This program guide is for teacher use in planning and operating a local industrial arts program. It was developed by a committee of the Colorado Industrial Arts Association. The guide presents major concepts and information for a comprehensive program of elementary and secondary industrial arts, and it suggests a variety of educational activities and methods. Major chapters are (1) The Place of Industrial Arts in the General Education Programs, (2) Organization and Administration in the Industrial Arts Classroom, (3) Shop Planning and Maintenance, (4) Safety and Liability, (5) Fundamentals of Design, (6) Student Evaluation, (7) Historic Background and Current Trends in Industrial Arts Education, (8) The General Shop, (9) General Crafts, (12) Mechanical Drafting, (13) General Metals, (14) Power Mechanics, and (15) Woodworking. Most chapters include information, content outlines, photographs of facilities or projects, and an extensive bibliography of references. (EM)
INDUSTRIAL ARTS
A Guide for Colorado Schools

Colorado DEPARTMENT OF EDUCATION

Byron W. Hunsford, Commissioner of Education
Denver 1966
Colorado
State Board of Education

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INDUSTRIAL ARTS

A Guide for Colorado Schools

Prepared and published
with the cooperation of the
Colorado Industrial Arts Association
CIAA General Chairman for the Guide
William R. Erwin, Jr.
Colorado State College, Greeley

COLORADO STATE DEPARTMENT OF EDUCATION

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Division of Elementary and Secondary Education
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Denver, Colorado

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**FOREWORD**

Experiences which will provide our youth with an understanding of the highly industrialized society in which we live are a vital part of a comprehensive school curriculum. While the insights developed through the industrial arts curriculum may lead to the desire for specialized vocational education on the part of some children, the broader concepts, skills, work habits, and understandings developed are beneficial to all children and should be an integral part of the general education program.

This guide presents some major concepts in the several areas of a comprehensive industrial arts program and suggests a variety of activities and methods by which these concepts might be taught.

We are indebted to the many groups and individuals who helped prepare this guide. Special commendation should go to the Colorado Industrial Arts Association and Dr. William R. Erwin, Jr., CIAA General Chairman for the guide.

Byron W. Hansford
Commissioner of Education
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ACKNOWLEDGEMENTS

In 1958, the Executive Committee of the Colorado Industrial Arts Association, composed of A. N. Shaw, President, Grand Junction, William R. Erwin, Jr., Vice President, Greeley, and Jess Schmitt, Secretary-Treasurer, Westminster, proposed the production of a guide in Industrial Arts. An Outline was prepared and submitted to Industrial Arts teachers for criticism and suggestions.

Mr. Shaw requested assistance from the State Department of Education. Dr. Clifford Bebe, Director of the Division of Elementary and Secondary Education, and William L. Miller, Head of the Section on Secondary Education, represented the Department in the development of the Guide. One of Mr. Shaw's last official acts as President of the Colorado Industrial Arts Association was the appointment of the various production committees.

Mr. Sherwin D. Powell of Colorado Springs, the incoming President, continued emphasis on the project. The appointed committees worked diligently for completion of the Guide. The dedication of these people, who gave freely of their time and travel at their own expense, is evidence of the highest quality of professional responsibility.

Following the development of the first draft, editorial responsibility was assigned to William R. Erwin, Jr., of Colorado State College. He reviewed the work on production committees and brought the Guide to a state of unity and format for experimental distribution.

The guide was published in mimeographed form for trial use in Colorado schools. Suggestions, reactions, and criticisms were asked for. A second committee was formed to evaluate the suggestions and criticisms and to make the final revision of the guide for publication in final printed form.

Acknowledgment and appreciation on behalf of the Colorado Industrial Arts Association and the State Guide Committee is expressed to Max Hoover, an industrial arts student at Colorado State College, for the development of the illustrations used in the guide.

The names of those who cooperated in revision of the guide are listed on the preceding pages.
CHAPTER I
INTRODUCTION

Purpose of the Guide

The purpose of this guide is to assist the industrial arts education teacher to do a more effective job of teaching. It is especially prepared for the new teacher as an aid in selecting areas of work and developing courses of study. It should also prove useful to the experienced teacher as a guide for evaluation of those courses they are currently teaching, and to assist the administrator in evaluating his industrial arts program.

Surrounded as we are with mechanical devices dominating our entire lives, and recognizing that the development of hand and power tools has been responsible for our highly industrialized economy with the highest standard of living in the world, provisions should be made for industrial arts education experiences for all youth. Through these experiences, youth develop an understanding of the place of industry in our modern society.

Under our democratic educational philosophy of equal opportunity for every individual, each student should be given the chance to work to his or her full potential. Industrial arts education has a vital role to play in providing this opportunity for efficiency in our society. Every possible effort must be made to offer such a variety of areas of endeavor that each individual’s own interests, needs, and abilities may be fully developed. Industrial arts education, as a part of general education, does provide this necessary opportunity for a great many of our youth to adjust successfully to our complex modern environment.

While the contents of this guide are comprehensive, it should be understood that improvements may be necessary and beneficial as time goes on. After completing a review of this guide, it is hoped that each teacher will be motivated to strive for the best and most complete program possible in industrial arts education. It is realized that many plant facilities cannot accommodate an extensive or comprehensive program. Yet the teacher should strive for as complete and up-to-date a program as is practical and possible. It should be recognized that an industrial arts program offering only one area is inadequate.

The industrial arts education teacher or any other classroom teacher is encouraged to make adaptations of the guide to fit his or her needs. The wealth of information in this guide will provide the resourceful teacher with a great many new or forgotten ideas which should enable him to improve his industrial arts education program. The following points may be kept in mind as this guide is studied and used:

1. Use any material that will fit. Adapt that which is not directly applicable.
2. The several course outlines should be studied to give the teacher a broader concept of industrial arts education.
3. For the purpose of revision, new ideas should be jotted down and submitted to persons designated to work on revisions.
4. This is only a suggested guide so changes should be made to fit local needs.
Definition of Terms

The definitions of terms are for the purpose of clarification and to prevent misinterpretation of these terms as used in this guide.

**General Education**

Although general education cannot be defined in a single brief statement, for the purpose of this guide, general education is regarded as that part of knowledge, skills, and attitudes needed by each individual to be effective as a person, a member of a family, a worker, and a citizen.

**Industrial Arts**

Industrial arts is the study of industrial tools, materials, processes, products, and occupations pursued for general education purposes in shops, laboratories, and drafting rooms.

**Industrial Arts Education**

Industrial arts education is a synonymous term for industrial arts.

**Industrial Education**

Industrial education is a generic term used to designate various types of education of an industrial nature, vocational industrial education, industrial arts, technical education, and apprenticeship training in both public and private schools.

**Comprehensive (Composite) General Shop**

The comprehensive general shop may be defined as a type of organization which provides equipment and facilities for activities in two or more industrial areas. Actually, the number of areas represented may vary from two to as many as ten or more. For example, a comprehensive general shop might include experiences in woodworking, drawing, metalwork, and electricity. A more extensive development might include such additional areas as graphic arts, ceramics, textiles, leatherwork, and transportation. The limiting factors are the equipment and space available, and the interests and abilities of the teacher.

This type of shop organization has been developed to meet the exploratory needs of pupils, especially in the one teacher situation. It has also been used extensively as a beginning experience to be followed by more intensive courses in limited general or unit shops. That the comprehensive general shop is meeting a real need and is growing in favor is indicated by the fact that more pupils are enrolled in this type of organization than in any other single industrial arts activity.¹

**Limited General (Major Area) Shop**

The limited general shop has many of the features of the comprehensive type, but the activities and facilities are limited to work with a single basic material such as metal, wood, or to a closely related group or family of industries such as the electrical industries. An example is the general wood shop, which might include such activities as cabinet making, carpentry, woodfinishing, upholstery, wood carving, wood turning, model making, and pattern making.

This type of organization is becoming increasingly common in larger cities where it is desired to give pupils the benefit of a truly exploratory experience, but where the duplication of many comprehensive general shops is impractical. Pupils are frequently rotated through several different limited general shops.²

Unit Shop

The unit shop is usually limited to activities in a single industrial occupation. Examples are machine shop practice, welding, cabinet making, letterpress printing, and sheet metal work. Such organization is now found largely at the senior high school level where it appears to be needed for extensive specialization, or in large city systems where by rotation through many different unit shops pupils may approach the exploratory outcomes of the comprehensive or limited general shop. ³

Vocational Education

A program of education organized to prepare the learner for entrance into a particular chosen vocation or to upgrade employed workers; includes such divisions as trade and industrial education, technical education, agricultural education, distributive education, and home economics education. ⁴

References:


³Ibid, p. 32.

The Relation of Industrial Arts to General Education

Industrial arts education is a subject area defined as dealing with the understanding and interpretation of industrial activity. As an important part of general education, industrial arts education is concerned with materials, processes and products of industry. The student not only seeks knowledge of the industrial society in which he lives, but also learns how to use tools, work with materials, and perform basic processes. He defines problems, postulates solutions by design and written description, develops solutions, and tests products or manufacturing principles for validity.

Industrial arts education is not taught as a separate subject only to master a skill, but it is concerned with those phases of the subject which are related to life in general and the fulfillment of the purposes of general education.

The pictorial illustration on page 6 portrays the contributions of the field of industrial arts education to the general education of the individual pupil. Sketching and design become an essential medium for thinking and communication, and at the proper level of specialization is taught as an important separate area. The actual project developed experimentally tests the idea, therefore, developing skills, science, planning, creative expression, appreciation of materials and industry, and other phases of education necessary for balanced adjustment of the student.

Changes in industrial techniques also mean changes in other aspects of our economic life. New occupational structures resulting from new industries, inventions, or materials often mean changes in job opportunities, required skills, hours of work, financial return, leisure pursuits, retirement, and other related services. Methods of investing, methods of selling, distribution of goods, handling management-labor relations, and a myriad of other related aspects are influenced by new innovations. Industrial arts education can and does have a proud part in helping youngsters solve their problems resulting from such changes by aiding them to perceive these changes and to plan accordingly. Opportunities for correlation with mathematics, social studies, science, business, and the language arts are very extensive, and should be emphasized and used fully.

Children, adolescents, and adults of both sexes can find rewarding and satisfying experiences in manipulative and investigative activities of a technical nature. The need for activity is paramount at all levels of maturation and growth.

Children of the elementary school level are constantly developing motor skills in all experiences to which they are exposed. Adolescents of the early secondary levels are learning to extend and refine their abilities in activities of close manipulative nature. Success helps youngsters develop confidence and provides a basis for further motivation. The varied opportunities in industrial arts education offer a measure of success for everyone. Other personal-social needs can also be satisfied in a laboratory setting.

The general nature of the industrial arts education program provides opportunities for varied abilities and interests. The work can be challenging to the exceptional pupil and also to the youth of lower intellectual ability. Interest in technical work can raise the need for greater skill in the fundamentals.

Students often find it necessary to increase communicative skills to solve problems in the laboratory.
through reading and investigation. Problem situations in industrial arts accompany knowledges and communicative skills studied in the classroom. Thus, the high level of integration and correlation which can be achieved through coordinated effort is made clear to students and teachers.

As the pupil begins and advances with his industrial arts education training in the laboratory, he encounters specific training both directly and indirectly that is deemed necessary for achievement of the objectives of general education as interpreted by currently formulated objectives of industrial arts education.

As the pupil progresses further, he or she proceeds to assemble and retain within individual capacities and abilities, his education and training. Industry, teacher, school and community exert definite influences upon course content and policies regarding instructional methods and desired outcomes. There is a recognized individual contribution with respect to these authorities; however, considerable attention and effort are devoted to their close correlation in order to achieve a balanced overall educational plan.

After sufficient knowledge and manipulative training has been effected, the individual usually follows one or more separate pursuits in the application of his acquired industrial arts education learning as associated with education for living. A student may develop and expand his training with the eventual goal being a specific vocation; he or she may choose to follow an avocational approach, utilizing his development for worthwhile use of leisure time in personal recreation and hobby development; or, he or she may consciously or unconsciously use many of the acquired citizenship values and concomitant-learnings.

The Industrial Arts Program — Its Aims and Objectives

The development of industrial arts education to its present stage was simple and logical. Since wood was used widely in home and industry, was relatively inexpensive, easy to work, and necessitated only common hand tools, it became one of the early key materials for teaching industrial arts. Since paper and common drawing instruments also qualified for the same reasons, mechanical drawing also became a basic subject.

With increasing availability and use of metal, development of the automobile for transportation, growth of the graphic arts industry for the dissemination of knowledge, electricity for power and communication, a gradual introduction of these activities began in industrial arts education. In more recent years, new materials and processes, such as plastics, modern metal alloys, the semi-conductors, photo-offset lithography, photography, and light portable tools challenge the teacher and the planner of industrial arts education facilities.

The present emphasis in industrial arts education is toward the following basic industries:

1. Crafts
   a. Ceramics
   b. Jewelry
   c. Leather
   d. Plastics
   e. Textiles
2. Electricity and electronics
3. Graphic arts
4. Mechanical drafting
5. Metals
6. Power and transportation
7. Wood

The laboratory setting should be organized for close correlation with and enrichment of such social studies areas of industry as the following:

1. General organization
2. Names and location of current plants in major industries
3. Distribution and sales of products
4. Typical processes and operations
5. Labor-management relations
6. General financial structure and stock market securities
7. Securing of raw or semi-manufactured materials
8. Product analysis
9. Subsidiary contracts
10. Types of industrial research
11. Patent procedures, and the like

In order to teach and learn of the current industries it is necessary to have resources such as maps, charts, graphs, films, models, mock-ups, raw materials, and products. The laboratory setting should be conducive to work beyond the purely manipulative aspects of industry.

As we set out to develop a curriculum certain basic assumptions are made to serve as a basic philosophy for the evolving program in industrial arts education.

FIRST, we recognize certain important basic facts regarding our society:

1. That ours is a highly mechanized society.
2. That all occupations are becoming more and more dependent upon machines and automation.
3. That practically everything we use is a product of industry and mass production.
4. That industry is subject to rapid change—constantly producing new products with new materials and consequent new procedures.
5. That of necessity, workers from the unskilled to the professional designers are relearning their jobs...
General Education

every five to seven years.

6. That at best we can predict only the general fields of industry and aptitude of our school youth in selecting a vocation.

7. That, even then, the force of chance and circumstance further complicates vocational predictions.

SECOND, within the formative years, in addition to the well recognized moral values and basic skills, we must develop in our students the following:

1. Versatility—the inner capacity to adjust when change implies the necessity.

2. Understanding—the desire to seek the basic and fundamental “why” in all instruction.

3. Work attitudes—the value of responsibility, honesty, loyalty, cooperativeness, patience, persistence, initiative, and confidence in maintaining our democratic way of life.

4. Job background—job vocabulary, job classifications, purpose behind the various skills, traditions, and romance of the various occupations.

5. Tool knowledge—enough language, sciences, mathematics, arts, manipulative skills, and business techniques to achieve full personal stature.

6. Learning habits—a realization that learning and re-learning will go on continuously and that a few mental gymnastics mastered early will be of tremendous value throughout their productive years.

THIRD, we recognize that industrial arts education, which is concerned with industry and its organization, materials, tools, processes, occupations, products, and problems, is a significant part of the life preparation of all youth. Through selective and integrated activities, we can serve students destined for all occupational areas—the sciences, business, arts, industry, homemaking, and the professions in their effort to do the following things:

1. Work effectively with others as a leader or as a member of the group.

2. Read and understand drawings, graphs, and charts.

3. Convert ideas to plans and workable procedures to construct or understand the construction of the typical products of industry.

4. Understand American industry, including such phases as organization, location, raw materials, products, labor-management relations and distribution and sales.

5. Understand and give expression to the mechanical aspects of all subject matter and daily experiences.

6. Apply the principles of science and mathematics to the basic processes of industry.

7. Acquire basic skills used by industry.

8. Recognize quality and design in their own products and those of industry.

9. Maintain and use these products in a safe and efficient manner.

10. Explore the typical occupational areas of industry and lay a foundation for, and advance in, a chosen area.

11. Develop an interest in the crafts as a medium for creative expression in leisure time.

FOURTH, it is recognized that the curriculum in industrial arts be sufficiently flexible and appropriate in content and approach that it can serve the needs of all groups of students, namely:

1. The mechanical-minded student who needs a strong background in industrial arts for business enterprises in the fields related to mechanics, apprenticeship in the mechanical trades, or added technical courses after high school to prepare for vocations in the manufacturing, construction, transportation, graphic arts, communications, or power industries.

2. The college-preparatory student who needs at least the basics in drawing, electricity, and tool and machine processes as a practical foundation for engineering and the other scientific professions.

3. Students with only a casual mechanical interest in how things are made and how they work. Mostly a craft interest in mechanics as applied to hobby and general maintenance activities at the consumer level.

Grade Placement of Industrial Arts in Education Programs

This study guide is primarily intended for the industrial arts instructors in the junior and senior high schools of Colorado. However, it should be recognized that some phases of industrial arts are desirable at all levels of instruction.

It is believed that industrial arts has unlimited opportunities for teaching appreciation of environment and raw materials of industry. Therefore, activities within this area are appropriate and of high educational value whether taught as a separate subject area, or correlated closely with other subject areas, or integrated completely with the total program to the extent that they are not identified.

To accomplish the aims and purposes of industrial arts education, the program should be organized on five levels (see chart on the following page).

Level I—Kindergarten and Grades 1 through 3

In the lower elementary grades (K through 3) the emphasis in the learning activities and the interest of the students is centered around their immediate environment which consists of the home, the school, and the neighborhood. Many aspects of this environment are closely related to industrial arts and are familiar to the students. It is possible to relate new items of knowledge to those areas in which children have a natural interest and about which they desire to learn more.
<table>
<thead>
<tr>
<th>LEVEL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Elementary 1-6 (Integrated)</td>
</tr>
<tr>
<td>II</td>
<td>Exploration Comprehensive (composite) General Shop Broad and basic experiences in each of the seven areas offered (first 36 weeks, min. four areas)</td>
</tr>
<tr>
<td>III</td>
<td>General Industrial Arts Limited General Shop Experiences Continued experiences in four areas based on interest and ability (18 weeks each)</td>
</tr>
<tr>
<td>IV</td>
<td>Advanced Industrial Arts Unit Shop — Work in two areas (18 to 36 weeks each)</td>
</tr>
<tr>
<td>V</td>
<td>(Elective)</td>
</tr>
</tbody>
</table>

**LEVELS OF TEACHING IN INDUSTRIAL ARTS**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>COURSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>Metal</td>
</tr>
<tr>
<td>Graphic Arts</td>
<td>Electricity</td>
</tr>
<tr>
<td>Power Crafts</td>
<td>Drawing</td>
</tr>
<tr>
<td>Trans. Planning and drafting (a foundation for all areas)</td>
<td></td>
</tr>
</tbody>
</table>
Industrial arts is not to be taught as a separate subject but it should be integrated with other fundamental subjects and the industrial arts experiences should be utilized to deepen, enrich, and extend the learnings of the other areas of work. Industrial arts in this sense would become a way or method of teaching. Activities are stimulating enrichment for other areas.

As the child matures and progresses in school, the neighborhood for him will include the community with some of its functions, and activities, in which he and his family are concerned and participate. Holiday activities, seasons of the year, and activities in the neighborhood draw repeatedly upon construction, utilizing readily available and easily worked materials.

These interests will lead to a wider knowledge of the community activities. The students will be interested in the activities of the city, the farm, airports, space ships, space travel, firemen, policemen, trains, trucks, houses, foods, clothing, and many activities in which industrial arts can easily vitalize the program.

Their interest will then broaden much more and the topics for study and discussion will be centered around how food, shelter and clothing are obtained; how we travel and communicate with each other; our sources of water, electricity, fuel, and other necessary services; the characteristics of a good community; responsibilities of good citizens; and will also include a comparison of how people in different communities and countries live.

The teacher should provide an opportunity for creative activity in acquainting the child in the use of paper, wood, textiles, clay and many other simple materials to show how they are involved in the problems of food, clothing and shelter. Teachers should find the self contained classroom the most satisfactory setting to yield an acceptable degree of correlation of the learning activities. Tools and materials appropriate to the work are brought into the classroom.

In situations where a therapeutic need is to be met, more permanent and extensive facilities are required. In these cases, work areas and storage for tools and materials should be designed as a permanent area of the self-contained classroom.

Level 1 — Upper Elementary Grades 4 through 6

In grades 4-6 the industrial arts activities are of a more realistic nature utilizing individual and group undertakings to enrich the science, and social studies activities. At this level industrial arts may be integrated to any degree desirable or it may be identified, but taught in close correlation with other subjects. Emphasis should be placed on the broad areas of transportation, manufacturing and construction. The industrial arts activities will also serve to enrich and interpret the content of other subjects.

Most of the activities may be planned and directed in the self-contained classroom under the direction of the classroom teacher. Some, however, may require additional space and equipment, and a special activity room is desirable. This room needs only simple equipment (hand tools) and can serve several groups. The services of a special teacher in this area are desirable to assist the regular classroom teacher with some of the specialized activities. These services can best be utilized with a portable tool panel and work bench that may be easily moved from room to room as needed.

The preparation of the elementary classroom teacher becomes the key to the program's success. Through lack of experience, many teachers hesitate to incorporate such work into their programs. Actually,
industrial arts techniques at this level are natural and easy. Pre-service courses, in-service extension courses, and assistance from secondary school industrial arts teachers are available to elementary teachers who need assistance.

Level II — Exploratory Industrial Arts Education, Grades 7-9

Since the exploratory courses are a part of the general education program, they should not be elective. There is a strong feeling among authorities in the industrial arts field that a program of exploratory arts and crafts should be required of all youth, both boys and girls, in grade seven. It is hoped that these experiences will include some work in drawing, sketching, planning, leather, textiles, art metal, and wood carving.

It is also desirable that exploratory courses in grades eight and nine should be required of all boys as well as an elective course for girls. The keynote of the program is exploration of the likes and dislikes, discovery of aptitudes, an investigation of tools, materials, and basic processes of our contemporary industrial society. The courses provide help with educational, avocational, and vocational guidance of the student.

The work should be an activity program with related information to provide an understanding of the processes of American industry. The information units at this level should be general in character and devoid of too much detail. Also, the research and experimentation approach to teaching in the industrial arts laboratory opens new avenues of learning.

The experiences should be as broad as possible with introductory work taken in all areas. These should include: planning and drawing, wood, metal, electricity, graphic arts, crafts, and power transmission.

This area of instruction lends itself to the comprehensive (composite) general shop which is closely related to the function of the junior high school. Throughout the history of the junior high school movement, major emphasis has been on exploration and guidance, and provision for individual differences. The activities general shop fulfills these concepts by stressing exploratory activities in a diversified program. The general shop enriches the junior high school curriculum with its varied program and assists the student in a smooth transition between the elementary grades and the high school.

It is suggested that the comprehensive general shop in this guide be a four area shop. The thirty-six weeks of instruction in the eighth grade should include drawing and planning, wood, metal, and the fourth unit chosen by the instructor to fit the physical plant and the needs and interests of the pupils. The suggested units of instruction as shown in this guide were intended to meet the needs of all areas of instruction. The junior high teacher should choose the processes applicable for the areas offered in the school shop.

The ninth grade students should choose from the areas of drawing, electronics, graphic arts, power mechanics, crafts, etc., and perhaps limited general shop experiences in other areas.

Level III — Orientation (limited general shop) Grades 10 and 11

The work taken in grades ten and eleven should be elective course. The function here is to continue the exploration but at the same time give greater depth to the subject. Basic learnings give way to individual initiative in selection of problems. The plan of the program aims at fulfilling the objectives through individual work, group projects, planned visitations, visual aids, related lessons, and other means at the disposal of the teacher.

The scope of the work at this level should continue on a broad base for those majoring in industrial arts education type work with experiences in a minimum of four areas of the seven that are shown in the pictorial illustration (page 11). For the student in the college preparatory curriculum with engineering or a similar scientific goal, courses in drafting, metals, wood, power and electricity-electronics would be most helpful. To the other college preparatory students, and those in general curriculum, the courses should stress leisure time activities and a general knowledge program.

Level IV — Advanced Industrial Arts Education Grades 11 and 12

Work at this level should be elective. The classes on this level should provide considerable depth for those following an industrial arts education curriculum. The work should be concerned with an under-
standing of the "why behind the how." It is difficult to teach a specific skill for vocational purpose because of the rapidly changing employment picture. On this level skills within an occupational family should be developed so the student can adjust to the technological changes.

The work on this level should be for the full year in two areas for those majoring in industrial arts education. This type of instruction should be carried on in a unit shop with a pre-vocational emphasis.

For the college preparatory and general curriculum students, additional courses on level III could be selected.

**Special Courses**—Special courses can be organized within the existing framework of the industrial arts facilities. Courses such as this serve both boys and girls on any level for the general handyman activities required in today's home.

**Adult Level -- Post High School**

Shop and industrial laboratory programs for adults will vary with the interests and needs of the local community. They may be concerned with consumer, hobby and other forms of avocational interests. In abnormal times they may also meet limited vocational needs through special courses for retraining to relieve technical unemployment, on-the-job advancement or the special needs of a community during a major crisis.

**College Level --**

Industrial arts education on the college level is two parts: (1) college or university leading to a baccalaureate degree, and (2) junior college, generally thought of as terminal, and leading to an associate of arts degree. In the senior college and university level industrial arts education has three purposes: (1) professional teacher training, (2) general industrial arts education, and (3) recreational-avocational.

The professional teacher training program consists of the concentrated major of industrial arts education, a basic college course of general education plus professional courses in education. The courses in industrial arts education may be elective for any purpose the student may wish to use them.

### Bibliography -- Professional


CHAPTER III
ORGANIZATION AND ADMINISTRATION IN THE INDUSTRIAL ARTS CLASSROOM

Planning the Program

Careful planning before the start of the school year will determine the success of the industrial arts program. Everyone is aware of the detailed planning that takes place in industry. Dealing with groups of lively youngsters working in varied activities makes it imperative that each day be planned within the objectives set for the course.

It is often felt that planning courses of study and daily lesson plans is almost impossible with students working on different projects in different areas. This is often an excuse to omit planning entirely. Shop classes require detailed planning to operate successfully. If it can be taught it can be planned!

Consider the following when planning the program:

1. Objectives based on the needs of the students in their particular community.
2. Courses of study aimed at these objectives.
3. Lesson plans: flexibility necessary.
4. Importance of related information:
   a. Enriching the offerings of the course and helping to fulfill the general education values of industrial arts.
   b. Providing information about job opportunities and the world of work.
5. Knowledge, importance of attitudes and skills.
6. Teaching aids:
   a. Shop library
   b. Films
   c. Neat, attractive bulletin boards
   d. Displays and exhibits
   e. Instruction sheets
   f. Field trips
   g. Models and miniatures
   h. Pupil-personnel charts
   i. Progress charts
   j. Safety posters

Beginning the School Year

The first contact made with students is extremely important. Vivid impressions are made and the tone is set for the remainder of the school year. Every teacher is different and will follow many of his own ideas in starting the class. There is no set, exact way of doing things and this is as it should be. The teacher may find the following suggestions helpful:

First Day Suggestions:

1. Present yourself neatly with a well pressed shop coat or apron. This leaves a good impression. Wear a name plate.
2. Write the name of the course and your name on the chalkboard.
3. Seat students as soon as they enter the shop.
4. Get acquainted with your students:
   a. Introduce yourself and give them a brief description of your background.
   b. Have each student introduce himself and tell of his hobbies and interests.
5. Pass out enrollment cards or a sheet on which students will write their names. Stress clarity in writing!
6. Discuss safety and tie it in with:
   a. Good housekeeping
   b. Orderly performance
   c. Proper behavior
7. Give a brief overview of the course. (Costs, grades, etc.)

8. Show models of various projects (slides and pictures)

9. Tour the shop if time permits.

Suggestions Which May Be Covered During Remainder of the Week:

1. Assign work stations.

2. Explain work to be covered in various areas if in general shop.

3. Explain rotation in a general shop.

4. Discuss purpose and values of shop courses, tie them in with entire school program. Explain how they fit into the school's philosophy of education.

5. Discuss terms such as general shop, industrial arts, vocational education.

6. Discuss aptitude. Explain that students have a wide range of abilities just as in sports. Use examples.

7. Explain about aprons and proper dress for safety.

8. Lay foundation for proper shop conduct:
   a. Discuss proper attitude towards work and fellow students.
   b. Discuss personal safety. (Check with school on insurance)
   c. Discuss regard for school equipment and materials.

9. Explain the progress chart and grading system.

10. Explain paying for materials, shop fees.

11. Explain policy regarding make-up work.

12. Explain or discuss and construct student-personnel organization.

13. Explain school policies: absences, tardy permits, passes from class, fire drills, assemblies, lunch periods, and school bells.

**Personnel Organization in the Classroom**

The class should be organized in such a way as to make each member feel he is a responsible member of a team. The instructor might present his own plan to the class for acceptance or suggestions, or the group may construct the plan under the leadership of the instructor. Two suggested personnel organization plans are illustrated on pages 19 and 20.

A good pupil personnel organization is one of the keys to efficient operation of shop classes. Its main function is to improve instruction by relieving the instructor of many routine jobs characteristic of the shop.

Each instructor should set up a plan that will best fit his own situation depending on the type of class, number of areas taught, size of class and grade level. In order to be successful it should always be remembered that the teacher is in complete charge of all instruction. This responsibility should not be delegated to the students. The organizational plan should be presented in such manner that the students are willing to accept the plan. Operated properly it should also promote good citizenship through training in leadership, followership, cooperation, and in accepting responsibility. It should also provide for a better understanding of industry in utilizing its line type organization.

Mechanical aids commonly used for assigning students to duties are the rotating wheel, wood block set-up, and lists.

Rotating Wheel: Students' names, work assignments and time intervals are placed on different sized discs and rotated at various intervals.

The Wood Block Method: Students' names are fastened on ¼” thick rectangular pieces of wood which slide in a channel opposite the different jobs. For rotation, the bottom name is removed and placed on top.

Lists: Sheets are typed which include the names of the students with their assignments.

