11	Newspapers: Publishing, Publishing and Printing	103	43	33	
	21	Periodicals: Publishing, Publishing and Printing	21	3	3	
	32	Books: Publishing, Publishing and Printing	3	2	2	
	41	Miscellaneous Publishing	2	1	1	
	51	Commercial Printing, Except Lithographic	93	17	12	
	52	Commercial Printing, Lithographic	98	20	18	
	53	Engraving and Plate Printing	6	2	1	
	61	Manifold Business Forms Manufacturing	10	5	3	
	82	Blankbooks, Loose Leaf Binders and Devices	2	2	2	
	89	Bookbinding, and Miscellaneous Related Work	5	1	1	
	91	Typesetting	10	4	4	
	93	Photoengraving	6	2	2	
	94	Electrotyping and Sterrotyping	1	1	1	
30		Rubber and Miscellaneous Plastic Products	23	10	7	70
	79	Miscellaneous Plastic Products	23	10	7	

Major Code	Minor Code	Title	Number of manufacturing establishments	Number of establishments chosen as participants	Number of establishments responding	Total percentage of respondents
32		Stone, Glass, and Glass Products	12	3	3	100
	29	Pressed and Blown Glass and Glassware Not Elsewhere Classified	6	2	2	
	31	Glass Products, Made of Purchased Glass	6	1	1	
33		Primary Metal Industries	47	31	24	77.5
	17	Steel Pipe and Tubes	2	2	1	
	21	Gray Iron Foundries	11	6	5	
	23	Steel Foundries	8	7	4	
	39	Primary Smelting and Refining of Nonferrous Metals, Not Elsewhere Classified	5	3	3	
	61	Aluminum Castings	9	4	4	
	62	Brass, Bronze, Copper, Copper Brass Alloy Castings	6	3	2	
	69	Nonferrous Castings, Not Elsewhere Classified	2	2	1	
	91	Iron and Steel Forgings	3	3	3	
	99	Primary Metal Industries, Not Elsewhere Classified	1	1	1	
34		Fabricated Metal Products, Not Elsewhere Classified	265	117	82	70
	11	Metal Cans	5	4	4	
	21	Cutlery	1	1	1	

Major Code	Minor Code	Title	Number of manufacturing establishments	Number of establishments chosen as participants	Number of establishments responding	Total percentage of respondents
	23	Hand and Edge Tools, Except Machine Tools and Hand Saws	7	2	2	
	25	Hand Saws and Saw Blades	8	7	5	
	29	Hardware, Not Elsewhere Classified	9	5	4	
	33	Heating Equipment, Except Electric	9	3	2	
	41	Fabricated Structural Steel	14	10	10	
	42	Metal Doors, Sash, Frames, Molding and Trim	17	7	4	
	43	Fabricated Plate Work (Boiler Shops)	14	9	6	
	44	Sheet Metal Work	62	16	11	
	46	Architectural and Ornamental Metal Work	27	8	6	
	49	Miscellaneous Metal Work	1	1	1	
	51	Screw Machine Products	2	1	1	
	52	Bolts, Nuts, Screws, Rivets and Washers	1	1	0	
	61	Metal Stampings	11	4	1	
	71	Electroplating, Plating, Polishing, Anodizing and Coloring	24	8	6	
	79	Coating, Engraving, and Allied Services, Not Elsewhere Classified	12	5	2	
	81	Miscellaneous Fabricated Wire Products	14	8	3	
	91	Metal Shipping Barrels, Drums, Kegs, and Pails	1	1	0	

Major Code	Minor Code	Title	Number of manufacturing establishments	Number of establishments chosen as participants	Number of establishments responding	Total percentage of respondents
	93	Steel Springs	5	4	3	
	94	Valves and Pipe Fittings, Except Plumber's Brass Goods	8	6	5	
	98	Fabricated Pipe and Fabricated Pipe Fittings	4	2	2	
	99	Fabricated Metal Products, Not Elsewhere Classified	9	4	3	
35		Machinery (Except Electrical)	283	119	89	75
	22	Farm Machinery and Equipment	14	6	6	
	31	Construction Machinery and Equipment	9	4	2	
	32	Mining Machinery and Equipment, Except Oil Field Machinery and Equipment	3	3	3	
	34	Elevators and Moving Stairways	2	2	1	
	35	Conveyors and Conveying Equipment	3	1	1	
	36	Hoists, Industrial Cranes, and Monorail Systems	4	2	2	
	37	Industrial Trucks, Tractors, Trailers, and Stackers	15	9	6	
	41	Machine Tools, Metal Cutting Types	3	2	1	

