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ABSTRACT

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 appendixes. 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. (NN)

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.

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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 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.

To Mr. Brightwell, the members of the committee, the many others who assisted and to the State Department of Education, a deep appreciation for your efforts and a most sincere thank you.

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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.

Behavorial 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 knowledges 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 knowledges.

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 devlop 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.

*Taken from the *Handbook for Industrial Arts Education*, Missouri State Department of Education, 1969.

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 activites 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 aproach 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, prcedures, 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 metal-work. 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 activites 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 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. Titantium

2. Beryllium

3. Columbium

4. Tantalum

5. Tungston 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

1. Dowel Pins

2. Cotter Pins

3. Retainer Rings

4. Rivets

5. Keys

C. Adhesives

1. Kinds

2. Care

V. METAL FINISHES

A. Reasons for Finish

1. Protection

2. Appearance

3. Identification

B. Surface Preparation

1. Chemical Cleaning

2. Physical Cleaning

C. Mechanical Finishing

1. Buffing

2. Wire Brushing

3. Sand Blasting

4. Spot Finishing

D. Chemical Finishes

1. Hot Dipping

2. Annodizing

3. Electroplating

4. Metal Spraying

E. Organic Finishes

1. Coatings

2. Primers

3. Thinners

F. Application

1. Flow Coating

2. Spray

G. Drying

1. Air

2. Heat

ACTIVITIES COMMON TO METALWORK

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
I. GENERAL INFORMATION						
A. Planning						
1. Working Drawings	x	x	x	x	Study several working drawings of different metal projects.	Discuss and present design concepts through: Working Drawings Elements of Design Materials Use (Filmstrip: 2)
	x	x	x	x	Make a simple working drawing.	
2. Bill of Materials	x	x	x	x	Complete a bill of material. List materials used, calculate costs of parts used as well as finish, abrasives, and hardware.	Explain various parts of bill of materials and the reason for each.
3. Plan Procedures	x	x	x	x	Complete steps of procedure for a project.	Discuss procedure of constructing projects, bench procedures, machine procedures.
B. Industry vs Education	x	x	x	x		Discuss relationship of work in metals lab with industrial procedures.
C. Career Opportunities in Metals Industries	x	x	x	x	Choose a Metals trade occupation. Write a report relating to conditions, training, pay and future outlook.	Students report to class of different metal industry occupations. (U.S.B.L.S.-Occ. Outlook)
D. Safety	x	x	x	x	Know safety procedures required for each metalwork machine.	Demonstration and discuss on safety procedure of each machine used in metals lab. (Film: 8; 14; 19) (Pamphlet: 6) (Filmstrip: 3)
II. Commonly used metals						
A. Ferrous Metals	x	x	x	x	List characteristics and properties of workable metals and alloys.	Discuss mining procedures for production of common metals from raw form to finish product.

	x	x	x	x		Identify the various types of steels used in making the machinery and tools used in the metals lab.
	x	x	x	x	List kinds of ferrous metal found in the metals lab.	Show shapes of ferrous metals and where best to use each. (Film: 9; 11; 2)
B. Production Furnaces	x	x	x	x	List the procedures used by different production furnaces.	Discuss smelting procedures used by different types of production furnaces and projects. (Films: 4; 5; 6; 10; 13; 15; 16; 20; 22) (Pamphlets: 4)
	x	x	x	x	Identify main parts of different types of production furnaces.	Discuss types of alloys most often made from each type furnace used in U.S. production.
C. Steel Classification Numbers	x	x	x	x	Describe what SAE and AISI steel numbers mean.	Discuss AISI-SAE identifying numbers.
	x	x	x	x	List commonly used steels by SAE or AISI number.	Make a display chart showing the metal number systems and the colors that identify each kind of metal.
D. Non-Ferrous Metals	x	x	x	x	Report on the effect of each element added to total Aluminum Alloy. Compare alloying elements used in steel and aluminum alloys of base metals.	Discuss the Aluminum alloy numbering system. (Pamphlet: 1)
	x	x	x	x		Discuss base metals and common alloy.
	x	x	x	x		Collect and display extruded metal shapes. and identify the use made of each.
E. Space Age Metals	x	x	x	x	List some of the metals called "Space Age Metals."	Discuss some of the metals referred to as "Space Age Metals." Identify some of the characteristics that make them important.

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
III. ABRASIVES	x	x	x	x	Become familiar with different abrasives: natural and man made.	
A. Kinds of Abrasives	x	x	x	x	Use aluminum oxide, silicon carbide and crocus cloth on both ferrous and non-ferrous metals. Note the difference and see which abrasive is better on which metal.	Discuss kinds and grades of abrasives as they are used with coated abrasives and with grinding wheels. (Film: 1, 12)
B. Grain Sizes		x	x	x	Check the belt and disc grinder in the metals lab to see what grain size and what kind of abrasive grains are used on the belt---on the disc.	Make a display board with each grain size and each type of coated abrasive used in the metals lab and label each one.
C. Coated Abrasives		x	x	x	Become familiar with the different grades, backing, and lubricants related to abrasives.	Discuss the kinds and places that use abrasives in several local industries. (Film: 3)
		x	x	x	Use an expanded mandrel and an abrasive sleeve to polish curved surfaces on a project.	
		x	x	x	Use rubberize abrasives for grinding and polishing.	Demonstrate how to use rubberized abrasives for spot finishing and fine polishing.
D. Grinding Wheels		x	x	x	Be able to specify a grinding wheel for a particular use.	Demonstrate how to properly use abrasives on different metals to get different results.
		x	x	x	Test a gring wheel for soundness.	Demonstrate care and use of abrasive wheels on grinders and different power tools.
	x	x	x	x		Test for durability of different abrasives used dry and used wet.
	x	x	x	x		Check a local auto repair shop and what size(s) grain is used in valve.

IV. FASTENERS

A. Threaded	x	x	x	x	Fasten sheet metal with screws.	Use a display board of different fasteners made of different kinds of metal. Label each. (Bolts, nuts, screws, and washers) (Pamphlet: 3)
	x	x	x		Fasten metal with cap screws, machine screws and bolts.	
	x	x	x		Call the local hardware store and find out why fasteners have different finishes.	Discuss use of different types of threaded fasteners, finishes, and shapes.
	x	x	x		Determine which fastener will be needed for each project you make in the metals lab.	Discuss use of diffeent types of threaded fasteners, finishes, and shapes.
	x	x	x		Become familiar with procedures for drilling holes to receive bolts and sheet metal screws.	Discuss methods of specifying fasteners. (Bolts, nuts, screws, and washers) (Film: 17)
		x	x		Collect different kinds of lock washers, name each one and decide where it might best be used.	Discuss how to determine correct sizes of screws, bolts, nuts, and washers for particular jobs.
B. Non-Threaded Fasteners.	x	x	x	x	Become familiar with the many nonthreaded fasteners.	Discuss when and where dowel pins, retainer ring, rivets, and keys should be used.
	x	x	x	x	Find samples of non-threaded fasteners used in the metals lab and indicate why you think each one was used in its particular position.	Collect and display non-threaded fasteners. Label each with common names.
	x	x	x	x	Rivet sheet metal. Form a rivet head with a ball peen hammer--with a rivet set.	Demonstrate preparation and use of rivets, with rivets and hammer.
	x	x	x	x	Fasten sheet metal with "pop" rivets.	Discuss size and shape of common keys for shafts, wheels, etc.

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
C. Adhesives	X	X	X	X	Bond two or more metals with adhesives for metal.	Discuss kinds and applications of common adhesives for metals.
	X	X	X	X	Test metal fastened with adhesives for metal.	Demonstrate preparation and application of common adhesives for metal.
V. METAL FINISHES						
A. Reasons for finish	X	X	X	X	Become familiar with several finishes that are satisfactory for different kinds of metal.	Discuss different metal finishes and the advantage and disadvantage of each.
	X	X	X	X		Explain why finishes are used for appearance, identification and protection.
	X	X	X	X	Pick finishes to be used on metal projects to be made in the metal lab. Give reasons for each.	Demonstrate preparation and application of several finishes that are suitable for different kinds of metal.
:	X	X	X	X	Note the color coding of the equipment used in the metal lab. Study each color and what it stands for.	
B. Surface preparation	X	X	X	X	Clean metal for chemical finish.	Demonstrate safe use of chemical finishes and solvents.
		X	X	X		Explain the different methods of physically and chemically cleaning metal before applying the finish.
C. Mechanical Finishing	X	X	X	X	Try buffing and polishing with different kinds of wheels and different kinds of abrasives. Determine the best method for your metal.	Demonstrate the buffing wheel, flap abrasive wheel and wire sheel and explain the different finishes available with these methods.

		X	X	X	Try a wire wheel finish using different size wire.	Demonstrate different sizes and kinds of wire wheels.
		X	X	X	Determine if finer wire or heavier wire produces the kind of finish you want.	
		X	X	X	Sand blast an aluminum casting before applying the finish.	
D. Chemical Finishes	X	X	X	X	Identify several chemical solvents for different chemical finishes.	Discuss and demonstrate proper care of finish equipment. Stress eye safety.
	X	X	X	X	Clean finish equipment.	Discuss and demonstrate when possible hot dipping, annodizing, electrplating, and metal spraying.
E. Organic Finishes	X	X	X	X	Apply organic finish to a metal surface.	Discuss appropriate organic finishes for different metals.
F. Application	X	X	X	X	Use several metal finish applications available to you in the metals lab.	Identify and discuss the different metal finish applicators and procedure commonly used.
G. Drying	X	X	X	X	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.	Discuss metal finish drying procedures.

A. TEXT AND REFERENCE BOOK FOR ACTIVITIES COMMON TO METALWORK

Feirer, John L.*General Metals*. McGraw-Hill Book Company, New York, 1967.

Giachino, J.W. and N.L. Schoenhals. *General Metals for Technology*. Bruce Publishing Company, Milwaukee, Wisconsin, 1964.

Johnson, Harold V. *Technical Metals*. Chas. A. Bennett Company, Inc. Peoria, Illinois, 1968.

Ludwig, D.A. and W.J. McCarthy. *Metalwork Technology and Practice*. McKnight and McKnight Publishing Company, Bloomington, Illinois, 1969.

Machinery's Handbook, Industrial Press Incorporated, New York, 1969, 18th edition, Holbrook L. Horton, editor.

Making, Shaping and Treating of Steel, United State Steel Publisher, 1964, 8th edition, Harold E. McGannon, editor.

