Name: T. D. Bolinger   Date of Degree: August 3, 1957

Institution: Oklahoma State University   Location: Stillwater, Oklahoma

Title of Study: A COURSE OF STUDY IN GENERAL METAL IN THE SENIOR HIGH SCHOOL, BRISTOW, OKLAHOMA

Pages in Study: 83   Candidate for Degree of Master of Science

Major Field: Industrial Arts Education

Scope of Study: The report was made because the author recognized the need to formulate a desirable industrial arts program in the senior high school of Bristow, Oklahoma. The study also reveals the safety rules that should be used in the course of study. The ways of determing grades in the industrial arts classes were listed.

Finding and Conclusions: Industrial arts is not as new a field as most people think. Records show that industrial arts has been used for many years. The general shop was first used in the junior high school, but is changing very rapidly to the senior high school. One of the main disadvantages of the general shop at first was finding qualified teachers who could teach the several units that are sometimes required. A general shop will be very successful on any school level if well organized and if administered correctly. A general education curriculum is not complete without a well organized industrial arts program. To help organize the industrial arts program, a survey was taken to decide the courses that were needed and would best suit the needs of the community. Instructional units are prepared in the course of study for: Sheet Metal, Arc-Welding, Oxy-Acetylene Welding, and Machine Shop.

ADVISOR'S APPROVAL John B. Tate

A COURSE OF STUDY IN GENERAL METAL
IN THE SENIOR HIGH SCHOOL,
BRISTOW, OKLAHOMA

A COURSE OF STUDY IN GENERAL METAL IN THE SENIOR HIGH SCHOOL, BRISTOW, OKLAHOMA

By

T. D. Bolinger

Bachelor of Science

Northeastern State College

Tahlequah, Oklahoma

1956

Submitted to the School of Industrial Arts Education,
Oklahoma State University of Agriculture and Applied Science,
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
1957

A COURSE OF STUDY IN GENERAL METAL IN THE SENIOR HIGH SCHOOL BRISTOW, OKLAHOMA

T. D. Bolinger

Master of Science

1957

Report Approved:

John B. Tate

Report Advisor and Assistant Professor,
School of Industrial Arts Education

C. L. Hill

Associate Professor and Acting Head,
School of Industrial Arts Education

Robert MacVicar

Dean of the Graduate School

ACKNOWLEDGEMENTS

I wish to express my gratitude to all who have given their time and advice in writing this report.

To Mr. John B. Tate, my report advisor, I wish to express my appreciation for his guidance and assistance during the preparation of this report.

Sincere love and thanks is expressed to my parents, Mr. and Mrs. Ted Bolinger.

The author is grateful to his wife, Mary, for her assistance, patience, preliminary typing, and in the final preparation and typing of this report.

T.D.B.

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION	1
	Purpose of the Study	1
	Research Technique	1
	Previous Studies	2
	Definition of Terms	2
	Organizing the Remaining Chapters	3
II.	HISTORY AND OBJECTIVES OF INDUSTRIAL ARTS	5
	Part A. Early History of Industrial Arts	5
	Primitive Education	5
	Apprenticeship	6
	Sloyd	6
	Part B. Early Leaders of Industrial Arts	6
	Calvin Milton	7
	Frederick Gordon Bonser	7
	John D. Runkle	8
	Charles Russell Richards	8
	Charles A. Bennett	8
	Part C. Objectives of Industrial Arts	8
	Oklahoma State Department of Education Bulletin No. 105, Objectives	9
	William E. Warner's Objectives	10
	Louis V. Newkirk and Johnson's Objectives	11
	John R. Ludington's Objectives	12
	Gordon O. Wilber's Objectives	12
III.	HISTORY OF TOOLS	15
	Stages of Culture	15
	The First Tools	17
	Operational Principles	18
	Coming of the Machine Age	20
	Industrial Center	21
IV.	A COURSE OF STUDY IN GENERAL METAL	25