Major Code	Minor Code	Title	Number of manufacturing establishments	Number of establishments chosen as participants	Number of establishments responding	Total percentage of respondents
	44	Special Dies and Tools, Die Sets, Jigs and Fixtures	5	3	3	
	45	Machine Tool Accessories and Measuring Devices	3	2	2	
	48	Metalworking Machinery, Except Machine Tools; and Power Driven Hand Tools	3	2	2	
	51	Food Products Machinery	13	7	5	
	53	Woodworking Machinery	39	19	13	
	54	Paper Industries Machinery	5	3	2	
	55	Printing Trades Machinery and Equipment	9	2	2	
	59	Special Industry Machinery, Not Elsewhere Classified	6	3	2	
	61	Pumps, Air and Gas Compressors, and Pumping Equipment	4	4	3	
	64	Blowers, Exhaust and Ventilating Fans	2	2	2	
	65	Industrial Patterns	13	6	5	
	66	Mechanical Power Transmission Equipment, Except Ball and Roller Bearings	5	3	2	
	67	Industrial Process Furnaces and Ovens	3	2	1	
	69	General Industrial Machinery and Equipment, Not Elsewhere Classified	2	2	1	

Major Code	Minor Code	Title	Number of manufacturing establishments	Number of establishments chosen as participants	Number of establishments responding	Total percentage of respondents
	85	Refrigerators and Refrigeration Machinery Except Household; and Complete Air Conditioning Units	9	4	2	
	99	Miscellaneous Machinery Except Electrical	109	26	20	
36		Electrical Machinery Equipment and Supplies	61	34	25	73.5
	11	Electric Measuring Instruments and Test Equipment	3	2	2	
	12	Power, Distribution, and Specialty Transformers	5	2	1	
	13	Switch Gear and Switchboard Apparatus	6	4	4	
	21	Motors and Generators	3	3	3	
	22	Industrial Controls	8	4	4	
	23	Welding Apparatus	2	1	1	
	34	Electric Housewares and Fans	5	2	1	
	39	Household Appliances, Not Elsewhere Classified	1	1	0	
	42	Lighting Fixtures	4	2	0	
	44	Noncurrent Carrying Wiring Devices	2	1	1	
	61	Telephone and Telegraph Apparatus	1	1	1	
	62	Radio and Television Transmitting, Signaling, and Detection Equipment and Apparatus	4	2	2	

Major Code	Minor Code	Title	Number of manufacturing establishments	Number of establishments chosen as participants	Number of establishments responding	Total percentage of respondents
	79	Electronic Components and Accessories, Not Elsewhere Classified	2	1	0	
	91	Storage Batteries	11	6	3	
	93	Radiographic X-Ray, Fluoroscopic X-Ray, Therapeutic X-Ray, and Other X-Ray Apparatus and Tubes	2	1	0	
	94	Electrical Equipment for Internal Combustion Engines	2	2	2	
37		Transportation Equipment	97	49	25	51
	11	Motor Vehicles	4	2	1	
	13	Truck and Bus Bodies	11	7	3	
	14	Motor Vehicle Parts and Accessories	22	8	4	
	15	Truck Trailers	7	6	4	
	29	Aircraft Parts and Auxiliary Equipment, Not Elsewhere Classified	2	2	2	
	31	Ship Building and Repairing	10	8	4	
	32	Boat Building and Repairing	23	7	2	
	42	Railroad and Street Cars	1	1	1	
	91	Trailer Coaches	12	6	2	
	99	Transportation Equipment, Not Elsewhere Classified	5	2	2	
38		Professional, Scientific, and Controlling Instruments: Photographic and Optical				

Major Code	Minor Code	Title	Number of manufacturing establishments	Number of establishments chosen as participants	Number of establishments responding	Total percentage of respondents
		Goods; Watches and Clocks	27	16	12	75
	11	Engineering, Laboratory, and Scientific and Research Instruments and Associated Equipment	3	3	2	
	21	Mechanical Measuring and Controlling Instruments, Except Automatic Temperature Controls	5	1	0	
	31	Optical Instruments and Lenses	2	1	1	
	41	Surgical and Medical Instruments and Apparatus	3	2	2	
	42	Orthopedic, Prosthetic and Surgical Appliances and Supplies	8	6	5	
	43	Dental Equipment and Supplies	4	1	1	
	61	Photographic Equipment and Supplies	2	2	1	
39		Miscellaneous Manufacturing Industries	86	28	22	78.5
	31	Musical Instruments and Parts	2	1	1	
	41	Games, and Toys, Except Dolls and Children's Vehicles	7	3	2	
	49	Sporting and Athletic Goods, Not Elsewhere Classified	29	10	9	
	88	Mortician's Goods	5	3	3	
	93	Signs and Advertising Displays	36	10	6	
	99	Manufacturing Industries, Not Elsewhere Classified	7	1	1	