Metals Handbook, American Society for Metals, 1961, Vol. 1, 8th edition.

Walker, John R. *Machining Fundamentals*. Goodhart Wilcox Company, Inc., publishers, Homewood, Illinois, 1969.

B. FILMS FOR ACTIVITIES COMMON TO METALWORK

1. *Adventures in Abrasives* - 25 min. - Norton Co.
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. *Dont 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
13. *Metallurgy Plus* - 12 min. - Modern Talking Picture Service
14. *Metal Shop Safety* - 18 min. - McGraw Hill
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* - 26 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 Fourty 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

1. *Catalog, Poster Directory* - National Safety Council
2. *Safety Charts* - 8x11 - Clausing

DISTRIBUTORS ADDRESSES:

Clausing, 2019 N. Pitcher, Kalamazoo, Michigan, 49001

National Safety Council, 425 N. Michigan Ave., Chicago, Illinois, 60611

PART II
ART METAL

I. 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. Riviting

VI. MACHINE FORMING

A. Spinning

B. HERF--High Energy Rate Form

C. Stamp Forming

PART II - ART METAL

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
I. GENERAL INFORMATION						
A. Safety	x	x	x		Visit museums and art stores to study well designed articles.	Discuss safe practices using tools, equipment, chemicals, and materials used in art metal work.
B. Priacples and Elements of Design	x	x	x	x	Identify several metals used for art metal.	Discuss principles of design using art metals.
	x	x	x	x		Display objects of good design that use techniques of art metal work
C. Kiods of Metals	x	x	x	x	Calculate the cost of art metal used in a project.	Show examples of different kinds of metal used as art metal, observe the characteristics. (Film: 1.2)
D. Material Costs	x	x	x	x	Plan an art metal project.	Explain how material costs are calculated.
E. Planning	x	x	x	x	Layout a project made of sheet material.	Demonstrate principles of layout and development of objects made of sheet metal.
	x	x	x	x	Use a template to make object layout.	
	x	x	x	x	Transfer a design to metal.	
F. Cutting and Filing	x	x	x	x	Saw out a design with a jewelrs saw and file edges.	Display layout, cutting, and shaping tools used in art metal work.
	x	x	x	x		Demonstrate each tool using practices that will be commonly used by students.

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
G. Hammers	x	x	x	x	Use hammers to shape art metals with stakes.	
H. Stakes and Stake Plate	x	x	x	x	Use stakes with hammer to shape art metal surfaces.	Identify common metal stakes and demonstrate some of the common techniques of shaping metal on stakes.
I. Annealing	x	x	x	x	Anneal common art metals and not color changes as heat changes.	Demonstrate annealing techniques, discuss the need for annealing and when to anneal.
J. Pickeling	x	x	x	x	Mix a pickeling solution for different kinds of metals.	Discuss purpose and need for pickeling art metals.
	x	x	x		Clean and anneal art metal in a pickeling solution.	
II. HAND FORMING						
A. Holding & Forming Jigs	x	x	x	x	Use a forming jig to hold metal while shaping.	Demonstrate the use of and discuss holding and forming jigs.
B. Metal Tooling	x	x	x	x	Tool a pattern or design on foil.	Demonstrate metal tooling over hard and soft surfaces.
C. Beating Down	x	x	x	x		Demonstrate correct practices of beating down metal to maintain desired shape.
D. Low and High Raising	x	x	x	x	Raise copper or brass to a depth and shape of a pattern.	Demonstrate high and low raising over different types of forms.

III. SURFACE SHAPING	x	x	x	x	Flute, scallop and chase metal edges and surfaces.	Demonstrate the several methods of surface shaping used with art metals.
IV. SURFACE DECORATION	x	x	x	x		Demonstrate several methods of surface decoration used with art metals.
A. Peening	x	x	x	x	Peen the surface of some metal to use as surface decoration.	
B. Piercing	x	x	x	x	Saw pierce a design in a metal surface.	Demonstrate correct and safe practices of piercing metal.
C. Overlaying	x	x	x	x	Use the overlaying technique to decorate an object surface. Add decorative domes on edges of raised objects.	Demonstrate sweat soldering as a method fastening the overlay to the base metal.
D. Doming and Dapping	x	x	x	x	Decorate the edges of metal project with dapping tools.	
E. Engraving	x	x	x	x	Use a design on a surface requiring engraving and etching.	Demonstrate techniques of engraving and etching.
F. Etching	x	x	x	x	Use etching fluids and pastes safely. use a sample etch before the finish project is etched.	Discuss safety practices needed while etching with acid.
G. Buffing	x	x	x	x	Mount buffing wheels and give a high polish to a surface	
H. Metal Enameling	x	x	x	x	Clean, coat, enamel, and fire metal to proper temperature.	Discuss temperature effects on metal and demonstrate best temperatures for different metal thicknesses.
I. Color Finishes	x	x	x	x	Mix proper solutions and color several metals.	

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
V. FASTENING						
A. Soldering	x	x	x	x	Solder art metal with hard solder and soft solder.	Discribe different solders, their uses, melting tempeaturs, and compositions.
B. Fluxes	x	x	x	x	Apply fluxes to soldered joints.	Demonstrate safe and proper procedures of hard and soft soldering.
	x	x	x	x		Discuss solder fluxes, their use and application.
C. Heat Sources	x	x	x	x	Apply heat to a joint to be soldered.	Demonstrate several methods of applying heat for soldering.
D. Cementing	x	x	x	x	Fasten metals with adhesives.	List and describe characteristics of adhesives used in art metal work.
E. Riveting	x	x	x	x	Fasten art metal pieces with rivets.	Discuss fastening by rivets.
	x	x	x	x		Point out when it is best to use rivets or othe fasteners.
VI. MACHINE FORMING						
A. Spinning	x	x	x	x	Spin metal over a one piece chuck.	Discuss and demonstrate shaping art metal by machine processes.
B. H.E.R.F.		x	x	x	Study industrial methods and machines used to mass produce art metal work.	Explain how H.E.R.F. works and when and why it is used in industry.
C. Stamp Forming		x	x	x		Discuss stamp forming processes and where stamp forming is used.

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 Nominclature
- 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

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
I. NON-EDGE BENCH TOOLS	x	x				Identify common non-edge tools used in bench metalwork and demonstrate safe use of each.
A. Hammers & Mallets	x	x			Use a mallet to set a work piece in a vise on parallels.	Demonstrate proper use and care of commonly used mallets and hammers. (Film: 1,5)
B. Screw Drivers	x	x			Regrind a worn screwdriver tip.	Discuss different types of screwdrivers.
	x	x				Demonstrate proper reshaping of screwdriver tips.
	x	x				Display a large model of a properly ground screwdriver tip.
II. CLAMPING TOOLS	x	x			Clamp work in a vise secure to receive work.	Demonstrate proper care and use of commonly used clamping tools. (Filmstrips: 1,2)
	x	x			Adjust swivel base vise to position work.	
III. CUTTING TOOLS						
A. Chisels	x	x			Sharpen a flat cold chisel. Check the cutting angle with a center guage.	Discuss difference of chisels and punches.
	x	x				Demonstrate proper use and care of cutting bench hand tools. (Chisels & Punches) (Film: 3, 4)
B. Shears	x	x			Cut a pattern to shape with snips and shears.	Discuss different kinds of shears and snips. how they function.
	x	x			Sharpen straight snips.	Demonstrate how these tools are properly used and cared for.
	x	x			Sharpen and replace inside slitter blades.	

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
C. Files	x	x			Identify a file by length, shape & cut.	Discuss file terminology, shape & cut. Demonstrate proper and safe use and care of hand files.
	x	x			Clean a file with a file card.	
D. Hacksaws	x	x			Fit a frame with a new blade.	Demonstrate proper use and care of hacksaws and blades.
	x	x			Cut metal properly with a hacksaw.	Discuss hacksaw blades use and care.
E. Hacksaws (cont.)	x	x			Select a hacksaw blade for a particular job.	Identify how blades are specified.
IV. ASSEMBLY TOOLS	x	x			Fasten nuts with a wrench.	Discuss types of box end and open end wrenches commonly used in work. (Films: 5, 11, 14)
	x	x	x		Use the torgue wrench to tighten nuts or stud bolts to a given setting.	Demonstrate proper use and care of different types of wrenches.
	x	x	x			Demonstrate the efficiency in using sockets and ratchet wrenches.
V. MEASURE AND LAYOUT TOOLS						
A. Measuring Tools						
1. Rules	x	x			Measure a distance with a ruler to the nearest 1/64 inch.	Discuss the different layout and measuring tools commonly used in bench metal work.
	x	x			Use a circumference rule to layout a sheet metal pattern.	Demonstrate proper use of several measuring and marking tools.

2. Calipers	x	x			Adjust caliper to inside and outside dimensions or measurements.	
3. Squares	x	x			Layout angles and squares with the combination set.	Demonstrate many ways to use the combination square.
	x	x			Use layout dye and locate drill positions and draw parallel lines on metal objects.	Discuss layout dyes.
B. Layout Tools		•				
1. Layout Dye	x	x			Mark dyed surfaces with divider, punches and scriber.	Demonstrate application of dyes on metals. (Films: 5, 8, 9)
	x	x	x		Use the divider and/or trammel points to lay out all arcs and circles.	Demonstrate the use of all layout tools.
VI. DRILLS						
A. Sizes	x	x			Determine the size of a drill bit with a drill guage.	Discus different drills, purpose, use, and sizes. (Film: 12, 13)
B. Drill Nomineclature					Identify different parts of a drill bit and explain the funtion of each.	
C. Care and Use	x	x			Properly sharpen a drill bit to drill a particular metal.	Explain why a larger drill will not start its own hole.
		x	x	x	Study several ways a drill can be incorrectly ground and check the drills in the metal lab for these problems.	
D. Types of Drills	x	x			Drill a blind hole.	Discuss drill procedures involving pilot holes, counter boring and counter sinking, etc. (Filmloops: Series)
	x	x			Counterbore to a depth.	
	x	x			Counter sink a hole to receive a flat head cap screw.	

