The curriculum outline is designed to aid the instructor in developing a more complete course of study, for intermediate and secondary school students, to give the student an understanding of some of the tools, materials, processes, products, occupational opportunities, requirements, and working conditions associated with the metal and metal working industry. The guide is introduced by a discussion of objectives fundamental to a sound program of industrial arts education, followed by an outline and objectives for the content area of the course. The content is presented with reference to four levels of instruction. The guide is divided into nine parts, each containing an outline, course content divided into units of instruction, suggested instructional levels, student and teaching activities, and lists of resource materials. The nine parts are: activities common to metalwork, art metalwork, bench metalwork, metalwork forging practices, metalwork foundry practices, heat treatment of metals, machining metals, and sheet metal practices. There are three appendices. Appendix 1 lists free and inexpensive learning materials, magazines and newspapers, professional publications, and audiovisual sources. Appendix 2 provides a publishers' address list. Appendix 3 gives a metal equipment list, tool list, and textbook and reference book bibliography. (MH)
INDUSTRIAL ARTS
METALS TECHNOLOGY

A CURRICULUM GUIDE
FOR
INTERMEDIATE AND SECONDARY LEVEL
PROGRAMS

1974 EDITION

MISSOURI STATE DEPARTMENT OF EDUCATION
ARTHUR MALLORY
COMMISSIONER OF EDUCATION
JEFFERSON CITY, MISSOURI
STATE DEPARTMENT OF EDUCATION

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FOREWORD

This curriculum guide was formulated by a committee under the auspices of the Missouri Council for Industrial Arts Education. In preparing and publishing the curriculum guide, the appointed committee, cooperating with supervisory personnel of the State Department of Education, worked toward the goal of initiating and improving metals instruction in Missouri.

The guide is designed to aid teachers in establishing course objectives and course content, as well as planning teaching methods and evaluation procedure. It is intended that the individuals and groups that review and use this publication will find the suggested content, activities and teaching aids presented in a manner that will enable the user to adopt or adapt them in a meaningful manner.

The background experiences of the members of the metals committee included a variety of teaching experiences and educational qualifications so necessary in formulating a functional publication of this type. The donation of time and effort by committee members indicates the importance they place on metals instruction in industrial arts and in the overall education program. Special recognition also goes to the state and national professional industrial education organizations whose materials were reviewed.

[Signature]
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FOR DEVELOPING
THE CURRICULUM GUIDE FOR
INDUSTRIAL ARTS METALS TECHNOLOGY

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A sincere thank you to all the people who have contributed in any way to the completion of this Metalworking Curriculum Guide. A first thank you goes to the committee members who spent many hours writing and working with the different sections of the guide. Many other teachers helped with contributions of films, charts, pamphlets and other aids and ideas. Because there are too many of these teachers to mention each one by name, a general thank you for all of your contributions.

The most appreciated help and thus our best thank you, goes to the State Supervisor of Industrial Arts, Gene Brightwell, without his patience, encouragement, telephone conversations and personal visits, this guide could never have been completed.

Dr. Sherrell made some late changes and completed the final editing of this guide. The committee appreciates his efforts and thanks him for his many hours of work.

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INTRODUCTION

We are living in an age of metals. Ever since man first began to use metal for his tools and utensils his need for these products have continued to increase until today, his society relies heavily on products made either partly or completely of metals. Even these products are developed, processed and distributed by other products made partly or completely of metals.

This continuous demand for products made of metal ingenders a continual need for engineers, technicians, skilled workers, sales and service people, and teachers knowledgeable in the use and manufacturing of metals.

This curriculum guide is planned to aid the instructor in developing a more complete course of study in order to give the student an understanding of some of the tools, materials, processes, products, occupational opportunities, requirement and working conditions that are associated with the metal and metal working industry for intermediate and secondary school students in the state of Missouri. Each teacher using this guide should make adoptations to meet his teaching conditions and classroom facilities.

Consequently, the main purposes of the school then are to provide the knowledge and learning experiences that will prepare the student for his place in modern society. This learning involves stimulating the student’s interest, his creative ability, his productivity, and his development of safe work habits. Since there is an almost universal use of products made of some kind of metal, the school must include for our boys and girls adequate instruction in this field.
POINT OF VIEW AND OBJECTIVES

A principal purpose of American education is to assist each individual in his development as a productive member of society. The achievement of this purpose enables him to provide for his basic needs, to produce more than he consumes, and to contribute more than he receives. It also involves the development of ideals and goals, the acceptance of social responsibility, and the acquisition of desirable character traits.

Behavioral changes within the individual are effected through experiences and the interpretation of these experiences. The experiences provided by the school permit one to acquire the skills and knowledge which allow the individual to develop to his maximum potential with profit to himself and society. The learner's interpretation of these educational experiences provide for the further development of desirable character traits which lead to the wise application of the acquired skills and knowledge.

Industrial arts contributes to the purpose of American education by aiding individuals as they gain an understanding of their industrial-technological environment. In order that each individual may understand and learn to exercise some control over this environment, experiences in industrial arts must be an integral part of the overall educational program for all students, both boys and girls, and should be available at all grade levels. The importance of this experience is recognized in Missouri where credit in the practical arts, which includes industrial arts, is a secondary school graduation requirement.

Industrial arts education provides an opportunity for individuals to participate in direct experiences involving industrial skills and processes which foster an awareness of industry in American culture. These experiences are concrete, meaningful, and educational as they aid the individual in understanding abstract ideas. These experiences provide opportunity for an individual to apply mathematics, science, art, language arts, and other school subjects in purposeful situations.

Through the application of grouping and special instructional techniques, industrial arts in the secondary school can be organized to meet the needs of students of varying abilities. Individuals expecting to enter professional occupations as well as future industrial workers should benefit from industrial arts experiences. The need for industrial arts instruction has little relationship to the economic status of the student. Every person must be aware of and familiar with the concepts taught in industrial arts education if he is to live effectively in our industrial society.

Industrial arts education aids in the discovery and development of personal interests, aptitudes, creative thinking and technical abilities. Responsible and resourceful actions and judgements are matured through problem solving and self-expression in an environment related to industry. The future scientist or engineer may learn to solve technical problems, and the future technician or craftsman may develop skills and related understandings in industrial arts courses.

Realistic objectives, clearly stated, are essential to a sound program of industrial arts education. The following statements of purpose are fundamental to quality industrial arts education as it provides opportunities for students to:

- Develop an insight and understanding of tools, machines, materials, and processes as they relate to the production and servicing aspects of industry.

The field of industrial arts education is concerned with the study of materials and processes of industry and the creative use of design. Students of industrial arts education have an opportunity to gain a better understanding of mass production, automation, and other industrial methods if they actively participate in meaningful experiences dealing with the manufacturing of consumer goods, utilization and generation of energy as well as the servicing, testing, and repairing of industrial products.
Discover and develop abilities, aptitudes, and interests related to the technical pursuits and applied sciences.

Opportunities for students to have experiences which assist in the discovery of abilities and to develop their potentialities to the fullest is essential to the basic education of all youth. Allowance for differences of abilities, interests, and needs should be incorporated into the curriculum offerings so the student can better assess his abilities and interests for making an occupational choice, understanding his environment, and preparing himself to meet the changing demands of a technological society.

Develop basic skills in the safe and proper use of industrial materials, tools, machines, and processes.

Students are provided with experiences which help them develop basic skills relevant to industrial production: and servicing through these experiences, students gain a basis for making occupational choices. In addition, the skills provide a basis for a specialized occupational preparation. Many workers of the future will be required to train and retrain for different occupations during their lifetime. Fundamental skills and knowledge in diversified areas is most essential if this retraining is to be accomplished in an efficient manner.

Develop problem-solving and creative abilities relating to the tools, machines, materials, processes, and products of industry.

The industrial arts education program provides opportunities for solving various types of technical problems through experimentation and research as well as project planning and construction. The industrial arts laboratory setting provides an environment which makes possible a concrete, understandable approach to teaching problem-solving and critical thinking. Problem-solving in industrial arts education involves creative thinking and provides experiences which allow students to find solutions to problems and to evaluate the effectiveness of these solutions.


Legislative Consideration

The definition of vocational education in Federal legislation was supplemented to include industrial arts education in 1973. The Federal Register, Vol. 38 No. 244-Wednesday, Nov. 21, 1973, carries the rules and regulations for this legislation. More specifically these rules and regulations indicate that industrial arts educational programs shall be designed to:

"(i) Assist individuals in making of informed and meaningful occupational choices.

(ii) Prepare individuals for enrollment in advanced or highly skilled vocational and technical educational programs."

Both of these objectives are included in the previously stated objectives quoted from the Handbook for Industrial Arts Education.
LEVELS OF METALWORKING
LEVEL I - EXPLORING

This is recommended basic or beginning level for industrial arts activities in most schools and usually encompasses grades six, seven, eight and nine. At this level, metalworking experiences are a part of basic exploratory industrial arts offerings and normally should not be taught as a separate content. These experiences should be approached from the standpoint of their usefulness as information of an industrial area involved in the total experiences of this level. Hence, little formal metalworking would be done aside from that which may be needed in the understanding and development of exploratory activities of the course.

As a result of activities involved in Level I metalworking, each student should be able to:

1. Secure broad basic experiences in the fundamentals of metalworking tools and machines and processes used in the metalworking industries.

2. Obtain a knowledge of what occupational opportunities are available in the metalworking industry.

3. Gain exploratory experiences in metalworking processes in order to build a fund of knowledge on which an intelligent occupational choice may be made.

4. Gain knowledge of types of work a metalworker may do, and identify industries in which these activities may be employed.

5. Read, interpret, and make simple sketches that are descriptive of objects to be made in a school shop.

6. Select wisely, care for, and use properly the various products made of metal.
BASIC METALWORKING TECHNOLOGY
LEVEL II

Following the Level I experience and usually beginning around grade nine or ten, the Level II metalworking experiences are built upon the exploratory and basic experiences provided at Level I. The term "General Metalworking" is often used to describe this level, thus indicating a broad and basic approach to the field.

Level II industrial arts courses are generally considered to be elective courses. Although usually offered as a single course, metalworking at this level should serve the varied needs, interests, and abilities of students who wish to enroll.

Major emphasis at this level should be placed on the basic principles, skills, and terminology of metalworking. Opportunities for exploratory experiences in many of the specialty areas or fields of metalworking should be provided.

As a result of experiences at this level, students should be able to:

1. Demonstrate work habits and attitudes that will enable students to live as productive, cooperative, and intelligent citizens.

2. Assess one's personal assets and liabilities as related to those required in many metalworking occupations.

3. Identify and describe the career opportunities by special families of occupations relating to different metalworking industries; including pre-service and in-service preparation opportunities, entry and advancement opportunities and requirements, working conditions, and life style of persons employed in these industries.

4. Use basic tools, procedures, and materials of several metalworking industries to gain an understanding of the families of occupations of the several metalworking industries.

5. Demonstrate consumer knowledge and appreciation of the materials, products, tools, workmanship and design of the products of the modern metal industry.
ADVANCED METALWORKING TECHNOLOGY
LEVEL III

Level III metalworking courses are advanced offerings which are built upon and should be preceded by the Level II metalworking experiences. In addition to serving as an extension or continuation of competencies developed at Level II, courses at this level should provide in-depth experiences in a rather specialized phase or area of metalwork such as machining metals, materials testing, foundry, welding, bench metalwork, and sheet and art metalwork. Since the primary purpose of this level is to meet the more unique interests and needs of the individual, it may be necessary for some schools which have limited enrollment at this level to provide for a selection of specialized metalwork experiences in a single course.

As a result of experiences in metalworking at this level, students should:

1. Be able to demonstrate proficiency in the use of metalwork equipment used in a specialized metalworking field to the extent which represent solutions to problems that are accurate and complete, encountered in that area.

2. Apply the concepts of skill, accuracy, and systematic planning related to the metalworking problems.

3. Improve or increase his knowledge of the technical content associated with the specialized areas of metalwork.

4. Become aware of the need for continued improvement and development of the individual for advancement.

5. Improve problem solving and creative abilities.

6. Increase his knowledge of the occupational information related to the several metalworking areas.

7. Continue to evaluate his personal characteristics and aspirations as they relate to probable success in metalworking occupations.

8. Continue to develop consumer knowledge and appreciation of the products of the metals industry in their wise selection, care, and use.
SPECIALIZED METALWORKING TECHNOLOGY
LEVEL IV

Since the role of industrial arts at this level is to meet the specialized needs of youth, a specific standardized metalworking program cannot be prescribed that would be equally relevant and appropriate in all senior high schools. In general, emphasis should be placed on the development of additional specific metalworking skills and techniques where necessary and upon the technical knowledge associated with the respective areas.

Research and development activities or the development of creative and problem solving abilities should receive major attention at this level. Familiarization with occupational requirements, procedures, practices, standards, etc. would be of much significance to students whose occupational interests are related to metalworking.

In addition to occupationally oriented metalworking courses, offerings at this level may also serve as extended study for students with special interests and be directed to the needs of groups representing cross disciplines within the school. Students interested in welding, foundry, machining of metals, sheet or art metal-work may find interest in a course related to specialized metalworking technology. Potential engineers or mechanical designers may wish to study specialized topics related to the testing of different materials and observing strength factors. Potential architects may profit from activities related to characteristics of various metals. Construction enthusiasts may wish to work with architectural models and structural design techniques using metal for strength. Student behavioral objectives at this level will vary with the type of courses offered.
ACTIVITIES COMMON TO ALL METALWORK

This curriculum guide and the material relating to metalwork and the metal industries is intended for use as a guide by teachers and administrators preparing Industrial Arts Curriculums on the junior high and senior high school levels. In many cases this will be the student's first formal opportunity for experiences in this area. It is important, therefore, that these experiences be such that his interest is awakened and his curiosity aroused, and that he be given an opportunity for exploratory manipulative experiences with as many tools, materials, and processes as his maturity and ability may warrant.

While some degree of uniformity in Industrial Arts programs is desirable, it is recognized that this may not always be possible. This guide is therefore prepared with a certain amount of flexibility in mind. Instructors may achieve this flexibility by varying the emphasis placed on certain units of instruction and by varying the degree and kinds of student experiences in these units. Instructors desiring greater emphasis in one area of metalwork than another will find sufficient material in this guide to meet their needs.

While sequence of instruction units and course content is often a matter of individual preference, it is felt that this guide is so arranged as to enable the instructor to direct the student activities in a meaningful and logical manner. The experiences are arranged to show the suggested levels each can introduce to allow for progression from the more elementary to the advanced activities, with each element of learning laying foundation of knowledge for each succeeding element of learning.

SPECIFIC OBJECTIVES

FOR EXPLORING METALWORK AND THE METALS INDUSTRY

To gain some basic experiences with the fundamentals of metalworking tools and machines and metal working processes commonly used in the metals industry.

To gain some insight into the metalworking industries and some of their contributions to our civilization and importance to our society.

To acquire the ability to interpret drawings and perform the necessary operations to complete a metalworking job assigned.

To provide an opportunity for discovery and exploration of personal interests and aptitudes in those activities relating to the metalworking industries.

To gain knowledge about the many occupational opportunities to be formed in the metals industries.