APPENDIX D

LIST OF MANUFACTURING ESTABLISHMENTS

The following list is composed of the manufacturing establishments that cooperated in this study. The list is organized by the Major S. I. C. Codes and the Minor S. I. C. Codes as provided in the 1964 Edition of the Directory of Oregon Manufacturers and Buyer's Guide (29).

MAJOR GROUP 24 - LUMBER AND WOOD PRODUCTS, EXCEPT FURNITURE

2426 - Hardwood Dimension and Flooring Mills

Evans Products Company, Corvallis
Great Northern Products, Inc., Portland
Roberts Wood Products, Portland
Specialty Woodworking Company, Portland

2430 - Millwork Plants

American Lumber Company, Portland
Beutler-Quistad Lumber Company, Salem
Cascade Forest Products, Inc., Bend
Clear Fir Products of Oregon, Springfield
Clear Pine Mouldings, Inc., Prineville
Al Clements Lumber Company, Eugene
Heacock Door Manufacturing Co., Portland
Mayhew Sash & Door Company, Inc., Portland
Medford Moulding Company, Medford
Metler Brothers, Klamath Falls
Midgleys Millwork and Glass Co., Eugene
Mulino Sash & Door Manufacturing Co., Mulino
O. O. Olsen Manufacturing Co., Eugene
Oregon Trail Box Company, Bend
Simpson Timber Company, Portland
Truax Builders Supply, Portland
Western Overhead Door Company, Portland
Westwood Products, Salem

2430 - (Continued)

Whittier Moulding Company, Redwood

2433 - Prefabricated Wooden Buildings and Structural Members

Air-King Manufacturing Corporation, Tigard
Building Materials, Inc., Medford
Carlyn Panel Company, Roseburg
Continental Homes, Inc., Tigard
Duco-Lam Incorporated, Drain
Timber Laminators, Inc., Ontario
Timber Structures, Inc., Portland
Trussfab, Inc., Clackamas
Western Homes Company, Portland
Weyerhauser Company, Cottage Grove
Wood Components, Inc., Eugene

2499 - Wood Products, Not Elsewhere Classified

Bilt Rite Manufacturing Co., Woodburn
Chapman Timber Products, Inc., Cottage Grove
D. & M. Products, Inc., Portland
Duncan's Myrtlewood Crafters, North Bend
Friesen Core Company, Inc., Dallas
House of Myrtlewood, Coos Bay
Marx Fabricating, Inc., Portland
Mt. Pitt Company, Medford
St. Helens Wood Products Co., St. Helens
Simpson Timber Company, Portland
Toledo Products, Inc., Toledo

MAJOR GROUP 25 - FURNITURE AND FIXTURES

2511 - Wood Household Furniture, Except Upholstered

Barker Manufacturing Company, Portland
Eugene Planing Mill, Eugene
Lloyd's Homecraft Furniture, Portland
Noblecraft Industries, Inc., Hillsboro
Sterling Furniture Manufacturing, Inc., Portland
R. Veal & Son, Albany

2512 - Wood Household Furniture, Upholstered

Fashioncraft Furniture Corporation, Portland
Leonette Furniture Manufacturing Co., Portland
Portland Furniture Manufacturing Corporation, Portland
Rose City Upholstery, Portland
Tempo Furniture Corporation, North Portland

2541 - Wood Partitions, Shelving, Lockers, and Office and Store Fixtures

Boden Brothers Fixtures, Portland
Charles Grant Company, Portland

2542 - Metal Partitions, Shelving, Lockers, and Office and Store Fixtures

Peters Metal Fabricating Company, Portland

2591 - Venetian Blinds and Shades

Edmondson's Venetian Blind & Shade Company, Portland
Peake, The Shade Man, Portland
Window Products, Inc., Portland