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
E. Speed and Feeds	x	x			Adjust variable speed equipment to match drill size to kind of metal being drilled.	Demonstrate use of drill charts. Discuss feeds and speeds need to drill holes in metal.
	x	x			Use lubricants to extend use of a drill bit.	
F. Drilling Tools	x	x			Use a portable drill and a drill press to drill holes in steel plate.	Demonstrate proper and safe use of portable and stationary drilling machines (Charts: 1, 2)
G. Work Holding Tools	x	x			Hold and drill holes in sheet metal. Hold and drill holes in round stock.	Demonstrate use of drill press vise, v-block set and other holding fixtures.
H. Safety	x	x			Follow safe work procedures while drilling and working with metal.	Demonstrate and discuss safe work procedures with several shapes of metal.
VII. SCREW THREADS						
A. Terminology	x	x			Identify the size and type of thread found on a bolt.	Discuss screw threads, size, shapes, and terminology. (Film: 10.12)
	x	x			Use lubricants and cut threads on round stock pipes and in holes.	Demonstrate proer use and care of screw thread tools.
		x	x		Measure the number of threads on a socket cap screw with a screw pitch guage.	Show how to read a tap drill chart.

VIII. WROUGHT IRON WORK **(Low Carbon Steel)**	x	x			Bend, twist, shape and fasten metal bands.	Discuss wrought iron, wrought iron work, and the metal and designs used in the work. (Film: 6.7)
	x	x	x		Bend a scroll by hand and then with a universal bender and compare the effort and the end product.	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
4. *Files, How to Choose and Use Them* - Heller Tool Co.
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. *Tape-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. Diacro 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
8. Pratt and Whitney, Charter Oak Blvd. West Hartford, Connecticut 06101
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 C., 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 BISUAL

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

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
I. SAFETY	x	x			Learn and observe safe procedures for handling hot metal.	Demonstrate and discuss safety procedures to be observed when lighting the forge furnace, heating metal, and holding for forging.
	x	x			Protect your cloths, hands, face, eyes and hair when forgin hot metals.	Make available clothing and protection devices needed to work with hot metals.
II. SOURCES OF HEAT	x	x			Practice exact lighting procedures and adjustments on the forge furnace.	Discuss and demonstrate use and need of safety devices on forge furnaces.
	x	x				Discuss different sources of heat available for forge work.
III. FORGE TOOLS	x	x			Hold different shapes of metal with different tongs.	Discuss forge practices and how to hold metal to get best effect from hammer and anvil. (Phamphlet: 4)
	x	x			Use a hammer and anvil to shape hot metal.	Discuss and demonstrate: need, use and sizes of forging tools. (Pamphlet: 5)
IV. FORMING HOT METALS	x	x			Heat mild steel: test shaping ease at different temperatures.	Discuss metal chacteristics that lend themself best to forge practices. (Pamphlet: 1, 2,3)
A. Kinds of Forming	x	x			Draw, upset, flatten, bend, and punch hot metals.	Demonstrate techniques of shaping hot metal.

V. INDUSTRIAL FORGING	X	X	X		Identify open & closed, drop and press forging.	Discuss different methods of industrial forging.
	X	X	X			Observe the design advantage of forge over machined metal. (Film: 1, 2, 4)
VI. EMPLOYMENT OPPORTUNITIES	X	X			Take a field trip to observe forge operations.	Discuss forging occupations, working conditions, training needed, and future outlook.

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 Hoe for Kalagoo* - 27 min. - Modern Talking Pictures Service

16mm FILM DISTRIBUTORS FOR FORGING

Manager-Market Service, Wyman-Gordon Company, Worchester, Mass. 01601

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

PART V - FOUNDRY

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
I. FOUNDRY SANDS	x	x	x		Identify different kinds of sand and know where to use each type.	Discuss the advantages and disadvantages of differetn kinds of sand used in foundry practices. (Pamphlet: 1. 2. 3)
	x	x	x			Discuss the several ways industry tests foundry sand.
II. TEMPERING SAND	x	x	x		Mix and cut green sand and temper sand for molding.	Discuss desirable characteristics of foundry sand.
	x	x	x	x	Test sand for proper tempering.	Demonstrate proper procedure and tests for tempering sand. (Film:)
	x	x	x	x	Mix Core sand and binder and harden with heat or CO2.	Discuss foundry cores, core boxes, & core sand binders.
	x	x	x	x	Make a core for a mold.	
III. MOLDS	x	x	x	x	Make a green sand mold with sprue, risers, and channels and gates.	Demonstrate raming a green sand mold.
	x	x	x	x		Show how to cut channels, gates, risers, and sprue and cup. (Films: 2. 3)
	x	x	x	x	Ask your dentist how he uses investment casting.	Discuss different parts of molds.
	x	x	x	x	Use the ram, riddle to mold a pattern in a flask.	Explain the advantages and reasons for each part. (Filmstrip: 2)
	x	x	x	x	Patch and repair a mold with a slick and/or spoon.	
	x	x	x	x	Cut riser and sprue holders of a mold.	

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
IV. PATTERNS	x	x	x	x	Ram a mold using a split pattern.	Discuss the different kinds of patterns used in foundry and demonstrate how each is used to make mold. (Film: ")
	x	x	x	x	Ram a mold using a one piece pattern.	
	x	x	x	x	Use a match plate to make a mold.	
V. FOUNDRY METALS	x	x	x	x	Prepare ferrous and nonferrous metal to charge a furnace.	Discuss which metals can be melted in the school furnaces and how to prepare them for melting.
	x	x	x	x	Heat metal and pour a casting.	
	x	x	x	x	Use flux to clean molten metal	Discuss metal fluxes.
VI. SAFETY	x	x	x	x	Learn and follow safe procedures on handling hot metal.	Disuess and demonstrate safe procedures in lighting furnace, heating, and pouring hot metal.
	x	x	x	x	Wear safety clothing while pouring hot metal.	Make available clothing needed to work with hot metal.
	x	x	x	x	Practice exact lighting techniques, adjusting and charging a foundry furnace.	Demonstrate and discuss safety devices on the foundry furnaces.

VII. SOURCES OF HEAT	x	x	x		Read a pyrometer and determine melting and pouring temperatures of different metals.	Discuss melting and pouring temperatures of different metals.
		x	x	x		Discuss the techniques different foundry furnaces use to melt metal for pouring.
	x	x	x	x	Charge a furnace with metal.	
	x	x	x	x	Lift hot metal from a furnace.	
	x	x	x	x	Pour hot metal into a mold.	
VIII. INDUSTRIAL FOUNDRY MACHINES	x	x	x	x	If available use a jolt squeeze machine to ram a mold.	Discuss the different foundry machines used in industry for mixing sand, tempering, raming molds and testing castings. (Film: Mechanized Foundry)
IX. OCCUPATIONAL OPPORTUNITIES	x	x	x	x	Visit a foundry and pattern shop.	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
2. *Die Casting - How Else Would You Make It?* - 35 min. - Modern Talking Picture Service
3. *Manufacturing Jet Engine Blades* - Ralph E. Coe Co.
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 Foundrymans' Society, Golf and Wolf Roads, Des Plaines, Illinois 60016

Beardsly 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 Foundrymans' Society, Golf and Wolf Roads, Des Plaines, Illinois 600016

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. McEnglevan 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

Patternmaking and Founding, Smith, Robert E., 1954, McKnight and McKnight Publishing Co., Bloomington, Illinois 61701

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 Foundrymans' Society, Golf and Wolf Roads, Des Plaines, Illinois 60016

American Society for Metals, Metals Park, Ohio 44073

Ductile Iron Society, Box 858, Cleveland, Ohion 44122

Foundry Educational Foundation, Terminal Tower Building, Cleveland, Ohio 44122

Gray and Ductile Iron Foudners 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 QUENCEHS

- 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

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
I. METAL COMPOSITION		x	x	x		Discuss the different heat treatment processes of ferrous and nonferrous metals. (Phamphlet: 3) (Film: 1)
		x	x	x	Study the numbering system for aluminum, particularly the heat treating numbers.	Display in chart form the numbering system of ferrous and nonferrous metals.
		x	x	x		Explain the characteristics of hardness with carbon content of steel. (Film: 2, 4, 5)
		x	x	x	Study the kinds of steel used in the metals lab and identify each one as low, medium, or high carbon steel.	Demonstrate how steels can be identified as low, medium, and high carbon steels.
II. SAFETY		x	x	x	Wear proper clothing while handling hot metal.	Demonstrate safe procedures and equipment in working hot metal.
III. TYPES OF FURNACES		x	x	x	Set controls and heat metal to a desired temperatures.	Explain the differences in furnaces used in heat treatment of metals.
		x	x	x		Discuss sources of heat by fuel and show which is easiest to obtain, safest to use, and most economical.
		x	x	x		Describe the function and operation of the thermocouple.
IV. TYPE OF QUENCHES		x	x	x	Try several quench solutions.	Discuss metal quenches. Indicate advantages and disadvantages of each on different metals. (Film: 4)

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
V. HEAT TREATMENT PROCESSES		x	x	x	Compare high and low carbon steels and heat treatment processes.	Discuss critical temperatures of metals and molecular structured effect. (Pamphlet: 3, 3, 4)
		x	x	x	Case harden a piece of steel using powder and using pellets and compare the finish on the case hardened metal.	
VI. HARDNESS TESTING		x	x	x	Compare hardness scales and temperatures effects.	Discuss different hardness scales and demonstrate procedures for testing hardness with each.
		x	x	x	Test the hardness of several metals.	
VII. INDUSTRIAL APPLICATIONS		x	x	x	Study the automation of industrial furnaces used to heat treat metals.	Discuss method of heat treatment used in industry not used in school. Explain why.
VIII. OCCUPATIONAL INFORMATION		x	x	x	Look in references for jobs in dealing with heat treatment.	Discuss careers in heat treatment field. (Guest speaker) (Pamphlet: 1)

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
4. *Modern Heat Treating Methods*--Leeds and Northrup
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., Philadelphis, Pennsylvania 19144

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

Ohio State University, Motion Picture Division, 1885 Weld Ave., Columbus Ohio 43210

Purdue University, Visual Aids Bureau, Lafayette, Indiana 49707

B. CHARTS FOR HEAT TREATING

1. *Showing Temper and Heat Colors*--Bethelem Steel Corp., 701 E. 3rd St. Bethlelm, Pennsylvania 19016

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. Am rican 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 Nominclature

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. Tungston 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 Devises

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. Coolent 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 Nominclature