To develop the ability to recognize good design and craftsmanship as it relates to sound consumer knowledge in the selection, care, and use of metal tools and products of metals.
PART I
ACTIVITIES COMMON TO ALL METALWORK
AN OUTLINE

I. GENERAL INFORMATION
   A. Planning
      1. Working Drawings
      2. Bill of Materials
      3. Plan of Procedure
   B. Industry vs Education
   C. Career Opportunities in Metal Industries
   D. Safety

II. COMMONLY USED METALS
   A. Ferrous Metals
      1. Cast Iron
      2. Wrought Iron
      3. Steel
         a. Low Carbon
         b. High Carbon
         c. Alloy Steel
   B. Production Furnaces
      1. Blast
      2. Open Hearth
      3. Electric
      4. Bessemer Converter
      5. Basic Oxygen Process
   C. Steel Identification
      1. AISI-SAE Numbers
2. Spark Test
3. Color Code
4. Available Shapes

D. Non-Ferrous Metals
1. Aluminum and Aluminum Alloys
2. Base Metals--Copper-Tin-Nickel-Lead-Zinc
3. Alloys--Brass-Bronze-Pewter-Gar Alloy-Nickel-Silver, etc.
4. Precious Metals--Gold-Silver-Platinum
5. Available Shapes

E. Space Age Metals
1. Titanium
2. Beryllium
3. Columbium
4. Tantalum
5. Tungsten Alloys

III. ABRASIVES
A. Kinds of Abrasives
1. Natural
2. Synthetic

B. Grain Size
1. Wire Mesh
2. Silk Screen

C. Coated Abrasives
1. Bond
2. Backing--Paper-Cloth-Fiber
3. Shapes--Sheets, Belts, Disc, Spiral Bands, Cone, Strip Felt Drum, Flat Wheel

D. Grinding Wheels
IV. FASTENERS

A. Threaded
   1. Kinds of Bolts
   2. Nuts
   3. Washers

B. Non-threaded Fasteners
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   2. Cotter Pins
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   5. Keys

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#### I. GENERAL INFORMATION

**A. Planning**

1. **Working Drawings**
   - Study several working drawings of different metal projects.
   - Make a simple working drawing.

2. **Bill of Materials**
   - Complete a bill of material. List materials used, calculate costs of parts used as well as finish, abrasives, and hardware.

3. **Plan Procedures**
   - Complete steps of procedure for a project.

**B. Industry vs Education**

**C. Career Opportunities In Metals Industries**

**D. Safety**

**II. Commonly used metals**

**A. Ferrous Metals**

List characteristics and properties of workable metals and alloys.

Discuss and present design concepts through: Working Drawings, Elements of Design, Materials Use (Filmstrip: 2)

Discuss various parts of bill of materials and the reason for each.

Discuss procedure of constructing projects, bench procedures, machine procedures.

Discuss relationship of work in metals lab with industrial procedures.

Students report to class of different metal industry occupations. (U.S.B.L.S.-Occ. Outlook)

Demonstration and discuss on safety procedure of each machine used in metals lab. (Film: 8; 14; 19) (Pamphlet: 6) (Filmstrip: 3)

Discuss mining procedures for production of common metals from raw form to finish product.
Identify the various types of steels used in making the machinery and tools used in the metals lab.
Show shapes of ferrous metals and where best to use each.
(Film: 9; 11: 2)

B. Production Furnaces

List kinds of ferrous metal found in the metals lab.

List the procedures used by different production furnaces.

Identify main parts of different types of production furnaces.

Discuss smelting procedures used by different types of production furnaces and projects.

Discuss types of alloys most often made from each type furnace used in U.S. production.

Discuss AISI-SAE identifying numbers.
Make a display chart showing the metal number systems and the colors that identify each kind of metal.

Discuss the Aluminum alloy numbering system.
(Pamphlet: 1)

Discuss base metals and common alloy.
Collect and display extruded metal shapes and identify the use made of each.

Discuss some of the metals referred to as "Space Age Metals." Identify some of the characteristics that make them important.

E. Space Age Metals

List some of the metals called "Space Age Metals."

C. Steel Classification Numbers

Describe what SAE and AISI steel numbers mean.
List commonly used steels by SAE or AISI number.

D. Non-Ferrous Metals

Report on the effect of each element added to total Aluminum Alloy. Compare alloying elements used in steel and aluminum alloys of base metals.

List of some of the metals called "Space Age Metals."

Identify the carious types of steels used in making the machinery and tools used in the metals lab.
### ACTIVITIES COMMON TO METALWORK

<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
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<td>III. ABRASIVES</td>
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<td>C. Coated Abrasives</td>
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<td>D. Grinding Wheels</td>
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### IV. FASTENERS

#### A. Threaded

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- Fasten sheet metal with screws.

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- Fasten metal with cap screws, machine screws and bolts.

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- Call the local hardware store and find out why fasteners have different finishes.

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- Determine which fastener will be needed for each project you make in the metals lab.

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- Become familiar with procedures for drilling holes to receive bolts and sheet metal screws.

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- Collect different kinds of lock washers, name each one and decide where it might best be used.

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- Become familiar with the many non-threaded fasteners.

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- Find samples of non-threaded fasteners used in the metals lab and indicate why you think each one was used in its particular position.

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- Rivet sheet metal. Form a rivet head with a ball peen hammer—with a rivet set.

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- Fasten sheet metal with "pop" rivets.

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- Use a display board of different fasteners made of different kinds of metal. Label each.

  (Bolts, nuts, screws, and washers)
  (Pamphlet: 3)

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- Discuss use of different types of threaded fasteners, finishes, and shapes.

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- Discuss methods of specifying fasteners.

  (Bolts, nuts, screws, and washers) (Film: 17)

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- Discuss how to determine correct sizes of screws, bolts, nuts, and washers for particular jobs.

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- Discuss when and where dowel pins, retainer ring, rivets, and keys should be used.

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- Collect and display non-threaded fasteners. Label each with common names.

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- Demonstrate preparation and use of rivets, with rivets and hammer.

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- Discuss size and shape of common keys for shafts, wheels, etc.
# Activities Common to Metalwork

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<tr>
<th>COURSE CONTENT</th>
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<tr>
<td><strong>C. Adhesives</strong></td>
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<tr>
<td><strong>V. Metal Finishes</strong></td>
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<td><strong>A. Reasons for finish</strong></td>
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<td><strong>B. Surface preparation</strong></td>
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<td><strong>C. Mechanical Finishing</strong></td>
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<tr>
<td><strong>D. Chemical Finishes</strong></td>
<td>Try a wire wheel finish using different size wire. Determine if finer wire or heavier wire produces the kind of finish you want.</td>
<td>Try a wire wheel finish using different size wire. Determine if finer wire or heavier wire produces the kind of finish you want.</td>
<td>Try a wire wheel finish using different size wire. Determine if finer wire or heavier wire produces the kind of finish you want.</td>
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<td>Sand blast an aluminum casting before applying the finish.</td>
<td>Sand blast an aluminum casting before applying the finish.</td>
<td>Sand blast an aluminum casting before applying the finish.</td>
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<td><strong>E. Organic Finishes</strong></td>
<td>Identify several chemical solvents for different chemical finishes.</td>
<td>Identify several chemical solvents for different chemical finishes.</td>
<td>Identify several chemical solvents for different chemical finishes.</td>
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<td><strong>F. Application</strong></td>
<td>Apply organic finish to a metal surface.</td>
<td>Apply organic finish to a metal surface.</td>
<td>Apply organic finish to a metal surface.</td>
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<td><strong>G. Drying</strong></td>
<td>Use several metal finish applications available to you in the metals lab.</td>
<td>Use several metal finish applications available to you in the metals lab.</td>
<td>Use several metal finish applications available to you in the metals lab.</td>
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<td>Protect finish while drying. Spray several samples of metal with hammertone and wrinkle finish. Let some air dry and some dry in an oven. Note the difference.</td>
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<td>Protect finish while drying. Spray several samples of metal with hammertone and wrinkle finish. Let some air dry and some dry in an oven. Note the difference.</td>
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**Demonstrate different sizes and kinds of wire wheels.**

**Discuss and demonstrate proper care of finish equipment. Stress eye safety.**

**Discuss and demonstrate when possible: hot dipping, anodizing, electroplating, and metal spraying.**

**Discuss appropriate organic finishes for different metals.**

**Identify and discuss the different metal finish applicators and procedure commonly used.**

**Discuss metal finish drying procedures.**
A. TEXT AND REFERENCE BOOK FOR ACTIVITIES COMMON TO METALWORK


B. FILMS FOR ACTIVITIES COMMON TO METALWORK

2. A Product of the Imagination - 26 min. - Dept. of Interior
3. Better Off-Hand Polishing with Coated Abrasive Belts - Behr Manning
4. The Blast Furnace for Procuting Pig Iron - 7 min. - U.S. Steel Corp.
5. Cast Iron-Biography of a Metal - 27 min. - Dept. of Interior
6. Chemistry of Aluminum - 16 min. - Reynolds Aluminum Co.
7. Chemistry of Iron and Steel - 14 min. - U.S. Steel Corp.
8. Don't Push Your Luck - 20 min. - Fend All
9. Drama of Metal Forming - 28 min. - Shell Oil Co.
10. The Electric Arc Furnace - 7 min. - U.S. Steel Corp.
11. Hot Rolling of Steel Sheets - 7 min. - U.S. Steel Corp.
12. Manufacture of Modern Coated Abrasives - Behr Manning Co
15. Modern Steel Making - 23 min. - U.S. Steel Corp.
16. The Open Hearth Furnace - 7 min. - U.S. Steel Corp.
17. Parts From Wire - National Machinery Co.
18. Research in Steels - 28 min. - U.S. Steel Corp.
19. School Shop Safety - 14 min. - BFA
20. Steel and America - 28 min. - American Iron and Steel Institute
21. Steel Making Today - 29 min. - Dept. of Interior
22. The Washington Steel Story - Washington Steel
C. FILMSTRIPS WITH SOUND FOR ACTIVITIES COMMON TO METALWORK

1. America Grows with Iron and Steel - AISI
2. An Introduction to the Metal Shop - RMI
3. Safety in the Metal Shop - RMI

DISTRIBUTOR ADDRESS:
RMI Film Productions, 4916 Main Street Kansas City, Missouri 64112

D. PAMPHLETS FOR ACTIVITIES COMMON TO METALWORK

1. Aluminum Standards and Data - Aluminum Association
2. Career Opportunities for High School Graduates - Jones and Laughlan
3. Fasteners, What They are and How They are Used - Caterpillar
4. Mechanical Properties and Test - A to Z - Tinius Olsen
5. The Picture Story of Steel - AISI
6. Safety First in Steel - AISI

DISTRIBUTORS ADDRESSES:
Aluminum Association, Publications Dept., 750 Third Avenue, New York, New York, 10017
AISI - American Iron and Steel Institute, 150 East Forty Second Street, New York, New York, 10007
Caterpillar Tractor Co., 100 N. E. Adams St., Peoria, Illinois, 61612
Jones and Laughlan Steel Co., 3 Gateway Center, Pittsburgh, Pa., 15230
Tinius - Olsen Testing Machine Co., Easton Road, Willow Grove, Pa., 19090

E. CHARTS FOR ACTIVITIES COMMON TO METALWORK

2. Safety Charts - 8x11 - Clausing

DISTRIBUTORS ADDRESSES:
Clausing, 2019 N. Pitcher, Kalamazoo, Michigan, 49001
PART II
ART METAL

1. GENERAL INFORMATION

   A. Safety
   B. Principles and Elements of Design
   C. Kinds of Metals
      1. Aluminum
      2. Brass
      3. Copper
      4. Pewter
   D. Material Cost
   E. Planning
      1. Development and Layout
      2. Layout Tool
      3. Template-Pattern
   F. Cutting and Filing
   G. Hammers
   H. Stakes--Stake Plate
   I. Annealing
      1. Work Hardened
      2. Quick Cooling
      3. Slow Cooling
   J. Pickeling
      1. Acid-Water Solution
II. HAND FORMING

A. Holding and Forming Jigs

B. Metal Tooling
   1. Work Over Hard Surface
   2. Work Over Soft Surface
   3. Metal Foil
      a. Aluminum -- Copper

C. Beating Down
   1. Formed Wood Block
   2. Forming Hummer
   3. Forming Block
   4. Wooden Mallets

D. Low and High Raising
   1. Wood End Grain
   2. Metal Stake
   3. Sand Bags
   4. Raising Hammer

III. SURFACE SHAPING

A. Fluting

B. Scalloping

C. Chasing or Repousse

IV. SURFACE DECORATION

A. Peening
   1. Peen Hammer
   2. Stake

B. Saw Piercing
   1. Jewelers Saw
   2. Jewelers File
C. Overlaying
   1. Overlay Design
   2. Design Transfer
D. Doming and Dapping
   1. Dapping Block and Punches
   2. Ball Peen and Pipe
   3. Wood Form
E. Engraving
   1. Engraving Tools
F. Etching
   1. Etching Solution
   2. Etching Resist
G. Buffing and Polishing
   1. Types of Abrasives
   2. Buffing Wheels
H. Metal Enameling
   1. Transparent
   2. Opaque
   3. Overglaze
I. Color Finishing

V. FASTENING
A. Solder
   1. Soft
   2. Hard
B. Fluxes
C. Heat Sources
D. Cementing
E. Riveting
VI. MACHINE FORMING

A. Spinning

B. HERF--High Energy Rate Form

C. Stamp Forming
## PART II - ART METAL

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<td>H. HAND FORMING</td>
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<tr>
<td>A. Holding &amp; Forming Jigs</td>
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<td>B. Metal Tooling</td>
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<td>C. Beating Down</td>
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<td>D. Low and High Raising</td>
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<td>III. SURFACE SHAPING</td>
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<td>IV. SURFACE DECORATION</td>
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<td>A. Peening</td>
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<td>B. Piercing</td>
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<td>C. Overlaying</td>
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<td>D. Doming and Dapping</td>
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<td>E. Engraving</td>
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<td>F. Etching</td>
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<tr>
<td>G. Buffing</td>
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## PART II - ART METAL

<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
<th>STUDENT ACTIVITIES</th>
<th>TEACHING ACTIVITIES</th>
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<tbody>
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<td>I</td>
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<td>III</td>
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<tr>
<td><strong>V. FASTENING</strong></td>
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<tr>
<td>A. Soldering</td>
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<tr>
<td>B. Fluxes</td>
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<td>C. Heat Sources</td>
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<td>D. Cementing</td>
<td>X</td>
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<tr>
<td>E. Riveting</td>
<td>X</td>
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<tr>
<td><strong>VI. MACHINE FORMING</strong></td>
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<tr>
<td>A. Spinning</td>
<td>X</td>
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<td>B. H.E.R.F.</td>
<td>X</td>
<td>X</td>
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<tr>
<td>C. Stamp Forming</td>
<td>X</td>
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</tbody>
</table>
FILMS FOR ART METAL

1. Decorative Metal Work - Brandon Films

2. Metal Craft - Bureau Of Audio Visual Instruction

DISTRIBUTOR ADDRESSES

Brandon Films, Inc., 200 West 57th St., New York, New York, 10019

Bureau Of Audio Visual Instruction, 131 Livingston Street, Brooklyn, New York, New York, 1201
PART III
BENCH METALWORK