Duties of the shop superintendent:

This is the most important student position in the school shop. The superintendent should be elected by the class. He should set an example for good student behavior in developing citizenship. He should:

1. Arrive in the shop as soon as possible after the bell rings, obtain the keys from the in-
structor and open the storage lockers for his class.
2. Assist the instructor in starting and dismissing the class.
3. Keep a list of the various unit foremen and coordinate their work.
4. Help his foremen whenever necessary.
5. Help his foremen in selecting substitutes for absentees.
7. Help the instructor in clean-up inspection.
8. Report irregularities to the instructor.
9. Assist new students in their duties.
10. Lock all cabinets at the end of clean-up and return keys to the instructor.

Duties of unit forman should be:
1. Keep a list of all boys in his unit.
2. Maintain an alert for violations of safe practices.
3. Have charge of the tool panel in his area and check to see that all tools are returned.
4. Check to see that all benches and machines are swept clean in his area.
5. Check to see that all supplies are returned to their proper place.
6. Report missing tools or irregularities to the instructor.
7. Set a good example of student behavior.

Duties of unit foremen should be:
1. Assist the instructor in his responsibility for the safety of all students.
2. Watch carefully for violations of safe practices.
3. Report all violations of safe practices to the instructor.
4. Watch students for loose clothing that might be a hazard when working with machinery.
5. Check for students talking to a machine operator.
6. Check on "bunching up" by students around machines.
7. Help students arrange projects neatly in storage cabinets.
8. Check on the care of all machines. See that all guards are in working order, and goggles or plastic face masks are at all machines.
9. Assist the instructor in giving safety tests prior to the student using a machine.
10. Check the first aid kit and keep material in neat order.
11. Assist the instructor in maintaining a safety bulletin board.
12. Check tools for loose handles, broken parts, etc.
14. Light gas furnaces.

Duties of secretary should be:
1. Assist the instructor in checking attendance.
2. Assist in keeping student record cards.
3. Act as timekeeper.
4. Check the order of the planning area in keeping books and magazines in proper places.
5. Take over superintendent's duties in his absence.

Duties of tool foreman should be:
1. Have charge of all tools in the shop in either a tool room or on panels.
2. Check out and take in all tools if shop has a tool room.
3. Keep all tools neat and orderly.
4. Report all damaged or missing tools to the instructor.
5. Recondition some of the tools.
Records — Shop Accounting and Inventory

Record-keeping is a vital aspect of the well-organized and administered industrial arts program. Even though this phase of the work may seem tedious, pride should be taken in the efficient handling of records which ultimately provide for improved instruction.

Whenever money or objects of value are handled, accurate, up-to-date records should be carefully maintained as a protection for both the teacher and the student. Records are a clear index of progress made by students, of material covered, lectures, demonstrations, and tests administered by the teacher.

Accurate background data concerning each student provides valuable information for better understanding of individual pupil needs, and individualization of instruction is one of the basic and prime functions of the entire junior high school program.

Material should be filed where it is easily accessible, probably in a metal file cabinet kept right in the shop. Many different forms and records are used. The instructor should select those which he feels are necessary to adequately cover his needs.

Among the forms most commonly used are:

1. Class-record book
   Provided by the administration to all teachers for recording name and number of course, year, period class meets, names of student, attendance, test grades, final grades, etc. Usually turned in at end of year.

2. Plan of procedure
   Made out by the student and checked by the instructor. Includes a record of the projects completed, supplies and tools used, estimate and actual time required to complete project, steps followed, references, sketches, and final grade.

3. Progress charts
   Includes names of all students with grades on projects completed. Also lists grades for tests, quarters and finals. May include information on work station numbers, work assignments or property issued. This sheet is posted where all may see it. A suggested form is illustrated on page 22.

4. Personal cumulative shop record sheet
   Usually maintained by the office. Includes a running account of all achievements of the student. Record of all shop courses taken, interests, hobbies, mental ability, physical record, outside work experiences, grades in all courses, and comments by teachers.

5. Lesson plans
   Used in teacher preparation of lessons. May be planned in advance for an entire course and revised as necessary. Required in some school systems and encouraged in most. Helpful, too, for substitute teachers.

6. Inventory forms
   For keeping an accurate record of supplies and equipment on hand. Should be checked by the new teacher and kept up-to-date. Include the following: name, number, make, catalog number and description of article; unit and total cost when new, date of purchase, source of purchase, serial numbers, condition, quality and condition of expendable equipment and supplies.

7. Material record card
   Individual record including name of student, period, name of course, year, projects, materials used, cost, amount paid and balance due.

8. Demonstration record
   A brief record of the demonstrations presented to the various classes, with dates.

9. Machine permit
   Written permit signed by parent allowing student to use power equipment upon completion of instruction by the teacher, and having passed a written safety test for the particular machine with a mark and score of 100 per cent accuracy. The test and the permit, signed by the parent allowing the student to use the power equipment, should be kept on file as long as the student remains in the class. (See illustrations of permit forms on page 23.

10. Requisition forms
   One of the non-teaching jobs with which every shop teacher is concerned is the requisitioning of supplies. This chore can be made more pleasant if an organized method of planning and ordering is followed. A wide assortment of expendable supplies is used during the course of each year. To insure a new supply of exactly the correct items, detailed specifications should be listed: description of material, size, unit of measure, item number, cost, date required, and manufacturer's name.

Individual Responsibilities in Collection of Money

It is recommended that money be collected in the main office of the school with the student bringing the receipt to the shop instructor for shop records. A sample receipt is shown on page 22.
PROGRESS CHART (Form)

CLASS PROGRESS CHART

Area
School
Grade
Period
Date

Names of students

Learning units or jobs
Projects

STUDENT’S RECEIPT (Form)

STUDENT’S RECEIPT
WEST JUNIOR HIGH SCHOOL

Name ___________________________ Date ____________

Paid for __________________________________ Project or materials

Amount __________________ Received by ____________________________
MACHINE OPERATING PERMIT (Form)

MACHINE OPERATING PERMIT

Name________________________________________________________has completed all requirements for operating the power equipment listed below. All operating tests and safety tests have been satisfactorily completed.

This permit is for operation of the ________________________________

Date_________________ Instructor_______________________________

This permit will be revoked if any of the operational procedures or safety instructions pertinent to this equipment are violated. Re-instatement of this permit will be at the discretion of the instructor.

PARENT'S SLIP (Form)

PARENT'S PERMIT SLIP

Name________________________________________________________ has my permission to operate the machines and tools in the Industrial Arts shop for the year 19__19

In case an accident occurs we prefer that he receive medical treatment from Dr.__________________________

Office phone________________________ Address________________________

Signed by his parents or legal guardian

Date____________________________________
Following are generally accepted methods for efficient collection of materials used in the industrial arts shop:

1. Student punch card:
   
   Purchased in the office with a face value of $1.00 to $3.00. Deducted amounts are designated by punching around the edges of the card. Similar to conventional meal ticket. The instructor punches out the charges for supplies used by the student. This should be done in the presence of the student to enable him to continuously audit his account. Each student pays a specified amount which will vary with the various shop areas.

2. Annual accounting of funds:
   
   All money collected in the industrial arts department should be accurately accounted for, and turned over to the proper officials.

**Discipline as a Method of Teaching and a Factor in Shop Organization**

A good philosophy of discipline must be apparent throughout the entire school. It becomes the duty of every staff member, including the Industrial Arts personnel, to implement this philosophy in classrooms, shops, halls, and on the playground.

The best disciplinarian is one who is able to prevent discipline problems from arising rather than one who continually searches for a successful system of punishment to control misbehavior. Negative discipline, depending on strong-arm rule, should never be considered. Rather, the stress should be placed on the development of self-discipline. Positive goals should always be emphasized. Through these positive goals attitudes that will be carried with the student into adult life, allowing him to live cooperatively and successfully with others within the restraints of society, will be formed.

A good form of student government in the school and a personnel organization in the shop both help considerably in developing self-discipline. This self-control by the pupils in turn provides the proper teaching conditions for the classroom.

Discipline may be thought of as character education, providing for the development of attitudes, ideals and understanding that result in self-discipline as an adult.

Factors which help promote and encourage self-discipline in each individual student are found in the instructor, in the physical plant, and in the curriculum.

The Instructor as a factor in discipline:

1. Is well-trained in subject matter field.
2. Demonstrates with skill.
3. Learns student names quickly.
4. Is friendly and enthusiastic, taking a personal interest in each pupil.
5. Sets clear limits for behavior and helps students understand these limits.
6. Does not use sarcasm, but speaks emphatically and firmly.
7. Provides rules with explanations.
8. Gives compliments often.
11. Does not use threats, force apologies, or give penalties without considering individual differences.
12. Examines the background of each student for further understanding.
13. Encourages each child to work for his own self-approval, rather than approval of his peers or fear of punishment.
14. Has sense of humor.
15. Provides a grading system that is fair and understood by students.
16. Utilizes all known successful record and instruction sheets.
17. Continues his professional growth by studying and by joining professional organizations.

The physical plant as a factor in discipline:

The shop should be an attractive, comfortable, and pleasant place in which to work. An atmosphere of learning activity and productivity should prevail. Interesting and functional projects should be used in the course of study. A student must believe in what he is doing. The Physical Plant as a factor in discipline:

1. Provides ample storage space for projects. Damage and theft are discouraging to morale.
2. Is clean and well-lighted.
3. Provides for proper ventilation, temperature, with fans to draw out smoke, dust, etc.
4. Includes tools and machines that are kept in excellent working order. Dull tools create dissatisfaction.
5. Provides comfortable work space for each student. Overcrowding lively youngsters asks for discipline problems.

6. Provides a well-organized tool room or tool panels, accessible to students.

7. Provides facilities for lectures and tests.

8. Provides for a planning area including books, magazines, drawing equipment, etc., considered as the shop library.

The Curriculum as a factor in discipline:

1. Is carefully planned and challenging, meeting the needs, interests and abilities of the students in their school and community.

2. Includes interesting and functional subject matter with student appeal.

3. Provides flexibility and variety to meet student needs as follows:
   a. Variety of projects
   b. Interesting displays
   c. Well-planned demonstrations
   d. Slides, movies, field trips and speakers from industry. A check of the school faculty will provide a surprising number of resource people with hobbies, interests, and degrees in fields other than teaching.

Providing Adjustment for Individual Differences

Each student is a unique personality. All students vary in intellectual, social and emotional levels of development. Provisions must be made for each to develop to the fullest extent possible. The industrial arts program has much to offer in providing for individual differences. Its varied program of instruction in which the student has opportunities to explore many different activities provides a good foundation for more specific experiences at the secondary level. It is just as important to a student to find his weak points as it is to determine his strong points. Narrowing the fields of choice as progress is made through the secondary school makes final selection easier.

Interesting instructional material and projects at different levels of difficulty should be available in all industrial arts classes. Special provisions should be made for the slow and bright students as well as the average. Projects suitable to some members of the class may not apply to all. A variety of projects should be presented to the beginning student covering the same basic operations. This allows room for selection from the very beginning and creates interest. The faster student should be allowed to select projects (guided choice) upon completion of minimum requirements. He should be allowed and encouraged to do extra work such as developing a notebook in areas of interest, taking charge of bulletin boards, writing to industrial companies for literature, accepting positions of responsibility in the personnel organization of the shop, giving oral reports on related information and assisting slower students with their work.

For the slow learner, emphasis should be on "learning by doing." Every student must receive recognition and gain some measure of success and satisfaction. The alternative is frustration if the student is not guided according to his or her ability.

The shop atmosphere is also important in promoting individual differences. A pleasant, friendly atmosphere of learning should prevail. This, together with constructive discipline, are conducive to development of well-adjusted students. (See section on "Discipline as a method of teaching and a factor in shop organization" pp. 24-25.)

Ending the School Year

As in any successful venture, details must be planned to the very end. This is especially true in programs dealing with young people. The wise instructor will cope with the let-down attitude that inevitably
permeates a school during the last few weeks of the semester with unflagging attention to good planning. Every day, including the last, must be carefully planned.

Advantages of an orderly finish are excellently summarized by Ericson:

1. Students receive additional knowledge and experience and acquire insight into valuable lifelong habits.
2. Students who leave the shop not to return carry with them a respect for the work and for the teacher.
3. Students who return will be in better frame of mind to start in the right way, and will reap the profit of their work done at the close of the year.
4. Visitors, of whom there are many during the closing days, including prospective students, form a good opinion of the conditions maintained.
5. The teacher is largely relieved of the work which he otherwise would be obliged to do before the beginning of school.
6. It will be easier to start the work properly when classes return.1

Planning for these final critical weeks should start several months before they actually arrive. Two check lists will be helpful in pinpointing the end-of-year needs of the instructor in regard to the students and in regard to the shop.

An instructor's check list of things he should do is as follows:

1. Set definite standards so that there is no misunderstanding in regard to what is expected from each student through the final day of classes.
2. Stress completion of all projects with quality, providing after-school time for work if necessary.
3. Place limitations on projects you are sure students cannot complete, making sure end-of-year costs do not become excessive.
4. Arrange a list of maintenance jobs for students who finish early, as well as a list of small, new-interest projects. Loafing during the last few days destroys an otherwise successful year. Specific maintenance projects include:
   a. Sand and refinish benches.
   b. Oil hand tools.
   c. Oil machines and loosen or remove belts.
   d. Clean finishing room, close paint cans, clean brushes, scrape bench top of old paint and repaint walls.
   e. Straighten storage and supply cabinets.
   f. Build new bulletin board or other small conveniences for shop.
   g. Repaint machines using color dynamics.
   h. Eliminate excess and unusable materials.
   i. Clean and polish sink area and fountain.
   j. Remove bulletin board material.
   k. Remove, dust, and store displays, models and teaching aids.
   l. Have students pay bills for supplies.
   m. Remove projects from shop.
   n. Dust and store books, magazines and instructional material. Separate those in need of repairs.

A check list of administrative and maintenance duties might be as follows:

1. Prepare the annual inventory.
2. Prepare and submit the annual requisition.
3. Bring all shop records up-to-date.
4. Prepare a list of equipment which needs maintenance during the summer.
5. Check all hand tools for repair.
6. Arrange to have damaged or worn books repaired.
7. Arrange to have machine and hand saws sharpened.
8. Revise and store all instructional material.
9. Pull main switch on power tools and lock.
10. Make out grade cards and permanent record sheets. Most schools issue instructional sheets on the closing administrative details.2

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**Bulletin**

SHOP PLANNING & MAINTENANCE
CHAPTER IV
SHOP PLANNING AND MAINTENANCE

With present day enlightened thinking concerning Industrial Arts Education among school administrators, shop planning has become an important part of the over-all plan when considering the building of a new school plant or the modernization of an old one.

Location and Accessibility

The location and accessibility of the shop should be determined to a great extent by its use. For example, it is desirable to locate a woodworking shop or a metal working shop where delivery trucks will have easy access for unloading. It is also desirable to have these shops placed so that walls or other obstructions will not interfere with large projects such as boats or trailers being taken in or out of the shop. Obviously these would not be considerations in the location of a drafting room or a craftroom.

Noise is a characteristic of most shops. For this reason it is necessary to locate them away from areas of the school where noise would be distracting to other classes. In many schools they are placed in a wing with the music department.

Generally shops should be located on the ground floor. This provides for easy installation or removal of heavier machines, and facilitates the handling of bulk supplies such as lumber or steel. Basements are poor locations for shops because natural lighting is seldom good and ventilation is apt to be poor. Machines and tools are more subject to rust in basements.

Auxiliary Facilities

To be most effective certain auxiliary facilities are necessary in the shop.

1. The Lecture area: A place must be provided where students can assemble for lectures, demonstrations, group instruction, taking tests and other activities of this nature. Ideally this would be a separate room adjoining the shop or possibly between two shops. It has been found, however, that an open space large enough to accommodate chair desks with at least ten feet of blackboard space makes a satisfactory lecture area. In craft and similar shops where students work seated at tables, the lecture area may be dispensed with.

2. The Assembly area: Where large projects are likely to be built, some place in the room should be provided for assembling these projects. Preferably it should be located where the natural light is good and where assembly will not interfere with the use of machines or the normal flow of traffic. Approximately 10 per cent of the shop space should be available for assembly.

3. The Finishing room: In addition to furnishing a dust proof space where projects may be finished, this room should provide space for storing projects while undergoing the finishing process. The National Board of Fire Underwriters and most local fire departments have very strict specifications for the construction of these rooms particularly where spray finishing is to be done.

A separate spray booth must be provided for spray finishing. All switches, lights, and motors, both in spray booth and finish room must be explosion proof. The spray booth must be built of non-combustible material and the inside walls should be smooth and non-porous. Booth must be equipped with a filter equipped door, an exhaust filter, and an exhaust fan capable of moving 100 linear feet of air per minute across the horizontal cross section of the booth.

4. Storage: Two kinds of storage need to be provided for in-school shops. Storage for supplies must be provided and some place to store student projects during construction will be needed.

Generally it is more satisfactory to store lumber and rolled steel stock horizontally. Where space is a problem these may be stored vertically.
In vertical storage the length of stock that may be stored is limited by the height of the ceiling, often necessitating cutting the material before it can be stored. This not only takes time, but results in more waste. Lumber is more prone to bend and warp when stored vertically. This is particularly true of plywood which should be stored flat if possible.

Some provision for storage of small items such as bolts, screws, nails, hinges, and jewelry findings, is very necessary, but is often overlooked in the planning of a shop. Needless to say, provision should be made to keep all supplies under lock.

Ideally a storage locker with lock should be provided for each student. These should be large enough to accommodate the unassembled parts of the largest projects that will be made. Where projects are quite large it is sometimes desirable to have at least a few large lockers to hold larger pieces, and it is customary for several students to share the larger lockers.

5. Other Facilities: Every shop should have a place for students to wash and most shops also need some place to wash brushes and other dirty equipment. A sink that is to be used for cleaning should be equipped with a special trap which will allow easy cleaning. The round or semi-round Bradley type wash basins are satisfactory for washing but they require considerable space and are expensive. They are not satisfactory for cleaning brushes. A drinking fountain in connection with the sink is a desirable facility that is often overlooked in shop planning. At practically no cost this item will save the teacher much of the bother that accompanies students leaving the room to get a drink.

Gas lines and air lines should be provided in metal shops, machine shops, wood shops, auto shops, electric shops, and craft shops. These lines are much easier and cheaper to install if they are included in the original building plans. It is sometimes very difficult to get them into a shop after it is built.

**Equipping the Laboratory**

Since all school shops are equipped on a limited budget, care must be used in the selection and purchase of tools and equipment. In determining what equipment to purchase, the following factors should be kept clearly in mind:

1. **The underlying purpose of the program:** The objective to be achieved with the activities which will promote their attainment is an important consideration in the selection of shop equipment. Equipment for a program where trade classes are to be held in the evening should be as nearly the same as used in industry. Where the aims of the program are largely appreciation and understanding of industry, lighter duty machines generally can be used.

2. **The maturity level of the students:** Equipment for a seventh grade exploratory course in woodwork would naturally differ considerably from that selected for an advanced high school course.

3. **The type of shop organization:** If a central shop is being considered instead of a unit shop, the amount of each kind of equipment needed will be less, but a greater variety of equipment will be needed.

4. **The class size:** (see chart)

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**RECOMMENDED NUMBER OF SQUARE FEET PER STUDENT FOR A CLASS OF TWENTY-FOUR, NOT COUNTING AUXILIARY ROOMS**

<table>
<thead>
<tr>
<th>JR. HIGH SCHOOL</th>
<th>MINIMUM</th>
<th>SATISFACTORY</th>
<th>DESIRABLE</th>
<th>% TO BE ADDED FOR AUX. ROOMS</th>
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<td>75</td>
<td>90</td>
<td>30</td>
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<tr>
<td>Metal work</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>25</td>
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<tr>
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<td>60</td>
<td>80</td>
<td>10</td>
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<td>Crafts</td>
<td>50</td>
<td>65</td>
<td>80</td>
<td>10</td>
</tr>
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<td>General comprehensive</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>20</td>
</tr>
<tr>
<td>Power mechanics</td>
<td>60</td>
<td>75</td>
<td>90</td>
<td>20</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>HIGH SCHOOL</th>
<th>MINIMUM</th>
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<th>% TO BE ADDED FOR AUX. ROOMS</th>
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<tr>
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<tr>
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<td>Auto mechanics</td>
<td>80</td>
<td>90</td>
<td>100</td>
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</table>
5. Room size: Even though adequate room size may be provided for in the original planning, plans are often modified to keep the cost of a building within the budgeted amount, and floor area has to be reduced.

6. The probable amount of money available: It is desirable to plan the equipment list on the basis of the first five of the above considerations before considering the amount of money available. By starting with a complete picture of the ideal equipment, deletions may be more intelligently accomplished. The most important items can then be purchased, leaving those of less importance to be purchased at a later date.

The following considerations in the purchase of shop equipment will save money for the school and much grief for the teacher:

1. Hand Tools
   a. Purchase only standard brand tools made by a reputable manufacturer. It is usually not necessary to buy the premium line of a given manufacturer, but it is best to avoid the cheapest or the home workshop line. The better tools will do their work better, require less frequent sharpening and repairing and will often outlast several cheaper tools. It is also easy to purchase regular parts for standard tools. This is seldom true of off brands.
   b. Purchase tools which fit the students. Smaller planes, smaller saws, and smaller hammers should be provided for smaller students. This does not mean the toy sizes. Too small a tool is worse than one too large.
   c. Try to determine the largest number of students who will be using a given tool at a given time. Use this figure as a basis for purchasing rather than using a tool list prepared by some other person.

2. Machine Tools
   a. Machine tools should be purchased to satisfy the purpose for which they are to be used. A unit shop may require heavy, production type machines, while a general shop will probably require light or medium duty machines. Generally the light or medium duty machines are satisfactory for Industrial Arts shops, since trade preparation is not a major goal.
   b. In machines as in hand tools it pays to buy only those of standard make, backed by reputable manufacturers.
   c. Unit type machines are preferred to combination machines. Combining a circular saw, a mortiser and jointer on a single stand reduces the usefulness of the machine and creates safety hazards.
   d. Be sure to purchase machines of the proper voltage. Many new buildings are now wired for 208 volts. Motors designed to operate on 220 or 230 volts will not operate satisfactorily on the lower voltage.
   e. Grinding equipment should be provided with safety shields of safety glass or plastic.
   f. All motors should be provided with some type of overload protection.
   g. All machines should have individual motor drives, controls, and stands.

**Equipment Layout**

In locating the equipment in a new shop or relocating equipment in an old shop the following procedure will be found helpful. Make a scale drawing of the room to be used showing all doors, windows, and other structural details which might affect the placement of equipment.

Prepare scale cutouts of all major pieces of equipment, including machines, benches, and cabinets. These cutouts may then be moved about on the scale drawing to determine the best arrangement of the equipment.

In arranging equipment first consideration should be given to making the arrangement as safe as possible. This means wide traffic aisles (forty-two inches is a good width), ample space around machines, a minimum of crisscrossing traffic, and good natural lighting on work areas. In the regular pursuit of his work it will often be necessary for a student to move from his station to other areas where things are stored for his use. These lines of travel should seldom cross other lines of travel.

Aside from safety the next most important consideration is the proper flow of stock being worked.

The normal flow of stock through the woodworking shop would be from cutoff saw to planer, to jointer, and then to bench saw. It is logical then to arrange these machines so that the stock will move smoothly out of the stockroom and through the machines with a minimum of effort or travel by the worker.

**Remodeling Existing Facilities**

A teacher is more likely to have a chance of remodeling an existing shop or turning an existing room into a shop than he is to get to plan a new one. In such a case the location, size, shape, and proportions of a shop are already established. A number of things,
however, can be done to make an old shop into an adequate avenue of learning.

1. The artificial lighting can usually be improved by installation of fluorescent fixtures.

2. Work places and machines can be rearranged as suggested.

3. New doors and windows can often be cut.

4. Partitions can be removed, or new ones put up to create needed auxiliary rooms.

5. Walls and ceilings can be painted to improve natural lighting and appearance. It is highly recommended that when repainting, one of the accepted color schemes such as “Color Conditioning” or “Color Dynamics” be followed.

6. Reconditioning floors.

7. Providing additional utility outlets.

### Space Per Student

Areas of shops are determined by the activity involved, by the grade level they are to serve and certainly by the amount of money available. Generally shops are much more likely to be too small than too large. In planning shops it is customary to allow so many square feet per student as a starting point in drawing plans.

The following table shows desirable, minimum and satisfactory areas per student for various courses, based on a class size of twenty-four students. In general the smaller the class the more footage per student is needed.

It is recommended that shop length be approximately twice the width.

Many shops make more efficient use of space by using wall panels for tool storage. A well-planned tool panel makes for ease of access, checking, and good display.
Care and Maintenance of Equipment

No one can do his best work with tools which are in poor condition, and certainly students are no exception. It is the duty of the shop teacher to see that all tools and machines are in first class condition at all times. Not only is this important from the standpoint of safety and good craftsmanship but it fosters the attitudes, and habits, which industrial arts promotes.

Hand Tools: Tool sharpening is perhaps the most frequently needed tool maintenance in any school shop. Teachers should know how to sharpen the tools in the shop. They should provide some system for periodic checking on their condition and see that tools are kept sharp and in good condition.

Handles of hammers, chisels, mallets, saws and planes should be kept tight and should be replaced when they are split or cracked.

Machines: A most necessary item of maintenance on machines is regular and proper lubrication. An expensive machine can be quickly ruined if bearings are allowed to run dry. A regular schedule for oiling machines should be established and this schedule should be followed religiously. Some teachers use a color scheme to accomplish this. Bearings which are to be oiled daily are indicated by painting the area surrounding the oil hole one color, those which need to be oiled weekly are painted another color, etc.

Excessive lubrication is to be avoided for it is messy and in some cases, particularly in motor lubrication, may interfere with proper operation. As a rule, however, it is better to over lubricate than to under lubricate. The local oil dealer can be helpful in determining the proper type and weight of oil or grease to use. Avoid detergent type motor oils for they affect the seals on some types of bearings.

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SAFETY

START

STOP

CAUTION
All industrial arts education teachers should be gravely concerned with student safety in the school shop. However, the larger class enrollments make it very difficult for the teacher to give the necessary individual attention to each student. Also the increase in the complex course offerings in the use of tools, materials, and processes make the job more difficult for the instructor. Even though these conditions exist, the teacher must not get a negative philosophy, “It can't happen to me.” Shop teachers must be safety minded and have an alert awareness of all types of hazards. The teacher should continually ask himself this question: “Do I set a good example in safety at all times?”

Safety is an attitude accompanied by habits. The development of proper safety habits and attitudes is one of the primary objectives of industrial arts education teaching. An effective school shop safety program does not just happen. It is a result of careful and continual planning. The safety problems that confront the teacher are determined by the school laws of the state, philosophy of the school, the physical plant, and the organization within the system.

Simple policies and rules should be established and then must be enforced. In other words, there must be no compromise with safety. Nothing but a perfect score is acceptable, for the ultimate goal of safety instruction is to protect pupils from accidents due to their errors or lack of knowledge.

Positive safety education is based on accident prevention. Present day conditions make it imperative that safety education be a part of the training of all students; it should be a part of every course of study, and teachers should teach, practice, and display safety practices at all times.

Because of the legal liability and moral responsibility, it is good common sense for every shop teacher to prevent accidents by eliminating, as far as he can, all mechanical and physical hazards because these are tangible. Other phases of safety instruction are intangible, but nevertheless important in the over-all picture.

Positive safety instruction is self-preservation for the teacher, for the supervisor, and for the administrator. Safety is everybody's job. We should do an excellent job of safety instruction if we conscientiously follow Scott's safety check list.

**SAFETY CHECK LIST**

**Attitude and Personality**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>Do I think, speak, and act in regard to shop safety at all times?</td>
<td>☐</td>
</tr>
<tr>
<td>2.</td>
<td>Have I integrated my safety program with what I am teaching, in an interesting, logical manner?</td>
<td>☐</td>
</tr>
<tr>
<td>3.</td>
<td>Are my students keenly aware that shop safety is a vital, required part of my shop program?</td>
<td>☐</td>
</tr>
<tr>
<td>4.</td>
<td>Do I immediately curb horseplay and carelessness in the shop at all times?</td>
<td>☐</td>
</tr>
<tr>
<td>5.</td>
<td>Have I explained and demonstrated the need for cooperation among students and teacher when certain jobs of lifting, gluing of boards, and carrying of materials become necessary in the shop?</td>
<td>☐</td>
</tr>
<tr>
<td>6.</td>
<td>Am I acquainted with the school laws of state regarding shop safety, negligence, etc.?</td>
<td>☐</td>
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</tbody>
</table>

**Shop Dress**

<table>
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<th></th>
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<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>If students are required to wear shop coats or aprons, do I insist that they be</td>
<td>☐</td>
</tr>
</tbody>
</table>
kept neat, clean, and buttoned or tied at all times?

☐  ☐ 2. If students do not wear coats or aprons, do I insist that they refrain from wearing new or loose clothing?

☐  ☐ 3. Have I told the students the danger of wearing long sleeved shirts, neckties, jewelry, etc., and am I on constant guard to see that no one forgets?

Material Shortage

☐  ☐ 1. Is the material on lumber racks, metal racks, clamp racks, etc., stored neatly and safely at all times?

☐  ☐ 2. Are all materials stored in proper, convenient places and not left lying about in haphazard fashion?

☐  ☐ 3. Are all material storage places sufficiently lighted?

☐  ☐ 4. Do I guard against overstocking racks, shelves, etc.?

Hand Tools

☐  ☐ 1. Are my tool panels, tool room, etc., organized in a neat, safe fashion?

☐  ☐ 2. Have I told my students the danger of using dull hand tools?

☐  ☐ 3. Have I stressed the safety points on the various hand tools during my talks and demonstrations and am I on constant guard to see that the student participation is done correctly?

☐  ☐ 4. Have I explained and demonstrated the correct procedure for carrying sharp edged tools?

Machinery

☐  ☐ 1. Is each machine properly located in respect to space, efficiency, and safety?

☐  ☐ 2. Are all cutting edges, belts, pulleys, etc., carefully guarded?

☐  ☐ 3. Is there adequate light for the safe operation of each machine?