D. Reaming Speeds and Feeds

PART VII - MACHINING METALS

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
I. MACHINE PLANNING						
A. Machine Drawings						
1. Working Drawings	x	x	x	x	Study several working drawings of projects requiring machining oprations for its frabrication.	Discuss Tolerance diminishing found on machine drawing and what students in machining metal need to know. (Chart: 1, 2)
	x	x	x	x	Become familiar with the lines, notes, dimensions, and abbreviations used on machine drawings.	
2. Bill of Material	x	x	x	x	Make a bill of material: List parts, materials, AISI and non-ferrous numbers.	Discuss AISI and SAE numbering include non-ferrous metal.
	x	x	x	x	Calculate cost of materials.	
3. Basic Machine Operations	x	x	x	x	Determine which bench and machine operations are needed to complete each project and in what order is each performed.	Discuss basic machine operations as a quick overview.
B. Measuring	x	x	x	x		Explain procedures for sawing, drilling, turning, boring, milling, grinding, polishing, shaping, planing, and slotting. (Chart: 3)
1. Metric System	x	x	x	x		Examine the difference between English and metric measurements. (Chart: 5, 6, 7, 8)

	x	x	x		Read a machinist. Rule to 1/64th".	
					Change common fractions to decmal.	Discuss reasons for limits and tolerances and why they are used. (Chart: 4, 12, 13)
2. Types of Rules	x	x	x	x	Read a micrometer. Read the vernier gages.	Demonstrate the use of vernier gages and micrometers. (Pamphlet: 2, 3, 4)
	x	x	x	x	Use dial indicator to check work centered on lathe and to align work on milling machine.	
3. Tolerance and Limits	x	x	x	x	Check outside and inside radii with radius guage.	Give information on industrial use of several of the extremely accurate measuring guages.
	x	x	x	x	Measure inside diameters of holes and slot with telechoping gage and/or hole gage.	Demonstrate measuring with adjustable parallels and outside micrometer.
4. Guages and Other Measuring Devices	x	x	x	x	Use gage blocks to check accuracy of tools and setups.	
C. Work Layout						
1. Layout Dyes	x	x	x	x	Coat metal with dye.	Demonstrate use of surface plate, surface gages and/or vernier height gage to layout intricate parts. (Film loop: Bench skills 1-15)
2. V-Blocks	x	x	x	x	Use divider and trammel points to layout arcs and circles.	
	x	x	x	x	Locate and drill holes in round stock held in V-Blocks.	

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
II. SAFETY						
A. Safe Practices	x	x	x	x	Work in a neat and orderly manner whether planning your work or actually working on a machine.	Explain color coding of parts of all machines.
	x	x	x	x	Wear safe clothing and eye protection.	Demonstrate safe work procedures for each machine.
	x	x	x	x	Clean machine every time it is used.	Explain the importance of thinking and acting in a safe manners.
	x	x	x	x		Discuss the importance of reporting missing machine guards or machines not in proper working order, and all personal injuries.
	x	x	x	x		Point out location and proper use of all fire extinguishers.
III. DRILLING						
A. Drills	x	x	x	x	Use drills to drill holes in metal.	Discuss the different kinds of drills and when to use each. (Film: 1A)
1. Sizes	x	x	x	x	Identify drill size by shank markings and drill gauge.	Explain drill procedures for all sized drills.
2. Drill Nomenclature	x	x	x	x	Sharpen several drills by hand and/or machine.	Discuss the parts of sharp twist drills and determine procedure to check for wear and dullnes. (Film: 22)
3. Drill Care	x	x	x	x	Study several ways a drill may be incorrectly ground and check drills used in metals lab for these problems.	Demonstrate proper drill grinding and faults of incorrect grinding.

4. Drill Practices	x	x	x	x	**Figure size of pilot holes for a given size of counterbore.**	
5. Types of Drills	x	x	x	x	**Counter sink holes for flat head machine screws.**	**Explain when carbide tipped drills are used to replace retular drills.**
	x	x	x	x	**Center drill stock for mounting in lathe.**	
6. Feeds and Speeds	x	x	x	x	**Select proper feed and speed in drilling metals.**	**Discuss the need for drill feeds and speeds in metal.**
	x	x	x	x	**Compare effect of different feeds and speed of different metals.**	**Study drill speed chart.**
7. Drill Press	x	x	x	x		**Discuss the size. adjustments. procedures of using the drill press and holding stock for drilling. (Film loop: Drill press series)**
8. Work Holding	x	x	x	x	**Set-up several ways to hold metal for drilling.**	
9. Lubricants	x	x	x	x	**Use lubricants while drilling and milling.**	**Explain why proper lubricants will extend life of cutting edge and produce a more accurate sized hole.**
	x	x	x	x		**Discuss different lubricants used with different metals.**
10. Drill Safety	x	x	x	x	**Follow drill press safety rules.**	**Demonstrate and discuss drill press safe practices.**
11. Industrial Practices			x	x		**Discuss and display industrial drill procedure material of equipment and numerical control applications and micro precision drilling machines. (Film: 20)**

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
IV. METAL CUTTING						
A. Power Hacksaw						
1. Blades	x	x	x	x	Saw stock to length.	Discuss hacksaw blades set, number, and shape of teeth.
	x	x	x	x	Write specifications for hacksaw blades.	Demonstrate installation, use and adjustment of hack saw blades.
	x	x	x	x	Set-up saw vise for angular cuts.	Discuss types of cutting fluids used on "wet" saw machines.
	x	x	x	x		Demonstrate hack saw feeds and feed mechanisms.
B. Bandsawing Metal	x	x	x	x	Cut off metal with a band saw.	Discuss the band saw versus other metal removing machines.
1. Horizontal and Vertical Sawing	x	x	x	x		Explain the kinds of blades used in horizontal band saws compared to vertical band saws.
	x	x	x	x	Use band saw to cut metal, both wet and dry.	Discuss the set, type, and spacing of band saw teeth and when to use each.
	x	x	x	x	Adjust feed of band saw frame and blade guides to cut different kinds of metal.	Demonstrate proper installation and adjustment of band saw blades. (Film: 18)
2. Band Saw Safety	x	x	x	x	Follow safety rules pertaining to horizontal and vertical band saws.	Demonstrate safe sawing practices for both horizontal and vertical band sawing.

		x	x	x		Discuss the value of variable speeds on band saws. (Chart: 10)
C. Friction Sawing		x	x	x	If equipment is available, cut metal by friction sawing.	Study speeds and kinds of blades needed for friction sawing.
		x	x	x	Weld and repair a metal cutting blade.	Demonstrate proper preparation, welding and finishing metal cutting blade use.
V. MACHINE LATHE						
A. Kinds and Sizes	x	x	x	x	Measure lathe to determine size.	Discuss the size, types and basic parts of common machine lathes. (Film: 10) (Film loop series: The English Lathe)
B. Line of Power	x	x	x	x	Change speed of the lathe for different operations.	Discuss the "Line of Power" of lathe from electricity to feeding cutter bit.
C. Turning Attachments	x	x	x	x	Check stock for face turning and between center turning.	Discuss work holding devices in order to pick the best for each kind of operation.
D. Cut Feeds and Speeds	x	x	x	x	Figure speeds (RPM) and feeds for each job done on lathe.	Explain methods to calculation lathe speeds and bit feed for different metal and operations.
E. Mounting Work	x	x	x	x	Layout the center for round stock, center drill ends and mount between centers.	Discuss mounting tools and the need for different mounting tools.
	x	x	x	x	Fasten work with proper lathe dog.	
F. Turning Between Centers	x	x	x	x	Set up lathe for different speeds for rough and finish turning between centers.	Discuss proper cutter bit and holder for any given lathe operation.
	x	x	x	x	Grind cutter bits for particular lathe operations.	Demonstrate how to grind cutter bit to shape for particular lathe operations.

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

B. Vises	x	x	x	x	Use parallels in the machinist vise to machine flat surfaces.	Demonstrate safe procedures in holding metal for machining in sevral kinds of machinist vises.
VII. MILLING MACHINE						
A. Kind and Size			x	x	Identify kinds, sizes, and relative merits of each.	Discuss features of the different mills, and the advantages and disadvantages of each type.
B. Parts and Controls			x	x	Operate the mill using 3 directional feeds and use the rapid traverse lever to rapidly position work.	Discuss the three directional feed available on the mill and demonstrate the operation of the controls of feeds.
C. Cutting Feeds and Speeds			x	x	Calculate the speed for a piece of stock, set mill controls and mill stock.	Explain procedures for calculating feeds and speeds on a mill.
D. Types of Cutters			x	x	Identify the different types of cutters for both horizontal and vertical mills.	Discuss the different type of mill cutters. Indicate those for horizontal and vertical mills and which may be used on each.
E. Holding and Driving Cutters			x	x	Mount mill cutters on horizontal mill arbors--use space collars.	Explain procedures to mount mill cutters on both horizontal and vertical mill. (Pamphlet: 1)
F. Work Holding Attachments			x	x	Clamp work in a vise for milling.	Discuss the comparative advantages and disadvantages of the swivel vise and/or universal vise over the plain vise.
		x	x	x		Discuss the capacity of the magnetic vise.
		x	x	x		Discuss the procedures of indexing work for gear cutting.
G. Coolents Fluids			x	x	Use coolents in milling metal.	Discuss the common machine coolent fluids, their contents, and use.
H. Milling Safety			x	x	Operate mill safely.	Demonstrate and discuss safe milling practices.

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
I. Industrial Milling		x	x	x		Discuss industrial milling procedures not dulicated in the metals lab.
III. GRINDING						
A. Belt and Disc Grinding		x	x	x	Grind metal surfaces to a specific size.	Discuss grain sizes and which is far rough and finish grinding.
		x	x	x		Display a test strip showing several grain sizes and finishes they produce.
		x	x	x		Discuss the various forms of grinding. Indicate the advantages and disadvantages of each. (Film: 5)
B. Surface Grinding			x	x	Adjust surface grinder to grind within ten-thousandth of an inch. (.0001)	
1. Kinds and Sizes			x	x	Discuss the kinds and sizes of surface grinders.	
2. Work Holding Devices			x	x	Use the magnetic chuck to hold work while grinding.	Explain how the magnetic chuck works and how it is turned "on" and "off."
3. Grinding Wheels			x	x	Choose the proper wheel to grind mild steel and install on the spindle.	Discuss the importance of using the right wheel for different kinds of metal. (Film: 8, 9)
			x	x	Write specifications to order a given type of wheel.	Study the number and letter system of identifying the make up of a grinding wheel.
4. Coolents			x	x	Use a coolant during grinding operations.	Discuss collants as cutting fluids and show best application for types of work.