I. NON-EDGE BENCH TOOLS
   A. Hammers-Mallets
   B. Screwdrivers

II. CLAMPING TOOLS
   A. Clamps
   B. Vises

III. CUTTING BENCH TOOLS
   A. Chisels
   B. Shears
   C. Files
   D. Hack Saw

IV. ASSEMBLY TOOLS
   A. Wrenches
   B. Pliers

V. MEASURE AND LAYOUT TOOLS
   A. Measuring Tools
      1. Rules
      2. Calipers
      3. Squares
   B. Layout Tools
      1. Layout Dye
      2. Punch
      3. Scriber
      4. Divider
      5. Surface Plate
VI. DRILLS
   A. Sizes
   B. Drill Nomenclature
   C. Care and Use
   D. Types of Drills
   E. Speeds and Feeds
   F. Drilling Tools
   G. Work Holding Tools
   H. Safety

VII. SCREW THREADS
   A. Terminology
   B. American Standard Thread Series
   C. Thread Lubricant
   D. Thread Fits
   E. Thread Types
   F. Thread Sizes
   G. Screw Plate
      1. Taps and Tap Wrench
      2. Dies and Die Stock

VIII. WROUGHT IRON (LOW CARBON STEEL)
   A. Wrought Metal Design
   B. Bending and Twisting Methods
   C. Fastening Wrough Metal
### PART III - BENCH METALWORK

<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
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<tr>
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<td>I</td>
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<tr>
<td>I. NON-EDGE BENCH TOOLS</td>
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<tr>
<td>A. Hammers &amp; Mallets</td>
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<tr>
<td>B. Screw Drivers</td>
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<tr>
<td>II. CLAMPING TOOLS</td>
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<td>III. CUTTING TOOLS</td>
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<tr>
<td>A. Chisels</td>
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<td>B. Shears</td>
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<td>I    II   III  IV</td>
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<tr>
<td>C. Files</td>
<td>x    x    x</td>
<td>Identify a file by length, shape &amp; cut.</td>
<td>Discuss file terminology, shape &amp; cut.</td>
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<tr>
<td></td>
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<td></td>
<td>Demonstrate proper and safe use and care of hand files.</td>
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<td></td>
<td></td>
<td>Clean a file with a file card.</td>
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</tr>
<tr>
<td>D. Hacksaws</td>
<td>x    x    x</td>
<td>Fit a frame with a new blade.</td>
<td>Demonstrate proper use and care of hacksaws and blades.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cut metal properly with a hacksaw.</td>
<td>Discuss hacksaw blades use and care.</td>
</tr>
<tr>
<td>E. Hacksaws [cont.]</td>
<td>x    x    x</td>
<td>Select a hacksaw blade for a particular job.</td>
<td>Identify how blades are specified.</td>
</tr>
<tr>
<td>IV. ASSEMBLY TOOLS</td>
<td>x    x    x</td>
<td>Fasten nuts with a wrench.</td>
<td>Discuss types of box end and open end wrenches commonly used in work. (Films: S. 11. 14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use the torque wrench to tighten nuts or stud bolts to a given setting.</td>
<td>Demonstrate proper use and care of different types of wrenches.</td>
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<td></td>
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<td>Demonstrate the efficiency in using sockets and ratchet wrenches.</td>
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<tr>
<td></td>
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<td></td>
<td>Discuss the different layout and measuring tools commonly used in bench metal work.</td>
</tr>
<tr>
<td>V. MEASURE AND LAYOUT TOOLS</td>
<td></td>
<td></td>
<td>Demonstrate proper use of several measuring and marking tools.</td>
</tr>
<tr>
<td>A. Measuring Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Rules</td>
<td>x    x    x</td>
<td>Measure a distance with a ruler to the nearest 1.64 inch.</td>
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<tr>
<td></td>
<td></td>
<td>Use a circumference rule to layout a sheet metal pattern.</td>
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</tbody>
</table>
### B. Layout Tools

<table>
<thead>
<tr>
<th>1. Layout Dye</th>
<th>x</th>
<th>x</th>
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</thead>
<tbody>
<tr>
<td>Mark dyed surfaces with divider, punches and scriber.</td>
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<tr>
<td>Use the divider and/or trammel points to lay out all arcs and circles.</td>
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</table>

### VI. DRILLS

<table>
<thead>
<tr>
<th>A. Sizes</th>
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<tbody>
<tr>
<td>Determine the size of a drill bit with a drill gauge.</td>
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<tr>
<td>Identify different parts of a drill bit and explain the function of each.</td>
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<table>
<thead>
<tr>
<th>B. Drill Nomenclature</th>
<th>x</th>
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</thead>
<tbody>
<tr>
<td>Properly sharpen a drill bit to drill a particular metal.</td>
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<tr>
<td>Study several ways a drill can be incorrectly ground and check the drills in the metal lab for these problems.</td>
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<table>
<thead>
<tr>
<th>C. Care and Use</th>
<th>x</th>
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<tbody>
<tr>
<td>Drill a blind hole.</td>
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<tr>
<td>Counterbore to a depth.</td>
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<tr>
<td>Counter sink a hole to receive a flat head cap screw.</td>
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<thead>
<tr>
<th>D. Types of Drills</th>
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<tbody>
<tr>
<td>Drill a blind hole.</td>
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<tr>
<td>Counter sink a hole to receive a flat head cap screw.</td>
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</table>

- **Adjust caliper to inside and outside dimensions or measurements.**
- **Layout angles and squares with the combination set.**
- **Use layout dye and locate drill positions and draw parallel lines on metal objects.**
- **Demonstrate many ways to use the combination square.**
- **Discuss layout dyes.**
- **Demonstrate application of dyes on metals. (Films: 5, 8, 9)**
- **Demonstrate the use of all layout tools.**
- **Discuss different drills, purpose, use, and sizes. (Film: 12, 13)**
- **Explain why a larger drill will not start its own hole.**
- **Discuss drill procedures involving pilot holes, counter boring and counter sinking, etc. (Filmloops: Series)***
### PART III - BENCH METALWORK

<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
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<tbody>
<tr>
<td>E. Speed and Feeds</td>
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<tr>
<td>F. Drilling Tools</td>
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<tr>
<td>G. Work Holding Tools</td>
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<tr>
<td>H. Safety</td>
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<td>VII. SCREW THREADS</td>
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</table>

#### E. Speed and Feeds
- Adjust variable speed equipment to match drill size to kind of metal being drilled.
- Use lubricants to extend use of a drill bit.

#### F. Drilling Tools
- Use a portable drill and a drill press to drill holes in steel plate.

#### G. Work Holding Tools
- Hold and drill holes in sheet metal.
- Hold and drill holes in round stock.

#### H. Safety
- Follow safe work procedures while drilling and working with metal.

#### VII. SCREW THREADS

<table>
<thead>
<tr>
<th>A. Terminology</th>
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#### Demonstration and Discussion
- Demonstrate use of drill charts. Discuss feeds and speeds need to drill holes in metal.
- Demonstrate proper and safe use of portable and stationary drilling machines (Charts: 1, 2).
- Demonstrate use of drill press vise, v-block set and other holding fixtures.
- Demonstrate and discuss safe work procedures with several shapes of metal.

#### A. Terminology
- Identify the size and type of thread found on a bolt.
- Use lubricants and cut threads on round stock pipes and in holes.
- Measure the number of threads on a socket cap screw with a screw pitch gauge.
- Discuss screw threads, size, shapes, and terminology. (Film: 10.12)
- Demonstrate proper use and care of screw thread tools.
- Show how to read a tap drill chart.
Bend, twist, shape and fasten metal hands.

Bend a scroll by hand and then with a universal bender and compare the effort and the end product.

Discuss wrought iron, wrought iron work, and the metal and designs used in the work. (Film: 6.7)

Demonstrate the several shapes that can be formed on different bending machines.
A. FILMS FOR BENCH METAL WORK

1. A B C of Hand Tools Part I and II - General Motors Corp.
2. A Question of Time - Simonds Saw
3. Chisels and Hammers - 15 min. - Modern Talking Picture Service
5. Hand Tool for Metal Working - 25 min. - BFA
6. Hand Tool Workers - General Motors Corp.
7. It's Easy to Bend - 17 min. - Diarco Corp.
8. Layout Tools for Metal Work - 13 min. - Sterling
9. Punches, Drifts, Bars, and Hacksaws - 32 min. - Modern
10. Rolling for High Production - 28 min. - Cleveland Twist Drill Co.
11. Tap-o-Matic - 13 min. - Pratt and Whitney
12. Threading Time - 24 min. - Geometric Tool Co.
13. Use and Care of Twist Drills - 23 min. - Cleveland Twist Drill Co.
14. Wrenches, Pliers, and Screwdrivers - 37 min. - Modern

16mm FILM DISTRIBUTORS FOR BENCH METAL WORK

1. BFA Educational Media, 2211 Michigan Ave., Santa Monica, California 90404
2. Cleveland Twist Drill Co., P.O. Box 6656, Cleveland, Ohio 44101
3. Diarco Corp., 300 Eighth Ave., Lake City, Minn.
4. General Motors Corp., Public Relations Dept., 1775 Broadway, New York, New York 10019
5. Geometric Tool Co., One Valley Street, New Haven, Connecticut 06515
6. Heller Tool Co., Heller Drive, Newcomerstown, Ohio 43832
7. Modern Talking Picture Service, Swank Motion Pictures Inc. 201 S. Jefferson. St. Louis, Mo. 63103
9. Simonds Saw and Steel Co., 3323 West Addison St., Chicago, Ill. 60618
10. Sterling Educational Films, 241 E. 34th St., New York, New York, 10016
B. FILMSTRIPS WITH SOUND FOR BENCH METAL WORK

1. Bench Metal Work - RMI
2. The Crib Foreman's Assignment - RMI

RMI Film Productions, 4916 Main St., Kansas City, Missouri 64112

C. CHARTS FOR BENCH METAL WORK

1. Decimal Equivalents and Tap Drill Sizes - 23x28 - Starrett
2. Tap Drill Sizes - 13x17 - South Bend

South Bend Lathe Co., 500 W. Sample St., South Bend, Indiana 46623
Starrett Tool Co., 1001 Crescent St., Athol, Massachusetts 01331

D. PAMPHLETS FOR BENCH METAL WORK

1. File Philosophy - Nicholson

Nicholson File Co., Providence, Rhode Island 02904
E. FILM LOOPS FOR BENCH METAL WORK

DRILL PRESS SERIES (10 COLOR LOOPS) - Veva-Brett Visual Aid Service

1. Counterboring On The Drill Press
2. Countersinking On The Drill Press
3. Drawing The Drill Back To Center
4. Drill In Flat Stock
5. Drilling A Blind Hole
6. Drilling Large Holes On Drill Press
7. Drilling Through The Center Of Round Stock
8. Introducing The Drill Press
9. Reaming On The Drill Press
10. Starting A Tap In The Drill Press

Veva-Brett Visual Aid Service, 7821 Big Bend Blvd., Webster Groves, Mo. 63119
PART IV
METALWORK FORGING PRACTICES

I. SAFETY
   A. Clothing
   B. Eye Protection
   C. Furnace Safety Valves

II. SOURCES OF HEAT
   A. Furnaces

III. FORGE TOOLS
   A. Tongs
   B. Hammers
   C. Anvils
   D. Forge Metals

IV. FORMING HOT METALS
   A. Kinds of Forming

V. INDUSTRIAL FORGING
   A. Die Forging
   B. Drop Forging
   C. Press Forging
   D. Pneumatic Hammer

VI. EMPLOYMENT OPPORTUNITIES
## PART IV - FORGING

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<tr>
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<tbody>
<tr>
<td>I. SAFETY</td>
<td>x x</td>
<td>Learn and observe safe procedures for handling hot metal.</td>
<td>Demonstrate and discuss safety procedures to be observed when lighting the forge furnace, heating metal, and holding for forging.</td>
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<tr>
<td></td>
<td>x x</td>
<td>Protect your clothes, hands, face, eyes and hair when forging hot metals.</td>
<td>Make available clothing and protection devices needed to work with hot metals.</td>
</tr>
<tr>
<td>II. SOURCES OF HEAT</td>
<td>x x</td>
<td>Practice exact lighting procedures and adjustments on the forge furnace.</td>
<td>Discuss and demonstrate use and need of safety devices on forge furnaces.</td>
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<tr>
<td></td>
<td>x x</td>
<td>Discuss different sources of heat available for forge work.</td>
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</tr>
<tr>
<td>III. FORGE TOOLS</td>
<td>x x</td>
<td>Hold different shapes of metal with different hammers.</td>
<td>Discuss forge practices and how to hold metal to get best effect from hammer and anvil. (Pamphlet: 4)</td>
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<tr>
<td></td>
<td>x x</td>
<td>Use a hammer and anvil to shape hot metal.</td>
<td>Discuss and demonstrate need, use and sizes of forging tools. (Pamphlet: 5)</td>
</tr>
<tr>
<td>IV. FORMING HOT METALS</td>
<td>x x</td>
<td>Heat mild steel; test shaping ease at different temperatures.</td>
<td>Discuss metal characteristics that lend themselves best to forge practices. (Pamphlet: 1, 2, 3)</td>
</tr>
<tr>
<td>A. Kinds of Forming</td>
<td>x x</td>
<td>Draw, upset, flatten, bend, and punch hot metals.</td>
<td>Demonstrate techniques of shaping hot metal.</td>
</tr>
<tr>
<td>V. INDUSTRIAL FORGING</td>
<td></td>
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<td>Identify open &amp; closed, drop and press forging.</td>
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<td></td>
<td>Discuss different methods of industrial forging.</td>
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<td>Observe the design advantage of forge over machined metal. (film: 1, 2, 4)</td>
</tr>
<tr>
<td>VI. EMPLOYMENT OPPORTUNITIES</td>
<td>x</td>
<td>x</td>
<td>Take a field trip to observe forge operations.</td>
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<td>Discuss forging occupations, working conditions, training needed, and future outlook.</td>
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</tbody>
</table>
A. 16mm FILMS FOR FORGING

1. *Forging in Closed Dies* - 28 min. - Modern Talking Pictures Service

2. *Hands of the Giant* - Manager Market Service

3. *High Energy Rate Forging* - 18 min. - USI Clearing

4. *One How for Kalagoo* - 27 min. - Modern Talking Pictures Service

16mm FILM DISTRIBUTORS FOR FORGING


Modern Talking Pictures Service, Swank Motion Pictures Inc., 201 S. Jefferson St., St. Louis, Missouri 63103

Penn State Visual Aids Lab, Pennsylvania State University, University Park, Penn.