☐  ☐ 4. Are the machine accessories, for each machine, placed in the proper location? (Avoid reaching over running machines for needed accessories.)

☐  ☐ 5. Are all machine switches guarded and properly painted?

☐  ☐ 6. Are all machines clean and properly painted?

☐  ☐ 7. Are goggles a necessity for the operator of certain machines such as grinders, lathes, etc.?

☐  ☐ 8. Have proper safety rules and demonstrations been shown, studied, and talked about informally for the operation of each machine before any student participation?

☐  ☐ 9. Is student participation on each machine an individual affair, whereby each student must qualify by passing tests?

Finishing Room — Acids

☐  ☐ 1. Is there proper ventilation in the finishing room?

☐  ☐ 2. Is there a special booth for spraying, if much spraying is done?

☐  ☐ 3. Are large quantities of combustible materials kept in fireproof rooms or closets?

☐  ☐ 4. Are oily rags and waste kept in proper receptacles?

☐  ☐ 5. Is the finishing room kept neat and clean at all times?

☐  ☐ 6. Are all containers closed tight and stored away from heater pipes or radiators?

☐  ☐ 7. Are acids and other harmful agents used in the shop kept in proper containers and clearly labeled and are they stored in a safe place?

General Safety Rules

☐  ☐ 1. Is the shop well lighted, clean, free of grease and oil on the floor, and neatly painted?

☐  ☐ 2. Does each machine have an adequate safety lane area painted on the floor?

☐  ☐ 3. Are all light switches in good working condition and of the right type for each part of the shop? (For instance: mercury switches in the finishing room.)

☐  ☐ 4. Have all lines and electrical circuits been checked for proper load?

☐  ☐ 5. Are all plugs and extension cords in good condition? (No splices or poorly taped wires.)

☐  ☐ 6. Are you familiar with all fuse panels for your shop? Are proper fuse loads always maintained?
Yes  No

7. Have the fire extinguishers been checked recently and are they of the right type for each part of the shop in which they are located?

8. Do I help promote shop safety by keeping pleasant board displays?

9. Do I have a fair knowledge of first aid and what to do in case of an accident?

10. Is there a good first aid chest at my service in the event that I should need it?

11. Are insurance and accident report papers neatly filed and kept ready (just in case)?

Should an accident occur in the school shop, the teacher may give first aid, notify a doctor or send the student to the school nurse. He should notify the parents or have this done from the school office. In addition, it is a growing practice to expect every teacher to make a preliminary accident report, and it should be kept on file until the person has reached legal age. The following is a suggested preliminary accident report:

Preliminary accident report to be filled out immediately after an accident in the shop.

School ..............................................................

1. Who was injured?

2. On what day and what time did the accident occur?

3. What was the nature and extent of injury?

4. Who gave medical treatment?

5. Where did the accident occur?

6. Who saw the accident or was near the injured when the accident occurred?

7. What was the cause of the accident?

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When an accident occurs in the school shop the teacher must be able to show sufficient evidence that he consistently maintains all reasonable safety precautions, or he is liable. The general agreement among authorities on school law is that teachers will likely be considered negligent under the following conditions, if an accident occurs in the shop:

1. Teacher fails to demonstrate safe techniques and practices for each individual piece of equipment.

2. Absence of teacher from shop while pupils are in the shop.

3. Teacher leaving the shop, with an unqualified person in charge of the class.

4. Pupils using equipment in the shop which has not been approved by the board of education. Some teachers bring their personal equipment to the school shop.

5. Permitting pupils to work in the shop other than during the regularly scheduled periods and especially without acceptable supervision.

6. Permitting pupils not enrolled in shop classes to use the equipment.

7. Pupils being sent outside the shop to perform hazardous duties.

8. Making the use of all power tools compulsory.

9. Allowing pupils, especially prone to accidents, to use power machines. Some physical and some mental conditions should make a pupil ineligible insofar as the use of some power tools is concerned.

10. Failure to keep written reports of every accident occurring in the school shop regardless of the type of injury.

11. Failure to administer safety tests and to retain such satisfactorily passed tests for use in case of liability suits charging negligence. To some teachers the term “satisfactorily passed” means 100 percent correct or the student doesn’t use the equipment.

12. Failure to get written statements from witnesses in case of accident.

13. Failure of the teacher to keep in mind the fact that his or her pupils are children and that the actions of children are normally guided by childish impulses.

14. Failure to realize that the case mentioned above is defined by law as greater caution when dealing with children than with adults.

**Bibliography -- Safety**

**Books**


**Periodicals**


CHAPTER VI
FUNDAMENTALS OF DESIGN

Design is probably one of the least understood fields connected with the industrial arts. It is a field that is constantly changing. The teacher should be aware of new ideas and try to incorporate them into his teaching to keep his designing up-to-date.

The average industrial arts teacher feels that design is something for which he has little or no talent. However, this same teacher could improve his ability to design even though perhaps he does not possess a natural artistic ability. It is true that artistic ability is a great help to the designer; however, a thorough knowledge of the fundamentals of design will not only help the average industrial arts teacher do a satisfactory job of designing, but is essential before the artist can become a good designer. If a knowledge of the fundamentals of design can be of help, then let us in industrial arts study these fundamentals to do the job we are doing to the best of our ability.

Kinds of Design

In designing, form must follow function. A car, no matter how beautiful, is worthless unless it will run. Too much of our design has been bound by the past and therefore has been retarded. For instance, the first car was shaped like the buggy instead of having the sleek lines we know today.

There are two important types of design, structural and decorative. Of these two, structural design is much more important.

1. Structural design: Structural design refers to the shape and size of an object and will vary enormously depending on what the object is to be used for. Some of the principles to follow in structural design are:
   a. It must be adapted to the use for which it is intended.
   b. It must be simple.
   c. It must be well proportioned.
   d. It must be suited to the materials of which it is made and the processes necessary in making it.

   Some examples of good structural design are the airplane or the San Francisco Oakland Bay Bridge, in which the design is a result of the object's function.

2. Decorative design: Although decorative design is the lesser in importance of the two types, it is still important to good design. Some of the principles of good design are:
   a. Decoration should be in moderation.
   b. Decoration should strengthen the object.
   c. Decoration should be placed at weak spots.
   d. Background areas should be the same size.
   e. Background space should give simplicity.
   f. Decoration should be suited to the material used and the use of the object.

Elements of Design

The elements of design are line, shape, size, texture, value and color. It is with these tools that the designer must work.

1. Line: Every design is made up of lines which vary as to width, texture, direction and extent. The principles give line its meaning. For example, the direction of the line may be vertical, horizontal, curved, or zigzagged. The vertical line appears to be direct, tense, stiff, uncompromising, harsh, hard, unyielding; while the horizontal line has a slow, lazy appearance.

   The zigzag line denotes excitement or nervousness. The weight, texture, and extent of a line can also be used to set the mood for design.
2. **Shape:** Every design is made up of some part of the triangle, rectangle, square, circle, cone or ellipse. It is the proper blending of these shapes that produces our good designs. Almost every person can produce each of these and, like building a complex piece of furniture, from simple operations the designer can produce the desired results by putting these simple shapes together.

3. **Size:** Size refers to the measurement of an object. In the field of industrial arts, we most often find size as a standard measure that has been worked out to fit the needs of the average size person. Almost any catalog is a good reference for the standard size of a given object.

4. **Texture:** Texture is the minute structure of a material. Texture appeals to the sense of touch. It may be rough or smooth, pebbly or prickly, or satiny or velvety.

   Texture also has great appeal to the sense of vision. By association of visual experiences with tactile experiences, we say a surface looks wet or dry, rough or smooth. Because of the importance of texture, manufacturers have in recent years introduced new materials such as glass blocks, corrugated sheet glass, chromium, plastics, sponge rubber, metallic paper, and cellulose fabrics; texture has become a richer, more versatile element that has expanded the scope of the designer.

5. **Value:** Value is the quality of visible light reflected by a tone. It is lightness or darkness of tone. For example, we refer to green as light green or dark green — both are greens but there is a difference in their value.

6. **Color:** Color must be a factor in design because color affects us psychologically. For example, red is an active color while brown suggests restfulness. Color also has the suggestion of warmth or coolness. Such colors as yellow, orange, and red appear warm, while blue, green, and violet appear cool. The designer, in order to produce the desired results, must consider all of the above elements.

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**Principles of Design**

The principles of design include balance, dominance, unity, proportion, and repetition. They are the factors that make a design have a good appearance.

1. **Balance:** Balance is the result of the interplay of forces; the resolution of stress and strain. Its effect is one of repose and satisfaction. Lack of balance creates a desire for change. The designer uses the following methods to obtain balance:
   
a. Through giving evidence of adequate strength.
   
b. Through functional relationship of all parts.
   
c. Through equalized arrangement with respect to an axis, a center of interest, or a line of motion.

2. **Dominance:** In good design, some part of the design must be dominant or stand out among the other parts. If there are several dominant parts, these parts must harmonize.

   Dominance can be achieved by several methods such as: making one unit larger, making a unit stronger in value or different in texture or color. Dominance is also achieved by shape or repetition of some part of the object.

3. **Unity:** Unity is the tying together of parts of a designed object. Unity may be produced by a number of means, among which are the following:
   
a. Through a clear evidence of function.
   
b. Through reducing complex combinations of parts or elements to a relatively few simple forms.
   
c. Through regular or sequential arrangement of elements.
   
d. Through unity of style elements within a design or in related designs.

4. **Proportion:** Proportion is the law of relationships. Good proportions are the result of harmonious relationships of lines and of masses. Proportion should not be easily analyzed. Masses having the proportion of 2 to 3, 3 to 5, 2 to 5, 5 to 8, or similar ratios are good. This holds true in dividing areas as well as in the outside dimensions; however, this is not a hard, fast rule. The best proportions is that which best suits the use for which the object is intended. Some things to consider in proportion are:
   
a. Arrangement must hold interest.
   
b. Arrangement must be best for the sizes and shapes used.
   
c. Sizes grouped together must be complimentary.
   
d. Space relationships must be pleasing.
   
e. Scale must be proportionate.

5. **Repetition:** Repetition is the using of some element of the design over and over to produce harmony. Some of the ways this can be achieved are through the repetition of color, parts of a project or in the processes used to make the article.

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**Qualities to Consider in Designing**

Qualities that should be considered in designing are as follows:

1. The size and shape of the object.
2. The purpose the object is to serve.
3. The limitations of the material to be used.
How to Produce Good Design

1. Knowledge of fundamentals: A thorough knowledge of the fundamentals of design are essential to good design. Without this knowledge of fundamentals the designer is like the cabinet maker trying to make a piece of furniture without a knowledge of woodworking tools.

2. Steps in designing:
   a. There must be a need.
   b. Standard requirements must be known.
   c. The most suitable materials should be selected.
   d. The details of form, line, proportion, and construction must be decided. Sketches will help in doing this.
   e. The best of the sketches should be selected and a full-sized working drawing made from it.
   f. Proportion and details must be refined.
   g. The drawing should be checked.
   h. Revisions should be made where necessary.
   i. The article made from the drawings should be examined to learn how well the idea has worked in practice, and to see how improvement can be made on the next design.

How to Teach Design

1. Design through fundamentals: It is important that the student become proficient in the use of fundamentals of design. In order to establish this proficiency, the teacher should teach design fundamentals and provide ample opportunity for the student to practice these fundamentals through exercises dealing with the various areas.

2. Design as an aesthetic value: With practice and use of fundamentals of design, the student will eventually develop an appreciation for good design. This will help the student do better work and become more skilled in the designing of his projects. This aesthetic value, however, like appreciation, is a result of all we do rather than being something toward which we teach.

Summary

Structural and decorative are the two types of design with structural being more important than decorative. The factors which the designer must consider are line, shape, size, texture, value and color. A thorough knowledge of these tools is important to good design. The principles the designer must keep in mind when designing are: balance, dominance, unity, proportion, and repetition.

Some other qualities which must be considered in designing are: purpose, material limitations, and limitations of tools and processes in producing the object. The industrial arts teacher can produce good design through mastering the fundamentals of design and following definite steps in the actual designing.

Design can be taught through the teaching and student practice of the fundamental tools and principles of design. Aesthetic values will be a result of good teaching and practice. These aesthetic values will prove helpful to the student in determining what is good and poor design.

Bibliography -- Design

Books

Periodicals
EVALUATION
CHAPTER VII

STUDENT EVALUATION

Evaluation of student accomplishments in any course depends upon the purposes of the student and the objectives of the course. Types of marks must, of course, conform to those used throughout the local system. Some desirable characteristics of any grading system are as follows:

1. It should consume a minimum of the teacher’s time.
2. It should be based upon a wide scope of student responses and attainment.
3. The grading should be frequent.
4. Uniform standards of grading should be applied.
5. Grades should be permanent.

If the course is exploratory in nature, evaluation should be indicative of the honest effort made on the part of the student to acquaint himself with a wide range of industries (offerings of the course), and his ability to formulate firm decisions regarding his interests and aptitudes in the various areas and processes. Although decisions of interest and aptitude may be positive or negative, the student’s logic based upon his understanding of processes is a firm basis for grading. Quality of work in the exploratory courses should be considered only insofar as it indicates interest and attitude. Students should be evaluated in shop cleanup, class participation, interest, effort, open-mindedness and wholesomeness of attitude, cooperation, and soundness of decisions regarding areas and processes. If evaluation is frequent, changes and change trends in the marks given should be considered.

In general shop or unit courses (beyond the exploratory level) quality of work, quantity of work, general background knowledge, and technical knowledge should be measured. Shop cleanup, class participation, interest, effort, cooperation, and other applicable phases of attitude should also be evaluated. A generally accepted scale of four basic points is as follows:

- Knowledge (general and technical) ..... 25%
- Quality of work .................................. 25%
- Quantity of work .................................. 25%
- Effort and attitude .................................. 25%

The knowledge evaluation should consider ability to plan and adapt acquired information, ability to follow instructions, tests (objective, performance, and subjective), ability to read drawings, and recitation.

Quality should include accuracy in proportion to ability, in proportion to class average, and in proportion to trade standards, neatness, and artistic ability.

Quantity evaluation should consider time factor in relation to ability, class average, thoroughness, and quality. Extra work above requirements of the course and extra work service in the shop should also be considered.

Effort evaluation should consider desirable habit formation, determination, perseverance, initiative, self-direction, honesty, dependability, use of time, attendance, and industry. Attitude evaluation is closely related to effort though a little more general in nature. It should include:

1. Cooperation with group and teacher.
2. Care and use of equipment.
3. Organization and pride in work.
4. General courtesy and respect for rules and general situation in the shop.
5. Observation of safety factors.
6. Respect for other students and their work.
7. Respect for authority.
9. Thriftiness in use of materials and equipment.

Percentages of the four points should be adjusted to fit the individual shop and objectives of the course.

Bibliography -- Evaluation

Books
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CHAPTER VIII
HISTORIC BACKGROUND AND CURRENT TRENDS IN INDUSTRIAL ARTS EDUCATION

A study of the history of industrial arts should, if it is to be of value, (1) aid us in solving present day problems in industrial arts education, (2) assist us in justifying our present practices, or (3) assist us in improving our program and practices in industrial arts education so that it may be fully justified as a part of the total educational program. The histories of “industrial arts education” and “industrial education” are one and the same until the Smith-Hughes Law was passed in 1917. (See illustration on page 48).

The industrial subjects in education in America have gone through some interesting changes in less than a century. Much was gained from these European experiments in this field of education. Those experiments were: The Russian Plan of Tool Instruction; The German Manual Training; and the Swedish Sloyd movements.

The Russian Plan of Tool Instruction (1868)

The characteristics and purposes of the Russian system were as follows:

1. For development of trade instruction (inaugurated by Della Vos of the Imperial Technical Institute of Moscow, Russia, in 1868).
2. To train engineers and skilled workers for building Russian railroads.
3. To organize industrial vocational education for groups (first attempt to such organization).
4. For formal instruction of a series of exercises, joints, models in wood and metal (did not contain the element of boy interest).

Influence of the Russian Plan were largely in the direction of organization and administration. The plan was not adopted in its entirety, but the following influences and practices have come down to us and are used today:

1. The course of study was based upon occupational analysis.
2. Courses built on principle of working from simple to complex.
3. Subject matter was organized for teaching purposes.
4. Teaching methods were developed.
5. Pupils were trained in groups rather than singly.
6. Progress of the student could be determined at any time.
7. Both individual tool sets and benches and general tools were included in the equipment.
8. Pupils worked from drawings they had previously made.
9. Separate shops were established for the different equipments or trades.
10. Models and charts were hung on the walls of the shops.
11. Time required for learning a trade was shortened from that required under apprenticeship.
12. Accuracy required was increased as the course progressed.
13. One model was completed before another was begun.

The German Manual Training (1870)

The movement was developed by Dr. Waldemar Goetze for a distinctive type of manual training in Germany.
BEGINNINGS OF INDUSTRIAL ARTS

RABELAIS (1490-1553)

JOHN LOCKE (1632-1704)

ROUSSEAU (1712-1778)
"Emile"—developing natural capacities

FROEBEL (1782-1852)
"Education for work through work"

JOHN RUSKIN (1819-1900)
Arts & Crafts

CYGNAEUS (1858-1866)
Social-economic motive

JOHN DEWEY
Activity program
Industrial nature of society
Work as basic to social understanding

SMITH-HUGHES LAW 1917

RABELAIS (1490-1553)

JOHN LOCKE (1632-1704)

ROUSSEAU (1712-1778)
"Emile"—developing natural capacities

FROEBEL (1782-1852)
"Education for work through work"

JOHN RUSKIN (1819-1900)
Arts & Crafts

ABRAHAMSON & SALOMON (1874)
"Theory of Educational Sloyd"

DELLA VOS (1868)
Mechanical skills for military engineers

HASKELL INSTITUTE (1884)

HAMILTON INSTITUTE (1870)

INDUSTRIAL COMPETITION

JOHN DEWEY
Activity program
Industrial nature of society
Work as basic to social understanding

SMITH-HUGHES LAW 1917

GENERAL EDUCATION

GENERAL SHOPS

DEVELOPMENTAL EXPERIENCES

Skills
Related Information

TRADE SHOPS

Professions or Trade Training
Education of Vocational Guidance

CONTINUATION SCHOOLS
COOPERATIVE SCHOOLS
PART TIME SCHOOLS

VOCATIONAL TRADE TRAINING
Some of its influence in our industry today are:
1. Instruction was largely pedagogical and psychological.
2. Useful articles were made.
3. There were both class and individual instruction.
4. Organization of content was methodical.
5. Teachers were trained persons who received supplemental instruction in mechanics from skilled artisans.
6. Interests of students were capitalized upon.
7. The learning experience, through carefully directed doing, was emphasized as much as the content.
8. The program was given an independent place in the curriculum.

**Swedish Sloyd**

Characteristics and purposes of the Swedish Sloyd system were:

1. A Swedish Sloyd was a man skilled in many arts, primarily in wood (modeling with cutting tools more than other phases).
2. Chief purpose was social.
3. Social aim was to help raise the moral standards of boys, which had deteriorated with the factory system and the decline of the home Sloyd.
4. From occupational education viewpoint, the purposes were both general and specialized.
5. Influences of Sloyd on American education handwork are:
   a. Discipline was formal and a transfer of training was part of the underlying philosophy.
   b. Projects were useful and boy interest followed work of the exercise type.
   c. Drawings were made by the students.
   d. Aims established contributed to general education.
   c. Cultural values were recognized.
   f. Practice of making notes, sketches, and lists of operations in a notebook were inaugurated.
   g. Student had some choice in selection of project.
   h. Class instruction was supplemented by individual instruction.

**Development of Industrial Arts Education in the United States**

Calvin M. Woodward established the Manual Training School of Washington University in 1879, which followed closely the Russian Plan of Tool Instruction. He advocated handwork as a part of general education of all boys. School was largely vocational in nature in order to secure funds. They were aimed to train skilled mechanics and prospective junior executives. This system followed closely the Russian plan of instruction. Courses in wood, metal, and drawing were taught.

No clean-cut line can be drawn between the names "manual training" and "manual arts". The newer term contains the thought art and design. The designing of problems to be made in a school shop became an important part of educational handwork, and the true "educational project" was born. Influences of the manual arts era are:

1. Designing of problems became an important part of shop work.
2. Development of project method.
3. Shop work broadened into other trade, industrial and craft fields, than wood and iron.

A new concept was clearly brought about by Russell in 1909 and Bonser in 1911. The industrial arts concept was largely in terms of the elementary school level. Russell said, "Study of industries should be for the sake of securing a better view of man’s part in controlling production, distribution, and consumption."

Well-defined influences resulted:

1. Related informative subject matter of industrial arts assumed a position of greater importance.
2. Consumer’s values rather than producer’s values became a controlling purpose.
3. It became more generally accepted as a branch of general education.
4. It became based on the theory that a wide sampling of industrial experiences was desirable.
5. In school work, industries and industrial life assumed greater importance.
6. The general shop and the general industrial arts course was born.

The character of the subject matter of industrial arts today lends itself unusually well to three important present-day movements in education in America: namely, individual differences, reasoning or problem solving, or correlation.
Bibliography -- History


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GENERAL SHOP
INSTRUCTIONAL AIDS AND ORGANIZATION ARE THE KEY TO TEACHING A SUCCESSFUL GENERAL SHOP.
The general shop is closely related to the function of the junior high school. Throughout the history of the junior high school movement to the present, major emphasis has been on exploration and guidance, and providing for individual differences. The general shop fulfills these concepts by stressing exploratory activities in a diversified program. It enriches the junior high curriculum with its varied program and assists the student in making a smooth transition from elementary to senior high school. Special attention is given to helping students discover their aptitudes and interests. Hand and basic machine tool operations are stressed through the construction of functional projects. An understanding of industry is developed through the use and care of supplies, tools, and equipment, safety practices, related information and use of line-type, pupil-personnel organizational charts. It is recommended that teachers who are able to take part in the planning of junior high general shops consider at least nine weeks in each of the various areas of industry. Broad areas included in this guide are: mechanical drawing, power mechanics, graphic arts, metalworking, electricity-electronics, woodworking and crafts. Nine weeks in each area would provide 1 1/2 years of exploratory experience. It is generally acceptable for all seventh and eighth grade boys and girls to take general shop. Semester courses in these areas on an elective basis should be provided in the ninth grade. In smaller schools, it may be necessary to plan shops for rotation in the various areas on a six weeks basis to give students the exploratory experiences. In this case, three areas of work taught in one shop could be taken in the seventh grade while the other three would be taken in the eighth grade. The smaller the school system, the greater the number of activities that may be taught in each shop. The junior high general shop should be closely related to the senior high industrial arts program.

At the senior high school level, unit shops should be available for students at least one year following their basic hand and machine tool operations. This higher level of training should encompass new materials and processes of modern industry. By its very nature, these courses should be taught in the unit shop rather than in the general shop.

The instructional material taught in a general shop is similar to the "basics" of material taught in a unit shop. The unit shop naturally covers the material in much greater depth. The instructor may choose the material he wishes for his comprehensive general shop from the unit shop courses presented in this guide. Material suitable to the general shop are indicated by asterisks in the sections containing the subject content of the various areas. Craft material may be used in total for the general shop.

The general shop must be well organized to function smoothly. This type of shop requires a high degree of planning and therefore requires a well-qualified high
SUGGESTED FLOOR PLAN FOR GENERAL SHOPS

DIARY
CASE
SUGGESTED FLOOR PLAN FOR GENERAL SHOPS

CRAFTS
SEATING AREA
FINISHING ROOM
OFFICE
SUPPLY ROOM
FIN. RM.
OFFICE
SUPPLY ROOM
SEATING AREA
POWER MECHANICS
EQUIPMENT INDEX

1. DRAFTING TABLE
2. WORK BENCH
3. TOOL STORAGE PANEL
4. GRINDER
5. BAND SAW
6. LATHE
7. JOG SAW
8. DRILL PRESS
9. POWER SAW
10. BUFFER
11. SHEET METAL BREAK
12. SLIP ROLL
13. LATHE
14. SHAPER
15. METAL BENCH
16. SQUARING SHEARS
17. GRINDER
18. DRILL
19. STAKE BENCH
20. SOLDER BENCH
21. POWER MECHANICS BENCH
22. BENCH
23. ELECTRICAL BENCH
24. ELECTRICAL BENCH
25. ELECTRICAL SOLDER BENCH
26. KILN
27. COAT & BOOK RACK
caliber teacher. Instruction sheets of all types should be utilized to aid the instructional process. Pupil-personnel charts, scale drawings or mock-ups of beginning projects and other teaching aids should be prepared beforehand.

It is suggested that a study of the book "Teaching Multiple Activities In Industrial Education," by Silvius and Curry be made in preparation to teaching the general shop. Topic 7, p. 83, should especially be studied. Following are some of the headings: "Areas for Activities", "Designating Work Stations", "Numbering Work Stations", "Getting the Class Started at the Beginning of the Term".

Looking to the future, the industrial arts teacher should be alert to new ideas which will make his instruction meaningful to our society. It is possible to correlate industrial arts to science, mathematics, art, language arts and other subjects for the purpose of improving industrial arts. It is possible to teach mass production in a general shop as a means to help interpret industry. As an example, a study by the class could be made of a functional combination-materials project that would utilize all of the areas taught in a particular multiple-activity shop. Instead of being too concerned with rotation following a given amount of time, students would work at only several stations making duplicate parts. Observing the class structure would give them a keen insight into the actual workings of industry.

Power mechanics should be considered as one of the areas of work in the general shop at the junior high school level. For students who want to pursue this course further, unit courses should be available at the senior high school level. It is because of the impact that power has on our civilization that it is included in this guide. Information about the history of power and its importance to our way of life is presented to the students through various means such as reference books, films, and cut-outs of different power units which can be manipulated by students to learn and understand operating principles.

Teachers should be encouraged to experiment with new ideas and it is hoped that school boards will provide monies for experimentation and research to industrial arts teachers. If time were provided during the summer months, more Industrial Arts teachers would be encouraged to work closer with industry in determining what should be taught to best interpret industry. Industry must be encouraged to take a closer look at Industrial Arts.

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Craft classes are held in the several general levels of the public schools; elementary, junior high and senior high schools. The varied areas of crafts provide desirable activities in industrial arts. They are highly interesting to the students, provide for creative activity, development of avocational interests, and give the student an opportunity to study many industrial materials and products. The nature of the subject matter in crafts makes it appropriate for beginners, regardless of grade level, to begin with less difficult projects and advance according to individual abilities.

The areas of study as listed in this guide are normally included in a general shop type course, usually taught at junior high level, and are taught simultaneously to small groups or individuals within the class. Another common approach is to have the entire student group pursuing a specific area for a length of time and then progressing through other areas of work as might be chosen by the teacher and the students. However, required or elective area offerings vary with the over-all program as organized in each school, and with the type of physical plants available. There are a number of factors (physical plant, tools, equipment, qualifications of the instructor, etc.) to determine the areas to be offered in general crafts. However, approximately six to nine weeks should be spent in each of the chosen areas.

The crafts areas discussed in this guide are not to be considered complete. Selections from other areas in the guide are quite often taught in craft shops and prove to be very satisfactory. For other suggested areas of study, check wood carving, art metal, linoleum block printing, textiles, camp crafts, and others.

There are no real prerequisites for courses in crafts, although previous drawing and shop practices are helpful in the secondary schools.

The specific objectives of crafts courses could be listed as avocational interests and consumer education through knowledge gained regarding the manufacturing processes and practices, and through selection of well-made consumer goods together with the recognition of quality workmanship and materials. Many reference books should be available in the shop library for project selection and study, rather than using specific textbooks for the areas of study in general crafts. References are listed at the end of the crafts area as an aid to the teacher in building a shop library.

CERAMICS

Ceramics and pottery are products made from clay. Everyone uses ceramic products in many different forms, such as dishes, toys, building tile, brick, bathroom fixtures, and many others. The making of clay products is a large and growing industry in the world today, and therefore is an important part of our industrial arts program.

Hardly any material in nature offers a broader opportunity to study than clay, and few substances affect our daily life more closely. Clay is the only material in nature which can be molded or changed in shape without breaking up, or destroying its continuity as a whole, and still retain a new shape or form.

A course in basic ceramics should include an understanding of the ceramics industry, and job opportunities. An appreciation of good design, workmanship, and finish on any ceramic product should be emphasized. Students should have the opportunity to model small figures and objects with their hands and modeling tools. Knowledge should be obtained in the slab and coil method, slip casting, and firing and glazing of ceramic projects.

Working with clay helps a student to recognize well designed and quality products on the market today. Sometimes the study of ceramics can develop into a worthwhile hobby, or leisure time activity.
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning the project</td>
<td>*Design of clay projects</td>
<td>Characteristics of clay</td>
<td>Books 22, 41</td>
</tr>
<tr>
<td>Conditioning of clay</td>
<td>*Methods of preparing clay</td>
<td>Reasons for edging and preparing clay</td>
<td>Books 22, 27 Film 114</td>
</tr>
<tr>
<td>Simple modeling of clay projects</td>
<td>*Free form projects</td>
<td>Tools or instruments used</td>
<td>Book 22</td>
</tr>
<tr>
<td>Coil building method</td>
<td>*Layout procedures</td>
<td>Advantages and uses of coil method</td>
<td>Books 27, 35 Film 105</td>
</tr>
<tr>
<td>Slab building method</td>
<td>*Layout procedures</td>
<td>Advantages and uses of slab method</td>
<td>Books 15, 48 Film 94, 109</td>
</tr>
<tr>
<td>Slip casting</td>
<td>*Use of plaster of paris molds</td>
<td>How molds are made, and different types of molds</td>
<td>Books 41, 48 Film 105</td>
</tr>
<tr>
<td>Decorating processes</td>
<td>*Methods of applying decoration</td>
<td>Reasons for decorating ceramic projects</td>
<td>Book 48 Film 105</td>
</tr>
<tr>
<td>Glazing</td>
<td>*Preparation and the application of glaze 4 methods used</td>
<td>Types of glazes Care and handling of glazed pieces</td>
<td>Books 22, 27 Films 91, 93, 101</td>
</tr>
<tr>
<td>Firing</td>
<td>*Ways of stacking kiln for different firings</td>
<td>Types of kilns, their uses and advantages</td>
<td>Books 27, 50 Films 92, 110</td>
</tr>
</tbody>
</table>

* Identifies areas applicable to general shop.
** Check reference numbers at end of unit.