MAJOR GROUP 27 - PRINTING, PUBLISHING, AND ALLIED INDUSTRIES

2711 - Newspapers: Publishing, Publishing and Printing

Albany Greater Oregon, Albany
Ashland Publishing Company, Inc., Ashland
Astorian Budget Publishing Company, Astoria
Baker Publishing Company, Baker
Benton County Herald, Corvallis
Coos Printing Company, North Bend
Corvallis Gazette-Times, Corvallis
Cottage Grove Sentinel, Inc., Cottage Grove
Courier Publishing Company, Grants Pass
Daily Journal of Commerce, Portland
East Oregonian Publishing Company, Pendleton
Enterprise-Courier Company, Oregon City
Insurance News, Incorporated, Portland

2711 - (Continued)

Klamath Publishing Company, Klamath Falls
LaGrande Publishing Company, LaGrande
Lake Oswego Review, Lake Oswego
Lincoln County Leader, Toledo
Medford Printing Company, Medford
News-Register Publishing Company, McMinnville
News Review Publishing Company, Roseburg
News Times Publishing Company, Forest Grove
North Clackamas Publishers and Printers, Inc., Milwaukie
Oregon Publishing Company, Portland
Polk County Itemizer-Observer, Dallas
Portland Reporter Publishing Company, Portland
Press Publishing Company, Salem
Redmond Spokesman, Redmond
Sentinel-Mist Publishing Company, St. Helens
Springfield News, Inc., Springfield
Stayton Mail, Inc., Stayton
Times, Inc., Coos Bay
Valley Publishing, Inc., Beaverton
Van Dahl Publications, Albany

2721 - Periodicals: Publishing, Publishing and Printing

C. C. Crow Publications, Inc., Portland
E. Hofer & Sons, Portland
Miller Freeman Publications, Inc., Portland

2732 - Books: Publishing, Publishing and Printing

Metropolitan Printing Company, Portland
Portland Publications House, Inc., Portland

2741 - Miscellaneous Publishing

Pacific Inland Tarrif Bureau, Inc., Portland

2751 - Commercial Printing, Except Lithographic

Beattie and Company, Portland
Conger Printing Company, Portland
Hallwyler Printing Company, Portland
Hillsboro Argus, Inc., Hillsboro
Independent Printing Company, Portland

2751 - (Continued)

Kleist and Company, Portland
Knapp Printing Company, Salem
Malheur Publishing Company, Ontario
News Press, Inc., Coos Bay
Potter Manufacturing Company, Eugene
Shelton-Turnbull-Fuller, Inc., Eugene
Warner-Pigg & Company, Portland

2752 - Commercial Printing, Lithographic

Abbott, Kerns & Bell Company, Portland
Arcady Press, Portland
Dunham Printing Company, Portland
Durham & Downey, Inc., Portland
Glass-Dahlstrom Printers, Portland
Gordon's Stationery Company, Portland
Charlie Helwig Company, Portland
J. Y. Hollingsworth, Company, Portland
Kilham Stationery & Printing Company, Portland
Klocker Printery, Medford
Koke Printing & Lithographing, Eugene
Lee's Litho, Portland
Quick Service Litho Print Company, Eugene
Ryder Printing Company, Portland
Schultz, Wack & Weir, Inc., Portland
Statesman Publishing Company, Salem
Stevens-Ness Law Publishing Company, Portland
Trade Litho, Inc., Portland

2753 - Engraving and Plate Printing

Fine Arts Engravers, Portland

2761 - Manifold Business Forms Manufacturing

Lane-Miles Standish Company, Portland
Moore Business Forms, Inc., Salem
Standard Printing & Office Supply, Portland

2782 - Blankbooks, Loose Leaf Binders and Devices

Check Printing Company, Portland

2789 - Bookbinding, and Miscellaneous Related Work

Lincoln and Allen Company, Portland

2791 - Typesetting

Paul O. Giesey Adcrafters, Portland
Portland Linotyping Company, Portland
Schiegel Typesetting Company, Portland
Updike & Johnson, Typesetting, Portland

2793 - Photoengraving

Beaver Engraving Company, Inc., Portland
Hicks-Chatten Engraving Company, Portland

2794 - Electrotyping and Stereotyping

Oregon Engraving & Electrotyping Company, Portland

MAJOR GROUP 30 - RUBBER AND MISCELLANEOUS PLASTICS PRODUCTS

3079 - Miscellaneous Plastics Products

Anderson Die & Manufacturing Company, Portland
Beaman Plastics, Portland
Cascade Plastics, Portland
Grant & Roth Plastics, Portland
Plastolite of Oregon, Inc., Aloha
Scientific Research Company, Portland
Thorolyte Fiberglas, Inc., Portland