5. Wheel Dressers			x	x	Set-up a wheel dresser and "true" a grinding wheel.	Identify a "loaded" wheel and discuss how it should be cleaned.
			x	x		Demonstrate the procedure for dressing he face of a wheel.
6. Sharpening Milling Cutters.			x	x		Discuss the process of sharpening millin cutters. Indicate which can be sharpened in the school shop. (Film: 4)
7. Safe Grinding Practices			x	x	Follow safe grinding practices.	Demonstrate safe grinding practices.
8. Industrial Grinding			x	x		Discuss and provide as many industrial grinding operations as possible.
IX. SHAPER						
A. Kinds and Sizes			x	x	Set controls and machine a flat surface.	Study the shapers in the school lab and discuss how shapers are sized. (Film strip: How to operate the shaper)
B. Table and Cutter Feeding			x	x	Mount work for milling.	Discuss the best methods to mount work on shaper table.
			x	x	Calculate number strokes/min. needed for rough and finish cut on metal.	Explain procedures to calculate strokes/ min. for rough and finish cutting.
C. Parts and Controls			x	x	Practice hand feeding "down on a vertical or angular surface.	Demonstrate controls of shaper and methods of operation.
D. Speeds and Feeds			x	x	Set depth of cut for rough and finish cut on metal.	
E. Cutting Tool Holders			x	x	Sharpen a cutter bit for a particular metal.	Discuss cutter bits and compare with the lathe bits.
F. Shaper Operations			x	x		Compare different shaper operations: Indicate similarities and difference.
G. Safe Shaper Practices			x	x	Use the shaper following safe practices.	Demonstrate and discuss safe shaper practices.

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
X. MACHINE OCCUPATIONS						
A. Job Opportunities	x	x	x	x	Check newspaper for machine operation job opportunities.	Make a display of job opportunities in the machining field on bulletin board. (Guest speaker) (Film: 11)
B. Outlook	x	x	x	x	Find out what diffeent jobs are in machining field, training needed and where to get the training.	
XI. QUALITY CONTROL						
A. Testing			x	x		Discuss types of testing for quality control. Explain all aspects of several methods.
XII. AUTOMATION MACHINING						
A. Numberical Control			x	x		Discuss numerical control machining: Indicate the advantages and disadvantages. (Film: 6, 12, 13, 14, 19, 20, 23)
B. Electrical Discharge Machining (EDM)			x	x		Discuss EDM process and explain how metal is removed. List the advantages and disadvantages.
C. Electrical Chemical Machining (ECM)			x	x		Discuss EGM process and indicate advantages and disadvantages.
D. Chemical Machining			x	x		Discuss these methods of machining and compare them to conventional machining--which metals are best machines by these methods.

XIII. REAMING

A. Hand & Machine Reaming		x	x	Drill a hole and ream to a specific size with a hand reamer and a chucking reamer.	Discuss the need and purpose of reaming.
B. Sizes		x	x		Demonstrate hand and machine reaming. (Film: 2)
C. Nomineclature		x	x	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

4. *The Cutting Edge* - 25 min. - Norton Co.

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

6. *Gilman World of Automation* - 22 min. - Gilman Engineering Co.

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

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

9. *How to Select the Right Grinding Wheel* - 30 min. - Norton Co.

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

11. *Machine Maker* - Bureau of Audio Visual Aids

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

21. *Tools and Rules for Precision Measuring* - 30 min. - L. S. Starrett Co.

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

23. *What Makes America Great* - 23 min. - Doall Co.

DISTRIBUTORS ADDRESSES

Anocut Engineering Company, 2375 Estes Avenue, Elk Grove Village, Illinois 60007

Behr Manning Co., Sales Promotion Dept., Troy, New York.

Bureau of Audio-Visual Aids, 131 Livingston St., Brooklyn, NY 11201

Cincinnati Milacron, 4701 Marburg Ave., Cincinnati, Ohio 45209

Cleveland Twist Drill Co., P. O. Box 6656, Cleveland, Ohio 44101

Doall Company, 254 N. Laurel Ave., Des Plaines, Illinois 60016

Giddings and Lewis Machine Tool Co., 142 Doty Street, Fond Du Lac, Wisconsin 54935

Gilman Engineering and Manufacturing Co., 305 W. Delavan Drive, Janesville, Wis. 54935

Modern Talking Picture Service, 201 S. Jefferson, St. Louis, Mo. 63101

National Machine Tool Builders Assn., 2139 Wisconsin Ave., Washington, D.C. 20007

Norton Company, One New bond Street, Worchester, Mass. 01606

Pratt and Whitney, Charter Oak Boulevard, West Hartford, Conn. 06101

RMI Film Productions, Inc., 4916 Main Street, Kansas City, Missouri 64112

Simonds Saw and Steel Co., 3323 West Addison Street, Chicago, Illinois 60618

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

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

Superior Electric Co., 6328 W. Roosevelt Rd., Oak Park, Illinois 60304

Teledyne Landis, 5th and Church Streets, Waynesboro, Pennsylvania 17268

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 Lath · 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 Micormeter 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*
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

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
8. *Modernized Metric System* - 29x45 - U. S. Government Printing Office Chart #0-316-911.
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

DISTRIBUTORS ADDRESSES

Brown & Sharpe MFG. Co., Precision Park, North Kingston, Rhode Island 02852

Do All Company, 254 N. Laurel Avenue, Des Plaines, Illinois 60016

Plasticoid Products Inc., North Road, Warehouse Point, Connecticut 06088

South Bend Lath Co., 500 W. Sample St., South Bend, Indiana 46623

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

U. S. Government Printing Office, Washington, D. C.

Welch Scientific Co., 7300 N. Linder Ave., Skokie, Illinois 60706

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

General Industrial Machine Shop Revised, Johnson, Harold V., 1970, Charles A. Bennett Co., Inc., Peoria, Ill. 61614

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

Machinery's Handbook, Oberg, John and Jones, F. D., 1971, Industrial Press Inc., 200 Madison Ave., New York, New York 10016

Machine Shop and Foundry Projects, Kauffman, H. J., 1959, McKnight and McKnight Publishing Co., Inc., Bloomington, Illinois 61701

Machine Shop Operations and Set-up, Porter, Harold W., Lawshe, Charles H., and Lascoe, Orville D. 1954, American Technical Society, 848 E. 58th St., Chicago, Illinois 60637

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

Machine Shop Series, Delmar Publishers, Inc., Mountain View Ave., Albany, N. Y. 12205
Bench Work
Drill Press Work
Lathe Work
Machine Shop Measurement
Milling Machine Work
Shaper Work

Machine Shop Technology, Felker, C. A., 1962, Bruce Publishing Co., 850 Third Ave., New York, New York 10022

Machine Shop Training Course, Volume I & II, Jones, Franklin D., Industrial Press Inc., 200 Madison Avenue, New York, New York 10016

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

Machine Tool Operation Part 1, Burghart, Henry D., Axelrod, A. and Anderson, J. 5th Edition, 1959, McGraw-Hill Book Co. Inc., Manchester Road, Manchester, Mo. 63011

Machine Tool Operation Part II, 4th edition, Burghart, Henry D., Axelrod, A., Anderson, J. 1960, McGraw-Hill Book Co., Inc., Manchester Road, Manchester, Mo. 33011

Machine Tool Technology, McCarthy, Willard J. and Smith, Robert E., 1968, McKnight and McKnight Publishing Co., Bloomington, Illinois 61701

Machine Trades Blueprint Reading, Ihne, Russell W. and Streeter, Walter E., 6th Edition 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

Shop Theory, Anderson, James and Tatro, Earl E., 1968, McGraw-Hill Book Co., Manchester, Mo. 63011

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. Maching 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

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

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
VII. FASTENING SHEET METAL	x	x	x		Layout and drill holds to receive rivets & sheet metal screws.	Discuss several methods of fastening sheet metal. Determine which is best for a given project.
	x	x			Set rivets to fasten seams.	Demonstrate layout, drilling & setting rivets, setting pop rivets. (Film: 6)
	x	x			Tin a soldering copper.	
	x	x			Compare school metal lab riveting and heavy industrial riveting.	Explain sheet metal screw sizes and types and hole preparation
	x	x			Select best flux for brazing, or soldering.	Demonstrate seam preparation, soldering and brazing sheet metal.
	x	x			Fasten seams with adhesives.	Explain procedures to fasten with adhesives.
VIII. SHEET METAL FINISHES	x	x	x		Apply primer and finish to several kinds of sheet metal.	Discuss kinds, characteristics, and preparation-application of several finishes for sheet metal.
	x	x			Apply crinkle finish.	Display different finishes applied by hand, spray can, and spray gun.

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
7. *The Miracle of the Can* - Modern Talking Picture
8. *The Sheet Metal Worker*- Ideal Pictures Corp.
9. *The Story of Stainless* - 27 min. - Modern Talking Pictures
10. *Tinplate* - Dept. of Interior

16mm FILM DISTRIBUTOR ADDRESSES

1. Alcoa Informational Aids, Film Series, 1501 Alcoa Bldg., Pittsburg, Penn. 15219
2. Department of the Interior, Bureau of Mines, 4800 Forbes Ave., Pittsburg, Penn. 15213
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, Pittsburg, 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, 7821 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

Metal Spinning Techniques, Johnson, Harold V., 1960, Bruce Publishing Co., 850 East Third Avenue, New York, new York 10022

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

Sheet etal 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 Drawing, Bretz, Howard, 1971, Industrial Press Inc., 200 Madison Avenue, New York, New York 10016

Sheet Metal Shop Practice, Bruce, leroy F. and meyer, Leo, American Technical Society, 848 East Fifty Eighth Street, Chicago, Ill. 60637

Sheet etal Technology, Budzik, Richard A., Howard W. Sams and Company Inc., 4300 West Sixty Second Street, Indianapolis, Indiana 46268

Sheet Metalwork, Smith, Robert E., 1961, McKnight and McKnight Publishing Co., Bloomington, Illinois 61701

Sheet Metal Workers Manual, Broemel, L., and Daugherty, J. S., 1961, Frederick J. Drake and Company, 381 Park Avenue South, New York, New York 10016

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. Tpyes 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

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
I. OXYACETYLENE						
A. Safety	x	x	x	x	Learn and practice safe welding procedures at all times.	Discus and demonstrate safe welding procedures. (Film loops: 1-12)
B. Gas Production and Sources	x	x	x	x		Discuss methods of producing gases used in oxyacelyene welding. (Film: 4, 6)
C. Equipment	x	x	x	x	Set regulators for welding.	Explain why oxygenacethlene regulators are marked differently and how. (Pamphlet: 3) (Film loops: 1-10)
	x	x	x		Replace an empty tank with a full tank of gas.	Use a chart to indicate a simple process of producing oxygen and acetylene. (Chart 1)
D. Welding Rods	x	x	x	x		Use a chart to compare th thickness of metal, size of torch tip, and size of rod to be used. (Chart 2)
E. Welding Drawings	x	x	x	x	Demonstrate the ability to read a welding drawing.	Discuss the different welding symbols and the meaning of each.
F. Torch Flames	x	x	x	x	Practice adjusting the torch flame for each type and size of flame.	Explain the different kinds and sizes of flames and indicate when each may best be used. (Filmstrip: 1)