Projects — Ceramics

Animals Projects of imagination
Automobiles Candle stick holders
Candle stick holders
Heads Ash trays
Ash trays Bowls
Bowls Salt and pepper shakers
Salt and pepper shakers Mugs
Mugs Vases
Vases
LAPIDARY

During recent decades, the collecting of minerals and the subsequent fashioning and mounting of them as gems have become fascinating hobbies for thousands of nature lovers. The area of lapidary enables the student to learn more about our natural world of the earth and rocks beneath our feet. It is an applied approach to geology. The student also learns many of the industrial techniques in the shaping and forming of these stones that have lapidary value. The student also acquires skills in working with metal and an appreciation of work well done while fabricating the mountings for the polished stones.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawing with diamond saw</td>
<td>*Coolant to be used Orientation of stone Safety in operation of diamond saw</td>
<td>Industrial uses for diamonds Types of blades and sawing machines</td>
<td>**Book 2</td>
</tr>
<tr>
<td>a. Slabbing b. Trimming</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marking with template and aluminum pencil Free form designing</td>
<td>*Design</td>
<td>Why templates are used Material used for marking stone</td>
<td>Books 20, 59</td>
</tr>
<tr>
<td>Grinding to outline with beveled edge</td>
<td>*Degree of bevel Water coolant Safety in operation of grinders</td>
<td>Physical characteristics of grinding wheels Grit sizes</td>
<td>Book 49</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
</table>
| Dopping stone          | *Temperature control  
                        Dopping waxes  
                        Stones that are heat sensitive                       | Composition of dopping wax                            | Book 2                  |
| Grinding crown         | *Crown of cabachon  
                        (should be an arc or circle)                            | Meaning of cabachon  
                        How silicon carbide is made                            | Book 2                  |
| Sanding                |                                                                                         | *Safety in operation of sander  
                        Advantages of each type of sander  
                        Kind and size of abrasives  
                        How to tell when sanding is complete                 | Types of machines  
                        Abrasives  
                        a. Natural  
                        b. Man-made  
                        Common industrial uses                             | Book 2                  |
| Polishing              | *Polishing agents  
                        Polishing wheel  
                        a. Material  
                        b. Speed                                               | Types of polishing equipment  
                        Hardness of gem stone                                  | Book 6                  |
### Units of Instruction

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
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</thead>
<tbody>
<tr>
<td>Advanced processes</td>
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<tr>
<td>a. Drilling of stone</td>
<td>Operation of a gem drill</td>
<td>Abrasives</td>
<td>Book 2</td>
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<tr>
<td></td>
<td></td>
<td>a. Diamond bort</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>b. Boron carbide</td>
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<tr>
<td>b. Lapping</td>
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</tr>
<tr>
<td></td>
<td>*Operation of cast iron flat lap unit</td>
<td>Abrasives</td>
<td>Book 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Grit sizes</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>b. Silicon carbide</td>
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<tr>
<td>c. Sphere cutting</td>
<td></td>
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<tr>
<td></td>
<td>Operation of a sphere cutting machine Sawing in preparation for cutting sphere</td>
<td>Same as above Process of polishing</td>
<td>Books 49, 54</td>
</tr>
<tr>
<td>d. Faceting</td>
<td></td>
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</tr>
<tr>
<td>e. Tumbling</td>
<td>*Operation of a tumbler. Grits and grit sizes. Comparative hardness of stones</td>
<td>Geologic formation of stones</td>
<td>Book 43</td>
</tr>
<tr>
<td>f. Carving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operation of beginning and advanced lapidary equipment</td>
<td>Suitable stones for carving</td>
<td>Book 54</td>
</tr>
</tbody>
</table>

* Identifies areas applicable to general shop.

Projects — Lapidary:

1. Paper weight
2. Desk pen base
3. Cabachons to be used for:
   a. Ring stones
   b. Pendant
   c. Earrings
   d. Cufflinks
   e. Tie bar
   g. Brooch
   f. Belt buckle
   h. Bracelet
   i. Bola tie
   j. Buttons
LEATHER

Leatherwork has become a successful industrial arts area. It is an excellent transitional activity between the elementary school with its arts and crafts and industrial arts at the secondary level. The student is able to learn fundamental safety rules and shop organization of industrial arts without being exposed to the dangers of machines.

While the employment opportunities for hand leather workers are limited, there are numerous industries which process leather into machine-made goods in large quantities. These include the shoe, garment, and personal accessory industries, as well as sporting goods industries and others.

The leisure-time applications of leatherworking are almost without limit. Leatherworking skills can be used to produce gifts as well as to produce useful items for the craftsman himself.

The teacher with little training and experience in leatherworking can start a course in junior high school on a small budget, then enlarge the program as his skill and confidence grow. Few materials can be worked so well at so many different levels of skill.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Making patterns</td>
<td>*Use of tin snips</td>
<td>Theory of design</td>
<td>**Book 8</td>
</tr>
<tr>
<td>a. Cutting leather</td>
<td>Lay out drawing</td>
<td>Uses or application of leather</td>
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<tr>
<td>b. Surface design</td>
<td>Tracing techniques</td>
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<tr>
<td></td>
<td>Reading a rule</td>
<td></td>
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<tr>
<td>Cutting leather</td>
<td>*Use of leather shears</td>
<td>Techniques used by</td>
<td>Chart 63</td>
</tr>
<tr>
<td></td>
<td>Use of X-Acto knife</td>
<td>saddle makers</td>
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<tr>
<td></td>
<td>Use of round knife</td>
<td>Uses of leather</td>
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<td></td>
<td>Use of draw gauge</td>
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<td></td>
<td>Use of square</td>
<td></td>
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</tr>
<tr>
<td>Wetting leather</td>
<td>*Uniform sponging (avoid water spotting)</td>
<td>Making leather</td>
<td>Films 111, 112</td>
</tr>
<tr>
<td></td>
<td>Casing (avoid mildew)</td>
<td>Types of tannage</td>
<td></td>
</tr>
<tr>
<td>Establishing edge and the border of leather</td>
<td></td>
<td>History</td>
<td>Book 8</td>
</tr>
<tr>
<td>Transferring design</td>
<td>*Use of tracer</td>
<td>Artifacts</td>
<td>Book 8</td>
</tr>
<tr>
<td></td>
<td>Use of stylus</td>
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<tr>
<td></td>
<td>Use of modeling tool</td>
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<td></td>
<td>Use of pencil</td>
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<tr>
<td></td>
<td>Thumb tack pattern</td>
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<tr>
<td></td>
<td>Tape pattern</td>
<td></td>
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<tr>
<td>Tooling processes</td>
<td>*Outline tooling</td>
<td></td>
<td>Chart 66, Booklet 71</td>
</tr>
<tr>
<td></td>
<td>Flat modeling</td>
<td></td>
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<tr>
<td></td>
<td>Stippling</td>
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<td>Beveling</td>
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<td></td>
<td>Repouse</td>
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</tbody>
</table>

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<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Stamping</td>
<td>*Border stamping &lt;br&gt; Set stamping for large areas</td>
<td></td>
<td>Film 88</td>
</tr>
<tr>
<td>Carving</td>
<td>*Use of swivel cutter &lt;br&gt; Bevel stamping &lt;br&gt; Interior stamping &lt;br&gt; a. Camouflage &lt;br&gt; b. Shades &lt;br&gt; c. Bevelers &lt;br&gt; d. Stops &lt;br&gt; e. Veiners &lt;br&gt; f. Seeders &lt;br&gt; g. Background &lt;br&gt; h. Decorative cuts</td>
<td></td>
<td>Pamphlets 67, 68, 69, 70, 72, 76, 77, 78, 79, 80 &lt;br&gt;Films 89, 90, 107</td>
</tr>
<tr>
<td>Coloring leather</td>
<td>Antique dye &lt;br&gt; Liquid dye &lt;br&gt; Colored inks</td>
<td>How dye is made</td>
<td>Pamphlet 74</td>
</tr>
<tr>
<td>Skiving</td>
<td>*Edge skiving &lt;br&gt; Skiving lace</td>
<td></td>
<td>Book 8</td>
</tr>
<tr>
<td>Cementing</td>
<td>*Lining &lt;br&gt; Project assembling</td>
<td>Types of cement and glues</td>
<td>Pamphlet 73</td>
</tr>
<tr>
<td>Punching</td>
<td>*Use of round drive punch &lt;br&gt; Use of rotary spring punch &lt;br&gt; Use of thonging chisel &lt;br&gt; Use of bag punch &lt;br&gt; Use of strap end punch</td>
<td>Dry leather &lt;br&gt;Damp leather &lt;br&gt;End grain punching or thonging block</td>
<td>Book 8</td>
</tr>
<tr>
<td>Sewing</td>
<td>Use of automatic sewing awl &lt;br&gt;Harness needle &lt;br&gt;Sewing machine</td>
<td></td>
<td>Pamphlet 82</td>
</tr>
<tr>
<td>Lacing</td>
<td>Spiral or whip stitch &lt;br&gt;Cross whip stitch &lt;br&gt;*Single cordovan &lt;br&gt;Double cordovan &lt;br&gt;Florentine</td>
<td>Making lacing needle from tin can metal</td>
<td>Pamphlet 84 &lt;br&gt;Chart 64</td>
</tr>
<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>Splicing lace</td>
<td>Skiving and cementing Tuck and lace</td>
<td></td>
<td>Book 8</td>
</tr>
<tr>
<td>Cleaning</td>
<td>Oxalic acid Saddle soap</td>
<td>Types and composition of cleaners for leather</td>
<td>Book 8</td>
</tr>
<tr>
<td>Finish</td>
<td>Wax Neatsfoot Oil Treeing compound Neat-Lac</td>
<td>Techniques for refinishing old leather Tannery finishing methods</td>
<td>Book 8</td>
</tr>
<tr>
<td>Attaching hardware</td>
<td>Snap fasteners Eyelets Bag clasps Buckles Rivets</td>
<td></td>
<td>Book 8</td>
</tr>
<tr>
<td>Braiding and weaving</td>
<td>4-plait square 4-plait octagonal 4-plait round diamond 4-plait round spiral Turks head Block bre'j</td>
<td>Romance of rawhide</td>
<td>Books 24, 25 Pamphlet 75</td>
</tr>
</tbody>
</table>

Projects — Leathercraft:

- Triangle coin purse
- One post key case
- Bookmark
- Small coin purse
- Comb case
- Two post key case
- Baggage tag
- Coin purse (one flap, 2 compartment)
- Triangle two flap coin purse
- Snap comb case
- Comb and file case
- Two flap coin purse
- Four hook key case
- Identification card case
- Two flap accordion coin purse
- Pull ring key case
- Six hook key case
- Knife sheath
- Axe sheath
- Combination coin purse and key case
- Double photograph holder
- Standard size cigarette case
- King size cigarette case
- Ladies billfold
- Men's billfold
- One-piece accordion coin purse
- Tooled belt
- Stamped belt
- Carved belt
- Check fold and card case
METAL JEWELRY

Metal jewelry may be offered as an area of general crafts or as an area in general bench metal work. This area enables the student to use a creative approach to jewelry as an art expression, and encourages the student to utilize the short stock of the non-ferrous materials of the metal shop. It also enables the student to acquire some skills in some of the industrial processes of the metals field. An appreciation of a job well done is easily taught through the personal items completed in the metal jewelry area.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and layout of project</td>
<td>*Design and structure of different articles of jewelry</td>
<td>Functional design</td>
<td></td>
</tr>
<tr>
<td>Make bill of materials</td>
<td></td>
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</tr>
<tr>
<td>Cutting of material</td>
<td>*Correct use of snips</td>
<td>Industrial methods</td>
<td></td>
</tr>
<tr>
<td>a. Using tinner’s snips</td>
<td>Operational technique in the use of jeweler’s saw</td>
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<tr>
<td>b. Using jeweler’s saw</td>
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<tr>
<td>Drilling of material</td>
<td>*Safety in use of drill press</td>
<td></td>
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</tr>
<tr>
<td>a. Hand drill</td>
<td>Operation of hand drill</td>
<td>How to sharpen a drill bit</td>
<td></td>
</tr>
<tr>
<td>b. Drill press</td>
<td>Operation of flex Shaft drill</td>
<td></td>
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<tr>
<td>Shaping and smoothing of material</td>
<td></td>
<td>Cleaning and care of files Abrasives Correct use of a jeweler’s vise</td>
<td></td>
</tr>
<tr>
<td>a. Filing</td>
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<tr>
<td>b. Sanding</td>
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<tr>
<td>Soldering</td>
<td>*Methods of cleaning</td>
<td></td>
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</tr>
<tr>
<td>a. Cleaning</td>
<td>Purposes of fluxes</td>
<td>Physical properties of solders</td>
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</tr>
<tr>
<td>b. Fluxing</td>
<td>Methods and safety in the use of pickle</td>
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<tr>
<td>c. Temperature control</td>
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<tr>
<td>d. Use of pickle</td>
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</table>

*Identifies areas applicable to general shop.
<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>Assembly</td>
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</tr>
<tr>
<td>a. Wiring</td>
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<td>b. Clamping</td>
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<tr>
<td>Buffing and polishing of metals</td>
<td>*Safety in the use of a buffer</td>
<td>Industrial jewelry making Abrasives and polishing materials</td>
<td>**Book 6</td>
</tr>
<tr>
<td>Stone setting</td>
<td>*Refer to lapidary unit</td>
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<tr>
<td>Etching</td>
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<tr>
<td>Engraving</td>
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<tr>
<td>Casting</td>
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<tr>
<td>a. Sand molds</td>
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<td>b. Investment</td>
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<tr>
<td>c. Lost wax</td>
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**Check reference numbers at end of unit.**
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<tbody>
<tr>
<td>Enameling</td>
<td>*Operation of kiln</td>
<td>Techniques in enameling</td>
<td>Book 44</td>
</tr>
<tr>
<td>a. Kiln</td>
<td>Firing temperature</td>
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<tr>
<td>b. Torch</td>
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<td>Chasing</td>
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<td>Repousse</td>
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<td>Coloring</td>
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</tbody>
</table>

Projects — Metal Jewelry:

<table>
<thead>
<tr>
<th>Item</th>
<th>Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver band ring</td>
<td>Tie clip</td>
</tr>
<tr>
<td>Silver brooch</td>
<td>Ring with stone</td>
</tr>
<tr>
<td>Necklace swing</td>
<td>Bracelet with stone</td>
</tr>
<tr>
<td>Earrings</td>
<td>Free form jewelry</td>
</tr>
<tr>
<td>Cuff links</td>
<td></td>
</tr>
</tbody>
</table>
MOSAICS

These wonderful, colorful pictures that capture the imagination of all are becoming more popular every day. Mosaics may have started when some of our ancestors clothed in animal skins, found colorful pebbles along some stream and arranged them by sticking them into a clay bank along the stream. Who can say how they started, since archeologists have found mosaics at least 5,000 years old.

It is strange that there is no relationship between the materials used and the term "mosaics". When you speak of oil painting you know the medium used is oil mixed with ground minerals (color pigments). The same thing applies to water colors. They are minerals that can be mixed with water. In mosaics the different mediums or materials used can be counted in the thousands. A few of the materials are metal, stones, shells, ceramic tile, glass tile, Byzantine tile, felt, seeds, and countless others. The term mosaic generally refers to many pieces put together to form a design. The main fraction. The main qualities of mosaics are color, texture and light refraction. These materials form a perfect media for design, originality, art expression and are also used in industry.

<table>
<thead>
<tr>
<th>Units of instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan project</td>
<td>*Design pertaining to mosaics</td>
<td>Different tiles and materials—source of materials Principles of design abstract, realistic, etc.</td>
<td>**Books 1, 29, 34, 61 Films 102, 115</td>
</tr>
<tr>
<td>Figure cost Making out project sheet</td>
<td>*Cost of various tiles and materials Size of various tiles and materials Composition of these materials</td>
<td>Price sheets Simple mathematics Methods of measurement</td>
<td></td>
</tr>
<tr>
<td>Check-out of materials</td>
<td>*Conservation of materials</td>
<td>Check-out procedures</td>
<td></td>
</tr>
<tr>
<td>Layout procedure</td>
<td>*Use of layout tools</td>
<td>Marking and measuring methods</td>
<td></td>
</tr>
<tr>
<td>Construction of foundation for mosaic</td>
<td>*Cutting, forming, surfacing, and assembling of base materials</td>
<td>Reference to original drawing and plan of procedure</td>
<td>Films 102, 115</td>
</tr>
<tr>
<td>Layout of mosaic pattern</td>
<td>*Techniques of design layout</td>
<td>Reference to original drawing and plan of procedure</td>
<td>Book 1</td>
</tr>
<tr>
<td>Application of mosaic tile</td>
<td>*Technique of cutting, shaping, and cementing the tiles</td>
<td>Composition of cements and the methods and applications of mosaics in industry</td>
<td>Books 1, 29, 34, 61</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application of border design</td>
<td>*Methods of complementing the whole project</td>
<td>Elements and principles of design</td>
<td>Book 1 Films 102, 115</td>
</tr>
<tr>
<td>Grouting</td>
<td>*Color combination, mixture and texture</td>
<td>Source of materials</td>
<td>Book 1</td>
</tr>
<tr>
<td>Cleaning and polishing of the tiles</td>
<td>*Materials used in cleaning and polishing</td>
<td>Future care and maintenance</td>
<td>Book 1</td>
</tr>
</tbody>
</table>

Projects — Mosaics:

- Wall plaque
- Table lamp
- Table top
- Book ends
- Trays
- Drawer pulls
- Trivets
- Desk sets
- Jewelry box
- House number
- Planter box
- Holiday themes
- Hot plate
- Patio pieces
- Coasters
- Candle holders
PLASTICS

The area of plastics may be added to the curriculum with a minimum of added expense for equipment because the regular wood and metal working tools and equipment may be used. With the increase in the development of the varied plastics, it is becoming one of the leading industrial materials. Many skills, techniques, and appreciation for craftsmanship may be developed in working with plastics and related materials.

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<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
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</thead>
<tbody>
<tr>
<td>Plan project</td>
<td>*Design for plastics</td>
<td>Types of plastics, cloth flexible containers, sheet film cast, paint, etc.</td>
<td>**Films 97, 98, 99, 100, 103, 106, 107</td>
</tr>
<tr>
<td>Making bill of materials</td>
<td>*Cost of materials, i.e., thickness, color, sheet rod tubing, extruded shapes</td>
<td>Manufacturing data extrusion, casting, laminating, etc.</td>
<td>Film 113</td>
</tr>
<tr>
<td>Layout of material</td>
<td>*Marking methods on plastic—pencil, scribe, compass, etc.</td>
<td>Layout procedures</td>
<td>Film 96</td>
</tr>
<tr>
<td>Sawing, hand</td>
<td>*Coping, hacksaw, and hand wood saws</td>
<td>Proper use of blade, number of teeth per inch, etc.</td>
<td>Film 96</td>
</tr>
<tr>
<td>Sawing with power equipment</td>
<td>*Safety procedures</td>
<td>Methods of setting blade, number of teeth, surface feet per min. operation, skip tooth blades, etc.</td>
<td>Film 96</td>
</tr>
<tr>
<td>Drilling</td>
<td>*Safety procedures</td>
<td>Specially ground drills</td>
<td>Film 96</td>
</tr>
<tr>
<td>Sanding—power and hand</td>
<td>*Safety procedures</td>
<td>Types of abrasives, Types of backings</td>
<td>Film 94</td>
</tr>
<tr>
<td>Polishing—power &amp; hand</td>
<td>*Safety practices</td>
<td>Abrasives, buffing wheels, polishes, anti-static waxes</td>
<td>Film 96</td>
</tr>
<tr>
<td>Cementing</td>
<td>*Soak, dip, capillary, laminating clear cements, colored cements</td>
<td>Types of cements, Adding color</td>
<td>Film 104</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
### Units of Instruction

<table>
<thead>
<tr>
<th>Heat forming</th>
<th>Heat forming</th>
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<tbody>
<tr>
<td><em>Blow and draw forming, straight line bending, hand held jigs, temperatures</em></td>
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<tr>
<td>Thermosetting and thermoplastic materials. Uses of various types</td>
<td>Film 99</td>
</tr>
<tr>
<td>Surface decoration</td>
<td>Surface decoration</td>
</tr>
<tr>
<td>Overlays, etching, engraving Handwork and machine</td>
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<tr>
<td>Industrial methods and uses</td>
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<tr>
<td>Carving</td>
<td>Carving</td>
</tr>
<tr>
<td>a. Surface</td>
<td>a. Surface</td>
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<tr>
<td>b. Internal</td>
<td>b. Internal</td>
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<tr>
<td>Safety practices, using power equipment, flex-shaft, hand held machine, router, drill press</td>
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<tr>
<td>Grinding drills, use of burrs and other cutters</td>
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<tr>
<td>Casting</td>
<td>Casting</td>
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<tr>
<td>Types of materials, mixing and procedures, embedding and use of color</td>
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<tr>
<td>Catalytic action of components</td>
<td>Film 100</td>
</tr>
<tr>
<td>Dyeing and coloring</td>
<td>Dyeing and coloring</td>
</tr>
<tr>
<td>Procedures</td>
<td>Procedures</td>
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<tr>
<td>Types of dyes</td>
<td>Types of dyes</td>
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</tbody>
</table>

### Projects — Plastics:

<table>
<thead>
<tr>
<th>Desk items:</th>
<th>Towel rings</th>
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<tr>
<td>Pen sets</td>
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<tr>
<td>Stamp boxes</td>
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<td>Trays</td>
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<tr>
<td>Letter holders</td>
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<td>Letter openers</td>
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<td>Bedroom items:</td>
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<tr>
<td>Powder boxes</td>
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<tr>
<td>Vanity sets</td>
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<tr>
<td>Pin boxes</td>
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<tr>
<td>Trays</td>
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<tr>
<td>Jewelry boxes</td>
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<tr>
<td>Earring hangers</td>
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<tr>
<td>Night lights</td>
<td></td>
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<tr>
<td>Lamps</td>
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<tr>
<td>Other parts of the house:</td>
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<tr>
<td>House numbers</td>
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<tr>
<td>Mail box</td>
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<tr>
<td>Candle holders</td>
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<tr>
<td>Lamps:</td>
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<tr>
<td>Reading</td>
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<td>Bed</td>
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<td>Pin-up</td>
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<td>Television</td>
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<tr>
<td>Night lights</td>
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<tr>
<td>Bathroom items:</td>
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<tr>
<td>Towel bars</td>
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<tr>
<td>Towel rings</td>
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<td>Detergent dispensers</td>
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<td>Scoops</td>
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<tr>
<td>Salt and pepper shakers</td>
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<tr>
<td>Serving dishes</td>
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<tr>
<td>Serving trays</td>
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<tr>
<td>Canape servers</td>
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<tr>
<td>Wall shelves</td>
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<tr>
<td>Kitchen items:</td>
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<tr>
<td>Towel bars</td>
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<tr>
<td>Towel rings</td>
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<tr>
<td>Soap holders</td>
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<tr>
<td>Detergent dispensers</td>
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<td>Scoops</td>
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<td>Salt and pepper shakers</td>
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<td>Serving dishes</td>
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<td>Serving trays</td>
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<tr>
<td>Canape servers</td>
<td></td>
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<tr>
<td>Wall shelves</td>
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</tbody>
</table>

### Bibliography — Crafts

#### Books


51. Shanklin, Margaret E. *Use of Native Craft Materials*. Peoria, Ill.: Chas A. Bennett Co.


60. Woelf, Natalie. *Glovetmakinng for Beginners*. Bloomington, Ill.: McKnight and McKnight, 1951.


Other Resource Materials

Charts:


64. *Craftool Lacing Chart*. Denver: Tandy Leather Company.


Pamphlets:


78. Stohlman, Al. *Figure Carving*. Denver: Tandy Leather Co.


84. Thompson, R. W. *How to Lace*. Denver: Tandy Leather Co.

85. Thompson, R. W. *Lucky Seven Text Book*. Denver: Tandy Leather Co.


Films and Filmstrips

88. *Adventures in Modern Leathercraft*. 13½ min., Colo-Craft or Tandy Leather Co., Denver, Colo.
89. The Art of Figure Carving. 17 min., Colo-Craft or Tandy Leather Co., Denver, Colo.
90. The Art of Leathercraft Carving. 23½ min., Colo-Craft or Tandy Leather Co., Denver, Colo.
96. Eyes of Flight (care and maintenance, drilling, sawing). Rohm and Haas Co.
100. Frambles Friend (polyethylene plastics). Spencer Chemical Co.,
103. Oil for Aladdin's Lamp (plastics research). Shell Oil Co.
107. Saddle Making. 16 min., Colo-Craft or Tandy Leather Co., Denver, Colo.
108. Simple Molds. Indiana University, Bloomington, Indiana.
110. Stacking and Firing of the Kiln. Indiana University, Bloomington, Indiana.
111. The Story of Leather. Ohio Leather Co.
112. Story of Tioga Oak Sole Leather. 16 min., Colo-Craft or Tandy Leather Co., Denver, Colo.
113. Story of Tenite (molding, extrusion, mallet and screwdriver stock). Eastman Chemical Products.
114. Throwing on the Wheel. Indiana University, Bloomington, Indiana.

Filmstrip:
CHAPTER XI

BASIC ELECTRICITY AND ELECTRONICS

We are now living in the “Age of Electricity and Electronics”. Anyone who wishes to feel at home in the world of modern technology must be familiar with the fundamentals of electricity and electronics. We are constantly depending upon electricity and electronics that have added comfort and convenience to our daily lives. Many students may never operate some of the objects of nuclear science, but they need to know the basic principles of the electrical things that are commonly found in their homes today.

This course outline will be useful as a guide for a separate course sequence in electricity and electronics or as a guide to preparing units which can be included in a metals, wood, crafts, or other suitable laboratory setting. Every effort has been made to identify those topics of fundamental knowledge and experiences which might be covered in a sequential order. The fundamental topics of knowledge identified by asterisks are considered to be minimum requirements, and these areas would be applicable to the general shop. The purpose of identifying certain topics of knowledge is to indicate to the teacher the basic concepts which lead to an adequate understanding of the field of electricity and electronics.

Electricity-electronics can be taught in the junior or senior high school. Regardless of the level started, students should begin with the same or similar concepts and experiences. This will facilitate any transition brought on by the mobility factor of the school population. It is strongly recommended that the courses outlined be taught, wherever possible, during the entire school year. The division of time related to theory, demonstrations, and student activities is left to the judgment of the individual teacher. A sincere attempt should be made to include theory, demonstrations, project construction, and experiments. Project construction should be used to supplement a sound program of instruction rather than having projects determine course content.

Wherever “Fundamental Knowledge” items exist but no student operations are listed, it is to be understood that the student should be required to explain the concepts involved. The fundamental purpose of this course of study is to create an interest in the student and to develop an understanding of the area of electricity and electronics.

A third outline has been included in brief form to help those individuals whose time and equipment warrant further instruction. This third outline deals with general applications of electricity and electronics in the home and industry.

Equipment Recommendations:

Grades 10-11-12

The electricity-electronics laboratory should be as well equipped as possible. The following recommendations are considered minimum needs for a class of 24 students.

**Basic Electricity**

One each of the following:

1. Five-inch oscilloscope
2. Vacuum tube voltmeter
3. Volt ohm milliammeter
4. R.F. signal generator
5. Audio oscillator
6. Tube checker
7. Transistor — diode checker
8. Capacitor checker
9. D.C. power supply (portable)
10. Signal tracer

In addition, one vacuum tube voltmeter for each two students.

**Basic Electronics**

One each of the following for each four students is recommended, assuming that the above equipment is available to the electronics classes.

1. Five-inch oscilloscope
2. Audio oscillator
3. D.C. power supply (portable)
4. R.F. signal generator
Basic Electricity

The study of electrostatics, electromagnetic, and electro-chemical effects of electron motion in components considered to be liquid or solid in nature which have resistance, capacitance and inductance, will be Basic Electricity. Placing a dividing line between “pure” electricity and “pure” electronics is rather difficult. For the separation in this course of study, those areas of instruction dealing with devices, circuits, or systems involving emission, behavior, and effect of electronics in gases, vacuums, crystals and semi-conductors will be covered in Electronics.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HISTORY, ELECTRON THEORY</strong></td>
<td>Historical development of electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check shop voltages</td>
<td>*Safety in the electrical shop</td>
<td></td>
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<tr>
<td>Atomic structure of matter</td>
<td></td>
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</tr>
<tr>
<td>Charge and Discharge a capacitor with DC</td>
<td>*Law of electrical charges</td>
<td>Definition of electricity (dynamic and static)</td>
<td>**F.S. 127 Films 75, 19, 80, 83, 84, 85</td>
</tr>
<tr>
<td>Electron motion and current flow</td>
<td></td>
<td></td>
<td>Film 122</td>
</tr>
<tr>
<td>Electrical terminology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Units of electrical measure and their symbols</td>
<td></td>
<td></td>
<td>Film 68</td>
</tr>
<tr>
<td>Mathematical applications for electricity (sliderule)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Job opportunities in Electricity-Electronics</td>
<td></td>
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</tbody>
</table>

Identifies areas applicable to general shop.
* Check reference numbers at end of unit.
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
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</thead>
<tbody>
<tr>
<td><strong>MAGNETISM</strong></td>
<td></td>
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<tr>
<td>Compare strength of several magnetic fields</td>
<td>Types of magnets (natural &amp; artificial)</td>
<td>Theory of magnetism</td>
<td>Films 90, 92, 93, 94</td>
</tr>
<tr>
<td>Test materials with magnet to check induced magnetism</td>
<td>Magnetic properties of materials</td>
<td>Shapes of magnets</td>
<td>Collect metallic materials to show their magnetic qualities, if any</td>
</tr>
<tr>
<td>Experiment with electromagnetic device such as; sucking coil, relay, bell, buzzer, electric pencil</td>
<td>*Laws &amp; theories of electromagnetism</td>
<td>Theory of magnetic measurement</td>
<td></td>
</tr>
<tr>
<td>Assemble simple voltaic cell; rotate PM motor as generator, check output of solar cell, thermocouple, or crystal with galvanometer</td>
<td>Sources &amp; methods of producing electrical energy (thermal, photovoltaic, solar, mechanical, chemical, piezoelectric)</td>
<td>Applications of electromagnetism</td>
<td>Read directions with compass and explain the need for corrections and geo. location</td>
</tr>
<tr>
<td><strong>PRODUCTION OF ELECTRICITY</strong></td>
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<tr>
<td>Assemble simple voltaic cell; rotate PM motor as generator, check output of solar cell, thermocouple, or crystal with galvanometer</td>
<td>*Types of electrical current (AC &amp; DC)</td>
<td>Maintenance &amp; limitations of electrical generators</td>
<td>Open &amp; inspect an old car generator, explain its operation</td>
</tr>
<tr>
<td><strong>PRODUCTION OF ELECTRICITY</strong></td>
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<td><strong>PRODUCTION OF ELECTRICITY</strong></td>
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### Units of Instruction

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<th>Related Information</th>
<th>Instructional Materials</th>
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<td>Applications of electrical generators</td>
<td>F.S. 126</td>
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### MEASURING INSTRUMENTS

- **Theory, types & application of meter movements**
  - Purpose & methods of meter calibration

- **Take meter readings**
  - Interpretation of meter scales & ranges

- **Determine type of current in conductor (AC - DC)**
  - Characteristics of commercial meters

- **Replace meter fuses; batteries**
  - Care & applications of measuring instruments

- **Repair test leads**
  - Open and explore the internal structure of a meter (V.O.M. or V.T.U.M.)