MAJOR GROUP 32 - STONE, CLAY AND GLASS PRODUCTS

3229 - Pressed and Blown Glass and Glassware, Not Elsewhere Classified

Design Industries, Inc., Eugene
Glas-Kraft Products, Portland

3231 - Glass Products, Made of Purchased Glass

ABC Fiberglass, Inc., Portland

MAJOR GROUP 33 - PRIMARY METAL INDUSTRIES

3317 - Steel Pipe and Tubes

Beall Pipe and Tank Corporation, Portland

3321 - Gray Iron Foundries

Crawford & Doherty Foundry, Co., Portland
Industrial Iron Works, Portland
Northwest Foundry & Furnace Company, Portland
Rich Manufacturing Company of California, Portland
Tube Forgings of America, Inc., Portland

3323 - Steel Foundries

Esco Corporation, Portland
Pacific Steel Foundry Company, Portland
Precision Castparts Corporation, Portland
Western Foundry Company, Portland

3339 - Primary Smelting and Refining of Nonferrous Metals, Not Elsewhere Classified

Oregon Metalurgical Corporation, Albany
National Metalurgical Corporation, Springfield
Wah Chang Corporation, Albany

3361 - Aluminum Castings

Central Brass and Aluminum Foundry, Portland
Eugene Aluminum & Brass Foundry, Eugene
Macadam Aluminum & Bronze Company, Portland
Pacific Light Metals Foundry Company, Portland

3362 - Brass, Bronze, Copper, Copper Base Alloy Castings

City Brass Foundry, Portland
Service Bronze & Brass Works, Portland

3369 - Nonferrous Castings, Not Elsewhere Classified

Nichols Tool & Die, Portland

3391 - Iron and Steel Forgings

Columbia Forge & Machine Works, Portland
Portland Chain Manufacturing Company, Portland
Schmitt Steel Inc., Portland

3399 - Primary Metal Industries, Not Elsewhere Classified

Beaver Heat Treating Corp., Portland

MAJOR GROUP 34 - FABRICATED METAL PRODUCTS, EXCEPT ORDNANCE, MACHINERY, AND TRANSPORTATION EQUIPMENT

3411 - Metal Cans

American Can Company, Astoria
American Can Company, Salem
American Can Company, Salem
Continental Can Company, Portland

3421 - Cutlery

Gerber Legendary Blades, West Linn

3423 - Hand and Edge Tools, Except Machine Tools and Hand Saws

Metal Processing Company, Portland
P & C Tool Company, Milwaukie

3425 - Hand Saws and Saw Blades

Borg-Warner Corporation, Portland
Paul Brong, Machine Works, Portland
Omark Industries, Inc., Portland
Pacific Saw & Knife Company, Portland
Spear & Jackson (U.S.), Inc., Eugene

3429 - Hardware, Not Elsewhere Classified

Hearth Craft, Inc., Portland
Modern Firescreens Company, Portland
Willamette Manufacturing & Supply Company, Inc., Portland
Winter Manufacturing Company, Portland

3433 - Heating Equipment, Except Electric

North Coast Manufacturing Corporation, Portland
Sandberg Manufacturing Company, Portland

3441 - Fabricated Structural Steel

Ray F. Becker Company, Portland
Columbia Wire & Iron Works, Portland
Eugene Truck & Machine Company, Eugene
Fought & Company, Inc., Portland
Oregon Iron Works, Inc., Portland
P & F Sales, Portland
Portland Wire & Iron Works, Portland
Rogue Valley Steel Company, Grants Pass
Soule Steel Company, Portland
Stevens Steel and Equipment Company, Salem

3442 - Metal Doors, Sash, Frames, Molding and Trim

Marion Butler Company, Inc., Portland
Chamberlin of Portland, Inc., Portland
Grand Metal Products Corporation, Portland
Salem Aluminum Window Company, Inc., Salem

3443 - Fabricated Plate Work (Boiler Shops)

American Pipe & Construction Company, Portland
Armco Steel Corporation, Hillsboro
Harris Ice Machine Works, Portland
McCulloch & Sons, Portland
Oak Street Tank & Steel, Inc., Ashland
Star Metal Fabricators, Portland

3444 - Sheet Metal Work

Carl B. Armpriest, Inc., Salem
E-Z Awn Manufacturing Corp., Portland
Gem-Top Manufacturing, Inc., Portland

3444 - (Continued)

General Metalcraft, Inc., Portland
Kleenair Furnace Company, Portland
Losi, Inc., Portland
Medford Steel and Blowpipe, Division of Concrete Steel Corp., Medford
Ted Nelson Company, Portland
Northwest Tube & Metal Fabricators, Portland
Reynolds Aluminum Supply, Portland
Salem Heating & Sheet Metal Works, Salem