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
G. Position Welds	x	x	x	x	Run a rodless corner weld to develop puddle control.	Demonstrate welding techniques for different positions, backhand, forehand, etc.
	x	x	x	x		Identify and discuss the various welding joint and the need for each. (Pamphlet: 4)
H. Heat Effect on Metals		x	x	x		Discuss the precautions and advantages that are advisable as a result of metal reacting to heat applied during welding.
I. Cutting Torch	x	x	x	x	Replace welding tip with cutting head on blow piper.	Disucss the principle of oxyacetylene cutting.
	x	x	x	x	Light and adjust cutting tip flame and regulators for straight and curved lines and different metal thicknesses.	Demonstrate the proper and safe procedures for lighting and adjusting cutting flames, adjusting regulators and cutting various thicknesses of metal. (Pamphlet: 2)
	x	x	x	x		Demonstrate piercing with a blow pipe cutter.
J. Brazing		x	x	x	Make a braze weld with simular and different kinds of metal.	Discuss the difference between brazing, soldeing, and welding.
		x	x	x	Compare brazed weld with oxyacetylene weld.	
		x	x	x		Compare and discuss different fluxes and different kinds of metal for workability.

II. METALLIC ARC WELDING						
A. Safety	x	x	x	x	Practice safe procedures in operating the equipment.	Discuss and demonstrate safe metallic arc welding procedures. (Film: 5) (Pamphlet: 6)
B. Types of Metal Arch Welders	x	x	x	x		Discuss types of arc welding and their apparent advantages.
C. Electrodes	x	x	x	x		Discuss arc welding electrodes, rod, flux, and size for different welds. (Pamphlet: 1)
D. Striking an Arc	x	x	x	x	Practice striking and maintaining a proper arc.	
	x	x	x	x	Practice running stringer beads.	
	x	x	x	x	Practice several types of welded seams.	Demonstrate several types of welds.
F. Carbon Arc						
1. Safety	x	x	x	x	Wear eye protection.	Discuss the dangers of carbon arc welding.
	x	x	x	x		Demonstrate safe carbon arc welding procedures.
2. Kinds of Metal Welds		x	x	x	Adjust tips, strike an arc and maintain it.	Discuss advantages and disadvantages of carbon arc welding. (Film: 1)
3. Types of Welds		x	x	x	Make several types of joint welds with carbon arc.	Demonstrate joint cleaning and preparation for carbon arc welding.

COURSE CONTENT	SUGGESTED LEVELS I	II	III	IV	STUDENT ACTIVITIES	TEACHING ACTIVITIES
III. TUNGSTEN INERT GAS WELDING (TIG)						
A. Safety		x	x	x	Practice safety procedures while using TIG equipment.	Demonstrate and discuss safe procedures using TIG welding equipment.
B. TIG Welding			x	x	Practice making welds with TIG equipment with and without filler rod.	Discuss the principles relating to tungsten inert gas welding. Its advantages and disadvantages.
			x	x		Find out how many local welding shops use TIG welding.
IV. METAL INERT GAS WELDING (MIG)						
A. Safety			x	x	Follow safe welding practices	Demonstrate and discuss safe welding procedures using MIG equipment.
B. Kinds of Metal Welded			x	x	Make several practice welds using several dissimilar metals. Running beads and joining the metals.	
C. Inert Gases Used			x	x		Discuss MIG weld principles and the advantages and disadvantages; of different inert gases; and welding rods (Size and Length)

V. RESISTIVE WELDING [SPOT]						
A. Safety	x	x	x	x	Practice safe welding procedures with spot welder.	Demonstrate and discuss safe practices using the spot welder.
B. Types of Welder Models	x	x	x	x	Practice spot welding using several different kinds of metals.	
C. Techniques of Welding	x	x	x	x		Demonstrate and discuss spot welding tips, different metal, thicknesses and times for each. (Film: 2)
VI. OTHER WELDING PROCESSES	x	x	x	x		Examine other welding processes being used today in American industry.
VII. OCCUPATIONAL OPPORTUNITIES	x	x	x	x	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 Enginering 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 Joing*
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. FILSMSTRIP 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 (Niagura 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 Niagura Lane North, Minneapolis, Minn. 55441

F. TEXTBOOKS AND/OR REFERENCE BOOKS FOR WELDING

Gas and AC Arc Welding and Cutting, Jennings, Royalston F., 1956, McKnight Publishing Co., Bloomington, Illinois 61701

Basic Oxyacetylene welding, Griffin, Ivan and Rodern Dr., Edwar., 1962, Delmar Publishers Inc., Albany, New York 12205

Pipe Welding Procedures, Rampaul, Hoobasar, 1975, Industrial Press Inc., 200 Madison Avenue, New York, New York, 10016

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 Adademy, Colorado 80840. Free. Titles include:

Growth into Leadership. 1966. 57 pp. Full color pictorial story of academy life.

Of Flight and Bold Men. 1966. 25 pp. Illustrated history of flying.

United States Air Force Academy Catalog. Rev. Annually, 208 pp.

THE AIA. The American Institute of Architects. 1735 New York Ave., N.W. Washington, D.C. 20006. 1969. 16 pp. Single copy free. Illustrated booklet about the architect, his profession, and his professional society.

CAREER OPPORTUNITIES IN AVIATION. National Aerospace Education Council. Suit 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 form *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:

Jobs in Trades and Crafts, Equipment Operation and Repair for Blue Collar Helpers in Various Occupations. 1968. Folder.

Opportunities in Trades and Crafts with the Federal Government. (58). 1964. Leaflet.

Forestry Schools in the United States. (A 13.2:Sch. 6/966-2). Supt. of Documents. Gov't. Printing Office. Washington, D.C. 20402. 1966. 17 pp. 15 cents. Evaluative, annotated list.

Should You Be a Manufacturing Engineer? American Society of Tool and Manufacturing Engineers. 20501 Ford Rd. Dearborn, Michigan 48128. Undated. 10 pp. Free. Advice from a former president of the Ford Motor Company.

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

Optics. Booklists. 1967. 14 pp. Books about optics for all ages.

Your career in Optics. Undated. 24 pp. Pictorial history of optics, an explanation of the science of optics, and career information.

CAREERS IN PETROLEUM ENGINEERING. Society of Petroleum Engineers of Aime. 6200 N. Central Expressway. Dallas, Texas 75206. 1958. 18 pp. Free. Basic facts about the petroleum engineering profession.

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

Opportunities in Steel. American Iron and Steel Institute. 150 E. 42nd St. New York, N.Y. 10017. 1967. 96 pp. 35 cents. Discusses variety of steel occupations.

U.S. ARMY, DEPT. OF THE ARMY. Headquarters. U.S. Army Recruiting Command. Hampton, Virginia 23369. Single copies free. Titles include:

A Guidance Handbook for Counselors. 1966. 22 pp. Approaching youth about military obligations.

Opportunities in the Welding Industry. American Welding Society. 345 E. 47th St. New York, New York. 1968. 23 pp. Free. Illustrated booklet presenting many aspects of jobs in welding.

CAREERS FOR WOMEN. U.S. Dept. of Labor. Women's Bureau, Washington, D.C. 20210. Single copies free. Send for free publications list and quantity discounts from Supt. of Documents. Gov't Printing Office. Washington, D.C. 20402. Titles included:

Leaflet 41. Why Not Be an Engineer? 1967. 6 pp.

Leaflet 45. Why Not Be a Mathematician? 1968. 5 pp.

Leaflet 47. Why Not Be a Technical Writer? 1968. 5 pp.

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 Construction. 22 pp.

Compressed Air Power in Manufacturing. 31 pp.

The Fundamentals of Compressed Air Power. 16 pp.

Disston Saw Tool and File Manual. H. K. Porter Co., Inc., Inc. Disston Division. Pittsburgh, Pennsylvania. 62 pp. Single copy free. Illustrated booklet. Also request one copy of each of 6 large bulletin board charts on the use and care of hand saws, power saws, and other cutting tools.

GOVERNMENT MATERIALS. Supt. of Documents. Gov't. Printing Office. Washington, D.C. 20402. Titles include:

Selected Shop Techniques. (NAS1.21:5010). 1965. 102 pp. 60 cents. 71 selected suggestions for machinists, mechanics, and technicians. Well illustrated. Sr. hi. and col. levels.

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:

American Standard Safety Code for the Use, Care, and Protection of Abrasive Wheels. B7.1-1964. 81 pp.

Cutting-off Wheels. 1965. 20 pp.

Disc Grinding. 1965. 20 pp.

Grinding Machines, High Speed, Heavy Duty. 1965. 13 pp.

Handling, Storage, and Inspection of Grinding Wheels. 1965. 15 pp.

Mounting Technique for Wheel Sleeves. 1965. 14 pp.

Mounted Wheels. 1965. 32 pp.

Portable Grinding Machines. 1965. 29 pp.

Safety Recommendations for Grinding Wheel Operation. 1965. 24 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:

Lead A Material for Modern Design. Undated. 7 pp. Highly informative, illustrated booklet on the uses of lead.

Primary Lead Production Areas in the United States. Undated. 11" x 17" map.

METAL CAN INDUSTRY. Can Manufacturers Institute, Inc. 821 15th St., N.W. Washington, D.C. 20005. Single copies free to teachers. Sample titles are:

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:

Drawings for Model Builders. 1964. A series of guides and detailed drawings for constructing a model steel mill. Available free to secondary teachers of science, industrial arts, and vocational education.

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.

New Dimensions in Steelmaking. 1967. 8 pp. Available free in classroom quantities to high school teachers. Discusses steel industry in our economy, technological changes, and job opportunities.

STEEL. Bethlehem Steel Corp. Bethlehem, Pennsylvania 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:

Blast Furnace Department. 1968. Pamphlet. Diagrams and discussion of the workings of a blast furnace.

Coke Plant Practice. Undated. 20 pp. A thorough, clearly illustrated discussion of the coke plant.

Electric Steelmaking. 1969. Pamphlet. How steel is made by the electric method. Illustrated.