USI-Clearing, 6499 W. 65th St., Chicago, Ill. 60638

B. PAMPHLETS FOR FORGING

1. *Evaluating the Forgeability of Steels* - Timken

2. *Forgeability of Steels* - Timken

3. *Mechanical and Physical Properties of Ferrous Forging* - AISI

4. *Metal Flow for Forging Steel* - AISI

5. *Principles of Forging Design* - AISI

DISTRIBUTORS

American Iron and Steel Institute, 150 East Forty Second St., New York, New York 10017

Timken Roller Bearing Co., 1835 Dueber Ave., Canton, Ohio 44706
PART V
METALWORK FOUNDRY PRACTICES

I. FOUNDRY SANDS
   A. Green Sand
   B. Petro-bond
   C. Facing Sand
   D. Core Sand
   E. Properties of Sand

II. TEMPERING SAND

III. MOLDS
   A. Kinds of Molds
   B. Tools
      1. Flask
      2. Rammer
      3. Spoon and Slick
      4. Spure Cutter
      5. Riddle
      6. Striker

IV. PATTERNS
   A. One Piece
   B. Slip Pattern
   C. Match Plate
   D. Styrofoam
   E. Core

V. FOUNDRY METALS
   A. Ferrous Metals
   B. Non-ferrous Metal
   C. Fluxes
VI. SAFETY
   A. Safety Zone
   B. Clothing

VII. SOURCES OF HEAT
   A. Kinds of Furnaces
   B. Furnace Tools

VIII. INDUSTRIAL FOUNDRY MACHINES
   A. Muller
   B. Core Mixer
   C. Sand Mixer and Rammer
   D. Jolt-squeeze Machine
   E. Sand Strength Tester
   F. Moisture Tester
   G. Electric Perimeter

IX. OCCUPATIONAL OPPORTUNITIES
<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
<th>STUDENT ACTIVITIES</th>
<th>TEACHING ACTIVITIES</th>
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<td>I    II   III   IV</td>
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<tr>
<td><strong>I. FOUNDRY SANDS</strong></td>
<td>x    x    x    x</td>
<td>Identify different kinds of sand and know where to use each type.</td>
<td>Discuss the advantages and disadvantages of different kinds of sand used in foundry practices. (Pamphlet: 1, 2, 3)</td>
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<td>Discuss the several ways industry tests foundry sand.</td>
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<td><strong>II. TEMPERING SAND</strong></td>
<td>x    x    x    x</td>
<td>Mix and cut green sand and temper sand for molding.</td>
<td>Discuss desirable characteristics of foundry sand.</td>
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<td>x    x    x    x</td>
<td>Test sand for proper tempering.</td>
<td>Demonstrate proper procedure and tests for tempering sand. (Film:)</td>
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<td>x    x    x    x</td>
<td>Mix Core sand and binder and harden with heat or CO2.</td>
<td>Discuss foundry cores, core boxes, &amp; core sand binders.</td>
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<td>x    x    x    x</td>
<td>Make a core for a mold.</td>
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<tr>
<td><strong>III. MOLDS</strong></td>
<td>x    x    x    x</td>
<td>Make a green sand mold with sprue, risers, and channels and gates.</td>
<td>Demonstrate ramming a green sand mold.</td>
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<td>Show how to cut channels, gates, risers, and sprue and cup. (Films: 2, 3)</td>
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<td>x    x    x    x</td>
<td>Ask your dentist how he uses investment casting.</td>
<td>Discuss different parts of molds.</td>
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<td>x    x    x    x</td>
<td>Use the ram, riddle to mold a pattern in a flask.</td>
<td>Explain the advantages and reasons for each part. (Filmstrip: 2)</td>
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<td>Patch and repair a mold with a slick and/or spoon.</td>
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<td>x    x    x    x</td>
<td>Cut riser and sprue holders of a mold.</td>
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<td>COURSE CONTENT</td>
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<td>VII. SOURCES OF HEAT</td>
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| VIII. INDUSTRIAL FOUNDRY MACHINES | X | X | X | X | If available use a jolt squeeze machine to ram a mold. |

| IX. OCCUPATIONAL OPPORTUNITIES | X | X | X | X | Visit a foundry and pattern shop. |

Discuss melting and pouring temperatures of different metals.

Discuss the techniques different foundry furnaces use to melt metal for pouring.

Discuss the different foundry machines used in industry for mixing sand, tempering, ramming molds and testing castings. (Film: Mechanized Foundry)

Discuss foundry industry occupations, working conditions, training needs, and future outlook. (Filmstrip: 1)
A. 16mm FILM FOR FOUNDRY

1. Cast Iron - Biography of a Metal - 25 min. - AFS
4. Mechanized Foundry - Foundry Flexibility - 29 min. - Link Belt
5. Metallurgy Plus - Modern Talking Picture Service
6. New Face of a Foundry - General Motors
7. Patternmaking - 20 min. B&W - AFS
8. What About the Small Foundry - Beardsley and Piper

DISTRIBUTORS ADDRESSES
American Foundryman's Society, Golf and Wolf Roads, Des Plaines, Illinois 60016
Beardsley and Piper Div., Pettibone-Mulliken, 5001 W. Grand Ave., Chicago, Illinois 60639
General Motors Corp., Public Relations Dept., 1775 Broadway, New York, New York 10019
Link Belt Div., FMG Corp., Public Relations Dept., Prudential Plaza, Chicago, Ill. 60601
Modern Talking Picture Service, Swank Motion Pictures Inc., 201 S. Jefferson, St. Louis, Missouri 63103
Ralph E. Coe Company, 7 Hopper Street, Utica, New York

B. FILMSTRIP WITH SOUND FOR FOUNDRY

1. Careers in the Cast Metals Industry - Filmstrip I - 20 min. Filmstrip II - 20 min. - AFS
2. How to Make a Sand Mold and a Foundry Casting - RMI

DISTRIBUTORS ADDRESSES
American Foundryman's Society, Golf and Wolf Roads, Des Plaines, Illinois 60016
RMI Film Productions Inc., 4916 Main St., Kansas City, Missouri 64112
C. PAMPHLETS FOR FOUNDRY

1. An Elementary Manual - McEngleman
2. A Glossary of Foundry Terms - Steel Founders Society
3. Petro Bond - Precision Casting with conventional Foundry Equipment - Baroid
4. What Molding Process to Use? American Colloid

DISTRIBUTORS ADDRESSES

1. American Colloid Company, 5100 Suffield Court, Skokie, Illinois 61176
2. Baroid Division National Lead Company, P.O. Box 1675, Houston, Texas 77001
3. McEngleman Heat Treating and Manufacturing Company, P.O. Box 31, Danville, Illinois 61832
4. Steel Founders Society of America, Westview Towers, 21010 Center Ridge Road, Rocky River, Ohio 44116

D. BOOKS FOR FOUNDRY TEXTBOOKS AND/OR REFERENCE


E. SOURCES OF INFORMATION ON METAL CASTING PROCESSES

This list of associations, societies, etc. will prove very helpful to any teacher or student who wishes to look a little deeper into the area of metal casting. Each source has a varied list of films, booklets, charts, etc. concerning the metal casting industry. A letter on school stationary will bring a list of information and services available from any or all of the organizations listed.

Aluminum Association, 420 Lexington Ave., New York, New York 10017
American Die Casting Institute Inc., 366 Madison Ave., New York, New York 10017
American Foundrymen's Society, Golf and Wolf Roads, Des Plaines, Illinois 60016
American Society for Metals, Metals Park, Ohio 44073
Ductile Iron Society, Box 858, Cleveland, Ohio 44122
Foundry Educational Foundation, Terminal Tower Building, Cleveland, Ohio 44122

Gray and Ductile Iron Founders Society Inc., National City-East sixth Building, Cleveland, Ohio 44114

Investment Casting Institute, 3525 W. Peterson Road, Chicago, Illinois 60645

Malleable Founders Society, Union Commerce Building, Cleveland, Ohio 44115

Society of Die Casting Engineers Inc., 14530 West 8 Mile Road, Detroit, Mich. 48237

Steel Founders Society of America, 21010 Center Ridge Road, Rocky River, Ohio 44116
PART VI
HEAT TREATMENT

I. METAL COMPOSITION
   A. Ferrous
      1. Metal Identification Numbers
   B. Non-ferrous

II. SAFETY
    A. Clothes
    B. Equipment

III. TYPES OF FURNACES
    A. Muffle (box) Type
    B. Single and Double Chamber
    C. Sources of Heat
       1. Furnace Power
       2. Furnace Controls
       3. Industrial Furnaces

IV. METAL QUENCHES
    A. Type of Quench
    B. Quench Materials

V. HEAT TREATING PROCESSES
    A. Tempering
    B. Annealing (normalizing)
    C. Case Hardening

VI. HARDNESS TESTING
    A. Degree of Hardness
    B. Test Equipment
VII. INDUSTRIAL APPLICATION
   A. Flame Hardening
   B. Induction Hardening
   C. Case Hardening

VIII. OCCUPATIONAL INFORMATION
   A. Available Job
   B. Occupational Outlook
# HEAT TREATMENT

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<td>VII. OCCUPATIONAL INFORMATION</td>
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A. 16mm FILMS FOR HEAT TREATING

1. *Heat Treatment of Aluminum*--Purdue University
2. *Heat Treatment of Steels*--Ohio State
3. *Making Metals Behave*--Metal Treating Institute
5. *Principles of Heat Treating*--20 min.--Educators Guide

DISTRIBUTORS FOR FILMS

Educators Guide to Free Films, Randolph, Wisconsin 53956
Leeds and Northrup, 4901 Stenton Ave., Philadelphia, Pennsylvania 19144
Metal Treating Institute, 40 Helen Avenue, Box 448, Rye, New York 10580
Ohio State University, Motion Picture Division, 1886 Weld Ave., Columbus Ohio 43210
Purdue University, Visual Aids Bureau, Lafayette, Indiana 47907

B. CHARTS FOR HEAT TREATING


C. PAMPHLETS FOR HEAT TREATING

1. *A Career in Metallurgy Will Extend Your Reach*--ASM
2. *Heat Treatment of Ferrous Forging*--AISI
3. *Principle Alloying Elements in Steel*--U.S. Steel
4. *Water Hardening Tool Steels*--VASOC
DISTRIBUTORS FOR PAMPHLETS

1. American Iron and Steel Institute, 150 East Forty Second St., New York, New York 10017

2. American Society for Metals, Metlas Park, Ohio 44073

3. United States Steel Corp., Chicago Film Distribution Center, 208 S. LaSalle St., Chicago, Illinois 60690

4. Vasco-Ateeledyne Co., P.O. Box 151, Latrobe, Pennsylvania 15650
PART VII
MACHINING METALS

I. MACHINE PLANNING
   A. Machine Drawing
      1. Working Drawings
      2. Bill of Material
      3. Basic Machine Operations
   B. Measuring
      1. English and Metric Systems
      2. Types of Rules
      3. Tolerance and Limits
      4. Gauges and Other Measuring Devices
   C. Work Layout
      1. Layout Dies
      2. V-Blocks
      3. Right Angle Plate
      4. Surface Plate

II. SAFETY
   A. Safe Practices
      1. Color Coding Machine Parts
      2. Safety Rules For Machines
      3. Safe Clothing
      4. Eye Protection
      5. Cleaning Machines
      6. First Aid Equipment

III. DRILLING
   A. Drills
      1. Sizes
2. Drill Nomenclature
3. Drill Care
4. Drill Practices
5. Types of Drills
6. Speeds and Feeds
7. Drill Press
8. Work Holding Tools
9. Lubricants
10. Drill Safety
11. Industrial Drilling Machines

IV. METAL CUTTING
A. Power Hacksaw
   1. Types of Blades
   2. Blade Specifications
B. Band Sawing Metal
   1. Horizontal and Vertical
   2. Band Saw Safety
C. Friction Sawing
   1. Tungsten Carbide Blade
   2. Carbon Steel Blade
   3. Filing and Polishing
D. Blade Repair
   1. Welder

V. MACHINE LATHE
A. Kinds and Sizes
B. Line of Power
C. Turning Attachments
   1. Work Holding Devices
   2. Cutting Tools
D. Speeds and Feeds of Cuts

E. Mounting Work
   1. Live and Dead Centers
   2. Ball Bearing Center
   3. Lathe Dogs

F. Rough and Finish Cutting Between Centers
   1. Shape of Cutter Bits

G. Knurling

H. Threading on Lathe
   1. External
   2. Internal

I. Tapering
   1. Methods
   2. Calculations

J. Facing Operations
   1. Chucks

VI. SET-UP TOOLS

A. Block
   1. V-Blocks and Clamp
   2. Step Blocks
   3. Wedges
   4. Angle Plates
   5. Parallels

B. Vises
   1. Machinist Vise
   2. Swivel Base
   3. Magnetic Chuck

C. Bolts and Clamps
   1. Jack Screws
2. Parallel Clamps
3. T-slot Bolt
4. Strip Clamps

VII. MILLING MACHINE
A. Kinds and Sizes
   1. Knee and Column
B. Parts and Controls
C. Cutting Feeds and Speeds
D. Types of Cutters
E. Holding and Driving Cutter
F. Work Holding Attachments
G. Coolant Fluids
H. Safe Milling Practices
I. Industrial Milling

VIII. GRINDING
A. Belt and Disc Grinders
   1. Kinds of Abrasives
   2. Size of Grit
   3. Shapes and Sizes of Belts and Discs
   4. Speeds for Cutting
B. Surface Grinding
   1. Kinds and Sizes
   2. Work Holding Devices
   3. Grinding Wheels
   4. Collents
   5. Wheel Dresser
   6. Sharpening Milling Cutters
   7. Safer Grinding Practices
   8. Industrial Grinding
IX. SHAPER
A. Kinds and Sizes
B. Table and Cutter Feeding
C. Parts and Controls
D. Speed and Feed
E. Cutting Tools and Holders
F. Shaper Operations
G. Safe Shaper Practices
H. Industrial Shaper, Planer and Broaching

X. MACHINE OCCUPATIONS
A. Job Opportunities in Metal Machining Field
B. Future Outlook

XI. QUALITY CONTROL
A. Testing

XII. AUTOMATION MACHINING
A. Numerical Control
B. Electric Discharge Machining (EDM)
C. Electrical Chemical Machining (ECM)
D. Chemical Milling

XIII. REAMING
A. Hand and Machine Reaming
B. Reamer and Sizes
C. Reamer Nomenclature
D. Reaming Speeds and Feeds
### PART VII - MACHINING METALS

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<tr>
<td>I. MACHINE PLANNING</td>
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<td>A. Machine Drawings</td>
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<td>1. Working Drawings</td>
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<td>Study several working drawings of projects requiring machining operations for its</td>
<td>Discuss Tolerance diminishing found on machine drawing and what students in machining metal need to know. (Chart: 1, 2)</td>
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<td>B. Measuring</td>
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### SUGGESTED LEVELS

I  II  III  IV

### STUDENT ACTIVITIES

- **I. MACHINE PLANNING**
  - **A. Machine Drawings**
    - **1. Working Drawings**
      - Study several working drawings of projects requiring machining operations for its fabrication.
      - Become familiar with the lines, notes, dimensions, and abbreviations used on machine drawings.
    - **2. Bill of Material**
      - Make a bill of material: List parts, materials, AISI and non-ferrous numbers.
    - **3. Basic Machine Operations**
      - Determine which bench and machine operations are needed to complete each project and in what order is each performed.
  - **B. Measuring**

### TEACHING ACTIVITIES

- **Discuss Tolerance diminishing found on machine drawing and what students in machining metal need to know.** (Chart: 1, 2)
- **Discuss AISI and SAE numbering include non-ferrous metal.**
- **Discuss basic machine operations as a quick overview.**
- **Explain procedures for sawing, drilling, turning, boring, milling, grinding, polishing, shaping, planing, and slotting.** (Chart: 3)
- **Examine the difference between English and metric measurements.** (Chart: 5, 6, 7, 8)
| 2. Types of Rules | X | X | X | X | Read a machinist. Rule to 1/64th".
| Change common fractions to decimal. |
| Read a micrometer. Read the vernier gages. |
| Use dial indicator to check work centered on lathe and to align work on milling machine. |
| Check outside and inside radii with radius gage. |
| Measure inside diameters of holes and slot with telechoping gage and/or hole gage. |
| Use gage blocks to check accuracy of tools and setups. |
| 3. Tolerance and Limits | X | X | X | X | Discuss reasons for limits and tolerances and why they are used. (Chart: 4. 12, 13) |
| Demonstrate the use of vernier gages and micrometers. (Pamphlet: 2. 3. 4) |
| Give information on industrial use of several of the extremely accurate measuring gages. |
| Demonstrate measuring with adjustable parallels and outside micrometer. |
| 4. Guages and Other Measuring Devices | X | X | X | X | Demonstrate use of surface plate, surface gages and/or vernier height gage to layout intricate parts. (Film loop: Bench skills 1-15) |
| C. Work Layout | X | X | X | X | Coat metal with dye. |
| 1. Layout Dyes | X | X | X | X | Use divider and trammel points to layout arcs and circles. |
| 2. V-Blocks | X | X | X | X | Locate and drill holes in round stock held in V-Blocks. |
## PART VII - MACHINING METALS

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### A. Drills

#### 1. Sizes

- **Suggested Levels:** x x x x
- **Student Activities:** Identify drill size by shank markings and drill gauge.
- **Teaching Activities:** Explain drill procedures for all sized drills.