3446 - Architectural and Ornamental Metal Work

Commercial Welding Company, Inc., Oregon
Fold-A-Fence Corporation, Lake Oswego
Kinco Products, Inc., Portland
McCabe Powers Body Company, Portland
Oregon Brass Works, Portland
Rose City Ironcraft Shop, Inc., Portland

3449 - Miscellaneous Metal Work

Mercer Steel Company, Inc., Portland

3451 - Screw Machine Products

Enoch Manufacturing Company, Portland

3461 - Metal Stampings

Simplicity Tool Company, Portland

3471 - Electroplating, Plating, Polishing, Anodizing and Coloring

Allied Plating, Inc., Portland
Alloy Plating and Polishing Company, Portland
American Plating Company, Portland
East Side Plating Works, Portland
Pacific Plating Works, Portland
Victory Plating Works, Portland

3479 - Coating, Engraving and Allied Services, Not Elsewhere Classified

City Galvanizers Company, Portland

3479 - (Continued)

Hall Process Company, Clackamas

3481 - Miscellaneous Fabricated Wire Products

Custom Wire Products, Inc., Portland
H. W. Huserik & Son, Inc., Portland
Russellville-Kerr Wire and Metal Industries, Portland

3493 - Steel Springs

Benz Spring Company, Portland
Storey Tool & Die Works, Portland
Zimmerman's Spring Works, Inc., Portland

3494 - Valves and Pipe Fittings, Except Plumber's Brass Goods

Irrigation Equipment Company, Inc., Eugene
McCracken Machine Works, Inc., Portland
Moore's Irrigation Company, Corvallis
W. G. Rovang & Associates, Inc., Portland
Wade Manufacturing Company, Portland

3498 - Fabricated Pipe and Fabricated Pipe Fittings

Albina Pipe Bending Company, Portland
Warren Manufacturing Company, Inc., Beaverton

3499 - Fabricated Metal Products, Not Elsewhere Classified

Whitcomb Crichton, Portland
Dorfile Manufacturing Company, Inc., Portland
Sure Seal Equipment Company, Portland

MAJOR GROUP 35 - MACHINERY, EXCEPT ELECTRICAL

3522 - Farm Machinery and Equipment

J. A. Freeman & Son, Portland
Kenworth Manufacturing Company, Portland
Lewis Manufacturing Company, Inc., Klamath Falls
Oregon Manufacturing Company, Beaverton

3522 - (Continued)

Parman & Ellis, Portland
Rear's Manufacturing Company, Inc., Eugene

3531 - Construction Machinery and Equipment

Sutherlin Machine Works, Inc., Sutherlin
Young Iron Works of Oregon, Eugene

3532 - Mining Machinery and Equipment, Except Oil Field Machinery and Equipment

El-Jay Manufacturing Company, Inc., Eugene
Throwaway Bit Corporation, Portland
Wagner Mining Scoop, Inc., Portland

3534 - Elevators and Moving Stairways

Portland Elevator Company, Portland

3535 - Conveyors and Conveying Equipment

Industrial Services, Inc., North Bend

3536 - Hoists, Industrial Cranes, and Monorail Systems

Convertahoist Manufacturing Company, Inc., Medford
Paulson Machine Works, Portland

3537 - Industrial Trucks, Tractors, Trailers, and Stackers

Foster Manufacturing Company, Inc., Madras
Gerlinger Carrier Company, Dallas
Holt, Independence Division, Jeddeloh Brothers, Sweed Mills, Inc., Independence
Hyster Company, Portland
Mater Machine Works, Corvallis
Timber Tractor Company, Springfield

3541 - Machine Tools, Metal Cutting Types

Production Parts Manufacturing Co., Milwaukie

3544 - Special Dies and Tools, Die Sets, Jigs and Fixtures

Arnel's Ceramic Molds, Portland
Future Products Company, Portland
Portland Die & Stamping Company, Inc., Portland

3545 - Machine Tool Accessories and Measuring Devices

Hanchett Manufacturing Company, Portland
Speed City, Inc., Corvallis

3548 - Metalworking Machinery, Except Machine Tools, and Power Driven Hand Tools

Ammo Products, Inc., Portland
Electro-Glass Laboratories, Inc., Beaverton

3551 - Food Products Machinery

Atlas Sheetmetal & Hotel Supply Company, Portland
E. H. Carruthers Company, Warrenton
Key Equipment Company, Inc., Milton-Freewater
L. N. Miller Dehydrater, Company, Eugene
Sowa, Inc., Woodburn