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**Wall or notebook charts available on meter movements from manufacturers**
<table>
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<tr>
<td><strong>DC CIRCUITS</strong></td>
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- **Experiment with conductors of various materials in series with light bulb—note effects of resistance**
- **Purpose, types & sizes of electrical conductors**

- **Layout series circuit**
  - *Purpose & types of electrical insulators*
  - Films 110, 112

- **Layout parallel circuit (use schematic symbols)**
  - *Schematic diagram symbols & theory of circuit layout (series-parallel)*
  - Films 100, 112

- **Set-up circuit & take voltage readings—calculate expected readings for same circuit & compare differences**
  - *Ohm's Law for DC circuits*
  - Films 95, 96, 101

- **Kirchhoff's Law for DC circuits**
  - Film 97

- **Watt's Law for DC circuits**

- **Measure resistance with Ohm-meter**
  - *Types, sizes & functions of fixed & variable resistances*  

- **Determine resistor values from color code**
  - *Purpose & functions of E.I.A. resistor color code*
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<td>Read color-code calculator</td>
<td>Applications of voltage divider networks</td>
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<td>Tin soldering tool</td>
<td>*Definitions &amp; applications of mathematical prefixes (milli, micro, mega, kilo, nano, micro-micro)</td>
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<td>Ohm's Law demonstration board set-up very helpful</td>
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<td>Solder electrical connections</td>
<td>Types &amp; sizes of electrical switches</td>
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<td>Locate &amp; price specific electrical compo-</td>
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<td>Connect 2-way &amp; 3-way switches in circuit</td>
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<td>Draw &amp; interpret schematic diagram of</td>
<td>*Functions of circuit diagrams (schematic &amp; wiring)</td>
<td>Methods of communicating electrical ideas (words, symbols, pictures)</td>
<td>F.S. 125</td>
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<td>electrical device</td>
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<td>Heat with electrical current</td>
<td>Effects of electrical current</td>
<td>Theory of varying or pulsating DC</td>
<td>Film 78</td>
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<td>Light with electrical current</td>
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<td>Connect &amp; energize electromagnet</td>
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<td>Electroplate with electric current</td>
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<td>Connect cells in series &amp; parallel &amp; take voltage readings</td>
<td>*Theory &amp; application of hooking cells in series, parallel, series-parallel</td>
<td></td>
<td>Films 100, 110, 111</td>
</tr>
<tr>
<td>Connect sockets, switches &amp; plugs</td>
<td></td>
<td>Types of electrical energy (kinetic &amp; potential)</td>
<td></td>
</tr>
<tr>
<td>Tie Underwriters knot</td>
<td></td>
<td>Comparison of mechanical &amp; electric power</td>
<td></td>
</tr>
<tr>
<td>Measure electrical power (Est &amp; calculate, or use wattmeter)</td>
<td></td>
<td>Measurement of electrical power</td>
<td>Film 70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Function &amp; application of power networks (power factor)</td>
<td></td>
</tr>
</tbody>
</table>

**SAFETY**

*Safety rules for working with electrical devices*

<p>| Test &amp; replace over-current protective devices | Sizes &amp; types of circuit protection devices | Demonstrate fuse &amp; circuit breaker |
| Proper use of sockets, switches &amp; extension cords | | Field trip to local power line repair crew. Have them explain safety procedures they use |
| *Proper grounding of electrical equipment | | |
| *Effects of current on human body | | |</p>
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>*First-aid for electrical shock</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>ALTERNATING CURRENT</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>*Theory of AC generation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Characteristics &amp; functions of sine curve</td>
<td>Demonstrate A.C. wave forms on Oscilloscope (sine &amp; square)</td>
<td></td>
</tr>
<tr>
<td>Measure RMS voltage with meter</td>
<td>Values of AC current &amp; voltage (average, peak, RMS, effective)</td>
<td>Film 67</td>
<td></td>
</tr>
<tr>
<td>Measure current with meter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make graph of sine wave</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meanings of phase &amp; phase angle</td>
<td></td>
<td>Explanation of frequency spectrum</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Demonstrate and measure frequency of line current with frequency meter (if available)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>INDUCTANCE AND INDUCTORS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Characteristics &amp; effects of inductance</td>
<td>Demonstrate effect of inductance on current flow</td>
<td></td>
</tr>
<tr>
<td>Construct soldering gun, transformer or some similar device</td>
<td>Measurement of inductance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theory &amp; application of inductive circuits</td>
<td></td>
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</tr>
<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td></td>
<td>Theory &amp; application of Lenz's Law</td>
<td></td>
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<tr>
<td></td>
<td>*Theory of transformer operation</td>
<td>AC circuit calculations involving inductance</td>
<td>Film 115</td>
</tr>
<tr>
<td></td>
<td>Types, sizes &amp; applications of coils &amp; inductive devices</td>
<td></td>
<td>Film 91</td>
</tr>
<tr>
<td></td>
<td>Factors affecting or controlling inductance</td>
<td></td>
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</tr>
<tr>
<td>TRANSFORMERS</td>
<td>*Characteristics, types, &amp; uses of transformers</td>
<td>Impedance matching of power transformers</td>
<td>Tear down old low voltage X-former—locate taps and primary windings</td>
</tr>
<tr>
<td></td>
<td>Theory of transformer construction</td>
<td>Interpretation of transformer color code (leads)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Transformer power losses</td>
<td>Inspect X-former core—observe laminate strips</td>
</tr>
<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>-----------------------------------------------------</td>
<td>---------------------------------------------------</td>
<td>---------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Charge &amp; discharge capacitor in series with neon lamp</td>
<td>*Definition &amp; theory of capacitors</td>
<td></td>
<td>Film 71</td>
</tr>
<tr>
<td>Cut open discarded capacitor</td>
<td>*Types &amp; physical construction of capacitors (fixed &amp; variable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Build capacitor checker</td>
<td>Theory of capacitive measurement</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Causes &amp; effects of capacitance</td>
<td>Interpretation of E.I.A. capacitor color code</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Circuit applications of capacitors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CAPACITANCE AND CAPACITORS**

**AC CIRCUIT ANALYSIS**

- Hook-up L-C circuit
  - Theory of LRC series circuits

- Hook-up R-C circuit
  - Theory of LRC parallel circuits

- Hook-up L-R circuit

- Hook-up LRC circuit (Observe condition of resonance)
  - Vector addition of currents

- Demonstrate effect of filter capacitors in a power supply using oscilloscope
<table>
<thead>
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<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work problems involving impedance (Z)</td>
<td>Calculation of circuit impedance (Z)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effect of frequency on AC circuits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characteristics &amp; applications of series-parallel resonant circuits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functions &amp; applications of filter circuits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construct diode, selenium or similar type power supply</td>
<td></td>
<td>Frequency measurement &amp; waveform characteristics of RF</td>
<td></td>
</tr>
<tr>
<td>Methods of coupling AC circuits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MOTORS AND GENERATORS</strong></td>
<td></td>
<td></td>
<td>F.S. 126 Films 77, 89, 113</td>
</tr>
<tr>
<td>Connect &amp; operate DC generator</td>
<td>Theory, operation, types &amp; construction of DC generators</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operate small DC motor powered by DC generator</td>
<td>*Theory, operation, types &amp; construction of DC motors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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</tr>
<tr>
<td>Clean armature commutator on motor or generator</td>
<td>Purpose &amp; need for DC motor control</td>
<td>Build mock-up or dynamic model of series DC motor</td>
<td></td>
</tr>
<tr>
<td>Requirements of motor control &amp; maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theory, operation, types, &amp; construction of alternators</td>
<td></td>
<td>F.S. 126</td>
<td></td>
</tr>
<tr>
<td>Need for frequency &amp; voltage stabilization in alternators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse direction of AC or DC motor</td>
<td>*Theory, operation, types &amp; construction of AC motors</td>
<td>F.S. 126</td>
<td></td>
</tr>
<tr>
<td>Connect a reohstat &amp; vary speed of motor</td>
<td>Requirements of AC or DC motor protection &amp; control</td>
<td>Methods of rewinding motors &amp; generators</td>
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</tbody>
</table>

**ELECTRIC WIRING AND ILLUMINATION**

Purpose & function of National Board of Fire Underwriters
<table>
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<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Need &amp; purpose of national electric code</td>
<td>Selection &amp; requirements of service entrance</td>
<td>National electric code available from city building inspectors office or local electrical contractor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Types &amp; applications of switches &amp; controls for housewiring</td>
<td>Theory of light production by current passing through low pressure gas</td>
<td></td>
</tr>
<tr>
<td>Replace fluorescent lamp, starter &amp; ballast</td>
<td>Types &amp; operation of gas discharge lamps</td>
<td>Tour house under construction with wiring exposed. Have electrician explain procedure followed in wiring the house</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Operation &amp; application of arc lights</td>
<td></td>
</tr>
<tr>
<td>Construct or repair lamp (household)</td>
<td>Electric power &amp; poly-phase systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adequate wiring requirements</td>
<td></td>
<td></td>
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<tr>
<td>Repair common household appliance</td>
<td>Need, application &amp; calculation or branch circuits</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Theory &amp; need for good lighting</td>
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</tbody>
</table>
Basic Electronics

This course is designed as a sequence course for junior-senior high school students who have completed the course in basic electricity. This course should cover thirty-six weeks of instruction of technical and related information associated with electronic components, circuits and equipment.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION TO ELECTRONICS</td>
<td>Historical development of electronics</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>General applications of electronics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify electronic symbols</td>
<td>*Types &amp; purpose of electronic symbols</td>
<td>Basic transmitter &amp; receiver operation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New electronic developments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>List precautions in handling electronic components</td>
<td>*Assembly techniques for electronic components</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Types &amp; operation of electronic components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan &amp; layout etched circuit</td>
<td>History &amp; methods of producing printed circuits</td>
<td>Job opportunities in electronics</td>
<td></td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct transistorized project on printed circuit</td>
<td>Planning &amp; layout of etched circuit</td>
<td>Principles of chassis layout</td>
<td></td>
</tr>
<tr>
<td>Methods of mounting components on printed circuit board</td>
<td>Common materials for making printed circuits</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ELECTRON TUBES**

*Physical characteristic & construction of electron tubes & sockets*

Theory of tube & pin numbering systems

**Operating theory of vacuum tubes (rectifiers & amplifiers)**

Purpose, function & operation of tube testers

**Films 117, 118, 119, 120, 121**

Make characteristic curve experiment on vacuum tube

Theory & characteristic curves of vacuum tubes

Film 72

*Types & classification of vacuum tubes*

*Vacuum tube terminology*

*Purpose & operating theory of vacuum-tube grids*

Films 117, 121

Construct simple tube receiver

Construct power supply

Typical operating conditions of vacuum tubes

**Check reference numbers at end of unit.**
<table>
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<td></td>
<td>Special characteristics of vacuum tubes</td>
<td></td>
<td>Film 72</td>
</tr>
<tr>
<td></td>
<td>Tube parameters &amp; dynamic characteristic of vacuum tubes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Look up various tubes &amp; state their operating conditions</td>
<td>*Function &amp; use of the tube manual in electronics</td>
<td></td>
<td>Vacuum tube mock-up showing grids &amp; physical arrangement of tube construction</td>
</tr>
</tbody>
</table>

**SEMI-CONDUCTORS**

Effect, purpose & development of miniaturization in electronic components

Construct simple transistor receiver; or metronome, code practice oscillator, wireless microphone, light flasher, intercom, etc.

*Theory & operation of semi-conductors

Films 104, 116

Physical properties of semi-conductors

Test diodes & transistors on tester

Construction of semi-conductors

Semi-conductor testing devices & techniques
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<thead>
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<th>Fundamental Knowledge</th>
<th>Related Information</th>
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</thead>
<tbody>
<tr>
<td>Work problems involving power supplies</td>
<td>*Types of power supplies</td>
<td>Ratings of power supplies</td>
<td></td>
</tr>
<tr>
<td>Construct power supply</td>
<td>*Power supply requirements for circuits &amp; components</td>
<td>Purpose of power supplies</td>
<td></td>
</tr>
<tr>
<td>Theory &amp; application of transistorized power supplies</td>
<td>Construction of power supplies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regeneration of power supplies</td>
<td></td>
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<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td></td>
<td>*Theory, types &amp; applications of rectifiers</td>
<td></td>
<td>Film 120</td>
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<tr>
<td></td>
<td>Theory, types &amp; application of filter circuits</td>
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<tr>
<td></td>
<td>Theory &amp; application of voltage divider networks</td>
<td></td>
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<tr>
<td>Make tests on various power supplies</td>
<td>Repair &amp; maintainence of power supplies</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Purpose, function &amp; operation of voltage doubler &amp; tripler networks &amp; circuits</td>
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<tr>
<td></td>
<td></td>
<td>Theory &amp; operation of vibrator power supplies</td>
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<tr>
<td>AMPLIFIERS</td>
<td></td>
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<tr>
<td></td>
<td>*Physical nature of sound</td>
<td></td>
<td>Development of harmonics &amp; their effects in electronics</td>
</tr>
<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>*Electrical transmission &amp; reproduction of sound</td>
<td></td>
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<tr>
<td>Construct amplifier</td>
<td>Types, applications &amp; classes of amplifiers (A, AB, B, C)</td>
<td>Requirements &amp; developments of high-fidelity &amp; stereophonic sound systems (Decibels, wattage)</td>
<td>Explain the DB scale on the V.O.M. and how it is used</td>
</tr>
<tr>
<td></td>
<td>Theory &amp; operation of various types of amplifier circuits (RF, IF, AF, Push-pull &amp; parallel or power)</td>
<td></td>
<td>Film 117</td>
</tr>
<tr>
<td>Connect &amp; match audio inputs &amp; outputs to amplifier</td>
<td>Types &amp; operation of common amplifier coupling circuits</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Rating &amp; measurement of amplifier output</td>
<td>Need for temperature stabilization in transistor amplifiers</td>
<td></td>
</tr>
<tr>
<td>Take voltage &amp; current measurements of amplifier &amp; figure watts output or input</td>
<td></td>
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<td></td>
<td>*Comparison of vacuum tube &amp; transistor amplifiers (physical &amp; circuit diagrams)</td>
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<tr>
<td></td>
<td>Methods of biasing vacuum-tube &amp; transistor amplifiers</td>
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<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
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<tr>
<td></td>
<td>Operation &amp; purpose of amplifier control circuits</td>
<td>Theory &amp; operation of volume control circuits</td>
<td></td>
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<td></td>
<td>Types &amp; theory of feedback in amplifiers (regenerative &amp; degenerative)</td>
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<td></td>
<td>Purpose &amp; need for decoupling circuits</td>
<td></td>
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<td></td>
<td>*Methods &amp; need for circuit shielding</td>
<td></td>
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<tr>
<td></td>
<td>Theory, operation &amp; application of magnetic amplifiers</td>
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</tbody>
</table>

**OSCIllATORS**

*Purpose, function & operation of electronic oscillator

Experiment with or construct oscillator circuit

*Methods of feeding oscillator circuit

Types & theory of LC oscillators

Types & theory of RC oscillators

Purpose & operation of frequency controls

Types & applications of commercial signal generators (AF & RF)
<table>
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<th>Fundamental Knowledge</th>
<th>Related Information</th>
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<tbody>
<tr>
<td>TRANSMITTERS</td>
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<tr>
<td>*FCC regulations regarding radio wave propagation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construct low power AM transmitter (100 milliwatts maximum and modulate)</td>
<td>Types, theory &amp; operation of AM transmitters</td>
<td></td>
<td>Film 106</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type, theory &amp; operation of FM transmitters</td>
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<td></td>
<td>Methods of modulating or keying AM transmitters</td>
<td></td>
<td>Film 108</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Methods of modulating or keying FM transmitters</td>
<td></td>
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<td></td>
<td>Methods of coupling transmitter circuits</td>
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<td></td>
<td>Purpose and need for carrier frequency stabilization</td>
<td></td>
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<tr>
<td></td>
<td>*Nature, characteristics &amp; theory of radio waves</td>
<td></td>
<td>Films 69, 107</td>
</tr>
<tr>
<td></td>
<td>*Theory of electromagnetic wave propagation</td>
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<tr>
<td></td>
<td>Types, characteristics &amp; theory of transmission lines &amp; antennas</td>
<td></td>
<td>Film 105</td>
</tr>
<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td></td>
<td>Purpose &amp; operation of sideband transmission</td>
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<td></td>
<td>Principles of TV transmission</td>
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<td></td>
<td>Theory of microwave transmission</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>*Theories &amp; types of transducers (microphones &amp; speakers)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RECEIVERS</td>
<td>Construct or experiment with a simple AM receiver</td>
<td>*Types, characteristics &amp; theory of AM receivers</td>
<td>Trip to local radio or TV station for insights of basic operation</td>
</tr>
<tr>
<td></td>
<td>Methods &amp; limitations of demodulation in AM receivers</td>
<td>Types, characteristics &amp; theory of FM receivers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Methods &amp; limitations of demodulation in FM receivers</td>
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<tr>
<td></td>
<td>Allign a detuned AM superhetrodyne receiver</td>
<td>Theory &amp; procedure of AM receiver alignment</td>
<td></td>
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<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>Repair inoperable AM receiver</td>
<td>Theory &amp; procedure of FM receiver alignment</td>
<td>Methods &amp; procedures of radio repair &amp; troubleshooting</td>
<td></td>
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<tr>
<td></td>
<td>Note: A series of operations or activities might be laid out around several units, oscillators, amplifiers, etc., that would ultimately result in a superheterodyne or low power transmitter</td>
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<td></td>
<td>Theory &amp; types of time-delay circuits</td>
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<td></td>
<td>Theory of logic circuitry</td>
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<td>Principles of gating &amp; counting circuits</td>
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<td></td>
<td>Theory of TV receivers</td>
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</table>
Applications Of Electronics

This section of the outline is devoted to the two main applications of electronics. Electronics in industry and electronics in the home. The line of demarcation is not definite, but the materials are separated for ease of identification.

This section is provided in the study guide to give some guidance to leaders who wish to pursue the field of electricity and electronics in greater breadth. The applications listed are not comprehensive but are intended as a guide to major developments for which information is available and of basic importance.

<table>
<thead>
<tr>
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<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
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<td>INDUSTRIAL APPLICATION OF ELECTRONICS</td>
<td>Automation</td>
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<tr>
<td></td>
<td>Definition of mechanization, automatic, mechanization, and automation</td>
<td>Early examples of automated devices</td>
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<td></td>
<td>Technological change and automation (social and educational impact)</td>
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<td></td>
<td>Principle and significance of feedback in automation</td>
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<td>Computers</td>
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<tr>
<td></td>
<td>Computer mathematics (base 10 to base 2 and base 8)</td>
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<td></td>
<td>Principles of logic circuitry</td>
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<td></td>
<td>Types, application &amp; function of computers digital, analog, bionic</td>
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<tr>
<td>Units of Instruction</td>
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<td>Related Information</td>
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<tr>
<td></td>
<td>Types, function &amp; operation of computer storage devices</td>
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<tr>
<td><strong>Production of Electrical Energy</strong></td>
<td>Theory &amp; operation of fuel cells</td>
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<td></td>
<td>Applications, advantages &amp; disadvantages of fuel cells</td>
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<td></td>
<td>Theory &amp; applications of Bio-electrogenesis</td>
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<td>Theory &amp; applications of solar cells</td>
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<td><strong>Industrial Controls</strong></td>
<td>Theory &amp; operation of Servo Mechanisms</td>
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<td></td>
<td>Operation, theory, &amp; application of static switching devices</td>
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<td></td>
<td>Theory, application, &amp; operation of Synchronous devices</td>
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<td>Theory &amp; application of detection and sensing devices</td>
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<td>Theory &amp; application of magnetic amplifiers</td>
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<td>Units of Instruction</td>
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<td>Related Information</td>
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<tr>
<td><strong>Industrial Processes</strong></td>
<td>Types, applications &amp; theory of magnetic forming of materials</td>
<td>Types of magnetic materials &amp; theory of magnetic design</td>
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<td>Theory, operation &amp; application of high-frequency (induction heating)</td>
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<td>Purpose, theory &amp; applications of ultra-sonic cleaning</td>
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<td>Theory &amp; application of electron beam welding</td>
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<td>Operation, application &amp; theory of lasers &amp; masers</td>
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<td></td>
<td>History, theory &amp; applications of electroplating</td>
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<td>Theory &amp; applications of RADAR and SONAR</td>
<td>Function, operation &amp; theory of inertial guidance systems in space travel</td>
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<td>Theory &amp; applications of electro-luminescence</td>
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<td>Technique, theory &amp; application of facsimile reproduction</td>
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<td>Units of Instruction</td>
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<td></td>
<td>Impact, application &amp; theory of thin film &amp; flexible electronic circuitry</td>
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<td></td>
<td>History &amp; applications of micro-minituriization of electronic modules</td>
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<tr>
<td></td>
<td>Technique &amp; procedure of making sintered &amp; printed circuits</td>
<td>Precautions &amp; advantages of printed &amp; sintered circuits in electronics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>History &amp; development of electronics in modern medicine (anesthesia, X-ray, surgery, etc.)</td>
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</table>

**Applications of Electronics in the Home**

<table>
<thead>
<tr>
<th>Operation &amp; maintenance of public address systems &amp; intercoms</th>
<th>Theory, operation &amp; applications of high-fidelity &amp; stereophonic sound systems</th>
<th>Theory, types &amp; applications of magnetic tape recorders</th>
<th>Theory &amp; application of television</th>
<th>Theory, operation &amp; applications of Radio Control devices</th>
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</thead>
<tbody>
<tr>
<td>Units of Instruction</td>
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<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td></td>
<td>Theory &amp; applications of Amateur Radio</td>
<td>Theory &amp; operation of transistorized ignition systems</td>
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</tbody>
</table>

**Bibliography --**

**Electricity and Electronics**

Books — Basic Electricity

3. Collings, Merle D. *Projects in Electricity*. Bloomington, Ill.: McKnight and McKnight, 1941. 80 pp.


Books — Basic Electronics


Periodicals — Electricity and Electronics

55. *Bell Laboratories Record*

56. *Control Engineering*

57. *Design Engineering*

58. *Electronics Illustrated*

59. *Electronics World*


61. *Popular Electronics*

62. *Popular Science*

63. *Radio and Electronics*

64. *Radio-TV Experimenter*

65. *Science Experimenter*
66. **Science and Mechanics**

Films and Filmstrips—Electricity and Electronics

Film ordering key information:
- EBF—Encyclopedia Britannica Films
- MH—McGraw-Hill
- SVE—Society for Visual Education
- TAI—Teaching Aids Incorporated

Instructors will be able to order these films from the film libraries located at Southern State College, Pueblo; Colorado State College, Greeley; or Colorado University, Boulder.

Films:

67. **Alternating Current Theory.** 25 min., color, EBF 48523.

68. **Amperes, Volts, and Ohms.** 10 min., b & w, TAI HS-1102.

69. **Antenna Fundamentals—Propagation.** 13 min., MH.

70. **Basic Electricity.** 25 min., b & w, TAI HS-1005.

71. **Capacitance.** 25 min., color, EBF 48510.

72. **Characteristics of Vacuum Tubes.** 25 min., color, EBF 48553.

73. **Coulomb's Law—Electronics.** 25 min., color, EBF 48502.

74. **Coulomb's Law—Magnetism.** 25 min., color, EBF 48521.

75. **Effects of Electric Currents.** 25 min., color, EBF 48515.

76. **The Electric Field and Potential.** 25 min., color, EBF 48508.

77. **Electric Motors.** 25 min., color, EBF 48517.

78. **Electrical Equivalent of Heat.** 25 min., color, EBF 48516.

79. **Electricity at Rest.** 25 min., color, EBF 48501.

80. **Electricity in Motion.** 25 min., color, EBF 48503.

81. **Electromagnetic Waves.** 25 min., color, EBF 48551.

82. **Electromotive Force of A Battery Cell.** 25 min., color, EBF 48504.

83. **Electrons.** 11 min., b & w, EBF 258.

84. **Electrons at Work.** 14 min., color, EBF 1888.

85. **Electrostatics (second edition).** 11 min., b & w, EBF 467.

86. **Elements of Electrical Circuits.** 11 min., b & w, EBF 214.

87. **How to Produce Electric Current with Magnets.** 11 min., color, EBF 182.

88. **How Vacuum Tubes Work.** 17½ min., color, MH.

89. **Induced Electric Currents.** 25 min., color, EBF 48520.

90. **Magnetic Fields.** 25 min., color, EBF 48513.

91. **Magnetic Induction.** 25 min., color, EBF 48518.

92. **Magnetism.** 25 min., color, EBF 38512.

93. **Magnetism.** 16 min., b & w, EBF 764.

94. **Magnetism and Electricity.** 17 min., color, MH.

95. **Ohm's Law.** 5 min., color, Coronet.

96. **Ohm's Law.** 25 min., color, EBF 48505.

97. **Ohm's Law.** 19 min., b & w, TAI HS-1001.

98. **Oscillators.** 13 min., b & w, TAI HS-1107.


100. **Parallel Circuits.** 25 min., color, EBF 48507.

101. **Parallel Resistances.** 25 min., color, EBF 48509.

102. **The Potential Divider.** 25 min., color, EBF 48511.

103. **The Primary Cell.** 11 min., b & w, EBF 247.

104. **Principles of the Transistor.** 21 min., b & w, MH.


106. **Radio Transmitters—Principles and Typical Circuits.** 18 min., b & w, TAI HS-1118.

107. **Radio Waves.** 27 min., color, MH.

108. **The RF Amplifier and Modulator.** 10 min., b & w, TAI HS-1121.

109. **The RF Oscillator.** 17 min., b & w, TAI HS-1120.

110. **Series Circuits.** 25 min., color, EBF 48506.

111. **Series and Parallel Circuits.** 11 min., b & w, EBF 259.

112. **Series and Parallel Circuits.** 10 min., b & w, TAI HS-1101.

113. **A Study of Motors.** 25 min., color, EBF 48519.

114. **Transformers.** 25 min., color, EBF 48524.

115. **Transformers.** 25 min., color, EBF 48522.

116. **Transistor.** 9½ min., b & w, Bell Tel Co.
117. The Triode: Amplification. 14 min., b & w, TAI HS-970.

118. Vacuum Tubes. 25 min., color, EBF 48552.

119. Vacuum Tubes. 11 min., b & w, EBF 216.


121. Vacuum Tubes—Triode and Multipurpose Tubes. 12 min., b & w, TAI HS-973.

122. What is Electric Current? 14 min., color, EBF 1880.

123. What is Electricity? 13 min., b & w, EBF 765.

124. Wheatstone Bridge. 25 min., color, EBF 48514.

Filmsstrips:

125. Electrical Circuits. 57 frames, SVE 482-6.


127. Static Electricity. 65 frames, SVE 482-5.

Other Resource Materials—Electricity and Electronics


135. Cavitron Electron Oscillator Co. Electrical Discharge Machining. P. O. Box 1156, Newport Beach, Calif.


GRAPHIC ARTS

PRINTING.
CHAPTER XII

GRAPHIC ARTS

One of the most important factors in man's advance from barbarism has been the perfecting of the communications system providing a constant interchange of knowledge and opinion. Through the centuries there has come the development of communication in which man gains knowledge and transmits it from generation to generation.

Graphic Arts has played an important part in the process of progressive growth of civilization and today is one of the fastest growing industries.

When teaching Graphic Arts, the teacher must keep several objectives in mind.

1. To have the student explore and become acquainted with the basic mechanics of Graphic Arts reproduction.

2. To help the student appreciate the many scientific and technical aspects necessary to produce good printed material.

3. To enable the student to learn the many interesting facts about the history of printing.

4. To acquaint the student with the career opportunities in the graphic arts industry.

In general, graphic arts education should teach the student to understand and appreciate the many ways of producing printed material.

Note:

The suggested instructional material is not necessarily placed across from the proper operation, but it should be used for the complete unit. This was done because of duplication and overlapping.