#### 2. Drill Nomenclature

- **Suggested Levels:** x x x x
- **Student Activities:** Sharpen several drills by hand and/or machine.
- **Teaching Activities:** Discuss the parts of sharp twist drills and determine procedure to check for wear and dullness. (Film: 22)
<table>
<thead>
<tr>
<th>Topic</th>
<th>1</th>
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<tr>
<td>4. Drill Practices</td>
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<td>5. Types of Drills</td>
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<td>6. Feeds and Speeds</td>
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<td>7. Drill Press</td>
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<td>8. Work Holding</td>
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<td>9. Lubricants</td>
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<td>10. Drill Safety</td>
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<td>11. Industrial Practices</td>
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**Figure size of pilot holes for a given size of counterbore.**

**Counter sink holes for flat head machine screws.**

**Center drill stock for mounting in lathe.**

**Select proper feed and speed in drilling metals.**

**Compare effect of different feeds and speed of different metals.**

**Set-up several ways to hold metal for drilling.**

**Use lubricants while drilling and milling.**

**Follow drill press safety rules.**

**Explain when carbide tipped drills are used to replace regular drills.**

**Discuss the need for drill feeds and speeds in metal.**

**Study drill speed chart.**

**Discuss the size, adjustments, procedures of using the drill press and holding stock for drilling.**

*(Film loop: Drill press series)*

**Explain why proper lubricants will extend life of cutting edge and produce a more accurate sized hole.**

**Discuss different lubricants used with different metals.**

**Demonstrate and discuss drill press safe practices.**

**Discuss and display industrial drill procedure material of equipment and numerical control applications and micro precision drilling machines.** *(Film: 20)*
<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
<th>STUDENT ACTIVITIES</th>
<th>TEACHING ACTIVITIES</th>
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<tr>
<td></td>
<td>I</td>
<td>II</td>
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<tr>
<td>IV. METAL CUTTING</td>
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<td>A. Power Hacksaw</td>
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<tr>
<td>1. Blades</td>
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<tr>
<td>B. Bandsawing Metal</td>
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<tr>
<td>1. Horizontal and Vertical Sawing</td>
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<tr>
<td>2. Band Saw Safety</td>
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</tbody>
</table>
C. Friction Sawing

- If equipment is available, cut metal by friction sawing.
- Weld and repair a metal cutting blade.

V. MACHINE LATHE

A. Kinds and Sizes

- Measure lathe to determine size.

B. Line of Power

- Change speed of the lathe for different operations.

C. Turning Attachments

- Check stock for face turning and between center turning.

D. Cut Feeds and Speeds

- Figure speeds (RPM) and feeds for each job done on lathe.

E. Mounting Work

- Layout the center for round stock, center drill ends and mount between centers.
- Fasten work with proper lathe dog.

F. Turning Between Centers

- Set up lathe for different speeds for rough and finish turning between centers.
- Grind cutter bits for particular lathe operations.
<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
<th>STUDENT ACTIVITIES</th>
<th>TEACHING ACTIVITIES</th>
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</thead>
<tbody>
<tr>
<td>C. Knurling</td>
<td>x x x x</td>
<td>Set up lathe for knurling diamond or straight patterns.</td>
<td>Demonstrate proper knurling operations.</td>
</tr>
<tr>
<td>H. Threading on Lathe</td>
<td>x x x</td>
<td>Machine external threads to receive another threaded part.</td>
<td>Discuss thread operations on the lathe.</td>
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<tr>
<td></td>
<td></td>
<td>x x x x</td>
<td>Demonstrate the procedure to cut external threads on a lathe.</td>
</tr>
<tr>
<td>I. Tapering</td>
<td>x x x x</td>
<td>Calculate the amount offset needed for tapering.</td>
<td>Demonstrate internal threading with a boring bar.</td>
</tr>
<tr>
<td></td>
<td>x x x x</td>
<td>Set up compound rest for machining short angles. (Chamfer)</td>
<td>Discuss and demonstrate tapering operations and the methods to calculate tapers.</td>
</tr>
<tr>
<td>J. Facing Operations</td>
<td>x x x x</td>
<td>Face and center drill and countersink round stock using 3-Jaw universal chuck.</td>
<td>Demonstrate face turning holding stock in a 3-Jaw chuck.</td>
</tr>
<tr>
<td>1. Chucks</td>
<td>x x x x</td>
<td>Center stock in a 4-Jaw independent chuck with a dial indicator.</td>
<td>Demonstrate centering process using a 4-Jaw independent chuck and a dial indicator.</td>
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<tr>
<td></td>
<td>x x x</td>
<td></td>
<td>Discuss and demonstrate safe lathe operating procedures.</td>
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<tr>
<td></td>
<td>x x x</td>
<td></td>
<td>Demonstrate milling procedures using the head stock of the lathe. (Film: 16)</td>
</tr>
<tr>
<td>VI. SET-UP TOOLS</td>
<td></td>
<td>Use a v-block to hold round metal being drilled.</td>
<td>Discuss and demonstrate the use of various set-up blocks to hold stock for several different machine operations.</td>
</tr>
<tr>
<td>A. Blocks</td>
<td>x x x x</td>
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</tbody>
</table>
## VII. MILLING MACHINE

### B. Vises
- Use parallels in the machinist vise to machine flat surfaces.

### A. Kind and Sizes
- Identify kinds, sizes, and relative merits of each.

### B. Parts and Controls
- Operate the mill using 3 directional feeds and use the rapid traverse lever to rapidly position work.

### C. Cutting Feeds and Speeds
- Calculate the speed for a piece of stock, set mill controls and mill stock.

### D. Types of Cutters
- Identify the different types of cutters for both horizontal and vertical mills.

### E. Holding and Driving Cutters
- Mount mill cutters on horizontal mill arbors—use space collars.

### F. Work Holding Attachments
- Clamp work in a vise for milling.

### G. Coolants Fluids
- Use coolents in milling metal.

### H. Milling Safety
- Operate mill safely.

Demonstrate safe procedures in holding metal for machining in several kinds of machinist vises.

Discuss features of the different mills, and the advantages and disadvantages of each type.

Discuss the three directional feed available on the mill and demonstrate the operation of the controls of feeds.

Explain procedures for calculating feeds and speeds on a mill.

Discuss the different type of mill cutters. Indicate those for horizontal and vertical mills and which may be used on each.

Explain procedures to mount mill cutters on both horizontal and vertical mill. (Pamphlet: 1)

Discuss the comparative advantages and disadvantages of the swivel vise and/or universal vise over the plain vise.

Discuss the capacity of the magnetic vise.

Discuss the procedures of indexing work for gear cutting.

Discuss the common machine coolant fluids, their contents, and use.

Demonstrate and discuss safe milling practices.
<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
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<th>TEACHING ACTIVITIES</th>
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<tr>
<td>1. Industrial Milling</td>
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<td>3. Grinding</td>
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<tr>
<td>A. Belt and Disc Grinding</td>
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<tr>
<td>B. Surface Grinding</td>
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<tr>
<td>1. Kinds and Sizes</td>
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<tr>
<td>2. Work Holding Devices</td>
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<tr>
<td>3. Grinding Wheels</td>
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<td>4. Coolants</td>
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<tr>
<td>5. Wheel Dressers</td>
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<td>Set-up a wheel dresser and &quot;true&quot; a grinding wheel.</td>
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<tr>
<td>6. Sharpening Milling Cutters.</td>
<td>x x</td>
<td>Follow safe grinding practices.</td>
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<tr>
<td>7. Safe Grinding Practices</td>
<td>x x</td>
<td>Set controls and machine a flat surface.</td>
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<tr>
<td>8. Industrial Grinding</td>
<td>x x</td>
<td>Mount work for milling.</td>
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</table>

**IX. SHAPER**

<table>
<thead>
<tr>
<th>A. Kinds and Sizes</th>
<th>x x</th>
<th>Calculate number strokes/min. needed for rough and finish cut on metal.</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Table and Cutter Feeding</td>
<td>x x</td>
<td>Practice hand feeding &quot;down on a vertical or angular surface.</td>
</tr>
<tr>
<td>C. Parts and Controls</td>
<td>x x</td>
<td>Set depth of cut for rough and finish cut on metal.</td>
</tr>
<tr>
<td>D. Speeds and Feeds</td>
<td>x x</td>
<td>Sharpen a cutter bit for a particular metal.</td>
</tr>
<tr>
<td>E. Cutting Tool Holders</td>
<td>x x</td>
<td>Use the shaper following safe practices.</td>
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<tr>
<td>F. Shaper Operations</td>
<td>x x</td>
<td>Identify a &quot;loaded&quot; wheel and discuss how it should be cleaned.</td>
</tr>
<tr>
<td>G. Safe Shaper Practices</td>
<td>x x</td>
<td>Demonstrate the procedure for dressing the face of a wheel.</td>
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</table>

Discuss the process of sharpening milling cutters. Indicate which can be sharpened in the school shop. (Film: 4)

Demonstrate safe grinding practices.

Discuss and provide as many industrial grinding operations as possible.

Study the shapers in the school lab and discuss how shapers are sized. (Film strip: How to operate the shaper)

Discuss the best methods to mount work on shaper table.

Discuss cutters and compare with the lathe bits.

Compare different shaper operations: Indicate similarities and difference.

Demonstrate and discuss safe shaper practices.
### PART VII - MACHINING METALS

<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
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#### X. MACHINE OCCUPATIONS

A. Job Opportunities  
- Suggested Levels: I, II, III, IV  
- Check newspaper for machine operation job opportunities.

B. Outlook  
- Suggested Levels: I, II, III, IV  
- Find out what different jobs are in machining field. Training needed and where to get the training.

#### XI. QUALITY CONTROL

A. Testing  
- Suggested Level: I, II  
- Discuss types of testing for quality control. Explain all aspects of several methods.

#### XII. AUTOMATION MACHINING

A. Numerical Control  
- Suggested Level: I, II  
- Discuss numerical control machining: Indicate the advantages and disadvantages. (Film: 6, 12, 13, 14, 19, 20, 23)

B. Electrical Discharge Machining  
- Suggested Level: I, II  
- Discuss EDM process and explain how metal is removed. List the advantages and disadvantages.

C. Electrical Chemical Machining  
- Suggested Level: I, II  
- Discuss EGM process and indicate advantages and disadvantages.

D. Chemical Machining  
- Suggested Level: I, II  
- Discuss these methods of machining and compare them to conventional machining—which metals are best machines by these methods.
### XIII. REAMING

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<tbody>
<tr>
<td>A. Hand &amp; Machine Reaming</td>
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<td>B. Sizes</td>
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<td>C. Nomenclature</td>
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- **Drill a hole and ream to a specific size with a hand reamer and a chucking reamer.**
- **Discuss the need and purpose of reaming.**
- **Demonstrate hand and machine reaming.**
  (Film: 2)
- **Identify parts of a reamer.**
- **Note the differences in speed and feed of reaming versus drilling.**
A. 16mm FILMS FOR MACHINING

1. Anocut ECM - 22 MIN. - Anocut Engineering

1A. A Question of Time - Simonds Saw

2. The Art of Reaming - 48 min. - B&W - Cleveland Twist Drill Co.

3. Cool Chips - 16 min. - Cincinnati Milacron


5. Extending The Range of Modern Surface Grinding - 20 min. - Doall Co.


7. Grinding Cutter Bits - 20 min. - South Bend Lathe

8. The Grinding Wheel - 20 min. - Norton Co.


10. The Lathe - 20 min. - South Bend Lathe


12. New Sounds of Tape - 22 min. - Giddings and Lewis

13. New Tool Changing Machine Center - 16 min. - Giddings and Lewis

14. One How for Kalabo - 27 min. - Modern Talking Pictures

15. The Outside Micrometer - 12 min. - Starrett

16. PJ400 - 18 min. - Pratt and Whitney

17. Plain Turning - 20 min. - South Bend Lathe

18. Production Band Maching - 30 min. - Doall Co.

19. The Story of Productivity - 30 min. - Doall Co.

20. Tape-O-Matic - 13 min. - Pratt and Whitney


22. Use and Care of Twist Drills - 23 min. - Cleveland Twist Drill Co.

23. What Makes America Great - 23 min. - Doall Co.
B. FILMSTRIPS WITH SOUND FOR MACHINING

How to Operate a Vertical Milling Machine - RMI
How to Operate the Engine Lathe Part I - RMI
How to Operate the Engine Lathe Part II - RMI
How to Operate the Shaper - RMI

DISTRIBUTOR ADDRESS

RMI Film Productions, 4916 Main Street, Kansas City, Missouri 64112
C. FILM LOOPS FOR MACHINING

The Engine lathe (20 Color Loops) Veva-Brett Visual Aids

1. Aligning Centers
2. Boring
3. The Centerhole
4. Changing Chucks
5. Drilling and Reaming a Hole
6. Facing on the Lathe
7. Finishing Work on the Lathe
8. Holding Work Between Centers
9. The Lathe Tailstock
10. Longitudinal Cuts: Carriage Stop Limits
11. Longitudinal Cuts: Turning and Measuring
12. The Parting Tool
13. Starting a Die Squarely
14. Starting a Tap Squarely
15. Taper Turning: Compound Rest
16. Threads: Chasing
17. Threads: Setting Up
18. Truing Work: A Four Jaw Chuck
19. Using Collets
20. Using The Micrometer Dial

MACHINF SHOP BENCH SKILLS (15 Color Loops) VEVA-BRETT VISUAL AIDS

1. The Cold Chisel
2. The Divider
3. Filing Drawfiling and Polishing
4. The Hacksaw
5. The Height Gage
6. Laying Out Intersecting Lines
7. Laying Out Lines Parallel to an Edge
8. Measuring Depths
9. Measuring Holes - Small Hole and Telescope
10. Preparing Work for Layout
11. Reaming a Hole
12. Square - Centerhead - Protractor
13. Surface Gage
14. Tapping a Hole
15. Threading a Bolt

Veva-Brett Visual Aid Service, 7821 Big Bend Blvd., Webster Groves, Mo. 63119

THE OUTSIDE MICROMETER (8 color loops) STARRETT

1. How to Handle
2. Main Parts
3. Proper Care
4. Reading in Ten-thousandths
5. Reading in Thousandths
6. Reading in Three Steps
7. Screw Thread Measuring Principle
8. Test on Readings

L. S. Starrett Company, 1001 Crescent St., Athol, Massachusetts 01331
DRILL PRESS SERIES (10 color loops) - VEVA-BRETT VISUAL