3553 - Woodworking Machinery

Armstrong Manufacturing Company, Portland
Cranston Machinery Company, Inc., Oak Grove
H. H. C. Research and Development Corporation, Portland
Irvington Machine Works, Inc., Portland
Jeddeloh Brothers, Sweed Mills, Inc., Gold Hill
Kimwood Machine Company, Cottage Grove
Klamath Iron Works, Klamath Falls
L-M Equipment Company, Inc., Portland
Moore Dry Kiln Company of Oregon, North Portland
Portland Iron Works, Portland
Salem Equipment, Inc., Salem
M. A. Ward, Corporation, Eugene
West Salem Machinery Company, Salem

3554 - Paper Industries Machinery

Monarch Forge & Machine Works, Portland
Pacific Pulp Molding Company, Portland

3555 - Printing Trades Machinery and Equipment

Kenton Machine Works, Inc., Portland
Press Specialties Manufacturing Company, Portland

3559 - Special Industry Machinery, Not Elsewhere Classified

V. H. Langsville Manufacturing Company, Portland
Tuerck MacKenzie Company, Portland

3561 - Pumps, Air and Gas Compressors, and Pumping Equipment

Bingham Pump Company, Portland
Diesel Equipment Company, Portland
Pacific Pumping Company, Portland

3564 - Blowers, Exhaust and Ventilating Fans

American Sheet Metal Works, Inc., Portland
Archer Blower & Pipe Company of Oregon, Portland

3565 - Industrial Patterns

Dependable Pattern Works, Inc., Portland
Northwest Pattern Works, Portland
Peerless Pattern Works, Portland
Precision Pattern Works, Portland
West Side Pattern Works, Portland

3566 - Mechanical Power Transmission Equipment, Except Ball and Roller Bearings

3567 - Industrial Process Furnaces and Ovens

Skutt & Sons, Portland

3569 - General Industrial Machinery and Equipment, Not Elsewhere Classified

Ackley Manufacturing Company, Portland

3585 - Refrigerators and Refrigeration Machinery, Except Household, and Complete Air Conditioning Units

Brod & McClung-Pace Company, Portland
Rhodes Refrigeration, Inc., Portland

3599 - Miscellaneous Machinery, Except Electrical

CWS Grinding & Machine Works, Portland
Cascade Manufacturing Company, Portland
Eyerly Aircraft Company, Salem
Helser Machine Works, Inc., Portland
Hrubetz & Bushnell, Salem
Hydraulic Manufacturing Company, Portland
Kach Machine Works, Inc., Portland
Modern Tool and Gage, Milwaukie
Myrmo & Sons, Eugene
Northwest Industries, Inc., Albany
Olson Manufacturing Company, Portland
Precision Products Company, Inc., Gresham
Rowe Brothers Rebuilders & Equipment Company, Portland
Salem Iron Works, Salem
Sawyer Iron Works, Eugene
Skookum Company, Portland
Small Parts Manufacturing Company, Inc., Portland
Stark & Norris, Portland
Paul Sowa & Sons, Woodburn
Willamette Iron and Steel Co., Portland

MAJOR GROUP 36 - ELECTRICAL MACHINERY, EQUIPMENT AND SUPPLIES

3611 - Electrical Measuring Instruments and Test Equipment

Electro Scientific Industries, Inc., Portland
Tektronix, Inc., Beaverton

3612 - Power, Distribution, and Specialty Transformers

Schwager - Wood Company, Portland

3613 - Switchgear and Switchboard Apparatus

Coast Electric and Manufacturing Company, Portland
Electro-Mechanical Company, Portland
Fouch Electric Manufacturing Company, Inc., Portland
Mears Controls, Inc., Beaverton

3621 - Motors and Generators

Exact Electronics, Inc., Hillsboro
General Services Company, Corvallis
Oeco Corporation, Portland

3622 - Industrial Controls

Automatic Actuators Company, Lake Oswego
Controls and Communications Company, Eugene
Sel-Set Machinery, Salem
Westcon, Inc., Portland

3623 - Welding Apparatus

West Coast Alloys Company, Inc., Troutdale

3634 - Electric Housewares and Fans

Berham Manufacturing Company, Corvallis

3644 - Noncurrent Carrying Wiring Devices

Circle A-W Products Company, Portland

3661 - Telephone and Telegraph Apparatus

Code-A-Phone Electronics, Inc., Portland

3662 - Radio and Television Transmitting, Signaling, and Detection Equipment and Apparatus