LAYOUT & DESIGN

<table>
<thead>
<tr>
<th>Operations</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare a design</td>
<td>Principles of design</td>
<td>History of paper and paper classification</td>
<td>Charts</td>
</tr>
<tr>
<td></td>
<td>Principles of design and color</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Make layout, drawing, or</td>
<td>Principles of typographic style</td>
<td>Theory of color and design</td>
<td>Films 52, 59</td>
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<tr>
<td>thumbnail sketch</td>
<td></td>
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<tr>
<td>Make a dummy</td>
<td>Practical application of graphic arts</td>
<td></td>
<td>Models and displays</td>
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<tr>
<td></td>
<td>mathematics</td>
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<tr>
<td>Determine color scheme,</td>
<td>Principles of display type classification</td>
<td>Care of inks</td>
<td>Field trips</td>
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<tr>
<td>ink, and stock</td>
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<td>Composition of inks</td>
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<td></td>
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<td>Drying action of inks</td>
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<td>History of inks</td>
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<td>Operations</td>
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<td>Read, mark, and revise dummy</td>
<td>Common technical terms of the printer</td>
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<td>Read proofs</td>
<td>Proof marks, common rules of spelling, grammar, and punctuation</td>
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<td>COPY PREPARATION</td>
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<tr>
<td>Work with type case</td>
<td>Design principle of California job case</td>
<td>Historical background of relief printing</td>
<td>Charts</td>
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<td>Lay of common type cases</td>
<td>History of the alphabet</td>
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<td>Other types of cases and their use</td>
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<tr>
<td>Hold and adjust composing stick</td>
<td>Point system of measurement</td>
<td>Great printers in the past</td>
<td>American Type Founders</td>
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<td>Letter space type</td>
<td>Recognize spacing material</td>
<td>Ingredients in type metal</td>
<td>Printed samples</td>
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<tr>
<td>Set simple straight matter</td>
<td>Space in or space out of line</td>
<td>History of type</td>
<td>Films 37, 39, 45, 53, 54, 69</td>
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<td>Justify lines</td>
<td>Test for justification</td>
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<tr>
<td>Dump the stick</td>
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<td>Enlarged pieces of type, spacing material, and line gauge</td>
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<td>Tie up a type form</td>
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<td>Take proof of type set</td>
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<td>Read and correct proof</td>
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<tr>
<td>Make corrections</td>
<td>Use of cleaning fluids</td>
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<td>Set initial letters</td>
<td>Use of caps and small case letters</td>
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<td>Set conventional layouts</td>
<td>Space composition correctly</td>
<td>Design in printing</td>
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<td>Use different styles of type</td>
<td>Fonting schemes Type series and families</td>
<td>Development of type design</td>
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<td>Set special type and type forms</td>
<td>Use of special type, borders, ornaments, and initials</td>
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<td>Cut with a mitering machine</td>
<td>Use of mitering machine</td>
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<tr>
<td>Set tabular and ruled forms</td>
<td>Kinds of brass and strip rule</td>
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<td>Set piece and strip borders</td>
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<td>Set display matter</td>
<td>Type harmony</td>
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<td>Print multicolor forms</td>
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<td>Machine composition (if composing machinery is available)</td>
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<td>Safety information</td>
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<td>Take different types of pictures</td>
<td>Principles of the camera Types of cameras</td>
<td>History of photography Occupations of photography</td>
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<td>Develop exposed film</td>
<td>Use of developers and fixers</td>
<td>Safety information</td>
<td>Photo-lathe, Graphic Electronics, LaSalle, Ill.</td>
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<td>Make contacts</td>
<td>Contact printing</td>
<td>Hobbies in graphic arts</td>
<td>Eastman Kodak Co.</td>
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<td>Enlarge photographs</td>
<td>Principles of enlargers</td>
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<td>Samples of photographic copy</td>
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<td>Print pictures</td>
<td>Types and uses of films and paper</td>
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<td>Trim and mount pictures</td>
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<td>Prepare copy</td>
<td>Use of color filter</td>
<td>Color separation Use of photography in the Graphic Arts</td>
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<td>Expose and develop line negative</td>
<td>Theory of Photolithography</td>
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<td>Expose and develop halftone</td>
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<td>Lithographic paste-up</td>
<td>Combining line and halftone work</td>
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<tr>
<td>Prepare design</td>
<td>Adaptability of the silk screen process</td>
<td>Historical background of screen process, Importance of screen, Uses of screen process, The screen process industry, Job opportunities in the silk screen industry</td>
<td>Films 68, 72</td>
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<tr>
<td>Select desirable silk screen method</td>
<td>Methods of making silk screen design, Layouts for screen processes</td>
<td>Safety information</td>
<td>Samples of silk screen printing</td>
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<tr>
<td>Prepare silk screen frame for print</td>
<td>Adhere stencil</td>
<td>Cost of silk</td>
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<td>Related Information</td>
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<tr>
<td>Cut stencil</td>
<td>Block out balance of screen</td>
<td>Cost of stencil film</td>
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<td>Blockout</td>
<td>Application of blockout media</td>
<td>Various blockout media</td>
<td></td>
</tr>
<tr>
<td>Make a celluloid line engraving</td>
<td>Rotogravure processes</td>
<td>Line etching</td>
<td></td>
</tr>
<tr>
<td>Metal plates</td>
<td>Gravure operations</td>
<td>Halftone</td>
<td>Field trips</td>
</tr>
<tr>
<td></td>
<td>Gravure ink</td>
<td>Conventional etching</td>
<td></td>
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<td></td>
<td></td>
<td>Powerless etching</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Register process</td>
<td></td>
</tr>
</tbody>
</table>

**ROTOGRAVURE**

- Principles of gravure printing
- Types of intaglio (line etching, line engraving, drypoint)
- Industrial use of gravure printing
- Study of engraving
<table>
<thead>
<tr>
<th>Operations</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic plates</td>
<td></td>
<td>Color printing</td>
<td>Information from gravure manufacturers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Color scanning devices</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automatic engraving machine</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Polymer plastic plates</td>
<td></td>
</tr>
<tr>
<td><strong>LITHOGRAPHIC</strong></td>
<td></td>
<td>History of lithography</td>
<td>Films 47, 56, 66, 67, 74</td>
</tr>
<tr>
<td>Offset papers and inks</td>
<td></td>
<td>Occupations of lithography</td>
<td></td>
</tr>
<tr>
<td>Strip flats</td>
<td>Preparing negatives</td>
<td></td>
<td>Charts</td>
</tr>
<tr>
<td></td>
<td>Stripping flats</td>
<td></td>
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</tr>
<tr>
<td>Prepare chemicals</td>
<td>Mixing chemicals</td>
<td>Various chemicals and uses</td>
<td>Printed examples</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safety information</td>
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</tr>
<tr>
<td>Burn plates</td>
<td>Types of plates</td>
<td>Plate terminology and types</td>
<td>Information from lithographic companies</td>
</tr>
<tr>
<td></td>
<td>Plate preparations</td>
<td>Kinds of lamps</td>
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<tr>
<td>Operations</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>LINOLEUM BLOCK</td>
<td>Methods used in the past</td>
<td>History of block carving</td>
<td>Film 48</td>
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<tr>
<td></td>
<td>Basic difference of relief and intaglio</td>
<td>Opportunities in block carving</td>
<td></td>
</tr>
<tr>
<td>Prepare design</td>
<td>Multiple color registration</td>
<td>How to mount linoleum on blocks</td>
<td>Printed examples</td>
</tr>
<tr>
<td>Transfer to block</td>
<td>Reversing design</td>
<td></td>
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</tr>
<tr>
<td>Cut block</td>
<td>Use and care of cutting tools</td>
<td>Cost and types of cutting tools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEREOTYPE</td>
<td>Materials and equipment used in the</td>
<td>Uses of the stereo method in the printing</td>
<td>Film 53</td>
</tr>
<tr>
<td></td>
<td>stereotype process</td>
<td>industry</td>
<td></td>
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<td></td>
<td></td>
<td>Electro types</td>
<td></td>
</tr>
<tr>
<td>Selection of design</td>
<td>Molding the stereotype mat</td>
<td>Other duplicate platemaking</td>
<td>Charts</td>
</tr>
<tr>
<td>Preparation of mat</td>
<td>Positioning mat</td>
<td>Types of plates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heat control</td>
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<tr>
<td>Operations</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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</tr>
<tr>
<td>Make a stereotype casting</td>
<td>Casting the stereotype plate, Routing and trimming, Mounting the stereotype plate</td>
<td>Safety information</td>
<td></td>
</tr>
<tr>
<td>Melt and clean metal</td>
<td>Metal information</td>
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</tr>
</tbody>
</table>

## RELIEF PRINTING

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Make up and tie jobs in galley</td>
<td>Principles of job layout</td>
<td>Copyright laws, Development of the point system</td>
<td>Films 52, 53</td>
</tr>
<tr>
<td>Pull stone proof</td>
<td>Plane form</td>
<td>Importance of accuracy and neatness</td>
<td>Models</td>
</tr>
<tr>
<td>Position a form for lock-up</td>
<td>Position type form within chase</td>
<td>Common sizes in font of furniture</td>
<td>Lock-up and lock-up methods</td>
</tr>
<tr>
<td>Position furniture and lock-up for printing</td>
<td>Use of reglets, Use of quoins, Care of material used in imposition</td>
<td>Types of furniture</td>
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</tr>
<tr>
<td>Operations</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>Lock-up jobs in chase</td>
<td>Lock-up by square and chaser methods</td>
<td>Types of quoins</td>
<td></td>
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<td>Test form for lift</td>
<td></td>
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<tr>
<td>Unlock and distribute</td>
<td></td>
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<td></td>
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<tr>
<td>material</td>
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<tr>
<td>Lock-up</td>
<td>Imposition</td>
<td>Types of printing presses</td>
<td>Safety information</td>
</tr>
<tr>
<td>Work and tumble</td>
<td>Use of numbering machines</td>
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<tr>
<td>Work and turn</td>
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<tr>
<td>Work and flop</td>
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<tr>
<td>Work and twist</td>
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<tr>
<td>Work and back</td>
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<tr>
<td>Multi-page</td>
<td></td>
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</tbody>
</table>

**INK TRANSFER**

**DIRECT FROM TYPE**

<table>
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<tr>
<th>Preparation</th>
<th>Kinds of paper and inks</th>
<th>Illustrations</th>
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</thead>
<tbody>
<tr>
<td>Cut paper</td>
<td></td>
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<tr>
<td>Ink mixing</td>
<td></td>
<td></td>
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<tr>
<td>Care of inks</td>
<td></td>
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<tr>
<td>Drying action of inks</td>
<td></td>
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<table>
<thead>
<tr>
<th>Operate proof press</th>
<th>Types of proofing</th>
<th>Films 36, 69, 71</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulling proofs</td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prepare press for printing</th>
<th>Kinds of rollers and their composition</th>
<th>Field trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts of the press</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proper angle and pressure of squeegee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roller care and adjustment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Press adjustment and maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
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<td>-----------------------</td>
</tr>
<tr>
<td>Set up and run job on press</td>
<td>Proper press procedure</td>
<td>Kinds of presses</td>
</tr>
<tr>
<td></td>
<td>Location of gauge pins</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Registration and make ready</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Press feeding</td>
<td></td>
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<tr>
<td></td>
<td>Slip sheeting and drying</td>
<td></td>
</tr>
<tr>
<td>Remove job and clean press</td>
<td>Press clean-up and maintenance</td>
<td>Types of cleaning solvents</td>
</tr>
<tr>
<td>If automatic presses are available, instruction should be given on this level</td>
<td>Setting of automatic feeders and deliveries</td>
<td></td>
</tr>
<tr>
<td>Operate offset press</td>
<td>Types of plates</td>
<td>Gravure presses</td>
</tr>
<tr>
<td></td>
<td>Papers and inks</td>
<td>Photo copying machines</td>
</tr>
<tr>
<td></td>
<td>Press operation</td>
<td>Types of offset and gravure printing</td>
</tr>
<tr>
<td></td>
<td>&quot;Colo&quot; type processes</td>
<td>Kinds of paper and inks</td>
</tr>
</tbody>
</table>
### SPECIAL PROCESSES

<table>
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<th>Operations</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emboss, score, die cut, and perforate sheets</td>
<td>Embossing functions and processes</td>
<td>Types of moldings and mountings Various materials</td>
<td>Information from companies</td>
</tr>
<tr>
<td>Virkotyping</td>
<td>Application of ink and powder</td>
<td>Types of powder</td>
<td>Field trips</td>
</tr>
<tr>
<td>Print by silk screen</td>
<td>Proper ink consistency Control register</td>
<td>Silk screen production printing Pressureless printing</td>
<td></td>
</tr>
<tr>
<td>Clean silk screen</td>
<td>Proper care and use of Cleaning material</td>
<td>Cleaning solvents</td>
<td></td>
</tr>
<tr>
<td>Rubber stamp</td>
<td>Methods used in making rubber stamp</td>
<td>Use of rubber molds in the printing industry</td>
<td></td>
</tr>
</tbody>
</table>

### BINDING

<table>
<thead>
<tr>
<th>Operations</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to binding</td>
<td>Kinds of tools and equipment</td>
<td>History of binding The work of the librarian Book care and use Kinds of materials used in binding and finishing Uses of the binding processes</td>
<td>Films 38, 41, 42, 43, 44, 49, 53, 57</td>
</tr>
<tr>
<td>Operations</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-----------------------------------------------------------</td>
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<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Cut stock</td>
<td>Method of figuring and cutting stock</td>
<td>Safety information</td>
<td>Samples of different types of binding</td>
</tr>
<tr>
<td>Prepare and make pads</td>
<td>Perforating</td>
<td>Padding methods</td>
<td>Visual aid showing steps in making library and nicked corners</td>
</tr>
<tr>
<td>Wire stitch</td>
<td>Different kinds of stitches and sewing used in binding</td>
<td></td>
<td>Cutting chart</td>
</tr>
<tr>
<td>Marbling paper</td>
<td>Thinning ink Use of comb Dropping on water Drying paper</td>
<td></td>
<td>History of marbled paper</td>
</tr>
<tr>
<td>Assemble and jog papers</td>
<td>Ways of assembling and jogging papers Jogging, cutting, gathering, and folding paper</td>
<td></td>
<td>Folding machines</td>
</tr>
<tr>
<td>Make autograph books with hard covers</td>
<td>Binding of small booklets Make a nicked corner Slide and saddle stitch methods</td>
<td></td>
<td>Binding of small booklets</td>
</tr>
<tr>
<td>Operations</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
</tr>
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</tr>
<tr>
<td>Bind books</td>
<td>Procedures for bookbinding</td>
<td>Mechanical bindings</td>
<td></td>
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<tr>
<td></td>
<td>Ways of assembling</td>
<td></td>
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<tr>
<td></td>
<td>Make a library corner</td>
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</tbody>
</table>

**ALLIED INDUSTRIES**

The units in newspaper operations are studied through lectures, demonstrations, and not laboratory operations.

**NEWSPAPER**

- Use of character count in headlines and ads
- Spacing materials used for newspaper
- Planning gutters and margins
- Page makeup
- Justifying columns to length
- Responsibilities of proofreader
- Use of proofreader's marks
- Mounting cuts, Fairchilds, and engravings
- Locking news form in press bed
- Press operation

**Related Information**

- Importance of newspaper
- Paper industry
- Type foundry
- Graphic Arts chemicals
- Manufacturing of printing inks
- Manufacturing of printing plates
- Safety information
- Manufacturing of printing machines

**Instructional Materials**

- Films 46, 59, 60
- Samples of newspapers
<table>
<thead>
<tr>
<th>Operations</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office style feeder and delivery settings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setting of automatic feeders and deliveries</td>
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</tr>
</tbody>
</table>

**BUSINESS OF PRINTING**

- Research and development
- Advertising
- Sales
- Labor management
- Distribution

- Periodicals
- Publications
- Field trips
- Films 50, 51

**SUGGESTED PROJECTS**

**Planning**
- Make thumbnail sketch, rough layout and finished layout of:
  - Display work
  - Advertisements
  - Program or menu
  - Booklet—4 or 8 pages
  - Ticket
  - Business stationery
  - Personal stationery
  - Announcement
  - Personal calling cards
  - Shipping label
  - Coasters
  - Projects of your own choice

**Press Work (Power)**
- Print jobs, individual selections

**Photography**
- Expose a roll of film with a variety of situations:
  - Outside-day
  - Outside-night
  - Inside-day
  - Inside-flash
- Develop contact print and enlarge at least two

**Rubber Stamps**
- A rubber stamp of your name
- A rubber plate for printing

**Stereotype**
- Roll a mat of a type form
  (Be sure to use bearers)
- Cast a plate from mat
- Cast a plate from a commercial matrix

**Platemaking Linoleum**

**Block**
- Design and cut a two-color block and register
- Poster
- Cover
- Christmas card

**Binding**
- Cut stock for jobs in previous sections.
- Bind book different methods
# Bibliography -- Graphic Arts

## Books

5. Clark, Merle A. *Student Printing.* Peoria, Ill.: Chas A. Bennett Co. 95 pp.

## Periodicals

33. *Inland Printer,* 309 West Jackson Boulevard, Chicago 6, Illinois.
34. *Printing,* Walden, Sons & Mott, Inc., 666 Kinderkamack Road, Oradell, New Jersey.
Films — Graphic Arts

Film ordering key information:

When ordering films listed in this index, it is suggested that the order be written on official school letterhead as many of the films are available only to authorized educational institutions. When ordering films directly from the companies listed, state that the film is desired for industrial education classes, as many films are available for showing only to this group.

When ordering films to be shown on a specific date, order the films well in advance of the desired date of showing. Many companies state that to book a film for showing on a specific date the film must be ordered three months in advance.


DUC — C. T. Dearing Printing Co., Broadway at 11th Street, Louisville 1, Kentucky.

DRGWR CO — Denver and Rio Grande Western Railroad Co., Advertising Dept. (Films), U. O. Box 5482, Denver 17, Colorado.


HE CO — Horan Engraving Co., 44 West 28th Street, New York 1, New York.

HPP COR — Hudson Pulp and Paper Corporation, Advertising and Sales, Roanoke, Virginia.

HS CO or HSP — Harris Seybold Co., 4510 East 71st Street, Cleveland 5, Ohio.


IND — Audio-Visual Center, Indiana University, Bloomington, Indiana.


IPINK — International Printing Ink, Division of Interchemical Corp., 67 West 44th Street, New York 17, New York.


MIN — University of Minnesota, Bureau of Audio-Visual Instruction, 229 Northrop Memorial Auditorium, Minneapolis 14, Minnesota.


NFBC — National Film Board of Canada, Suite 2307 RKO Building, 1270 Avenue of the Americas, New York 20, New York.

RAP — Rapid Electrotype Co., McMicken Avenue at Race, Cincinnati, Ohio.

SUI — State University of Iowa, Bureau of Audio-Visual Instruction, Extension Division, Iowa City, Iowa.

WIS — Bureau of Visual Instruction, University Extension Division, University of Wisconsin, Madison 6, Wisconsin.

WPL — Western Printing and Lithography Co., Personnel and Training Dept., 1220 Mound Avenue, Ravine, Wisconsin.

WRU — Western Reserve University, Audio Visual Center, Cleveland, Ohio.

Films

36. Another Man's Business. 20 min., color, MIL.

37. Art and Technique of Photoengraving. 27 min., color, HE CO.

38. Bindery Operations. 45 min., WPL.

39. The Blue Streak Linotype Machine. 25 min., LINO.

40. Chemical Effects of Electricity. 17 min., $1.50, IND.

41. Elementary Bookbinding. 10 min., $2.00, IND or ILL.

42. From Pines to Paper. 32 min., color, HPP COR.

43. From Trees to Paper. 12 min., 60c, ISC.

44. Gift of Ts'lu—Paper. 33 min., 60c, ISC.

45. Heights and Depths. 8 min., $1.50. IND, ILL, or MIN.

46. Hemlock to Headlines. 29 min., color, DRGWR CO.
47. *How to Make a Good Impression.* 21 min., color, 1947, HSP.
48. *How to Make a Linoleum Block Print.* 14 min., $3.50, BFI.
49. *In Partnership With Nature.* 20 min., color, 1951, IPC.
50. *In Perfect Balance.* 13 min., color, 1952, MPPM.
51. *Look to the Years Ahead.* 30 min., color, 1947, MPPM or MIE.
52. *Magazine Magic.* 34 min., MOD.
53. *The Making of a Magazine.* 43 min., color, DPC.
54. *Manufacturing of Electrotype and Mats.* 11 min., RAP.
55. *Miracle of Paper.* 23 min., color, 1955, G CO.
   (Not available to elem. schools.)
56. *Modern Photo-engraving.* 15 min., color, KC.
57. *New Books for Old.* 15 min., WRU.
58. *New Wings for Publishing.* 35 min., color, CCP.
59. *Newspaper Story.* 16 min., $2.50, SUI.
60. *Newsprint.* 23 min., NFBC.
61. *Paper.* 11 min., $2.00, MIN.
62. *Paper Comes to Life.* 30 min., CHA.
63. *Paper in the Making.* 24 min., color, MTP.
64. *Paper Making.* 22 min., $2.50, ISC, ILL, or IND.
65. *Paper and Pulp Making.* 11 min., $1.25, SUI.
66. *Photo Lithography.* 45 min., color, EKC.
67. *The Modern Lithographer.* 11 min., color, $1.25, SUI, ILL, WIS, IND, or MIN.
68. *Poster Making: Printing by Silk Screen.* 14 min., $7.50, BFI.
69. *Printing.* 11 min., $1.25, ISC and SUI.
70. *Printing Through the Ages.* 17 min., $2.50, SUI.
71. *Putting a Job on a Platen Press.* 11 min., $3.50, BFI.
72. *Rainbows to Order.* 21 min. color, IP INK.
73. *Silk Screen Process in Lithography.* 20 min., $2.50, SUI.
74. *Technique of Lithography.* 32 min., $3.50, IND.
75. *Trees to Tribunes.* 44 min., color, 60c, ISC or SUI.
CHAPTER XIII

MECHANICAL DRAFTING

Mechanical drafting is the language of industry; that is, the means by which mechanical ideas are developed, recorded, and transmitted to others. It is the universal, graphic language which provides communication between industrial workers of the world. The term "mechanical drafting" is applied to work requiring, for the most part, the use of tools and instruments. However, freehand sketching must be considered an integral phase of drafting.

In this area of the industrial arts program, an attempt is made to do the following:

1. Provide exploratory contacts with as many different types of drafting as possible
2. Provide opportunities for general education, pre-engineering, and pre-vocational training
3. Teach usable skills in the production of working and pictorial drawings, freehand sketching and lettering
4. Develop the ability to read and interpret drawings through mental visualization
5. Develop the ability and habit of using drawing to plan jobs of a mechanical nature
6. Present a variety of interesting and useful facts about industry, machines, materials of construction and related occupations
7. Develop the ability for accuracy and neatness in doing a job
**BASIC MECHANICAL DRAFTING**

These units of instruction in mechanical drafting have been designed and developed in accordance with the definitions and objectives of industrial arts in general education. This course was designed to give the student background and a general overview of mechanical drafting. The units are flexible so that they may be adapted to the individual situation; however, they should be considered a minimum requirement for the school which offers a course in drafting.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
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</thead>
</table>
| *Introduction to mechanical drafting | Definition | History | **Texts and references**
| | | Vocational opportunities | Films: 80, 88, 108, 82, 117
| | | Uses | Guest speakers from industry |
| *Sketching | Purpose | Uses | Chalkboard, paper, pencils, eraser
| | Types | | Films: 75, 85, 113 |
| | Techniques | | Solid models and Overhead projector |
| *Alphabet of lines | Line value | | Chart: 127
| | Symbols | | Film: 74 |
| *Geometric construction | Circles and arcs | Importance in mechanical drafting | Chalkboard equipment
| | Angles | | Film: 116
| | Lines | Relationship to mathematics | Transparencies: 121, 124
| | Bisecting lines, angles, and arcs | Application to general work problems | part 1
| | Dividing straight lines into any number of equal parts | | |
| | Construction of hexagons, octagons, and pentagons | | |
| | Construction of ellipses, curves, involutes and spirals | | |
| | Tangents | | |

*Suggested for study in the comprehensive general shop.

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|                     | Revolution about a vertical axis perpendicular to the horizontal plane | | Chart: 180 |
| Revolution about a vertical axis perpendicular to the profile plane | | | |
| Direction of the revolution | | | |
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| Finding the true length of line by revolution | | | |
| Pattern development | Descriptive statement | Use in solving geometrical problems | Field trips to sheetmetal
| | | Industrial application of developments and intersections | and heating shops, oil and copper refineries, and sugar mills |
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ADVANCED MECHANICAL DRAFTING

Since we live in an industrial age, and mechanical drafting is the universal language of industry, these units of instruction meet the needs and abilities of all students in the secondary schools. The instructor would select, from the areas outlined, units of study based on the needs and interests of the individual student.

The prerequisite for this course is basic mechanical drafting.

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<td></td>
<td>Character of lines</td>
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<td></td>
<td>Cross-hatching and shading</td>
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<td></td>
<td>Arrangement of views</td>
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<td></td>
<td>Reference character</td>
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<td>Figure for official gazette</td>
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<td>Transmission of drawings</td>
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<td></td>
<td>Extraneous matter</td>
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<td></td>
<td>Symbols and legends</td>
<td></td>
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<tr>
<td>Production illustration</td>
<td>Pictorial drawing</td>
<td>Use in production lines</td>
<td>Catalogs</td>
</tr>
<tr>
<td></td>
<td>a. Isometric</td>
<td>Use in parts catalog</td>
<td>Craftint paper</td>
</tr>
<tr>
<td></td>
<td>b. Oblique</td>
<td>Use in maintenance</td>
<td>Film: 114</td>
</tr>
<tr>
<td></td>
<td>c. Cabinet</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Exploded views</td>
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<td>Orthographic projection</td>
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<td>Rendering</td>
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<tr>
<td></td>
<td>a. Line shading</td>
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<td>b. Stippling</td>
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<td></td>
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<tr>
<td></td>
<td>c. Smudge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural</td>
<td>Structural steel shapes</td>
<td>Simple stress and strain</td>
<td>Field trips</td>
</tr>
<tr>
<td></td>
<td>Symbols of structural steel shapes</td>
<td></td>
<td>Films: 68, 92</td>
</tr>
<tr>
<td></td>
<td>Rivets and bolts</td>
<td></td>
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<td></td>
<td>Welding symbols</td>
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<td></td>
<td>Reinforced concrete</td>
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<td></td>
<td>Brick structures</td>
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<td></td>
<td>Structural woods</td>
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<td></td>
</tr>
</tbody>
</table>
Units of Instruction | Fundamental Knowledge | Related Information | Instructional Materials
--- | --- | --- | ---
Welding | Basic symbols of gas and arc welds Supplementary symbols Weld dimensioning | Basic weld joints Basic gas and arc welds | Illustrations Models Chart: 131

Bibliography -- Mechanical Drawing

Books

*Suggested texts.


44. Roberts, William E. *Beginning Mechanical Drawing*. Peoria, Ill.: Chas. A. Bennett Co. 67 pp.


Periodicals


Films

66. "A" is for Architecture, 30 minutes, color, Audio-Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.


68. *The Arch Bridge*, 29½ minutes, United States Steel Film Distribution Center, Columbia Geneva Steel Division, 120 Montgomery Street, San Francisco, California.

69. Auxiliary Views, 11 minutes, silent (work sheets, ½¢ each), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.


74. Behind the Shop Drawing, 22 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

75. Body Bountiful, 25 minutes, General Motors Corporation, 508 United California Bank Building, 405 Montgomery St., San Francisco 4, California.

76. Building for the Nation, 28 minutes, United States Steel Film Distribution Center, Columbia Geneva Steel Division, 120 Montgomery Street, San Francisco, California.

77. Capital Letters, 21 minutes (work sheets, ½¢ each), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.


79. Development of Surfaces, 11 minutes, silent (work sheets ½¢ each), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.


81. Drafting Tips, 28 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

82. Draftsman, 11 minutes, Carl Mahnke Productions, Des Moines, Iowa.

83. Engineering, 11 minutes, Carl Mahnke Productions, Des Moines, Iowa.

84. Frank Lloyd Wright, 30 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

85. Freehand Drafting, 15 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

86. Ink Work and Tracing, 16 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

87. Intersection of Surfaces, 11 minutes, silent (work sheets), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.


89. Lettering, 18 minutes (work sheets), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

90. Lever-Age, 21 minutes, Shell Oil Company, 624 S. Michigan Ave., Chicago, Illinois.

91. Lower Case Letters, 18 minutes (work sheets), Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.
92. Mackinac Bridge Diary, 27 minutes, United States Film Distribution Center, Columbia Geneva Steel Division, 120 Montgomery Street, San Francisco, California.

93. Make a House Model, 11 minutes, color, Bailey Film, Inc., 65 DeLongpre Ave., Hollywood 28, California.


96. Perspective Drawing, 8 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.

97. Pictorial Drawing, 30 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.


99. Portrait of a City, Detroit, 26 minutes, color, Film Library, Ford Motor Company, 4303 Telegraph, Oakland 9, California.

100. Principal Dimensions, Reference Surfaces and Tolerances, 12 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.


107. Shop Drawings, 22 minutes, Audio Visual Aids Library, Pennsylvania State University, University Park, Pennsylvania.


111. Space, 10 minutes, color, Bailey Film Inc., 65 DeLongpre Ave., Hollywood 28, California.

112. Teaching Drafting with Transparencies, 9 minutes, Audio Visual Aids Library, Pennsylvania State University, University of Pennsylvania.

113. A Thing of Beauty, 16 minutes, General Motors Corporation, 508 United California Bank Building, 405 Montgomery Street, San Francisco 4, California.


115. Tomorrow Meets Today, 25 minutes color, Film Library, Ford Motor Company, 4303 Telegraph, Oaklond 9, California.


Other Resource Materials

Transparencies


124. RCA Overhead Transparencies for Mechanical Drafting, Parts I & II, RCA Educational Services, RCA Service Company, A Division of Radio Corporation of America, 204-2 Cherry Hill Offices, Camden 8, New Jersey.