1. Counterboring on the Drill Press
2. Countersinking On the Drill Press
3. Drawing the Drill Back to Center
4. Drill in Flat Stock
5. Drilling a Blind Hole
6. Drilling Large Holes on Drill Press
7. Drilling Through the Center of Round Stock
8. Introducing the Drill Press
10. Starting a Tap in the Drill Press

Veva-Brett Visual Aid Service, 7821 Big Bend Blvd., Webster Groves, Mo. 63119

D. CHARTS FOR MACHINING

1. Decimal Chart - 20x26 - Doall Company
2. Decimal Equivalent and Tap Drill Sizes - 23x28 - Starrett
3. How to Become a Machinist - 12x21 - South Bend
4. How to Read a Micrometer - 20x27 - Brown and Sharpe
5. International Metric System - 29x42 - Welch
6. Metric Table - 28x42 - Plasticoid
7. Metric Conversion Chart - 28x40 - Plasticoid
9. Precision Instruments, Notebook Set of 15 - 8½x11 - Starrett
10. Saw Blade Selector - 21x27 - Doall Company
11. South Bend Lathe Parts - 17x21 - South Bend
12. Starrett Precision Tools - 26x42 - Starrett
13. Starrett Satin Chrome Micrometer - 22x28 - Starrett

7-22
E. PAMPHLETS FOR MACHINING

1. *How to Choose and Use Cutting Tools* - Brown & Sharpe
2. *Micrometer Reading Made Easy* - Lufkin
3. *The Starrett Story* - Starrett
4. *Tools and Rules for Precision Measuring* - Starrett

DISTRIBUTORS ADDRESSES

Brown and Sharpe Cutting Tool Division, Centerdale, Rhode Island

Lufkin Rule Co., P. O. Box 728, Apex, North Carolina 27502

Starrett Tool Co., 1001 Crescent St., Athol, Mass. 01331

MODELS FOR MACHINING

1. Micrometer Caliper - Approx. 16'' high x36'' long - Welch
2. Vernier Caliper - Approx. 10'' wide x 30'' Long - Welch

DISTRIBUTOR'S ADDRESS

Welch Scientific Co., 7300 N. Linder Ave., Skokie, Illinois 60076
F. TEXTBOOKS AND/OR REFERENCE BOOKS FOR MACHINING

Fundamentals of Band Machining, Delmar Publishers Inc., Mountain View Avenue, Albany, New York 12205


How to Run a Drill Press, 1966, South Bend Lathe Co., 400 W. Sample St., South Bend, Indiana 46623

How to Run a Lathe, 1966, South Bend Lathe Co., 400 W. Sample St., South Bend, Indiana 46623

Machining Fundamentals, John R. Walkers, 1969, Goodhart-Wilcox Co., Inc., Homewood, Illinois 60430


Machine Shop Projects, Knight, Roy E., 1943, McKnight and McKnight Publishing Co., Inc., Bloomington, Illinois 61701


Bench Work
Drill Press Work
Lathe Work
Machine Shop Measurement
Milling Machine Work
Shaper Work


Machine Tool Metalworking, Feirer, John L. and Tatro, Earl E., 1961, McGraw-Hill Book Co., Inc. Manchester Road, Manchester, Mo. 63011


1972. American Technical Society. 848 E. 58th St., Chicago, Ill. 60637

Machinist Ready Reference, Compiled by Weingartner, C., Praken Publications Inc., 416 Longshore Drive. P. O. Box 623, Ann Arbor, Mich. 48107

PART VIII
SHEET METAL

I. TYPES OF SHEET METAL
   A. Ferrous
   B. Non-Ferrous

II. JOB DESIGN AND PLANNING
   A. Size and Cost of Metal
   B. Hardware Needed

III. Measure and Layout Tools
   A. Measuring Tools
   B. Marking Tools

IV. PATTERN DEVELOPMENT

V. CUTTING SHEET METAL
   A. Hand Tools
   B. Machining Cutting

VI. BENDING SHEET METAL
   A. Hand Tools
   B. Bending Machines

VII. FASTENING SHEET METAL
   A. Riveting
   B. Sheet Metal Screws
   C. Spot Welding
   D. Solder and Brazing

VIII. FINISHES FOR SHEET METAL
   A. Types of Finishes
   B. Application
   C. Drying
IX. SPINNING SHEET METAL
   A. Spinning Lathe
   B. Types of Metal
   C. Chucks
   D. Industrial Spinning

X. SAFE SHEET METAL PRACTICES
   A. Clothing
   B. Face Protection

XI. OCCUPATIONAL OPPORTUNITES
   A. Sheet Metal Jobs
   B. Outlook
## PART VIII - SHEET METAL

<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
<th>STUDENT ACTIVITIES</th>
<th>TEACHING ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. TYPES OF SHEET METAL</strong></td>
<td>x x x</td>
<td>Identify gauges and types of sheet metal found in the metals lab.</td>
<td>Discuss the production of sheet metal both ferrous and non-ferrous. (Film: 7)</td>
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<td>x x</td>
<td>Provide a display of most types of sheet metal. (Label each one) (films: 1, 2, 9, 10)</td>
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<td><strong>II. PROJECT DESIGN AND PLANNING</strong></td>
<td>Calculate cost of sheet metal used on a job.</td>
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<td>x x x</td>
<td><strong>III. MEASURE AND LAYOUT TOOLS</strong></td>
<td>Discuss why one metal would be better than another for a particular job.</td>
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<td>Layout a flat pattern for a tray like project.</td>
<td>Explain and demonstrate the development of a sheet metal project.</td>
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<td><strong>IV. PATTERN DEVELOPMENT</strong></td>
<td>x x x</td>
<td>Make a radial development of a cone.</td>
<td>Show how to transfer a pattern to sheet metal.</td>
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<td><strong>V. CUTTING SHEET METAL</strong></td>
<td>Discuss and demonstrate several methods of cutting sheet metal, by hand tools and machines. Explain capacity of cutting tools.</td>
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<td></td>
<td>x x x</td>
<td>Cut various shapes in sheet metal using hand tools and machines.</td>
<td>Demonstrate common sheet metal forms to be bend on common bending tools. (Films: 10 in color Part I II)</td>
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<tr>
<td><strong>VI. BENDING SHEET METAL</strong></td>
<td>x x x</td>
<td>Bend sheet metal over stakes, forming rolls, and combination rotary machine.</td>
<td>Display sample of several sheet metal seams. (Film: 3, 5)</td>
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<td>Fold hems, wire edges and seams.</td>
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<td>Set-up and use the box brake for bending boxes and seams.</td>
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</table>
## PART VIII - SHEET METAL

<table>
<thead>
<tr>
<th>COURSE CONTENT</th>
<th>SUGGESTED LEVELS</th>
<th>STUDENT ACTIVITIES</th>
<th>TEACHING ACTIVITIES</th>
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</thead>
<tbody>
<tr>
<td><strong>VII. FASTENING SHEET METAL</strong></td>
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<td><strong>Suggested Levels</strong>: I</td>
<td>II</td>
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<td><strong>VIII. SHEET METAL FINISHES</strong></td>
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</table>
| IX. SPINNING SHEET METAL | x | x | x | Spin a one piece pattern of aluminum.  
| | | | | Spin a rolled edge with a beading tool.  
| | | | | Discuss procedure for spinning. Demonstrate spinning a one piece pattern.  
| X. SAFE SHEET METAL PRACTICES | x | x | x | Practice safe work habits.  
| | | | | Show how to handle sheet metal without injuries.  
| XI. OCCUPATIONAL OPPORTUNITIES | x | x | x | Visit local sheet metal shops.  
| | | | | Discuss the sheet metal field and different jobs, salary, and the training needed.  

A. 16mm FILMS FOR SHEET METAL

1. *Forming and Bending of Stainless Steel* - 29 min. - Republic Steel
2. *General Sheet Metal Practice* - Alcoa
3. *How to Form Aluminum - Blanking and Piercing* - 16 min. - Dept. of Interior
4. *How to Form Aluminum Spinning* - 17 min. - Dept. of Interior
5. *How to Form and Join Aluminum* - Alcoa
6. *How to Rivet Aluminum* - Alcoa
8. *The Sheet Metal Worker* - Ideal Pictures Corp.
10. *Tinplate* - Dept. of Interior

16mm FILM DISTRIBUTOR ADDRESSES

1. Alcoa Informational Aids. Film Series. 1501 Alcoa Bldg., Pittsburgh, Penn. 15219
3. Ideal Pictures Corp., 58 E. South Water St., Chicago, Illinois 60601
4. Modern Talking Pictures Service. Swank Motion Pictures Inc., 201 S. Jefferson, St. Louis, Mo. 63103
5. Republic Steel Corp., Market Research Division, 1436 Republic Bldg., Cleveland, Ohio 44101

B. PAMPHLETS FOR SHEET METAL

1. *Career Opportunities for High School Graduates* - Jones and Laughlin
2. *Safety First In Steel* - AISI

American Iron and Steel Institute. 150 East Forty Second St., New York, New York 10017
Jones and Laughlin Steel Corp., 3 Gateway Center, Pittsburgh, Penn. 15230
C. CHARTS FOR SHEET METAL

1. Diarco Rollers - 24x36 - Diarco
2. Diarco Box and Pan Brake - 24x36 - Diarco
3. Diarco Bar Floder - 24x36 - Diarco

Diarco Corp., 300 Eighth Ave., Lake City, Minn. 55041

D. FILM LOOPS FOR SHEET METAL

WORKING WITH SHEET METAL--PART I (10 COLOR LOOPS) VEVA-BRETT VISUAL AIDS

1. The Chassis Punch
2. Common Types of Tin Snips
3. Installing Blind or Pop Rivets
4. Laying Out A Box
5. Layout Using A Drawing Overlay
6. The Levered Hand Punch
7. Preparing the Soldering Copper
8. Riveting
9. Using The Soldering Copper
10. Using the Snips

WORKING WITH SHEET METAL--PART II (10 COLOR LOOPS) VEVA-BRETT VISUAL AIDS

1. Adjusting Bend Clearance and Stop
3. Beading and Crimping
3. The Breading Machine
4. The Box and Pan Brake--Adjusting the Clamp--Bar Tension
5. Installing and Adjusting Beading Rolls
6. Making a Single Bead
7. Making Common Beads Using The Brake
8. Using the Brake to Make a Box
9. Wiring an Edge - Part I - Set Up
10. Wiring an Edge - Part II - Installing Wire

Veva-Brett Visual Aid Service, 7811 BIG Bend Blvd., Webster Groves, Mo. 63119

E. FILMSTRIPS WITH SOUND FOR SHEET METAL

1. Metal Spinning Techniques - RMI
2. Sheet Metal Worker - RMI

RMI Film Productions, 4916 Main St., Kansas City, Missouri 64112

G. TEXTBOOKS AND/OR REFERENCE BOOKS FOR SHEET METAL


*Precision Sheet Metal Blueprint Reading*, Budzik, Richard S., Howard V. Sams and Co. Inc., 4300 West Sixty Second Street, Indianapolis, Indiana 46268

*Sheet Metal Pattern Drafting and Shop Problems*, Daugherty, James S., and Powell, Robert E., 1961, Charles A. Bennett, Peoria, Ill. 61614

*Sheet Metal Practice*, Neundorf, William and Sevens, Claude, 1963, McGraw Hill Book Co., Manchester Road, Manchester, Missouri 63011


*Sheet Metal Shop Practice*, Bruce, Iery F. and Meyer, Leo, American Technical Society, 848 East Fifty Eighth Street, Chicago, Ill. 60617


8-8
PART IX
WELDING

1. OXYACETYLENE
   A. Safe Welding Practices
      1. Equipment
      2. Clothing
   B. Gas Production and Sources
   C. Equipment
      1. Cylinders
      2. Regulators
      3. Hoses
      4. Torches and Tips
   D. Welding Rods
      1. Flux Coated Rod
      2. Open Rod
      3. Lines and Views
   F. Torch Flames
      1. Neutral
      2. Carburizing
      3. Oxydizing
   G. Position Welds
      1. Flat-Horizontal-Vertical
      2. Welding Joints
      3. Backhand and Forehand Welding
   H. Heat effects of Metal
      1. Expanding
      2. Shrinking
      3. Warping
I. Cutting torch
   1. Manual
   2. Machine-Automatic
   3. Factors Effecting Equipment
   4. Types of Cutting

J. Brazing
   1. Advantages and Disadvantages
   2. Equipment
   3. Rods and Fluxes
   4. Brazing Welds

II. METALLIC ARC WELDING
   A. Safety
      1. Clothing
      2. Equipment
   B. Types Metallic Arc Welding
   C. Electrode Identification
      1. Selection and Use
      2. Continuous Feed
      3. Flux Coated
      4. Polarity
   D. Striking An Arc
      1. Scratch
      2. String Bead
      3. Padding
      4. Types of Welds
   E. Carbon Arc
      1. Safety
      2. Kinds of Metal Welded
      3. Type of Welds
III. TUNGSTEN INERT GAS (TIG)
   A. Safety
      1. Clothing
      2. Equipment
   B. TIG welding
      1. Ferrous
      2. Non-Ferrous
   C. Tungsten Inert Gases
      1. Carbon Dioxide
      2. Argon
      3. Helium
      4. Mixture
   D. Electrodes and Rods
   E. Advantages and Disadvantages
   F. Industrial Aspects

IV. METAL INERT GAS (MIG)
   A. Safety
      1. Clothing
      2. Equipment
   B. Kinds of Metal
      1. Ferrous
         Steel
         Stainless Steel
      2. Non-Ferrous Metal
         a. Aluminum
   C. Metal Inert Gases Used.
   D. Electrode
   E. Source of Heat
   F. Welding Positions
G. Types of Joints
H. Industrial Aspects

V. RESISTIVE WELDING (SPOT)
A. Safety
   1. Equipment
B. Kinds of Welders
   1. Portable
   2. Floor
C. Techniques of Welding
   1. Squeeze or Force Time
   2. Weld Time
   3. Forge or Hold Time
   4. Off or Release Time

VI. OTHER WELDING PROCESSES
A. Atomic Hydrogen
B. Electron Beam
   1. Vacuum
   2. High Temperature Weld
C. Electro Slag
D. Explosive
E. Laser
F. Self-Generating Oxyhydrogen
G. Stud Welding
H. Ultrasonic

VII. OCCUPATIONAL OPPORTUNITIES
## PART IX - WELDING

<table>
<thead>
<tr>
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<tr>
<td><strong>I. OXYACETYLENE</strong></td>
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<td>A. Safety</td>
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<td>B. Gas Production and Sources</td>
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<td>D. Welding Rods</td>
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<td>E. Welding Drawings</td>
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<td>F. Torch Flames</td>
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<td>G. Position Welds</td>
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<td>H. Heat Effect on Metals</td>
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<td>I. Cutting Torch</td>
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<td>J. Brazing</td>
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II. METALLIC ARC WELDING

<table>
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<tr>
<th>A. Safety</th>
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<tr>
<td><strong>Practice safe procedures in operating the equipment.</strong></td>
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<thead>
<tr>
<th>B. Types of Metal Arch Welders</th>
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<tbody>
<tr>
<td><strong>Discuss types of arc welding and their apparent advantages.</strong></td>
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<thead>
<tr>
<th>C. Electrodes</th>
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<tr>
<td><strong>Discuss arc welding electrodes, rod, flux, and size for different welds. (Pamphlet: b)</strong></td>
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<tr>
<th>D. Striking an Arc</th>
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<td><strong>Practice striking and maintaining a proper arc.</strong></td>
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<thead>
<tr>
<th>F. Carbon Arc</th>
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<tr>
<td><strong>Practice running stringer beads.</strong></td>
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<thead>
<tr>
<th>2. Kinds of Metal Welds</th>
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<td><strong>Adjust tips, strike an arc and maintain it.</strong></td>
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<th>3. Types of Welds</th>
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<tr>
<td><strong>Make several types of joint welds with carbon arc.</strong></td>
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<table>
<thead>
<tr>
<th>1. Safety</th>
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<tr>
<td><strong>Wear eye protection.</strong></td>
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<th>2. Kinds of Metal Welds</th>
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<tr>
<td><strong>Discuss advantages and disadvantages of carbon arc welding. (Film: 1)</strong></td>
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<th>3. Types of Welds</th>
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<tr>
<td><strong>Demonstrate joint cleaning and preparation for carbon arc welding.</strong></td>
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<td>COURSE CONTENT</td>
<td>SUGGESTED LEVELS</td>
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<td>III. TUNGSTEN INERT GAS WELDING [TIG]</td>
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<td>A. Safety</td>
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<tr>
<td>B. TIG Welding</td>
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<tr>
<td>IV. METAL INERT GAS WELDING [MIG]</td>
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<td>A. Safety</td>
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<tr>
<td>B. Kinds of Metal Welded</td>
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<td>C. Inert Gases Used</td>
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### V. RESISTIVE WELDING (SPOT)

#### A. Safety
- Practice safe welding procedures with spot welder.

#### B. Types of Welder Models
- Practice spot welding using several different kinds of metals.

#### C. Techniques of Welding
- Demonstrate and discuss spot welding tips, different metal, thicknesses and times for each.
  