Campbell-Norquist Company, Portland
Radio Specialty Manufacturing Company, Portland

3691 - Storage Batteries

Mac's Battery & Filler Service, Inc., Eugene
States Batteries, Inc., Portland
Sun Battery Company, Sherwood

3694 - Electrical Equipment for Internal Combustion Engines

Trunnell Manufacturing and Sales Company, Eugene
Willamette Electric, Inc., Portland

MAJOR GROUP 37 - TRANSPORTATION EQUIPMENT

3711 - Motor Vehicles

Freightliner Corporation, Portland

3713 - Truck and Bus Bodies

Gillespie Equipment Company, Inc., Portland
Schetky Equipment Corporation, Portland
Wentworth & Irwin, Inc., Portland

3714 - Motor Vehicle Parts and Accessories

Belleview Manufacturing Company, Portland
Lomac Motors, Inc., Portland
Power Brake Equipment Company, Portland
Premier Manufacturing Company, Portland

3715 - Truck Trailers

Fruehauf Corporation, Portland
General Trailer Company, Inc., Sprinfield
Page & Page Company, Portland
Westland Trailer Company, Portland

3729 - Aircraft Parts and Auxiliary Equipment, Not Elsewhere Classified

Electronic Specialty Company, Portland
McKinnon Enterprises, Sandy

3731 - Ship Building and Repairing

Albina Engine and Machine Works, Portland
Astoria Marine Corporation, Astoria
Hillstrom Shipbuilding Company, Coos Bay
Willamette Tug and Barge Company, Portland

3732 - Boat Building and Repairing

Hiway Products, Inc., Canby
R. E. Sells Marine Services, Portland

3742 - Railroad and Street Cars

Genderson Brothers Engineering Company, Portland

3791 - Trailer Coaches

Hood Trailer Industries, Inc., Clackamas
Rogue River Trailer Manufacturing Company, Grants Pass

3799 - Transportation Equipment, Not Elsewhere Classified

Brophy Machine Company, Clackamas
Bud Welding and Manufacturing Company, Grants Pass

MAJOR GROUP 38 - PROFESSIONAL, SCIENTIFIC, AND CONTROLLING INSTRUMENTS: PHOTOGRAPHIC AND OPTICAL GOODS: WATCHES AND CLOCKS

3811 - Engineering, Laboratory, and Scientific and Research Instruments and Associated Equipment

National Appliance Company, Portland
Phillips-Drucker, Inc., Astoria

3831 - Optical Instruments and Lenses

Mikros, Inc., Portland

3841 - Surgical and Medical Instruments and Apparatus

Argonaout Associates, Inc., Beaverton
Powell Laboratories, Gladstone

3842 - Orthopedic, Prosthetic and Surgical Appliances and Supplies

Artificial Limb & Truss Company, Portland
Coast Orthopedic Company, Portland
Hocks Laboratories, Portland
K. E. Karlson Company, Portland
Prosthetic & Orthopedic Supply Company, Inc., Portland

3843 - Dental Equipment and Supplies

Cascade M-D Products, Inc., Ashland

3861 - Photographic Equipment and Supplies

Sawyer's Inc., Portland

MAJOR GROUP 39 - MISCELLANEOUS MANUFACTURING INDUSTRIES

3931 - Musical Instruments and Parts

Rodgers Organ Company, Hillsboro

3941 - Games and Toys, Except Dolls and Children's Vehicles

American Junior Aircraft Company, Portland
Playcraft, Inc., Portland

3949 - Sporting and Athletic Goods, Not Elsewhere Classified

Capitol Tackle Manufacturing Company, Portland
Jarman-Williamson Company, Portland
Jensen, Luhr, & Sons, Inc., Hood River
Leflar Enterprises, Inc., Portland
Rose City Archery, Inc., Powers
S. R. Smith Company, Inc., Canby
Stackhouse Athletic Products, Salem
Troendly Manufacturing Company, Elkton
Western Wood Manufacturing Company, Portland

3988 - Mortician's Goods

American Casket Company, Portland
Oregon Casket Company, Portland
Portland Casket Company, Portland

3993 - Signs and Advertising Displays

Columbia Neon Company, Portland
Federal Sign & Signal Corporation, Portland
Gage Industries, Inc., Lake Oswego
Martin Brothers, Inc., Salem
Oregon Sign & Neon Corporation, Portland
Security Signs, Inc., Portland

3999 - Manufacturing Industries, Not Elsewhere Classified

Stagecraft Industries, Inc., Portland