Charts


130. Geometry of Engineering Drawing Chart, University of Kansas, Lawrence, Kansas.


135. Symbols, Eberhard-Faber, Wilkes-Barre, Pennsylvania.


Catalogs


139. Eugene Dietzgen Company of Colorado, 3875 Elm, Denver, Colorado.


141. A. Lietz Company, San Francisco, California.


144. Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

145. Universal Drafting Machine Corporation, Cleveland, Ohio.

146. V & E Manufacturing Company, Pasadena 20, California.
CHAPTER XIV

GENERAL METALS

More people are employed in the field of metalwork and more products are produced here than in any other industrial field. One out of every ten workers is employed in some area of metalwork. The skills vary greatly, from the unskilled helper to the master technician. The space age will become more dependent upon the metal-working industry to lead the way in the development of better methods and materials. Research in the development of alloys capable of withstanding tremendous heat is an example. More technicians and skilled workmen are needed. The industrial arts departments of the state can do their part to ignite the spark of interest within their students.

The scope of the general metals program will vary depending upon the size of the school, and the space and equipment available. An ideal program should include sheetmetal, foundry, forging, bench metal, art metal, machine shop, arc and gas welding. Sheetmetal, art metal, and bench metal are the areas that usually are taught in the junior high school. Every school should attempt to offer some of the areas if it is impossible to offer all of them. The areas within this guide are developed to include all of the basic processes, thereby allowing the school a choice of teaching part or all of the processes.

ART METAL

Art metal is concerned with the shaping and forming of non-ferrous metals. The purpose of teaching this area in the Colorado schools is to develop an appreciation of fine craftsmanship, an understanding of the properties of non-ferrous metals, and an avenue of self-expression.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Select and plan a project</td>
<td>Design (Consider function, form, durability, color, construction)</td>
<td>Non-ferrous metals, types and gauges</td>
<td>**Film: 107</td>
</tr>
<tr>
<td>*Make out a bill for material</td>
<td>Cost computation ☆ Safety</td>
<td></td>
<td>Film: 102</td>
</tr>
<tr>
<td>*Development and layout</td>
<td>Development of fundamentals</td>
<td>Development of techniques</td>
<td>Film: 89 Film: 84 Film: 93</td>
</tr>
<tr>
<td>*Cutting and filing</td>
<td>Use of shears, hacksaw, jewelers saw, and files</td>
<td>Types of shears, snips, saws, saw blades, and files</td>
<td>Pamphlet: 146</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
☆ Safety included in all operations—refer to Safety Unit, Chapter V
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Forming</td>
<td>Shallow forming, high raising, annealing, pickling, and use of forming tools</td>
<td>Types of forming tools</td>
<td>Equipment catalog: 142</td>
</tr>
<tr>
<td>*Assembling</td>
<td>Soft and hard soldering, riveting, and metal screws</td>
<td>Types of solder, flux, rivets, and screws</td>
<td>Pamphlet: 144</td>
</tr>
</tbody>
</table>
| *Drilling            | Hand and machine      | Types of drills and care | Film: 110  
Charts: 133, 134, 135 |
<p>| *Surface Decoration  | Planishing, peening, overlaying, piercing, coloring, etching, fluting, doming, scalloping, engraving, chasing, tooling, stippling, repousing, enameling, and electroplating | Etching materials, decorative, tools, types of color finishes, and principles of electroplating | Samples of decorative pieces |</p>
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
</table>
| *Finishing           | Polishing and protective coating | Types of polishing abrasives and compounds. Types of finishes | Film: 96  
Film: 83  
Chart: 82 |
| *Spinning            | Care and maintenance  
Set-up, centering, breakdown, shallow spinning, deep spinning, sectional chuck spinning, spinning on air, trimming, edging and finishing | Lubricants  
Shape allowances  
Speeds and tools  
Types of finishes  
Mass production methods  
Occupational information | Sample finishes  
Film: 104  
“Occupational Outlook Handbook” 149 |
| *Metal tooling       | Transfer pattern, inter-line, raise or emboss metal and finish | | |
Suggested projects — Art Metal:

<table>
<thead>
<tr>
<th>Ash tray</th>
<th>Belt buckle</th>
<th>Serving tray</th>
<th>Book ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Candy dish</td>
<td>Coaster</td>
<td>Tooled picture</td>
<td></td>
</tr>
<tr>
<td>Fruit bowl</td>
<td>Candle holders</td>
<td>Vase</td>
<td></td>
</tr>
</tbody>
</table>
General Metals / 153

BENCH METAL

Bench metal includes such basic operations as layout, cutting, forming, drilling, threading, riveting, and assembling. These operations are basic to advanced areas of metalwork. Mild steel is most commonly used, but copper, brass, aluminum or other materials may be used. Emphasis is placed on understanding industry by working with these various metals and studying their industrial uses. These metals are used in architecture and furnishings of modern construction and manufacturing.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
</table>
| *Select and plan a project | Design (Consider function, form, durability, color, construction) | Types of metals and their characteristics for shaping | Film: 98
Film: 106
Chart: 131 |
| *Make out a bill for material | Cost computation Safety | Manufacturing | |
| *Development and layout | Layout tools | History of measurement | Chart: 132 |
| *Cutting | Use of the hand and power hacksaw, cold chisel shears, files, bolt cutters, and thread cutting
Use of the grinder | Cutting lubricants
Selection and kinds of hacksaw blades
Types of chisels, files, grinders, and grinding wheels
Uniform thread standards | Pamphlet: 146
Pamphlet: 147
Film: 88
Chart: 136 |
| *Forming metal | Use of vises, forming machines, hand bending, hot and cold forming, twisting, and the use of hammers | Bend allowances
Types of bending machines
Bending jigs
Methods of heating
Types of hammers | Book: 44a |

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
 sabot included in all operations—refer to Safety Unit, Chapter V
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Drilling</td>
<td>Methods of drilling</td>
<td>Size and kinds of drills</td>
<td>Charts: 133, 134, 135</td>
</tr>
<tr>
<td></td>
<td>Use of machines</td>
<td>Cutting speeds</td>
<td>Film: 110</td>
</tr>
<tr>
<td></td>
<td>Countersinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Center punching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Assembling</td>
<td>Use of rivets, bolts,</td>
<td>Kind and size of rivets,</td>
<td>Film: 82</td>
</tr>
<tr>
<td></td>
<td>screws, welding, brazing,</td>
<td>bolts, and screws</td>
<td></td>
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<tr>
<td></td>
<td>resistance welding, and</td>
<td>Welding processes</td>
<td>“Occupational Outlook</td>
</tr>
<tr>
<td></td>
<td>holding jigs</td>
<td></td>
<td>Handbook” 148</td>
</tr>
<tr>
<td>*Finishing</td>
<td>Use of abrasives, surface</td>
<td>Kind and types of abrasives, paints and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>decoration, spot finishes,</td>
<td>chemicals</td>
<td>Film: 97</td>
</tr>
<tr>
<td></td>
<td>heat coloring, chemical</td>
<td></td>
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<tr>
<td></td>
<td>coloring, plating, paints</td>
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<tr>
<td></td>
<td>and fillers, peening and</td>
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<td></td>
<td>polishing</td>
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</tbody>
</table>

Suggested projects — Bench Metal:

- Book ends
- Address holder
- Wall lamp
- Plant hanger
- Serving tray
- Book rack
- Shelf bracket
- Tie rack
- Candelabra

- Fireplace tools
- Magazine rack
- Coffee table
- End tables
- Record rack
- Lamp post
- Desk
- Table and chairs
The purpose of teaching a unit in forging is to acquaint the students with the processes involved in forming and shaping of hot metals, cold metals, heat treatment of steel and forging in modern industry.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Select and plan a project</td>
<td>Design (Consider function)</td>
<td>Metals used in forging and their manufacture</td>
<td>Finished project Sequential operations plan **Film: 106</td>
</tr>
<tr>
<td>*Make out a bill for material</td>
<td>Cost computation ♦ Safety</td>
<td></td>
<td>Film: 92</td>
</tr>
<tr>
<td>*Operate a gas or coal forge</td>
<td>Temperature control</td>
<td>Types of forges and fuels</td>
<td>Film: 79</td>
</tr>
<tr>
<td>*Drawing out metal</td>
<td>Proper heat Proper use of hammers, anvils, tongs, swages</td>
<td>Types and sizes of hammers, tongs, swages, anvils</td>
<td>Finished projects Sequential operations plan</td>
</tr>
<tr>
<td>*Shaping and forming</td>
<td>Bending, twisting, upsetting</td>
<td>Principles of forge welding</td>
<td>Finished projects Sequential operations plan</td>
</tr>
<tr>
<td>*Cutting and punching</td>
<td>Harden, hot punch, cold punch, hot chisel, cold chisel</td>
<td>Cutting and punching tools</td>
<td>Sequential operations plan</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
♦ Safety included in all operations—refer to Safety Unit, Chapter V
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Heat treating</td>
<td>Annealing, hardening, surface hardening, tempering</td>
<td>Heat range determined by color, hardening compounds, annealing and tempering techniques, hardness testing</td>
<td>Sequential operations plan, Film: 90, Film: 91, Pamphlet: 152, Pamphlet: 151</td>
</tr>
</tbody>
</table>

Projects — Forging:

*Projects from high carbon steel*
- Cold chisel
- Pin punch
- Center punch
- Screwdrivers
- Drift punch
- Wrecking bar

*Projects from medium carbon steel*
- Screwdrivers
- Hammers
- Sledges
- Wrecking bar
- Toasting forks
- Foot scraper

*Projects from low carbon steel*
- Forgings
- Tent stakes
FOUNDRY

Foundry work is concerned with the melting and pouring of metals into molds to form castings. Pattern making should be taught in conjunction with foundry in the schools offering this area of learning. The purpose of teaching a unit in foundry in our modern schools is to acquaint the students with the practice of casting and also to give the student an understanding and appreciation of machining parts and other casting. As a part of the general metals course, aluminum casting seems to be the most practical method of teaching foundry.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Select and plan a project</td>
<td>Design (Consider form, function, durability, finish, and suitability of casting)</td>
<td>Types of metals and alloys</td>
<td>**Finished projects Pamphlet: 138</td>
</tr>
<tr>
<td>*Make out a bill for material</td>
<td>Cost computation &amp; Safety</td>
<td>Sample plan</td>
<td></td>
</tr>
<tr>
<td>*Patternmaking</td>
<td>Design, draft, materials, and shrinkage</td>
<td>Care of equipment Kinds of patterns</td>
<td>Chart Pattern development</td>
</tr>
<tr>
<td>*Cut and temper sand</td>
<td>Test sand</td>
<td>Kinds of sand for molding and cores Binders</td>
<td>Film: 95</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop. **Check reference numbers at end of unit. ‘Safety included in all operations—refer to Safety Unit, Chapter V
**Units of Instruction** | **Fundamental Knowledge** | **Related Information** | **Instructional Materials**
---|---|---|---
*Preparing the mold* | Pattern placement, ramming a drag, vent, parting compound, use of turning board, ramming the cope, locating sprue and riser holes, cutting gates, removing pattern, patch mold, and using molding tools | Types of flasks, parting compounds, and tools | Film: 99

*Core making* | Baked cores CO\text{2}\text{O} cores |  | Film: 75

*Pouring the mold* | Use and kinds of protective clothing and equipment Pouring temperatures Fluxing and skimming metal Floor preparation Pouring and cooling the metal | Types of furnaces and fluxes |  

*Removing, cleaning and finishing* | Shake out, cut gates, clean casting, file, sand, polish, paint, and special finishes and reflecting beads | Types of files Finishes Polishing Compounds and abrasives Mass production methods Occupational information | Chart: 129 Sample finishes Film: 85 Chart: 120 "Occupational Outlook Handbook" 148

**Suggested projects — Foundry:**

The beginning students should select a project such as a paper weight, book ends, plaque, or other one-piece casting. Cored or sectioned castings may be purchased from local stores but it is best to encourage the students to develop their own patterns.

More advanced foundry programs can be developed around a more complex project that includes other areas such as machine shop.
MACHINE SHOP

In machine work the basic power tools used in industry should be taught. The purpose is to acquaint students with these basic machines, to help students discover aptitudes and interests in this area, and to develop an understanding and appreciation of modern industry.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Select and plan a project</td>
<td>Design and blueprint reading</td>
<td>Metals and their alloys Ferrous and non-ferrous metals</td>
<td>**Pamphlet: 149 Film: 98</td>
</tr>
<tr>
<td>*Make out a bill for material</td>
<td>Cost computation Safety</td>
<td>Suitable materials</td>
<td>Film: 106 Flow chart: 149 Sample projects</td>
</tr>
<tr>
<td>*Development and layout</td>
<td>Uses of layout, tools, and materials</td>
<td>Types of measuring tools</td>
<td>Film: 105</td>
</tr>
<tr>
<td>*Use of the engine lathe</td>
<td>Care and maintenance Uses of chucks, drills, mounting work between centers, calipers, facing, tapering, knurling, boring, threading, filing, polishing, steady rest, follower rest, center rest, cutting tools, and coolants Grinding cutter bits (Selection of units influenced by grade, level, time, and equipment)</td>
<td>Principle parts of the lathe Speeds and feeds Special attachments such as milling and grinding attachments Types and sizes of cutter bits Types of coolants</td>
<td>Film: 103 Film: 87 Sequence of processes chart</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
☆Safety included in all operations—refer to Safety Unit, Chapter V
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Use of drilling machines</td>
<td>Care and maintenance</td>
<td>Types of drilling machines, taps, reamers, and boring tools</td>
<td>Charts: 133, 134, 135</td>
</tr>
<tr>
<td></td>
<td>Uses of drill presses and portable drills</td>
<td>Drilling speeds and feeds</td>
<td>Film: 110</td>
</tr>
<tr>
<td></td>
<td>Adjusting speeds and feeds</td>
<td>Clamping fixtures and tools</td>
<td>Chart: 136</td>
</tr>
<tr>
<td></td>
<td>Use of coolants</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boring, reaming and tapping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Use of the shaper</td>
<td>Care and maintenance</td>
<td>Types of shapers</td>
<td>Film: 78</td>
</tr>
<tr>
<td></td>
<td>Setting up work, clamping, adjusting stroke, feed, speeds, and bit grinding</td>
<td>Types and sizes of cutter bits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cutting keyways, vertical cuts, angular cuts, irregular cuts</td>
<td>Coolants</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tees, vees, and dovetails</td>
<td>Special set-ups</td>
<td></td>
</tr>
<tr>
<td>*Use of the milling machine</td>
<td>Care and maintenance</td>
<td>Types of milling machines, cutter gears, coolants</td>
<td>Film: 77</td>
</tr>
<tr>
<td></td>
<td>Set-up and use of the milling machine and attachments such as the index head and vertical mill attachment</td>
<td>Special set-ups such as indexing, clamping, fixtures and tools</td>
<td>Film: 76</td>
</tr>
<tr>
<td></td>
<td>Methods of fastening work for milling</td>
<td>Feeds and speeds</td>
<td>Pamphlet: 143</td>
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<tr>
<td></td>
<td>Adjusting feeds and speeds</td>
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<tr>
<td></td>
<td>Cutting keyways, grooves, flutes, slots, gears, angular surfaces, gang milling, and end milling</td>
<td></td>
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<tr>
<td>°Use of grinders</td>
<td>Care and maintenance</td>
<td>Types of grinding abrasives, grades, bonds, and speeds</td>
<td>Film: 86</td>
</tr>
<tr>
<td></td>
<td>Use of tool grinders, surface grinders, cutter grinders, and portable grinders</td>
<td>Types of grinding machines</td>
<td>Chart: 137</td>
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<tr>
<td></td>
<td>Adjusting feeds and speeds</td>
<td>Feeds and speeds</td>
<td>Film: 88</td>
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<td>Special set-ups</td>
<td>Film: 108</td>
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<td>Coolants</td>
<td>Chart: 121</td>
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<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
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<tr>
<td>*Use of power saws</td>
<td>Care and maintenance</td>
<td>Types of hacksaws,</td>
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<td>Use of hacksaws, bandsaws, and cutoff wheels</td>
<td>bandsaws</td>
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<td>Straight, angular, and contour sawing</td>
<td>Abrasive and friction saws</td>
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<td>Filing and polishing</td>
<td>Feeds and speeds</td>
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<td>Clamping devices</td>
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<tr>
<td>*Heat treating</td>
<td>Use of furnaces for heat treatment</td>
<td>Classification of steel</td>
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<td>Annealing, hardening, and tempering</td>
<td>Types of heat treating furnaces</td>
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<td>Temperatures and color</td>
<td>Quenching processes</td>
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<td>Critical temperatures</td>
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<td>Flame hardness testing</td>
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<td>Occupational information</td>
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<td>Mass production methods</td>
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</tbody>
</table>

*Suggested projects — Machine Shop:

- Punch
- Screwdriver
- "C" clamp
- Handy vise
- Cutting threads
- Cutting gears
- Drill press

- Drill press vise
- Anvil
- Surface gauge
- Tap wrench
- Weights
- Grinder
- Stand for portable drill

*Film: 90  
Film: 91  
Pamphlet: 152  
Pamphlet: 151  
Film: 94  
"Occupation Outlook Handbook" 148
Sheet metal has many applications ranging from heating, ventilation, and automobiles to small items found in the home. The unit in sheet metal should give the students an insight into the many phases of the industry. Sheet metal instruction can be a valuable part of any industrial arts program by developing basic skills such as reading a drawing, accuracy in planning, layout, cutting, shaping, and assembling.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Select and plan a project</td>
<td>Design (Consider form, function, durability, finish, and suitability)</td>
<td>Ferrous and non-ferrous metals Types and gauges</td>
<td>**Pamphlet: 150 Pamphlet: 149 Film: 106 Film: 98</td>
</tr>
<tr>
<td>*Make out a bill for materials</td>
<td>Cost computation ★ Safety</td>
<td></td>
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<tr>
<td>*Development and layout</td>
<td>Parallel line development Radial line development Triangulation</td>
<td>Techniques of development</td>
<td>Charts and samples (Instructor-made)</td>
</tr>
<tr>
<td>*Cutting sheet metal</td>
<td>Shearing Use of hand snips Use of cold chisels Filing</td>
<td>Types of shears Types of snips Types of chisels Types of files</td>
<td>Film: 74 Chart: 122 Pamphlet: 146 Pamphlet: 141</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
★ Safety included in all operations—refer to Safety Unit, Chapter V
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
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<tbody>
<tr>
<td>*Bending sheet metal</td>
<td>Use of brakes and folder &lt;br&gt;Hand bending</td>
<td>Types of bending equipment &lt;br&gt;Bend allowances</td>
<td>Equipment catalogs&lt;br&gt;Machinery's Handbook, 44a</td>
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<tr>
<td>*Forming sheet metal</td>
<td>Roll forming &lt;br&gt;Hand forming</td>
<td>Types of turning equipment</td>
<td>Equipment catalogs</td>
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<tr>
<td>*Drilling sheet metal</td>
<td>Hand and machine</td>
<td>Twist drills</td>
<td>Charts: 133, 134, 135 &lt;br&gt;Pamphlet: 140</td>
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<tr>
<td>*Punching sheet metal</td>
<td>Hand and machine</td>
<td>Types of punching equipment</td>
<td>Equipment and tool catalogs</td>
</tr>
<tr>
<td>*Fastening</td>
<td>Seams and joints</td>
<td>Kinds and sizes of fasteners &lt;br&gt;Types of solders and fluxes &lt;br&gt;Welding processes</td>
<td></td>
</tr>
<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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</tr>
<tr>
<td>*Finishing edges</td>
<td>Hemming and wiring</td>
<td>Bend allowances</td>
<td>Machinery's Handbook 44a</td>
</tr>
</tbody>
</table>

Suggested projects — Sheet Metal:

Cookie cutter  Planter
Scoop          Bed lamp
Letterholder   Patio lamp
Napkin holder  Wastebasket
Ash tray       House number
Serving        Picture frame
Tool tray      Wall shelf
Baking pan     Tool box
Measure can    Mailbox
Funnel         Magazine rack
WELDING

Welding is concerned with the melting and fastening together of metals by the use of heat. The purpose of teaching gas and electric welding is to expose the students to related information and practices in the art of welding. Whether it is used in a large industrial plant, a small job shop, or for personal use, welding is a valuable and an indispensible part of any general metals program.

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<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Assembling the equipment</td>
<td>☆ Safety Care and maintenance of equipment</td>
<td>Equipment nomenclature Protective equipment</td>
<td>**Charts on equipment</td>
</tr>
<tr>
<td>*Adjusting the equipment</td>
<td>Regulator settings Lighting, adjusting and turning off the torch Tip cleaning</td>
<td>Tank sizes and pressures Cylinder content and construction Acetylene generator</td>
<td>Catalogs on equipment Film: 113 Chart: 130</td>
</tr>
<tr>
<td>*Flat welding</td>
<td>Joint preparation, rodless, rod, fillet, butt, lap and jigs</td>
<td>Types and sizes of rod, ferrous and non-ferrous, and fluxes</td>
<td>Film: 81 Sample Welds</td>
</tr>
<tr>
<td>Position welding</td>
<td>Horizontal, vertical and overhead welding</td>
<td>Temperature control</td>
<td>Film strip &quot;Fundamental Equipment&quot; 114 &quot;Learn to Run a Bead&quot; 118 &quot;How to Make Welds&quot; 117 &quot;Welding Cast Iron&quot; 119 &quot;Hardsurfacing&quot; 115 &quot;Heating and Cutting&quot; 116</td>
</tr>
<tr>
<td>*Brazing and hard soldering</td>
<td>Low-temperature rods</td>
<td>Metal characteristics Fluxes and temperatures</td>
<td>Film: 100</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
☆ Safety included in all operations—refer to Safety Unit, Chapter V.
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
</table>
| Special welding processes | Cast iron, aluminum, pot metal, copper, and brass | Fluxes and special methods | Film: 109  
Film: 111 |
| *Cutting processes | Equipment, assembly, adjustment | Iron powder cutting  
Underwater cutting | |
| Controlling and correcting distortion | Clamping, peening, heating, presetting, and tack welding | Occupational information  
History of gas welding | “Occupational Outlook Handbook” 148  
Pamphlet: 139 |
| **ARC WELDING** | | | |
| Machine set-up | Amperage and voltage setting  
Polarity | Types of machines  
Protective equipment | Equipment Catalogs 145, 147 |
### Units of Instruction | Fundamental Knowledge | Related Information | Instructional Materials
---|---|---|---
*Striking the arc* | Arc length and electrode angle | Types, sizes, and coating of electrodes A.W.S. and A.S.T.M. standards | Charts: 126, 127, 128 Film: 101 Film: 112

*Flat welding* | Butt, lap and fillet Electrode position and manipulation | Electrode choice | Sample welds

Position welding | Horizontal, vertical and overhead welding Electrode position and manipulation | | Sample welds

Special welding | Carbon arc, inert gas, non-ferrous, cast iron, hard-surfacing and cutting Spot welding | Types of electrodes Occupational information | Charts: 126, 127, 128 Sample welds "Occupational Outlook Handbook" 148 Pamphlet: 139

Welding can be taught best by the use of various exercises. Examples of these are: running beads, flat, vertical, horizontal, and overhead.

Suggested projects — Welding
Vise  
Jack stands
Basketball goal  
Furniture
Bibliography -- General Metalwork

Books


Periodical


Films and Filmstrips

Film ordering key information:

ARSC — Air Reduction Sales Co., 205 West Monroe St., Chicago 6, Ill.


ADMC — Archer Daniels Midland Co., Foundry Products Div., 2191 West 110th Street, Cleveland 2, Ohio.

CTDC — Cleveland TwisL Drill Co., 650 Howard Street, San Francisco 5, Calif.

CFI — Colorado Fuel and Iron Corporation, P. O. Box 1920, Denver 1, Colorado.

CSC — Colorado State College, Instructional Materials Center (Attention: Booking Clerk), Greeley, Colo.

CSU — Colorado State University, Audiovisual Center (Attention: Booking Clerk), Fort Collins, Colo.

CU — Colorado University, Bureau of Audiovisual Instruction (Attention: Booking Clerk), Boulder, Colo.

C — Cromars, 922 Bannock Street, Denver 4, Colo.

DAC — Do-All Company, 254 North Laurel Avenue, Des Plaines, Ill.


GMC — General Motors Corporation, 405 Montgomery Street, San Francisco 4, California.

HH — Handy and Harman, 850 Third Avenue, New York 22, New York.

IU — Indiana University, Material Instruction Center (Attention: Booking Clerk), Bloomington, Ill.

LEC — Lincoln Electric Co., Box 3115, Cleveland 17, Ohio.


SBLC — South Bend Lathe Co., Publicity Dept., South Bend, Indiana.

USSC — United States Steel Corp., Public Relations Office, 323 Kearns Building, Salt Lake City 1, Utah.

Films:

74. *ABC's of Hand Tools*, GMC.
75. *The ADM of Cores*, ADMC.
76. *The Art of Generating and Gear Manufacturing Equipment*, FGSC.
77. *Basic Machines — Milling Machine*, CSC.
78. *Basic Machines — Shaper*, CSC.
79. *Bituminous Coal*, CU.
80. *Braze Welding*, CSU.
81. *Burning Blades*, ARSC.
82. *Coated Abrasives Speed Metalwork Production*, NC.
83. *Color and Texture in Alcoa Aluminum Finish*, ACA.
84. *Contemporary Silversmith*, HH.
85. *Die Casting*, C.
86. *The First Principles of Grinding*, CU.
87. *Grinding Cutter Bits*, SBLC.
88. *Grinding Wheel Safety*, NC.
89. *Handwrought Silver*, HH.
90. *Heat Treatment — Elements of Hardening*, CSC.
91. *Heat Treatment — Elements of Surface Harden- ing*, CSC.
92. *Indian Paint Rails*, CFI.
93. *Living Silver*, HH.
94. *Machinist and Tool Maker*, CU.
95. *Making a Simple Core*, IU.
96. *Manufactured Coated Abrasives*, NC.
97. *The Metalworker*, C.
98. *Modern Steelmaking*, USSC.
99. *Molding With a Loose Pattern*, IU.
100. *New Welding Procedures*, EWAC.
101. *Prevention and Control of Distortion in Arc Welding*, LEC.
102. *Product of the Imagination*, ACA.
103. *Rough Turning Between Centers*, SBLC.
104. *Spinning*, ACA.
105. *Steel Rule*, CU.
106. *Steel's Party Line*, CFI.
107. *Story of Copper*, CU.
108. *Techniques of Surface Grinding*, DAC.
110. *Uses and Abuses of Twist Drills*, CTDC.
111. *Welding Advances in Aluminum*, ACA.
Other Resource Materials

Charts:
121. Coated Abrasives, Norton Company, Publicity Department, Worcester 6, Mass.
123. Color Chart and Metal Finishes, Pittsburgh Plate Glass Co., Cleveland, Ohio.
124. Color Chart and Metal Finishes, Sherwin Williams Paint Co., Cleveland, Ohio.
125. Decimal Equivalent, Brown and Sharpe, Providence, Rhode Island.
128. Electrodes, Lincoln Electric Co., Box 3115, Cleveland 17, Ohio.
129. A File for Every Purpose, Nicholson File Co., P. O. Box 6488, Providence, Rhode Island, 02904.
130. Flame Adjustment, Air Reduction Sales Co., 205 West Monroe St., Chicago 6, Ill.
131. How Steel is Made, United States Steel Corp., Public Relations Office, 323 Kearns Bldg., Salt Lake City 1, Utah.
133. Number, Letter, and Fraction, Brown and Sharpe, Providence, R. I.

Pamphlets:
137. Tool Grinding Chart, Armstrong Brothers Tool Co., 5236 West Armstrong Ave., Chicago 46, Ill.

140. Cleveland Twist Drill Co. Care of Twist Drills. San Francisco: Cleveland Twist Drill Co., 650 Howard Street.
POWER MECHANICS
The objectives of general education and industrial arts, state that the student should be given every opportunity to acquire a basic understanding of the broad fields of learning so that he may eventually find his field of interest, aptitude, and ability. Once these have been found, directed guidance helps to place him in advanced courses of study which help to prepare him for his life's work and acceptance in our modern society.

Industrial arts, to more fully realize these objectives, must offer a greater variety of courses than has been the accepted trend. Nearly every junior and senior high school offers courses in woodworking which are acceptable for teaching skills, consumer knowledge and a vocational interest. When one studies the opportunities for life's work, we will have to admit that woodworking alone does not meet the objectives of general and industrial arts education.

There is an increasing need for power mechanics to be taught in the junior high school general shop, as well as in senior high. The unit is designed to acquaint the student with the basic concept of power progressing into the fundamentals of typical power units accessible to them. The shop work that is possible in this unit can enrich the learning units with both experimental and vocational type experiences.

Power mechanics, as a general field, has been more instrumental in the development of today's industrial might than has any other single industry. The small power unit and the automobile are special interest areas in the field of power mechanics, but of equal interest is the history of power along with research on modern power sources. To give a realistic view of the power mechanics field, all sources of power should be considered from conception to utilization.

Power mechanics is adaptable to almost any phase of the industrial arts program. Its teaching should follow logically units in drawing, metals and woodworking because these areas help to establish fundamental operations beneficial to the completion of suggested units of learning. Power mechanics lends itself well to integration with other courses in the school. General science, history, and mathematics are directly related, while a vocational interest, consumer knowledge and pre-vocational skills are other aspects of the course.
**POWER MECHANICS**

Safety must be stressed within all of the following learning units in power mechanics.