  (Film: 2)

### VI. OTHER WELDING PROCESSES

- Examine other welding processes being used today in American Industry.

### VII. OCCUPATIONAL OPPORTUNITIES

- List as many actual jobs in local community involved in the welding industry you can find.
- Invite local welders and welding suppliers to come to the school to demonstrate new procedures and talk about the welding industry.
A. CHARTS FOR WELDING

1. Oxyacetylene Flame Traits for Welding - Oxyacetylene Flame for Cutting 11x17 Smith
2. Oxyacetylene Welding Flame and Oxyacetylene Cutting Flame - 16x20 - Meco

DISTRIBUTORS ADDRESSES
Meco-Modern Engineering Co., 3555 Scott Ave., St. Louis, Missouri 63103
Smith Welding Equipment, 2633 S. E. Fourth Street, Minneapolis, Minn. 55414

B. 16mm FILMS FOR WELDING

1. Futures In Welding - 25 min. - MECO
2. How To Weld Aluminum, Resistance Welding - 17 min. - Dept. Of Interior
3. How To Weld Aluminum, Torch Welding - 17 min. - Dept. Of Interior
4. Oxyacetylene Flame, Master Of Metals - 19 min. - MECO
5. The Story of Arc Welding - 24 min. - Dept. Of Interior
6. Welding - 13 min.- Sterling

DISTRIBUTORS ADDRESSES
Department of Interior, Bureau of Mines, 4800 Forbes Ave., Pittsburg, Penn. 15213
Meco-Modern Engineering Company, 3555 Scott Ave., St. Louis, Mo. 63103
Sterling Educational Films, 241 East 34th St., New York, New York 10016

C. FILMSTRIPS FOR WELDING

1. Attaching the Torch
2. Brazing
3. Brazing Flux
4. Corner Welds
5. Cutting a Hole
6. Installing the Regulators
7. Lighting the Torch and Shutting Down
8. Oxyacetylene Cutting
9. Running Beads
10. Setting Up the Cutting Attachment
11. Turning On and Testing for Leaks
12. Welding Dress and Safety

DISTRIBUTOR ADDRESS
Veva-Brett Visual Aid Service, 7821 Big Bend Blvd., Webster Groves, Mo. 63119

WELDING SERIES (10 LOOPS IN COLOR) - TECHNIFAX EDUCATION DIVISION

1. Adjusting Gas Pressures with Torch Valves Closed and Lighting Torch
2. Adjusting Gas Pressures with Torch Valves Open and Lighting Torch
3. Braze Welding Beads
4. The Corner Joint
5. Edge and Flange Joints
6. Fillet Welds
7. Flame Effects on Molten Pool
8. Lines of Fusion Beads Without Rod
9. The Square Butt Joint
10. Weld Beads Using Filler Rod

DISTRIBUTOR ADDRESS
Technifax Education Division, Scott Grafic Inc., 195 Appleton St. Holyoke, Mass. 01040
D. FILMSTRIP WITH SOUND FOR WELDING

1. *How To Use The Oxyacetylene Welder* - RMI

   DISTRIBUTOR ADDRESS

   RMI Film Productions, 4916 Main St., Kansas City, Mo. 64112

E. PAMPHLETS FOR WELDING

1. *Arch Welding Electrode Selection* - Hobart
2. *Flame Cutting Facts* - Smith (4th St.)
3. *Gas Regulating Facts* - Smith (Niagara Land)
4. *Hobart Vest Pocket Guide* - Hobart
5. *Instructional Manual* - Welding, Cutting, Lead Burning - Meco
6. *Welding Armco Stainless Steels* - Armco

   DISTRIBUTORS ADDRESSES

   Armco Steel Corp., Market Development Corp., 7000 Roberts St., Kansas City, Mo. 64125
   Hobart Tech Center, Hobart Bros. Co., Box E.W. - 388, Troy Ohio 45373
   Meco-Modern Engineering Company, 3555 Scott Ave., St. Louis, Mo. 63103
   Smith Welding Equipment 2633 Southeast Fourth St., Minneapolis, Minn. 55441
   Smith Welding Equipment 2600 Niagara Lane North, Minneapolis, Minn. 55441

F. TEXTBOOKS AND/OR REFERENCE BOOKS FOR WELDING


INDUSTRIAL ARTS
FREE AND INEXPENSIVE LEARNING MATERIALS

HOW TO ORDER MATERIALS

MATERIALS LISTED IN THIS PUBLICATION ARE AVAILABLE ONLY FROM THE DISTRIBUTORS LISTED IN THE ANNOTATIONS, not from the editor of the book.

When ordering, give exact title or description of the item desired, print your name and full address, and include payment when there is a charge for material. Indiscriminate requests for "everything you have" should be avoided. It is permissible, however, to request a list of publications or to describe a teaching assignment and request appropriate materials. When possible, orders for materials should be made on school or organizational stationary, and mention should be made that the item is listed in FREE AND INEXPENSIVE LEARNING MATERIALS.
CAREERS AND CAREER GUIDANCE

AIR FORCE ACADEMY MATERIALS. Registrar. U.S. Air Force Academy, Colorado 80840. Free. Titles include:


CAREER OPPORTUNITIES IN AVIATION. National Aerospace Education Council. Suite 310, Shoreham Bldg. 806 15th St., N.W. Washington, D.C. 20005. 1967. 24 pp. 50 cents. Includes related high school courses, how to get started, complete roster of FAA-certificated mechanic schools, and sample FFA examination questions. Also include a survey of airline flight officer employment qualifications and opportunities.

BUSINESS. United Business Schools Assoc. Guidance Dept. 1101 17th St., N.W. Washington, D.C. 20036. Free. Titles include:

How to get Money for Vocational Education. 1968. Reprint from American Education. Scholarships and loans from the government and from private establishments.

The Job's the Thing. 1967. Reprint from American Education. The importance of vocational as opposed to a liberal arts education.

CIVIL SERVICE MATERIALS. U.S. Civil Service Commission. Washington, D.C. 20415. Free. Titles include:


OPTICS. Optical Society of America. 2100 Pennsylvania Ave., N.W. Washington, D.C. 20037. Free up to 100 copies. Titles include:


SOCIAL WORK. Family Service Assoc. of America. 44 E. 23rd St. New York New York 10010. Titles include:


Skilled Trades for Girls. 1967. 5 pp. Craft jobs well suited to girls.

INDUSTRIAL ARTS AND VOCATIONAL SKILLS

ARC WELDING TEACHING AIDS KIT. The Lincoln Electric Co. 22801 St. Clair Avenue. Cleveland, Ohio 44117. Free to Teachers of arc welding if requested on school letterhead stationery. Kit includes free-loan movie and free teaching aids information, wall charts, teacher-student guides, electrode data, and student awards information. Sr. hi. level.

COMPRESSED AIR AND GAS. Compressed Air and Gas Institute. 55 Public Square. Cleveland, Ohio. 44113. Undated. Free. Published as a service to engineering education. Illustrated booklets punched for a 3-ring note book. Titles include:

Compressed Air and Gas in the Process Industries. 28 pp.

Compressed Air Power. Chart. 23” x 30”. Illustrates principles of the different types of air compression.

Compressed Air Power in Manufacturing. 31 pp.

The Fundamentals of Compressed Air Power. 16 pp.


GRINDING WHEEL BOOKLETS. Grinding Wheel Institute. 2130 Keith Bldg. Cleveland, Ohio 44115. Free. Cutting, grinding, and abrasive wheel information in illustrated booklets. Sample titles are:

- Portable Grinding Machines. 1965. 29 pp.

POWER TOOLS. McKilligan Educational Shop Supply. Maine, New York 13802. Undated. Free. Titles include:

- How to use Taps, Dies, and High Speed Steel Drills. 12 pp. Illustrated booklet designed to provide layman with complete information.
- Power Hacksaw Blades. 15 pp. How to select and use power hacksaw blades. Illustrated.

LEAD. Lead Industries Assoc., Inc., 292 Madison Ave. New York, New York 10017. Free. Titles include:

- Primary Lead Production Areas in the United States. Undated. 11” x 17” map.
Metal Cans Serving Man Throughout the World. Leaflet. Tells the story and many uses of tin cans. Illustrated.

Notes About the Can Manufacturing Industry. Rev. For advanced and technical students.

IRON AND STEEL

FILMSTRIPS. American Iron and Steel Institute. Teaching Aids Distribution Center. Bedford Hills, New York 10507. One print of each filmstrip available free to each school. $1.00 for each additional print. Intended for use in high school chemistry, social studies, and science classes. Teaching suggestions booklet accompanies each. Color. Filmstrips include:

America Grows with Iron and Steel. Undated. 43 frames. Sound

The Chemistry of Iron. 1966. 35 frames. Silent

The Chemistry of Steel. 1966. 50 frames. Silent

The Cradle of an American Industry. 1966. 48 frames. Silent

IRON AND STEEL. American Iron and Steel Institute. 150 E. 42nd St. New York, New York 10017. Free. Titles include:


Education Cooperation Activities and Services of American Iron and Steel Institute. Rev. annually. 11 pp. A pamphlet dealing with the steel industry's cooperative activities in education during years 1948 to present.


STEEL. Bethlehem Steel Corp. Bethlehem, Penn -Ivania 18016. Undated. Free. Well illustrated. Titles include:

ABC’s of Steelwatching. 10 pp. Amusingly written booklet about building with steel.

Let’s Build a Bridge. 15 pp. Scientific facts about steel bridges in easy-to-read form. Inter. jr. hi. levels.

Steel Our Most Useful Metal. Pamphlet. Illustrated facts concerning the steel industry.
STEEL. CF & I Steel Corp. Publicity Dept., P.O. Box 316. Pueblo, Colorado 81002. Free in limited quantities. Titles include:

- How Steel Is Made. 17" x 19" poster.
- Steel Making in the Open Hearth Furnace. 1967. Pamphlet. How steel is made by the open hearth process.

STEEL INFORMATION BOOKLETS. United States Steel Corp., Public Relations Dept., 525 William Penn Place, Pittsburgh, Penn. 15230. Free to Teachers. Titles include:

- How Steel is Made. Kit, 8" x 10" x 2", contains color filmstrip, bottled samples of raw materials (iron and steel), and teachers guide and filmstrip text. (Limited to one kit for library or visual aid center). Useful in general science, chemistry, and social studies. Inter. through sr. hi. level.
- Wall Chart: How Steel is Made. Full color 35" x 45" linen backed wall charts which illustrates the flow of steelmaking process from raw materials to finished products. (Limited one chart for library of visual aid center). Inter. through sr. hi. level.
- The World of Steel. Extensively revised 1966. Covers story of iron and steelmaking, historical background, scientific, achievements. For social studies and science classes. Inter. through sr. hi. level.

STEEL MATERIALS. Alan Wood Steel Co. Conshohocken, Pennsylvania 19428. Free Titles Include:

- Information Pamphlets. Undated. Four illustrated pamphlets describing steel sheeting and stripping, steel plate, diamond, floor plate, and abrasive rilled steel flooring.
ALUMINUM. Aluminum Co. of America. 1501 Alcoa Bldg. Pittsburgh, Pennsylvania. 15219. Free to teachers. Titles include:

A Brief Story of Aluminum and Alcoa. 15 pp. Discussion of aluminum from mine to useful metal. Illustrated.

Flow charts. Two color charts depict the stages of aluminum production. Titles include:

Fabricating Chart. 13" x 29"
Refining Chart. 12" x 20"
Smelting Chart. 12" x 20"


SCIENTIFIC AMERICAN OFFPRINTS. W. H. Freeman and Co. 66C Market St., San Francisco, Calif. 94104. 20 cents each. Send of list of individual magazine articles for class room use, each including bibliography. Titles include:


U.S. ATOMIC ENERGY PUBLICATIONS. U.S. Atomic Energy Commission. P.O. Box 62. Oak Ridge, Tennessee 37830. Single copies free. Sr. hi. and col. levels:

PLUTONIUM. By William N. Miner. 1966. 54 pp. Describes discovery and uses of plutonium.


United States Steel Publications. Manager, Educational Services. Public Relations. United States Steel Corp. 525 William Penn. Place. Pittsburgh, Pennsylvania 15230. Send for college and university or elementary and secondary lists of free publications on general, economic, or scientific aspects of steel.

MAGAZINES AND NEWSPAPERS

Many of the magazines and newspapers listed below are free. Especially if a request is made on school district stationary. Some publishers will send a year's subscription free to help one decide if the magazine is useful. If a subscription price is changed, many school libraries have money budgeted for departmental magazines. Magazines written for and by various industries add considerably to the understanding of the student and help bridge that gap between school operations and industrial production methods.

**Abrasive Engineering.** Hitchcock Pub. Co., Hitchcock Bldg., Wheaton, Ill. 60187 (monthly - $15.00/year)

**Alcoa Aluminum Newsletter,** Public Relations Dept., The Editor, Alcoa Aluminum Newsletter. 1250 Alcoa Bldg., Pittsburg, Penn. 15219. (Monthly-Free)

**DuPont Magazine.** E. I. DuPont de Nemours and Co., Wilmington, Delaware 19898

**Industrial Finishing,** Hitchcock Publishing Co., Hitchcock Bldg., Wheaton, Ill. 60187 (Monthly - $7.50/year)

**Foundry.** Foundry. Penton Plaza. Ohio 44114 (Monthly-free)

**Iron Age.** Chilton Co., Inc., 56th and Chestnut St., Philadelphia, Penn. 19139 (Weekly - Controlled free subscriptions: otherwise $25.00/year)

**Machinery,** Industrial Press Inc., Machinery. 200 Madison Ave., New York, 10016 (Monthly - Free)

**Metalworking,** Metalworking Pub. Co., Inc., 221 Columbus Ave., Boston, Mass. (Monthly - $6.00/year)

**Metalworking News,** Fairchild Publications Inc., 7 East 12th Street, New York, New York 10003 (Weekly newspaper - $1.50/year)

**Metal Progress.** American Society for Metals, Metals Park, Ohio 44073 (Monthly/free)

**Modern Casting,** American Foundryman's Society, Golf and Wolf Roads, Des Plaines, Illinois 60016 ($15.00/year)

**Modern Metals,** Modern Metals Pub. Co., 919 N. Michigan Ave., Chicago, Ill. 60611 (Monthly $6.00/year to users of nonferrous metals)

**Modern Machine Shop,** Gardner Publications, Inc., 600 Main St., Cincinnati, Ohio 45202 (Monthly/free)

**Products Finishing,** Gardner Publications Inc., 431 Main St. Cincinnati, Ohio 45202 (Monthly/free)

**Production,** Bramson Pub. Co., Box 101, Bloomfield Hills, Mich. 48013 (Monthly-one year free-then $12.00/year.)

**Steel Facts,** American Iron & Steel Institute, Public Relations Dept., 1000 16th St., N. W. Washington, D. C. 20036 (Quarterly - Free).