How Steel Is Made. 17" x 19" poster.

Oxygen Steel. Colorful diagrams of the latest methods in steel production.

Seeing CF & I Steel in Action. 1969. 20 pp. Complete story of steel production at CF & I's Pueblo, Colorado plant.

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:

Alan Wood: A Century and a Half of Steelmaking. 1962. 23 pp. Illustrated history of the Alan Wood Steel Company.

Information Pamphlets. Undated. Four illustrated pamphlets describing steel sheeting and stripping, steel plate, diamond, floor plate, and abrasive rilled steel flooring.

METALS

ALUMINUM. aluminum Co. of America. 1501 Alcoa Bldg. Pittsburgh, Pennsylvania. 15219. Free to teachers. Titles includes;

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"

Basic Guide to Ferrous Metallurgy. Tempil Division. 132 W. 22nd St. New York, New York 10011. 1954. 8½" x 11" chart. Free. Indicates heat ranges for transformation of ferrous metals.

Copper. Anaconda Co. Advertising Dept. Room 2145. 25 Broadway. New York, New York 10004. Free in limited quantity. Kit of reprints and charts showing how copper is mined.

Gold regulations. (T1.10:G 26/3/959). Supt. of Documents. Gov't Printing Office. Washington, D.C. 20402. Rev. 1959. 16 pp. 10 cents. Federal regulations governing acquisitions, use, and sale of gold. Sr. hi. and col. levels.

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:

Titanium: A New Metal. (258). By George A. w. Boehm. 1949. 5 pp.

Zirconium. (259). By Stephen M. Shelton. 1951. 6 pp.

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.

Synthetic Transuranium Elements. By Earl K. Hyde. Rev. 1967. 44 pp. Discusses Transuranium production.

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.

Zinc--A Mine to Market Outline. Zinc Institute. 324 Ferry St. Lafayette, Indiana 47901. 96 pp. Free to teachers. Explains the importance of zinc, its processes of manufacture, its properties, and its application.

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

Man, Society and Technology, A Journal of Industrial Arts Education, American Industrial Arts Association, 1201 16th St., N. W. Washington, D. C. 20036

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 up date 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

Clausing Division, Atlas Press Co., 1915 N. Pitcher St., Kalamazoo, Mich.

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

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

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. 63631

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

American Business Systems Co., 416 S. Jefferson, Springfield, Mo. 65806

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

Deluis, Kasing and Co., Siekerwall 21, Bielfeld, 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 WCI

Funk and Wagnalls Co., (Div. of Readers Digest Books), 380 Madison Avenue, New York, New York 10017

Goodheart, 18250 Harwood Avenue, Homewood, Illinois 60430

Grossman Publishers, Inc., 125A East 19th Street, New York, New York 10003

Paul Hamlyn, 583 Fulham Road, London, England SW6

Hanover House, Garden City, New York 11530

Harcourt, Brace and World, Inc., 757 3rd Avenue, New York, New York 10017

Harper and Row Publishers, 49 East 33rd Street, New York, New York 10016

Hayden Book Company, (J. F. Rider Division) 116 West 14th Street, New York, New York 10011

Iliffee NTP Inc., 300 East 42nd Street, New York, New York 10017

Industrial Relations Counselors, 1270 Avenue of the Americans, New York, N. Y. 10020

Iowa State University Press, Press Building, Ames, Iowa 50010

Lippincott, J. B. Co., East Washington Square, Philadelphia, Penn. 13673

Little, Brown and Co., 34 Beacon Street, Boston, Mass 02154

Maclaren and sons, 268 Argyle Street, Glasgow, C2, Scotland

Macmillan Company (Div. of Crowell, Collier, and Macmillan) 866 3rd Avenue, New York, New York 10022

Meredith Press, 250 Ave., New York, New York 10017

Julian Messner, Inc., 1 West 39th Street, New York, N. Y. 10018

McKnight and McKnight Publishing Co., 29 East 10th St., N. Y., N. Y. 10003

McNally and Laftin, Publishers, 114 East De Le Guerra St., Box 1316, Santa Barbara, California 93102

John Murray, Ltd., 50 Albmarle Street, London, England W1

New Horizons Publishers (Div. of Fuller & Dees Marketing Group), 154 East Erie Street, Chicago, Ill. 60611

Oceana Publications, Inc., 40 Cedar Street, Dobbs Ferry, New York 10522

Oxford Book Company, 71 5th Ave., New York, New York 10003

Pergamon Press, Inc., 122 East 55th St., New York, New York 10022

Printing Industries of America, 20 Chevy Chase Circle, N. W. Washington, D. C. 20015

Putnam's G. P. Sons, 200 Madison Ave., New York, New York 10016

Reinhold Publishing Corp., 430 Park Ave., N. Y., N. Y. 10022

Richards Rosen Press, Inc., 29 East 21st Street, New York, New York 10011

Ronald Press Co., 79 Madison Ave., N. Y., N. Y. 10016

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

Technical Education Division, McGraw-Hill Book Co., 330 W. 42nd St., N. Y., N. Y. 10036

North American Publishing Co. 134 No., 13th St., Philadelphia, Penn.

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 alernatives. 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

I. FABRICATING MACHINES AND ACCESSORIES	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Bar Folder (30")	X	1	X	1
Arbor, Milling machine			X	2
Bender, Universal	X	1	X	1
Boring Bar (set)			X	2
Brake, Box and pan	X	1	X	1
Buffer, Long arm			X	1
Buffer, Pedestal	X	1		
Chuck, Magnetic			X	1
Cutter, Milling Machine,end (set)			X	1
Cutter, Milling Machine			X	1
Cutter, Milling Machine			X	1
Cutter, Milling Macnine			X	1
Cutter, Milling Machine, Slitting			X	1
Cutting-Off Tool, Lathe	X	6	X	6
Drill, Elec., Portable (¼")	X	1	X	1
Drill, Elec., Portable (3/8")			X	1
Drill, Elec., Portable (½")			X	1
Electroplating Unit	X	1	X	1
Forge, Gas			X	1
Foaming, Roll, Slip	X	1	X	1
Furnace, Crucible	X	1	X	1
Furnace, Heat treating	X	1	X	1
Grinder, Heavy duty pedestal			X	1

I. FABRICATING MACHINES AND ACCESSORIES	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Grinder, Pedestal	X	1	X	1
Grinder, Surface			X	1
Indicator, Dial test			X	2
Jolt Squeezer, Foundry			X	1
Knurling Tool Lathe (coarse)			X	6
Knurling Tool Lathe (fine)			X	6
Knurling Tool Lathe (medium)			X	6
Lathe, Metalworking (10")	X	3	X	6
Lathe, Metalworking (14")			X	2
Lathe, Spinning (12")			X	1
Mandrel, Epansion (set)			X	2
Milling Machine, Horizontal			X	1
Milling Machine, Universal			X	1
Milling Machine, Vertical			X	1
Oven, Core			X	1
Press Arbor			X	1
Press, Drill (15")	X	2	X	1
Press, Drill (17")			X	1
Rotary Machine, Combination			X	1
Sand Blaster			X	1
Sand Muller			X	1
Saw, Band (power)			X	1
Saw, Hack (power)	X	1	X	1
Setting Down Machine			X	1
Shaper, Metal			X	1
Shear, ring and circle cap. 20 ga., mild steel			X	1

I. FABRICATING MACHINES AND ACCESSORIES	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Shear, Squaring foot cap. 16 ga.: mild steel	X	1	X	1
Spray Gun Outfit general shop	X	1	X	1
Tester, Hardness			X	1
Tool Holder, Lathe (left hand)	X	6	X	6
Tool Holder, Lathe (right hand)	X	6	X	6
Tool Holder, Lathe (straight)	X	6	X	6
Torch, Gas	X	2	X	2
Welder, Arc (AC/DC)	X	1	X	1
Welder, MIG			X	1
Welder, Spot	X	1	X	1
Welder, TIG			X	1
Welding Outfit, Oxyacetylene	X	1	X	1
II. HAND TOOLS AND EQUIPMENT				
Anvil (100 lb.)	X	1	X	1
Apron, Foundry leather, approx. 44"L	X	2	X	2
Apron, Rubber	X	1	X	2
Apron, Welding leather, approx. 44"L	X	2	X	2
Awl, Scratch (6")	X	4	X	4
Bellows, Molder's (8")	X	1	X	1
Broom, Push (10")	X	3	X	3
Brush, Bench	X	12	X	12

II. HAND TOOLS AND EQUIPMENT	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Brush, wire overall length 10''	X	6	X	6
Bulb, Sponge	X	1	X	1
Caliper, Hermaphrodite (6'') lock joint			X	2
Caliper, Inside (6'') solid nut, bolt spring	X	6	X	6
Caliper, Outside (6'') solid nut, bolt spring	X	6	X	6
Caliper, Outside (8'') solid nut, bolt spring			X	2
Caliper, Vernier 5'' cap.			X	1
Can, Oily waste 10 gal. cap.	X	1	X	1
Can, Safety (1 qt.)	X	2	X	2
Can, Safety (1 gal.)	X	2	X	2
Chisel, Cape ½'' stock, ¼'' cutting edge	X	2	X	2
Chisel, Cold (set) cutting edge of ¼'', 3/8'', ½'', ¾''	X	1	X	2
Chisel, Diamond point (set) ¼'', 3/8'', ½'' bits	X	1	X	2
Chisel, Round nose (set) ¼'', 3/8'' bits	X	1	X	2
Clamp, ''C'' (4'')	X	4	X	4
Clamp, ''C'' (6'')	X	4	X	4
Clamp, ''C'' (8'')	X	4	X	4
Clamp, ''C'' (10'')	X	4	X	4
Countersink, Bit	X	1		
Countersink, High speed steel	X	1		
Crucible (# 4)	X	2	X	2
Crucible (# 10)	X	2	X	3