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<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
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<td>General safety</td>
<td>General shop safety</td>
<td>Safety equipment</td>
<td>Books: 66, 44</td>
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<td></td>
<td>Attitude, work habits,</td>
<td>Color code</td>
<td>Other Resources: 156</td>
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<td></td>
<td>dress and behavior</td>
<td>Accident reports</td>
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<td></td>
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<td>History and develop-</td>
<td>Human power</td>
<td>Human power and the</td>
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<td>Wind power</td>
<td>Animals as sources</td>
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<td>oxen, camels, dogs,</td>
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<td>Applied physics of</td>
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<td>Formulas and problems</td>
<td>Books: 66, 54, 81</td>
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<td>Simple machines</td>
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<td>Books: 48, 67, 46</td>
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<td>Electricity flow</td>
<td>Kinds of conductors</td>
<td>Films: 93, 97, 99, 100,</td>
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<td>106, 119, 112</td>
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<td><strong>Engine types</strong></td>
<td>Steam engine</td>
<td>Operating principles</td>
<td>Books: 5, 73, 82, 90, 91, 76, 72, 44, 76</td>
</tr>
<tr>
<td></td>
<td>Steam turbine</td>
<td>Applications of engine types; l-head, f-head, and l-head types</td>
<td>Films: 101, 102, 120, 124, 125, 126, 127, 131, 137, 140</td>
</tr>
<tr>
<td></td>
<td>Two stroke cycle</td>
<td>Variations of basic engine types</td>
<td>Other Resources: 156</td>
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<td>Gas turbine</td>
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<td></td>
<td>Diesel</td>
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<td>Jet and rocket</td>
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<td></td>
<td>Experimental engines</td>
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<tr>
<td></td>
<td>(rotary, free piston, omega, cam engine, etc.)</td>
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<table>
<thead>
<tr>
<th><strong>Power transmission and application</strong></th>
<th>Mechanical</th>
<th>Gears, clutches, belts, pulley, etc.</th>
<th>Books: 44, 46, 62, 63, 81</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Hydraulic</td>
<td>Hydrostatic drives</td>
<td>Film: 102</td>
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<tr>
<td></td>
<td>Pneumatic</td>
<td>Hydraulic fluids, cylinders, and pumps</td>
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<td>Electrical</td>
<td>Compressors and pneumatic equipment</td>
<td>Other Resources: 156, 149</td>
</tr>
<tr>
<td></td>
<td>Basic formulas in power transmission</td>
<td>Electrical power transmission</td>
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<td>Propulsion</td>
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<td>Units of Instruction</td>
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<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>Engine construction</td>
<td>Major parts and assemblies</td>
<td>Metals and problems encountered in designs</td>
<td>Books: 73, 66, 91, 69</td>
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<tr>
<td></td>
<td>Relationship between parts and tolerances</td>
<td></td>
<td>Films: 98, 101, 135, 137</td>
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<tr>
<td></td>
<td>Standards for bolts, nuts, and screws</td>
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<td>Other Resources: 156</td>
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<tr>
<td>Ignition systems</td>
<td>Magnetos</td>
<td>Manufacturing and industrial production</td>
<td>Charts</td>
</tr>
<tr>
<td></td>
<td>Battery ignition (coil, distributor, breaker points, condensor)</td>
<td>Personnel employed</td>
<td>Books: 5, 48, 82, 35, 36</td>
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<tr>
<td></td>
<td>Spark plugs and igniters</td>
<td>Electricity in ignition</td>
<td>45, 91, 32, 34, 40, 81</td>
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<td></td>
<td>Electronic ignition</td>
<td>Generators, alternaters, and batteries</td>
<td>116, 121, 126, 140, 141,</td>
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<tr>
<td></td>
<td>Principle of compression ignition</td>
<td>Kinds of spark plugs</td>
<td>94</td>
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<td></td>
<td>Other Resources: 156</td>
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<tr>
<td>Fuel systems and carburetion</td>
<td>Fuel storage, fuel pumps, and injection systems</td>
<td>Petroleum refining</td>
<td>Books: 4, 11, 13, 3, 60,</td>
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<td></td>
<td>Carburetors and carburetion</td>
<td>Types of fuel</td>
<td>24, 47</td>
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<td></td>
<td>Gravity flow systems</td>
<td>Chemistry of fuels and combustion</td>
<td>92, 95, 96, 103, 104, 107,</td>
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<td></td>
<td>Suction feed systems</td>
<td></td>
<td>129, 133, 134, 138</td>
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<tr>
<td></td>
<td>Fuel mixture and combustion</td>
<td></td>
<td>Other Resources: 156, 157</td>
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<th>Units of Instruction</th>
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</table>
| Cooling systems                   | Water cooling                                                                           | Antifreeze                                                                                               | Books: 2, 54  
|                                  | Air cooling                                                                            | Water pumps                                                                                              | Films: 105, 115, 142, 143                                                           | Other Resources: 149, 156 |
|                                  | Heat and heat transfer                                                                  | Radiators, thermostats, and cooling fins                                                                                                                   |                                                                                        |
|                                  | Cooling system design                                                                  |                                                                                                                                                                                                                     |                                                                                        |
| Lubrication and bearings         | Oils, greases, and other lubricants                                                     | Types of lubricants                                                                                     | Books: 4, 21, 25, 26, 27, 28, 54  
|                                  | Bearing types (ball, insert, roller, needle)                                            | Oil filters and types of oil pumps                                                                      | Films: 98, 96, 107, 129, 130, 132                                                  |
|                                  | Bushings, piston rings, and lubrication systems (pump, pressure and splash)             | S A E grades                                                                                                |                                                                                        |
|                                  |                                                                                                                                                        | Additives                                                                                               |                                                                                        |
|                                  |                                                                                                                                                        | Oil viscosity, ML, MM, MS                                                                               |                                                                                        |
|                                  |                                                                                                                                                        | Application of bearing types                                                                           |                                                                                        |
|                                  |                                                                                                                                                        | Friction                                                                                                |                                                                                        |
| Preventive care and maintenance of small gas engines | Care of fuel filter and air filter                                                      | Action of hydrocarbons in fuel and effect when exposed to oxygen                                         | Books: 54, 35  
|                                  | Engine lubrication                                                                      | Consumer knowledge                                                                                     | Film: 117                                                                             | Other Resources: 149, 156 |
|                                  | Preparing for storage                                                                  |                                                                                                                                                                                                                     |                                                                                        |
|                                  | Preparing for use after storage                                                        |                                                                                                                                                                                                                     |                                                                                        |
|                                  | Check wiring                                                                            |                                                                                                                                                                                                                     |                                                                                        |
| Servicing and trouble shooting the small gas engine | Servicing magneto                                                                      | Types of tune-up equipment                                                                               | Books: 54, 81, 58, 80  
<p>|                                  | Spark plugs                                                                            | Methods of gauging and measuring                                                                       | Films: 99, 106, 111, 117, 94                                                       | Other Resources: 149, 156 |
|                                  | Carburetor and governor                                                                    | Interpret readings                                                                                      |                                                                                        |
|                                  | Adjust ignition timing                                                                     |                                                                                                                                                                                                                     |                                                                                        |
|                                  | Engine tune-up                                                                          |                                                                                                                                                                                                                     |                                                                                        |
|                                  | Compression check                                                                      |                                                                                                                                                                                                                     |                                                                                        |
|                                  | Valve adjustment                                                                        |                                                                                                                                                                                                                     |                                                                                        |
|                                  | Atomic reactors                                                                        | Radiation and Isotopes                                                                                   |                                                                                        |
|                                  | Atomic fission                                                                         | Albert Einstein and fission                                                                              |                                                                                        |
|                                  | Heat exchangers                                                                        | Chain reaction                                                                                          |                                                                                        |
|                                  | Proposed uses of atomic power                                                         | Uranium-graphite pile                                                                                   |                                                                                        |
|                                  |                                                                                                                                                        | Mining and processing of uranium                                                                      |                                                                                        |</p>
<table>
<thead>
<tr>
<th>Units of Instruction</th>
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<th>Instructional Materials</th>
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<tbody>
<tr>
<td>Solar energy</td>
<td>Most types of energy trace back to solar energy Solar cells Applications of solar cells Solar battery Semiconductors Thermopile Photogalvanic cell</td>
<td>Organic fuels from solar energy Photosynthesis Solar energy and the weather Direct use of solar energy</td>
<td>Books: 48, 82, 67</td>
</tr>
<tr>
<td>Experimental modern power</td>
<td>Fuel cell Thermionic Magnelohydrodynamic (MHD) Thermoelectric Thermophotovoltaic (TPV) Piezoelectric effect</td>
<td>Chemical energy to electrical energy directly Heat energy to electrical energy directly</td>
<td>Books: 82, 67, 55</td>
</tr>
</tbody>
</table>
AUTO MECHANICS

A course in auto mechanics must satisfy the objectives of general education which stress exploratory experiences in breadth and, at the same time, provide basic experiences for pupils who feel the need to continue their concentration in mechanics with pre-vocational objectives in mind. The first part of this course has been prefixed with an asterisk (*), which indicates it to be basic and exploratory in nature. This portion of the course should be made available to all students, boys or girls, who wish to acquire a general knowledge of the subject field.

The second part of the course, those operations not prefixed with an asterisk (*), is designed to accommodate the student who feels the need for pre-vocational experiences. The operations and skills are specific and limited to a typical vocation rather than broad and general. The student who enrolls in this course should be desirous of pre-vocational skills and will therefore be selective in that it is designed for non-college bound.

Certain concepts of power mechanics should be acquired by the student before he enrolls in auto mechanics. If power mechanics is taught in a school, then it may be desirable to omit the basic operations listed under auto mechanics that are prefixed by an asterisk. If a course in power mechanics is not available, then it is recommended that all portions of auto mechanics be taught for a concentration in the mechanics field.

Both the basic (*) and specific portions of auto mechanics are designed to require one full year of instruction and laboratory experience. Time allowed should not be less than five periods per week in either daily or block programming.

Suitable texts are listed in the bibliography; one should be selected as a course book and augmented with suitable mock-ups, manuals, commercial publications, and films. A considerable number of field trips should be arranged for the students to aid them in acquiring knowledge about machine and tool operations where schools have a limited supply of special tools.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Basic and special hand tools</td>
<td>General and specific uses of tools</td>
<td>Meanings of torque tolerance and stresses</td>
<td>**Books: 68, 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vocabulary and safety</td>
<td>Film: 136</td>
</tr>
<tr>
<td>*Electricity and magnetism</td>
<td>Electron theory, magnetism and its applications in starting, generating and ignition systems</td>
<td>Consumer knowledge, Ohm's law, Henry and Faraday's magnetic induction Insulators, conductors, resistors, safety, chemistry and vocabulary</td>
<td>Books: 2, 14, 18, 20, 23, 33, 34, 36, 37, 38, 39, 40, 41, 45, 66, 52 Films: 99, 101, 106, 119, 141, 93 Other Resources: 155, 156</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop. **Check reference numbers at end of unit.
<table>
<thead>
<tr>
<th>Units of Instruction</th>
<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Small unit, service—fuel</td>
<td>Fuel flow, pumps, filters, lines, tanks, and carburetors Disassembly and check, assemble and test</td>
<td>Related industry, small power units and consumer knowledge Fuel industry, basic science and safety</td>
<td>Books: 3, 11, 12, 13, 24, 47, 66, 70, 72, 90 Other Resources: 149, 152, 161, 148</td>
</tr>
<tr>
<td>*Steering systems service</td>
<td>Check and adjust steering gear, linkage, bearings, wheels, and tires</td>
<td>Related industry, small power units and consumer knowledge Power assists, vocabulary and science</td>
<td>Books: 8, 9, 20, 21, 31, 25, 30, 66, 80, 83, 26 Film: 122 Other Resources: 149, 157</td>
</tr>
<tr>
<td>*Brake systems service</td>
<td>Master cylinders, wheel cylinders, lines, and hoses Service and repair, flush to clean, install new fluid, replace and adjust linings Pascal's law for hydraulics</td>
<td>Basic science, co-efficient of friction Interpret readings, consumer knowledge, safety and vacuum power assists</td>
<td>Books: 20, 55, 56, 31, 66, 73, 77, 80, 87, 74 Other Resources: 149, 157</td>
</tr>
<tr>
<td>*Standard transmissions and drive line service</td>
<td>Disassemble and check, service, reassemble and check Service standard disk clutches</td>
<td>Basic science and related industries pertaining to small power units Interpret readings</td>
<td>Books: 20, 61, 65, 66, 80, 83, 62 Other Resources: 149, 157</td>
</tr>
<tr>
<td>*Differential service</td>
<td>Disassemble and check, service, reassemble and check Final drives for small power units</td>
<td>Basic science of gear ratios Small power units and related industries</td>
<td>Books: 20, 42, 65, 83 Other Resources: 149, 157</td>
</tr>
<tr>
<td>*Engine types</td>
<td>Two-stroke and four-stroke cycle internal combustion small gas engines and auto Construction, lubrication, valve types, etc.</td>
<td>Related industries, outboard and other small units Engine types and uses of metals; meaning of horse power and torque</td>
<td>Books: 5, 12, 19, 57, 60, 67, 70, 72, 78, 81, 84, 90 Films: 120, 125, 126, 127, 131, 101 Other Resources: 149, 157</td>
</tr>
<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>Preservice engine checks</td>
<td>Use of tune-up and checking equipment Evaluate preservice checks on auto and small gas engines</td>
<td>Related industry, types of tune-up equipment Interpret readings, consumer knowledge</td>
<td>Books: 20, 18, 23, 33, 34, 36, 42, 53, 65, 79, 80, 90</td>
</tr>
<tr>
<td>*Engine service</td>
<td>Service and check cylinder heads, blocks, manifolds, connecting rods, rings, valves, lifters, crankshaft and bearings, timing gear or chains, oil pump, etc. Methods of cleaning, specifications and tolerances</td>
<td>Science of construction, metals used, consumer knowledge, related industry, methods of gauging and measuring Interpret reading, vocabulary and safety</td>
<td>Books: 5, 19, 20, 22, 53, 64, 72, 83, 90 Films: 111, 99, 135 Other Resources: 149, 157</td>
</tr>
<tr>
<td>*After engine service</td>
<td>Tune-up and evaluate result of service Readjust necessary items, practice proper break-in procedures</td>
<td>Consumer knowledge Follow-up on all units of study Safety</td>
<td>Books: 1, 65, 83</td>
</tr>
<tr>
<td>Tools and equipment</td>
<td>Review special tool uses in the automotive service trade</td>
<td>Service industries and consumer knowledge</td>
<td>Books: 20, 19</td>
</tr>
<tr>
<td>Tune-up and preservice checks</td>
<td>Review methods of locating trouble and keeping up with latest developments, interpret and evaluate tune-up data</td>
<td>Consumer knowledge, research in industry</td>
<td>Books: 20, 33, 23, 34, 47, 65, 83 Other Resources: 145, 149, 153, 156, 158</td>
</tr>
<tr>
<td>Automobile engine removal</td>
<td>Procedure to follow while removing accessories from the engine and removing the engine from the chassis</td>
<td>Interpret instructional readings Trace wiring color codes, chain hoists, safety</td>
<td>Books: 65, 20, 83 Other Resources: 145, 149, 153, 156, 158</td>
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<td>Units of Instruction</td>
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<tr>
<td>Engine disassembly</td>
<td>Procedure to remove manifolds, heads, pan, pistons and rods, vibration dampener, timing gears, clutch, crankshaft, camshaft, oil pump, etc.</td>
<td>Measuring devices used in service checking, keep abreast of industry, safety, economy, and consumer knowledge</td>
<td>Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158</td>
</tr>
<tr>
<td>Cylinder service</td>
<td>Check cylinders for ridge, taper and out of round, bell-mouth, etc. Remove ridge, hone, rebore or replace sleeves</td>
<td>Types of gauging devices used for cylinder bore checks Abrasives and uses in industry, for safety</td>
<td>Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158</td>
</tr>
<tr>
<td>Crankshaft and main bearing service</td>
<td>Clean, check with a micrometer, check for bent shaft between centers using a dial indicator, install and check bearing fit</td>
<td>Portable crankshaft and stationary cylinder grinders used in industry Metals used in bearings and recommended clearance, crank design and balance</td>
<td>Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158</td>
</tr>
<tr>
<td>Piston and connecting rod service</td>
<td>Cleaning, checking pistons, ring grooves, pin fit and rod alignment Methods of reconditioning pistons and rods</td>
<td>Industrial use of pin hones, knurling pistons, etc. Science of metals used in rods, rings, and pistons</td>
<td>Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158</td>
</tr>
<tr>
<td>Valves, guides, lifters and camshaft servicing</td>
<td>Remove and check valves and guides, cylinder heads or block, ream or replace guides, grind valves and seats, check springs, clean and assemble Check cam lobes for wear, check bearings and replace if necessary</td>
<td>Interpret readings for testing and servicing; metals used and why; safety and consumer knowledge</td>
<td>Books: 20, 65, 83, 27 Film: 108 Other Resources: 149, 157, 145, 153, 156, 158</td>
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<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
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<tr>
<td>Lubricating and cooling system service</td>
<td>Remove, clean block and replace soft plugs, water jacket direction nozzles, or tubes</td>
<td>Related oil and antifreeze industries Basic science and consumer knowledge</td>
<td>Books: 20, 65, 83 Films: 96, 105, 107, 133, 142, 143</td>
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<tr>
<td>Engine mounts</td>
<td>Check and service</td>
<td>Types of mounts and why used</td>
<td>Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158</td>
</tr>
<tr>
<td>Assemble engine and accessories, install in vehicle</td>
<td>Reassemble all parts and check for proper clearance and run-out of crankshaft, flywheel and housings Install, torque to proper amount</td>
<td>Interpret installation procedure for gaskets and sealing materials used Torque wrenches and types used and why</td>
<td>Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158</td>
</tr>
<tr>
<td>Break-in and final tune-up of engine</td>
<td>Pre-road tune-up checks Road-test driving and and proper breakin procedure</td>
<td>Safety on the highway Evaluation of experience acquired and of job done</td>
<td>Books: 20, 65, 83 Other Resources: 145, 149, 153, 156, 158</td>
</tr>
<tr>
<td>Standard transmissions, overdrives and automatic transmissions</td>
<td>Disassemble, clean, check, reassemble and check a standard transmission Make minor adjustments on an automatic transmission bands and linkage</td>
<td>Keeping abreast of industry Science of gears, ratios and types, consumer knowledge and safety</td>
<td>Books: 20, 65, 83, 61, 62 Other Resources: 149, 165, 145, 153, 156, 158</td>
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<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>Differentials and axles</td>
<td>Remove, service and check differentials Service rear axle and tracking</td>
<td>Keeping up with industry, consumer knowledge Safety and metals used</td>
<td>Books: 20, 65, 83</td>
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<td>Other Resources: 149,</td>
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<td>165, 145, 153, 156, 158</td>
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<tr>
<td>Steering and front end alignment</td>
<td>Minor adjustment and service checks on linkage, steering knuckles, ball socket or king pins and steering gears</td>
<td>Keep up with industry, consumer knowledge safety front end geometry and hydraulic power assists</td>
<td>Books: 20, 65, 83, 7, 8, 9</td>
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<td>Other Resources: 149,</td>
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<td>165, 145, 153, 156, 158</td>
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<tr>
<td>Brakes</td>
<td>Minor and major adjustment for all types of brakes and power assist units Lining types and coefficients of friction for each</td>
<td>Basic science, consumer knowledge, related industries, and safety</td>
<td>Books: 31, 55, 56, 66, 73, 74</td>
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<td>Other Resources: 144,</td>
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<td>145, 149, 153, 156, 158, 160</td>
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<tr>
<td>Chassis or frame, body and fender repair and refinishing</td>
<td>Service doors, windows, body and fender Rebuild rusted out sections or fill, paint, reupholster, straighten frame and operate spray equipment</td>
<td>Related service industries: cloth, glass, plastic and metals Safety and consumer knowledge</td>
<td>Books: 7, 8, 9, 10, 20, 65, 83, 31</td>
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<td>Other Resources: 145,</td>
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Bibliography -- Power Mechanics

Books and Pamphlets


Films and Filmstrips:


106. Colorado State University. *Ignition System*, Fort Collins: Colorado State University Film Library.


112. Colorado University. "Battery Electricity," Boulder: Colorado University Film Library.


Other Resources:


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149. Chrysler Corporation, Automotive Shop Manuals and Charts, Detroit: Plymouth, Chrysler and Dodge Divisions.


152. Fairbanks, Morse & Company, Service Manuals, Beloit, Wisconsin.


154. Fort Carson Training Aids Section, Free Films Catalog, Fort Carson, Colorado.

155. General Motors Corporation, Wall Charts Sections A through G, Anderson, Indiana, Delco-Remy Division.

156. General Motors Corporation, Automotive Shop Manuals and Wall Charts, Detroit, Michigan, Educational Relations Section, Buick, Cadillac, Chevrolet, Oldsmobile and Pontiac Divisions.

157. General Motors Corporation, Carburetor Charts, Sections No. 1 through No. 3, Rochester, New York, Rochester Products Division.

158. Studebaker-Packard Corporation, Automotive Shop Manuals, South Bend, Indiana, 635 South Main Street.


160. Willis Motors, Incorporated, Automotive Shop Manuals, Toledo, Ohio.

WOODWORKING
CHAPTER XVI

WOODWORKING

Wood is one of the most common materials known to man. It has been used for centuries and today constitutes a major factor in the home and office for utilization and beauty, and in industry and manufacturing as a raw material. Among the occupational categories of the woodworking industry that can be represented in industrial arts shops are: milling, carpentry, cabinet making and pattern making. The closely allied phases, such as upholstery, model making, stagecraft, and wood finishing should be included.

BENCH WOODWORKING

The woodworking industrial arts program is a part of general education offering exploratory and enrichment opportunities. When offered at the junior high school level in either a general or unit shop, it should be required of all 7th and 8th grade boys and offered on a selective basis thereafter.

In a bench woodworking shop, equipment should be available for both planning and instruction in hand-tool work, carving, finishing, carpentry and upholstery.

At the junior high level or any beginning level, stress should be on handtool operations with the possible use of the jig-saw, drill-press, and grinder. Emphasis also should be on safe working practices, the importance of following a set of orderly procedures, and the need to develop a certain degree of skill in handling tools and materials.

In any woodshop class, especially at the junior high level, the value of films and demonstration should not be overlooked. It is difficult to give an overall view of all the various phases of the woodworking field in the school shop and, as a result, field trips are often a valuable aid in providing a better understanding of the wood industry. Some areas of learning can be covered by film allowing for a close-up of operations that would be difficult to observe even on a field trip. Films may be utilized when teaching in areas such as lumbering, milling, manufacturing of allied products and the like. Demonstrations of operations considered too dangerous for junior high pupils can be given to give them an idea of things to come as they gain in experience and maturity.

BENCH WOODWORKING

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<th>Fundamental Knowledge</th>
<th>Related Information</th>
<th>Instructional Materials</th>
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<tbody>
<tr>
<td></td>
<td>Classification, properties and uses of common woods</td>
<td>Samples — finished and unfinished</td>
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<tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Lumbering — standard dimensioning and grading</td>
<td>**Models of grain pattern 86, 72, 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>*Plywood — its manufacture and uses</td>
<td>Charts and samples</td>
</tr>
<tr>
<td>*Selecting or designing a project</td>
<td>Making a sketch or working drawing</td>
<td>*Orthographic projections *Pictorial sketches Making templates and geometric layouts</td>
<td>Magazines Mail order catalogs 22, 44, 55, 59</td>
</tr>
<tr>
<td>*Make a materials list and plan of operations</td>
<td>*Read a working drawing *Figure board and square measure</td>
<td></td>
<td>11, 19</td>
</tr>
<tr>
<td>*Laying out the project</td>
<td>*How to use rules and squares *How to use marking tools *How to use gauges *How to use templates</td>
<td>*Types of rules *Types of gauges *Types of squares *The compass, dividers, and trammel points</td>
<td>Models 58, 98</td>
</tr>
<tr>
<td>*Cutting with hand saws</td>
<td>*How to identify and use the cross-cut and rip saws *How to saw holes and curves *How to use the miter box *How to use the back saw</td>
<td>*Types of and uses for hand saws How to fit hand saws</td>
<td>Enlarged models of saw teeth 67, 70, 88, 91, 94, 98</td>
</tr>
</tbody>
</table>

*Identifies areas applicable to general shop.
**Check reference numbers at end of unit.
<table>
<thead>
<tr>
<th>Units of Instruction</th>
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| *Boring holes with wood bits | *How to sharpen wood bits  
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| *Fastening with screws | *How to select bits when boring for screws  
*How to select the proper screw  
*How to sharpen and use a screwdriver  
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*How to drive and draw nails  
*How to use the nail set  
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| *Construction of panels and accumulated stock | *Matching grain  
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|                      | Selecting and caring for brushes*  | Production of shellac  
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|                      | Manufacture and use of brushes  
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### Projects — Bench Woodwork

Projects should be selected by the student and teacher and should meet the objectives of the course. Suggested projects are:

- Book racks
- Book ends
- End tables
- Coffee tables
- Book shelves
- Night stands
- Lamps
- Drawing tables
- Gun racks
- Typing table
MACHINE WOODWORKING

The machine woodworking program should be an area of emphasis available to all industrial arts programs. Organize the program so that instruction in hand and machine woodworking can be offered in the same shop area. This will allow efficient utilization of facilities and space. Along with hand and machine operations, such areas as carving, finishing, carpentry, cabinetry and upholstery should be offered.

Safety in the care and use of equipment must be emphasized to provide effective growth and development in machine operation.

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Bench woodworking should be considered a prerequisite for machine wood, in which basic skills and techniques are emphasized. Draw relationships to machine operations in the beginning course to show how these skills provide the foundation for further development. Three units of instruction should be provided in this area: bench wood, beginning machine woodwork, and advanced machine woodwork in the senior high school. Any instruction beyond this level should be vocational in nature.

The use of films and other audio-visual aids is an effective method of instruction as well as a means for showing industrial processes. Present the relationship between industrial arts and industry to show the importance and potential in this area of instruction.

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*Identifies areas applicable to general shop.
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<td><strong>Mortisers</strong></td>
<td>Setting and using Using drill press attachments Set and adjust chisels and butts Feed work Make set up for duplicate parts</td>
<td>Safety Size Parts Mechanical adjustments Care and maintenance Range of work which may be done Types</td>
<td>Instructional manual 9, 51</td>
</tr>
<tr>
<td><strong>Radial arm and swing saws</strong></td>
<td>Adjust and operate Operations: Cross cut Miter cut Ripping Dado cuts</td>
<td>Safety Size Parts Mechanical adjustments Care and maintenance</td>
<td>Instructional manual 9, 51</td>
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<tr>
<td><strong>Portable cut-off saws</strong></td>
<td>Adjust and operate Straight cuts Miter cuts Bevel cuts</td>
<td>Safety Size Parts Mechanical adjustments Care and maintenance Different types</td>
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<tr>
<td><strong>Portable power plane</strong></td>
<td>Adjust and operate</td>
<td>Safety Size Parts Mechanical adjustments Care and maintenance</td>
<td>Instructional manual</td>
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<tr>
<td>Units of Instruction</td>
<td>Fundamental Knowledge</td>
<td>Related Information</td>
<td>Instructional Materials</td>
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<tr>
<td>Application of hardware by machine</td>
<td>Electric hand drill and attachments: Power screw driver Depth gauge Router Kinds and uses: Bolts Cabinet hardware Door locks Butt hinges</td>
<td>Materials from which manufactured How sold: Quantities Current prices</td>
<td>Hardware Co. charts Instruction manuals</td>
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<tr>
<td>Spray gun finishing</td>
<td>Catch plates Equipment used in finishing: Hand Production Heat lamps Operation and maintenance</td>
<td>Types of spray guns Types of air compressors Paint tanks Hoses Types of power polishers Polishing compounds</td>
<td>Instruction manuals 54, 62</td>
</tr>
</tbody>
</table>

Projects — Machine Woodwork

Projects should be selected by the student and teacher, and should meet the objectives of the course.
Upholstery is a unit of instruction which has received little emphasis in the instructional program. The purpose of this unit is to introduce a basic program suitable for a shop program.

<table>
<thead>
<tr>
<th>Units of Instruction</th>
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<th>Related Information</th>
<th>Instructional Materials</th>
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<tr>
<td>Choice of materials</td>
<td>*Choice of materials</td>
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<td>Type</td>
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<td>Patterns</td>
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<td>Colors</td>
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<td></td>
<td>Characteristics that influence life, strength, and durability of fabrics</td>
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<td>Local upholsterer</td>
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<td>Furniture dealer</td>
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<td>*Books: 1, 2</td>
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<td>Equipment</td>
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<td></td>
<td>Shears, 6 inch</td>
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<td></td>
<td>Combination hammer</td>
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<td>and tack extractor</td>
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<td>Webbing stretcher</td>
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<td>Sewing machine</td>
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<td>Button machine</td>
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<td>History and origin of equipment and its use</td>
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<td>References on upholstery</td>
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<td>Processes</td>
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<td>Frame construction</td>
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<td>Cutting covers and</td>
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<td>Layout methods</td>
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<td>Books: 1, 2</td>
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<td>Webbing</td>
<td>Application, tacking</td>
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<td>and webb stretching</td>
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<td>Amount and location of webbing</td>
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<td>Methods of tacking and stretching webbing</td>
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<td>Springs</td>
<td>Basic springing and</td>
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<td>typing</td>
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<td>Number and sizes of</td>
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<td>Books: 1, 2</td>
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</table>

*Identifies areas applicable to general shop.

**Check reference numbers at end of unit.
<table>
<thead>
<tr>
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<tr>
<td>Stuffing (padding)</td>
<td>Stuffing</td>
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<td>Cotton, Rubberized hair, Foam rubber, Poly foam, Inter spring, Hand, Machine</td>
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<td>Sewing and tacking</td>
<td>Sewing and tacking</td>
<td>Types of needles, cord tacks, and twine</td>
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<tr>
<td>Cushion construction</td>
<td>Cushion construction</td>
<td>Layout of materials, Belt, Top, Bottom, Welt cord, Zipper</td>
<td>Book: 1</td>
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<tr>
<td>Assembly methods</td>
<td>Assembly methods</td>
<td>Hard sewing, Machine sewing</td>
<td>Books: 1, 2</td>
</tr>
</tbody>
</table>
Bibliography -- Woodworking

Books


Bulletins


68. Deft Finishing Chart. Torrence, Calif.: Desmond Brothers.


73. *How to Glue It.* Columbus: Franklin Glue Co.

74. *How to Select, Use and Care for Bits.* Wilmington, Ohio: Irwin Bit Co.

75. *How to Specify and Buy Industrial Arts Lumber and Plywood.* Denver: Frank Paxton Lumber Co.


77. *Joints and Their Uses.* Beloit, Wis.: Yates American Machine Co.


Films and Filmstrips*


90. *Fabrication of Western Pines.* Western Pine Association, Yeon Bldg., Portland 4, Oregon.


93. *Plywood, the Miracle Wood.* Douglas Fir Plywood Association, 301 Tacoma Bldg., Tacoma 2, Wash.


Other Resources


* Films may be obtained from practically every manufacturer by writing their educational or sales divisions.