**U. S. Steel News,** Personnel Services Dept., United States Steel Corp., 525 William Penn Place, Pittsburg, Pa.. (Bimonthly - Free)

**Welding Journal,** American Welding Society, 345 East 47th St., New York, N. Y. 10017 (Monthly - free with membership in AWS, otherwise $8.00/year)
PROFESSIONAL PUBLICATIONS

Industrial Arts and Vocational Education/Technical Education, 400 North Broadway, Milwaukee, Wisconsin 53201

Journal of Industrial Arts Education, 3100 Elm Ave., Baltimore, Maryland 21211


School Shop, Box 623, 416 Longshore Drive, Ann Arbor, Michigan 48107

AUDIO VISUAL SOURCES

There are many films, film loops, charts, pamphlets, etc. listed throughout this curriculum guide. They are listed because they are used by the committee or they have been suggested by other teachers.

New films, charts, etc. are constantly made available as new material or to replace current publications that are no longer up to date. This list of associations, societies, and other organizations that publish these aids is provided as a source to constantly update information. A letter on school stationary every year or two will bring a constant flow of new information to up-date classroom aids.

Alcoa Informational Aids, Educational Services Section, 818 Alcoa Bldg., Pittsburg, Penn. 15219

Aluminum Association, Publications Dept., 750 Third Ave., N. Y., N. Y. 10017

American Association of Industrial Management, Suite 309, Benso Manor, Jenkintown, Pennsylvania 19046 Book--300 Films listed. $7.50

American Foundrymens' Society, Golf and Wolf Roads, Des Plaines, Illinois 60016

American Iron and Steel Institute, 150 East Forty Second St., N. Y., N. Y. 10017

American Society for Metals, Metals Park, Ohio 44073

American Society of Testing Material, 1916 Race St., Philadelphia, Penn 19103

American Zinc Institute, 292 Madison Ave., N. Y., N. Y. 10017

Brett Visual Aid Service, 7821 Big Bend Blvd., Webster Groves, Mo. 63119

Cast Iron Pipe Research Association, Executive Plaza East, 1211 West 22nd St., Suite 323, Oakbrook, Illinois 60521


DCA Educational Products Inc., 4865 Stanton Ave., Philadelphia, Penn. 19144


Jam Handy Organization, School Service Dept., 2821 E. Grand Blvd., Detroit, Michigan 48211
McGraw-Hill Text Films and Film Loops, McGraw-Hill Book Co., Manchester Road, Manchester, Mo. 63103

Metal Treating Institute, 40 Helan Ave., Box 448, Rye, New York 10580

Modern Talking Pictures Service, Swank Motion Pictures Inc., 201 S. Jefferson, St. Louis, Mo. 63103

National Machine Tool Benders Assoc., 2139 Wisconsin Ave., Washington, D. C. 20017

Republic Steel Corporation, Advertising Division, Republic Bldg., Cleveland, Ohio 44101

RMI Films Production, 4916 Main Street, Kansas City, Missouri 64112

Society of Manufacturing Engineers, 20501 Ford Road, Dearborn, Mich. 48128

Society for Visual Educations Inc. 1345 Deversy Parkway, Chicago, Ill. 60614

Sound Film Loop Source Directory, Technicolor, Commercial and Educational Division, 1300 Frawley Drive, Cosa Mesa, Calif. 92627

South Bend Lathe Company, 400 W. Sample St., South Bend, Indiana 46623

United States Steel Corp., Chicago Film Distribution Center, 108 South La Salle St., Chicago, Ill. 60690

Visual Products Division 3-M Company, American Business Systems Co., 220 Main St., Joplin, Mo. 64801

Electronic Business Equipment Inc., 1500 Grand Ave., Kansas City, Mo. 64801

Themo-Fax Sales Inc., 1601 Washington Ave., St. Louis, Mo. 63103

16mm FILM DISTRIBUTORS ADDRESSES

American Iron and Steel Institute, 150 E. 42nd St., N. Y., N. Y. 10017

Behr Manning Co., 1100 Seminary St., Rockford, Ill. 61105

BFA Educational Media, 2211 Michigan Ave., Santa Monica, Calif. 90404

Department of the Interior, Bureau of Mines, 4800 Forbes Ave., Pittsburg, Penn. 15213

Fend All Company, 11001 Manchester Road, Kirkwood, Mo. 63122

McGraw-Hill Book Co., Test Film Dept., 1221 Ave. of the Americas, N. Y., N. Y. 10020

Modern Talking Pictures Service, Swank Motion Pictures, Inc., 201 S. Jefferson, St. Louis, Mo. 63103

National Machinery Co., P. O. Box 747, Tisson Ohio 44883

Norton Co., One New Bond St., Worcester, Mass. 01606

Rennolds Metals Corp., P. O. Box 2346, Richmond, Virginia 23218

Shell Oil Co., 149-07 Northern Blvd., Flushing, N. Y. 11354

United States Steel Corp., Chicago Film Distr. Center, 208 S. Lasalle St., Chicago, Ill. 60690

Washington Steel Corp. Washington, Penn 15301
Appendix II

PUBLISHERS ADDRESS LIST

Abelard-Schuman, Ltd., 6 West 57th Street, New York, New York 10019
Aero Publishers, 329 Aviation Road, Fallbrook, California
Aldine Publishing Co., 320 West Adams Street, Chicago, Illinois 60606
American heritage Publishing Co., 551 5th Avenue, New, New York 10017
American Technical Society, 848 East 58th Street, Chicago, Illinois 60637
Appleton Century (Div. of Meredith Press), 250 Park Avenue, New York, New York 10017
Arco Publishing Co., Inc., 219 Park Avenue, South New York, New York 10003
Charles A. Bennett Co., Inc., 809 Detweiler Drive, Peoria, Illinois 61614
Bentley, Robert, Inc., 872 Massachusetts Avenue, Cambridge, Mass. 02139
Bobbs-Merrill Co., Inc., (Div. of Howard W. Sams & Co., Inc.), 4300 West 62nd Street, Indianapolis, Indiana 46206
Bruce Publishing Co., 400 North Broadway, Milwaukee, Wisconsin 53201
Chilton Book Company, 401 Walnut Street, Philadelphia, Penn. 19106
Coward-McCann, Inc., 200 Madison Avenue, New York, New York 10016
Crowell, Collier Educational Corp. (Div. of Crowell, Collier and Macmillan, Inc.), 866 Third Avenue, New York, New York 10022
Crown Publishers, Inc., 419 Park Avenue, South New York, New York 10016
Delius, Kasing and Co., Siekerwall 21, Bielefeld, Germany
Dial Press, 750 Third Avenue, New York, New York 10017
Dodd, Mead and Co., 79 Madison Ave., New York, New York 10016
Doubleday and Co., Inc., 277 Park Avenue, New York, New York 10017
R. C. Dresser, Boston, Massachusetts 02101
Duell, Sloan and Pearce, 250 Park Avenue, New York, New York 10017
Faber and Faber, 24 Russell Square, London, England WC1
Funk and Wagnalls Co., (Div. of Readers Digest Books), 380 Madison Avenue, New York, New York 10017
Goodheart, 18250 Harwood Avenue, Homewood, Illinois 60430
St. Martins Press, Inc., 175 5th Ave., N. Y., N. Y. 10010

Sampson Law, Marston (Distributed by Ginn & Co.), Boston, Mass. 02101

Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Ind. 46206

Scholastic Book Services, Scholastic Magazines, 50 West 44th St., N. Y., N. Y. 10036

Scribner's Charles Sons, 597 Fifth Avenue, N. Y., N. Y. 10017

Sterling Publishing Co., Inc., 419 Park Ave., South N. Y., N. Y. 10016

Superior Publishing Co., 708 6th Ave., North, Box 1710, Seattle, Wash. 98111

Technical Publications, Inc., 934 Wyandotte St., Kansas City, Minn. 64105

Time-Life Books (Div. of Time, Inc.), Time & Life Bldg., N. Y., N. Y. 10020

Van Nostrand, D. Co., Princeton, New Jersey 08540

Walck, Henry Z., Inc. 19 Union Square, West, N. Y., N. Y. 10003

Ziff-Davis. 595 Broadway, New York, New York 10021

American Technical Society, 848 East 58th St., Chicago, Ill. 60637

Atlas Press Co., 1822 North Pitcher St., Kalamazoo, Mich. 49007

W. A. Benjamin, Inc., 2465 Broadway, New York 25, N. Y.

Cincinnati Milling Machine Company, Cincinnati, Ohio

Delmar Publishers, Inc., Mountain View Ave., Albany, N. Y. 12205

John L. Lincoln Arc Welding Foundation, Cleveland, Ohio


South Bend Lathe Works, South Bend, Indiana

The Steck Co., Box #2028, Austin, Texas 78765

John Wiley & Sons, Inc., 605 Third Ave., N. Y., N. Y. 10016
METAL EQUIPMENT LIST

HOW TO USE THE EQUIPMENTS LISTS

It should be emphasized that the lists presented in each Section are provided as recommendations and should be considered open and flexible. They are suggested only as a guide.

Any selection of equipment and tools for inclusion in these lists necessarily involves choices among alternatives. It is not intended that any one school should buy all of the items recommended, nor is this necessary. However, the purchase of all items in each list would assure the kind and amount of equipment sufficient to carry on basic processes within each area.
## TOOL LIST
### LEVELS I, II, III, IV
### METALS

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<th>ADVANCED QUANTITY</th>
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<td>Arbor, Milling machine</td>
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<td>Bender, Universal</td>
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<td>X 1</td>
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<td>Boring Bar (set)</td>
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<tr>
<td>Brake, Box and pan</td>
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<td>Buffer, Long arm</td>
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<td>Buffer, Pedestal</td>
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<td>Chuck, Magnetic</td>
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<tr>
<td>Cutter, Milling Machine, end (set)</td>
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<td>Cutter, Milling Machine, Slitting</td>
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<td>Cutting-Off Tool, Lathe</td>
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<td>Drill, Elec., Portable ((\frac{1}{4}&quot;)</td>
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<td>Drill, Elec., Portable (3/8&quot;)</td>
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<td>Drill, Elec., Portable ((\frac{1}{2}&quot;)</td>
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<td>Electroplating Unit</td>
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<td>Forge, Gas</td>
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<td>Foaming, Roll, Slip</td>
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<td>Furnace, Crucible</td>
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<td>Furnace, Heat treating</td>
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<td>Grinder, Heavy duty pedestal</td>
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<td>Item Description</td>
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<td>Advanced Quantity</td>
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<td>Grinder, Surface</td>
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<td>Indicator, Dial test</td>
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<td>Jolt Squeezer, Foundry</td>
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<td>Knurling Tool</td>
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<td>Lathe (coarse)</td>
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<td>Knurling Tool</td>
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<td>Lathe (fine)</td>
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<td>Knurling Tool</td>
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<td>Lathe, Metalworking (10&quot;&quot;)</td>
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<td>Lathe, Metalworking (14&quot;&quot;)</td>
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<td>Milling Machine, Horizontal</td>
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<td>Milling Machine, Universal</td>
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<td>Milling Machine, Vertical</td>
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<td>Oven, Core</td>
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<td>Press Arbor</td>
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<td>Press, Drill (17&quot;&quot;)</td>
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<td>Rotary Machine, Combination</td>
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<td>Sand Blaster</td>
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<tr>
<td>Sand Muller</td>
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<td>Saw, Band (power)</td>
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<td>Saw, Hack (power)</td>
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<tr>
<td>Setting Down Machine</td>
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<tr>
<td>Shaper, Metal</td>
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<tr>
<td>Shear, ring and circle cap. 20 ga., mild steel</td>
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10-17
I. FABRICATING MACHINES AND ACCESSORIES

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<th>Introductory</th>
<th>Quantity</th>
<th>Advanced</th>
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II. HAND TOOLS AND EQUIPMENT

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<td>Brush, wire overall length 10'</td>
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<td>Bulb, Sponge</td>
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<td>Caliper, Hermaphrodite (6'') lock joint</td>
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<td>Caliper, Inside (6'') solid nut, bolt spring</td>
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<td>Chisel, Cold (set) cutting edge of 1/4'', 3/8'', 1/2'', 3/4''</td>
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<td>Chisel, Diamond point (set) 1/4'', 3/8'', 1/2'' bits</td>
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10-24
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<td>Stake, Double seaming</td>
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## II. HAND TOOLS AND EQUIPMENT

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## III. GENERAL FURNISHINGS

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### III. GENERAL FURNISHINGS

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TEXTBOOKS AND/OR REFERENCE BOOKS
FOR METALWORKING


Basic Principles of Risering. American Foundrymen's Society. 1968, 64, Addison-Wesley.


Electroslag Welding. B. E. Paton, Editor, 1962, AWS.


Gundrilling, Trepanning and Deep Hole Machining, ASTME, 1967, ASTME.


Industrial Arts and Science. Woodward, Robert C., 1962, California State Department of Education.


Machinery's Handbook: A Reference Book for the Mechanical Engineer, Draftsman, Toolmaker and Machinist, Industrial Press, 1914-.


Machining Difficult Alloys: A Compendium on the Machining of High-Strength Steels and Heat-Resistant Alloys, American Society for Metals, 1962, Reinhold.


Machinist--Machinist's Helper, Arco, 1968, Arco.


Mechanical Design Analysis, Spotts, Merhyle F., 1964, Prentice-Hall.


Metal Progress Materials and Process Engineering Databook, ASM, 1970, ASM.


Metallurgy in the Service of Man, Dennis, William H., 1961, Pitman.


Metals Handbook, ASM, 1927, ASM.


Modern Joining Processes. AWS, 1966, AWS.


Modern Steels and Their Properties. Bethlehem Steel Co.


New World of Copper, The. Tracy, E. B. 1964, Dodd.


Premachining Planning and Tool Presetting. Runck, Robert A., 1967, ASTME.


Standard for Qualification of Welding Procedures and Welders for Piping and Tubing. AWS, 1969, AWS.

Standard Welding Symbols. AWS, 1968, AWS.


Terms and Definitions, AWS, 1969, AWS.


Welding Handbook. AWS, 1968, AWS.


"Change should be appreciated and made welcome, not avoided or resented. As Americans, we've benefited enormously from it. Today's change is rampant and nowhere is it more evident than in the field of education. We can no longer think in traditional terms. Tomorrow and for many years to come, education must recognize the "career" concept which included all areas and all levels of career preparation."

Arthur L. Mallory
Commissioner of Education