II. HAND TOOLS AND EQUIPMENT	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Crucible Hand Shank (# 4)	X	1	X	1
Crucible Lifter (2-man)	X	1	X	1
Crucible Ring Shank	X	1	X	1
Cutter, Bolt (minimum 14'')	X	1	X	1
Cutter, Pipe			X	1
Cutter, Sprue	X	1	X	1
Die, Dapping	X	1	X	1
Die, Letter (set)	X	1	X	1
Die, Number (set)	X	1	X	1
Divider, Spring (4'')			X	2
Divider, Spring (6'')	X	6	X	6
Divider, Spring (8'')			X	2
Dresser, Abrasive wheel	X	1	X	1
Drill, Hand ¼''	X	1	X	1
Drill, Hand (3/8'')	X	1	X	1
Drill Stand, Fractional	X	1	X	1
Drill, Twist (letter set)	X	1	X	1
Drill, Twist (number set)	X	1	X	1
Drill, Twist (fractional set)	X	1	X	1
Drill, Twist (fractional set)	X	1	X	1
Extractor, Screw (set)	X	1	X	1
Files				
8'' Flat Bastard Double-Cut	X	4	X	4
10'' Flat Bastard Double-Cut	X	4	X	4
4'' Mill Smooth	X	6	X	6
6'' Mill Smooth	X	6	X	6
8'' Mill	X	6	X	6
6'' Round Second-Cut	X	2	X	2
8'' Round Bastard	X	6	X	6
8'' Three- Second-Cut Square (Triangular)	X	4	X	4

II. HAND TOOLS AND EQUIPMENT	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
File Card and Brush	X	6	X	6
Flask, Foundry (large)	X	4	X	4
Flask, Foundry (small)	X	4	X	4
Gauge, Center	X	3	X	6
Gauge, Drill point			X	1
Gauge, Micrometer, Depth			X	1
Gauge, Radius and fillet			X	1
Gauge, Screw pitch	X	1	X	1
Gauge, Small hole			X	1
Gauge, Surface			X	1
Gauge, Telescopic			X	1
Gauge, Thickness (''feeler'')	X	1	X	1
Gauge, Vernier height			X	1
Gauge, Wire and sheet metal (American)	X	1	X	1
Gauge, Wire and sheet metal (U.S.S.)	X	1	X	1
Gloves, Asbestos (pair)	X	2	X	2
Gloves, Leather (pair)	X	4	X	6
Gloves, Thick rubber (pair)	X	2	X	2
Goggles (spectacles)	X	24	X	24
Goggles, Gas welding	X	3	X	3
Groover, Hand (set) set of 3: sizes 0, 2, 4	X	2	X	2
Hammer, Ball peen (8 oz.)	X	2	X	2
Hammer, Ball peen (12 oz.)	X	4	X	4
Hammer, Ball peen (16 oz.)	X	2	X	2
Hammer, Ball peen (30 oz.)			X	2
Hammer, Chipping			X	2

II. HAND TOOLS AND EQUIPMENT	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Hammer, Engineer's (40 oz.)	X	2	X	2
Hammer, Engineer's (48 oz.)	X	1	X	1
Hammer, Riveting	X	2	X	2
Hammer, Soft face (4 oz.)	X	2	X	2
Hammer, Soft face (8 oz.)	X	2	X	2
Helmet, Welding (arc) (head type)	X	2	X	2
Leggings, Molder's (pair)	X	2	X	2
Mallet, Hardwood	X	4	X	4
Mallet, Rawhide (10 oz.)	X	4	X	2
Mallet, Rubber	X	2	X	2
Micrometer, Inside (set)	X	1	X	1
Micrometer, Outside (1")	X	4	X	6
Micrometer, Outside (2")	X	2	X	2
Micrometer, Outside (3")	X	1	X	1
Micrometer, Outside (screw thread)			X	1
Micrometer, Outside			X	1
Mold, Ingot	X	1	X	1
Nipper, End cutting (6")	X	1	X	1
Oiler, Bench	X	12	X	12
Oilstone, Combination, India	X	2	X	2
Pan, Dust (12" steel)	X	1	X	1
Parallels, Adjustable (set)			X	1
Pencil Sharpener, Standard	X	1	X	1
Plate, Angle			X	2
Plate, Surface			X	1
Pliers, Combination (6")	X	6	X	6
Pliers, Combination (8")	X	4	X	4

II. HAND TOOLS AND EQUIPMENT	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Pliers, Diagonal cutting (6'')	X	2	X	2
Pliers, Needle nose (6'')	X	2	X	2
Pliers, Straight nose (8'')	X	2	X	2
Pliers, Vise-grip wrench (7'')	X	2	X	2
Punch, Center (set)	X	4	X	6
Punch, Drive (set)	X	1	X	1
Punch, Hollow (set)	X	1	X	1
Rammer, Hardwood	X	2	X	2
Reamer, Center (set)	X	1	X	1
Reamer, Expansion (set)			X	1
Reamer, Pipe	X	1	X	1
Riddle, Foundry	X	2	X	2
Rivet Set (set)	X	4	X	4
Rule, Circumference (36'')	X	2	X	2
Rule, Flexible, Steel tape (12')	X	2	X	2
Rule, Hook (12''L)			X	4
Rule, Short (set)			X	1
Rule, Steel (6'')	X	6	X	8
Rule, Steel (12'')	X	12	X	12
Rule, Steel (24'')	X	2	X	2
Saw, Hack (hand)	X	6	X	6
Saw, Jeweler's (4'')	X	2	X	2
Saw, Jeweler's (6'')	X	4	X	4
Scissors (8'')	X	1	X	1
Screwdriver, Offset Phillips (set)			X	1
Screwdriver, Offset Straight slot (set)	X	1	X	1
Screwdriver, Phillips (set)	X	1	X	1

H. HAND TOOLS AND EQUIPMENT	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Screwdriver, Standard bit	X	2	X	2
Scriber	X	6	X	6
Seamer, Handy	X	2	X	2
Shield, Face	X	12	X	12
Shovel, Square point	X	1	X	1
Sleeves, Molder's (18"L)	X	1	X	1
Slick and Oval (1")	X	1	X	1
Slick and Oval (1¼")	X	1	X	1
Snip, Aviation (left)	X	2	X	2
Snip, Aviation (right)	X	2	X	2
Snip, Aviation (Combination and straight) (10"L)	X	2	X	2
Snips, Hawkbill (3" cut)	X	1	X	1
Snips, Tinner's Straight (# 8)	X	4	X	4
Snips, Tinner's Straight (# 10)	X	2	X	2
Soldering Copper, Electric (60W)	X	1	X	1
Soldering Copper, Electric (200W)	X	1	X	1
Soldering Copper, Electric (300W)			X	1
Soldering Copper (pair)	X	4	X	2
Soldering Copper (pair)	X	2	X	2
Soldering Copper (pair)	X	1	X	1
Sparklighters	X	6	X	6
Square, Combination (12")	X	6	X	6
Square, Combination set (with protractor and Center head) (12")	X	1	X	1
Stake, Beakhorn	X	1	X	1

II. HAND TOOLS AND EQUIPMENT	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Stake, Blowhorn	X	1	X	1
Stake, Bottom			X	1
Stake, Candle mold			X	1
Stake, Conductor			X	1
Stake, Double seaming set with 4 edges			X	1
Stake, Grooving			X	1
Stake, Hatchet	X	1	X	1
Stake, Hollow mandrel	X	1	X	1
Stake, Needle case			X	1
Stake, Round head			X	1
Tap and die, Machine screw (set)	X	1	X	1
Tap and Die, NC (U.S. Standard) (set)	X	1	X	1
Tap and die, NF (S.A.E.) (set)	X	1	X	1
Tap and Die, Pipe (set)	X	1	X	1
Tongs, Blacksmith, Curved lop	X	2	X	2
Tongs, Pick up (flat lips)	X	2	X	2
Trammel points	X	1	X	1
Trowel, Foundry			X	1
Truck, Welding cylinder	X	1	X	1
V Block and Clamps (set)	X	1	X	2
Vise, Angle, Drill	X	1	X	2
Vise, Bench, Drill	X	2	X	2
Vise, Machinist's bench	X	12	X	12
Vise, Pen (set)	X	1	X	1
Wrench, Adjustable end (6''L)	X	2	X	2
Wrench, Adjustable (8'')	X	2	X	2

II. HAND TOOLS AND EQUIPMENT	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Wrench, Adjustable end (10'')			X	2
Wrench, Adjustable end (12'')			X	2
Wrench, Allen Key (hex) (set)	X	1	X	1
Wrench, Box (set)	X	1	X	1
Wrench, Open end (set) ¼'' - 1''	X	1	X	1
Wrench, Pipe (10'')	X	1	X	1
Wrench, Pipe (14'')			X	1
Wrench, Pipe (18'')			X	1
Wrench, Socket (3/8'' drive) (set)	X	1	X	1
Wrench, Socket (½'' drive) (set)	X	1	X	1
III. GENERAL FURNISHINGS				
Bench, Arc Welding	X	1	X	2
Bench, Gas Welding	X	1	X	2
Bench, Machine	X	1	X	2
Bench, Metalworking (2 place)	X	2	X	1
Bench, Metalworking (4 place)	X	4	X	4
Bench, Molding	X	1	X	1
Bench, Sheet Metal (with stake plates)	X	1	X	1
Bench, Soldering	X	2	X	1
Bench, Spot welding	X	1	X	1
Bench, TIG welding fire brick tip			X	1
Bookcase	X	1	X	1
Cabinet, Filing (4 drawers)	X	1	X	1

III. GENERAL FURNISHINGS	INTRODUCTORY	QUANTITY	ADVANCED	QUANTITY
Cabinet, Finishing (storage)	X	1	X	1
Cabinet, Small parts	X	1	X	1
Cabinet, Storage	X	4	X	6
Cabinet, Tool storage	X	1	X	1
Chair, Teacher's	X	1	X	1
Compressor, Air	X	1	X	1
Desk, Teacher's	X	1	X	1
Fire Blanket	X	1	X	1
Fire Extinguisher	X	3	X	3
First Aid Kit	X	1	X	1
Furance, Bench gas, 2 burner	X	2	X	2
Projector, Filmstrip (35mm) and slide (2'' x 2'')	X	1	X	1
Projector, Motion picture (Sound)	X	1	X	1
Projector, Overhead	X	1	X	1
Rack, Metal Storage	X	1	X	1
Screen, Projection	X	1	X	1
Spray, Booth, Dry			X	1
Stool, Student's adjustable	X	24	X	24
Table, Drafting	X	1	X	1
Table, Overhead projector	X	1	X	1

TEXTBOOKS AND/OR REFERENCE BOOKS FOR METALWORKING

Advanced Diemaking, Ostergaard, D. Eugene, 1967, McGraw-Hill Publishing Co.

Aim for a Job in the Iron and Steel Industry, Sullivan, J. W., Richards Rosen, 1967

Aim for a Job in Welding, Berg, L.D.T., 1967, Richards Rosen.

An Outline of Metallurgy, Simons, Eric N., 1969, Hart Publishing Co.

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