Chapter | Page

Part A. Teaching Problems........................ 25

Class Organization.......................... 25
Time Available.............................. 26
Shop Controls delegated to the Pupils...... 26
Methods of Teaching......................... 27
Starting the Class.......................... 27
Factors in Determining Grades in Industrial Arts.......................... 27
Equipment Available......................... 28
Method of Selection of Shop Subjects to be included in the General Shop....... 29
Objectives of the General Shop............. 30
Advantages of the General Shop............. 31
History of the General Shop................ 32
Textbooks used in this Course of Study..... 33
Reference Books used in this Course of Study................................. 33

Part B. Instructional Units for the General Shop................................. 33

Instructional Units in Sheet Metal......... 34
Instructional Units in Oxy-acetylene Welding.................................. 40
Instructional Units in Arc Welding......... 46
Instructional Units in Machine Shop........ 51

V. SAFETY RULES FOR A GENERAL SHOP.................. 68

Safety Rules for Arc Welding............... 68
Safety Rules for Oxy-acetylene Welding..... 70
Safety Rules for Machine Shop.............. 71
Safety Rules for Sheet Metal............... 75

VI. SUMMARY AND RECOMMENDATIONS....................... 79

Summary..................................... 79
Recommendations............................. 80

A SELECTED BIBLIOGRAPHY................................ 81

LIST OF TABLES

Table

I. Geological Periods of Development 16

II. Major Contributions of the Field of Tools 23

III. Suggested safe practices for Fighting Fires 77

CHAPTER I

INTRODUCTION

Since the beginning of the twentieth century, the progressive leaders have realized the rapid growth and expansion in the industrial arts. They have realized the utmost importance of the developing of a course in the curriculum of today. In recent years, industrial arts teachers, administrators, and educational leaders have recognized the general shop as one of the widely used methods for teaching industrial arts.

Purpose of the Study. This study was made because of the need for this type of work. The metal working area has not been taught in recent years in the Bristow Public School. There has been lack of room to accomodate such a program, as well as a qualified teacher to teach the course. To help take care of the room situation, a new shop is being planned and built. With the added working area, the author has been confronted with the problem of organizing a metal working program.

Research Techniques. This report was made through the extensive use of the many books, magazines, and reports in the library at Oklahoma State University. Other books were used from the personal libraries of Professor Cary L. Hill, and Professor Leroy H. Bengtson.

Previous Studies. There were courses of study that were prepared by the State Department of Education, which were very helpful in the making of this report. There were also reports and thesis that were similar, which were prepared by former students of the college, and were very helpful in preparing this report. Two reports which the writer found to be of significant help in the preparing of this report are listed below.

Kob, Howard, A Study of the General Metal Shop, 1949, 67 pages.

Wood, Harold, The Machine Shop in Industrial Arts Preparation, 1949, 72 pages.

Definition of Terms.

Course of Study: A comprehensive plan which shows the scope and teaching sequences of all activities provided for a particular subject in a curriculum. (12, page 4)

Curriculum: Is an orderly arrangement of integrated subjects, activities, and experiences which students pursue for the attainment of a specific goal. (12, page 2)

Industrial Education: A general term including all educational activities concerned with modern industry, its raw materials, products, machine, personnel, and problems. It, therefore, includes both industrial arts, the general education, or introduction to industrial-vocation education. (11, page 7)

General Education: General education aims to develop general intelligence, the power of appreciation in all common fields of utilization, and the ability to use language, mathematics, scientific methods, etc., without reference to any specific calling. (7, page 2)

<u>Vocational Education</u>: A generic term whose scope embraces all kinds of vocationally purposeful education such as industrial, homemaking, agricultural, commercial, mining, etc. (11, page 7)

<u>Vocational-Industrial Education</u>: Vocational-industrial educational courses are to train workers for the skilled and semi-skilled occupations which are a part of the modern industrial world. (26, page 15)

<u>General Shop</u>: A shop that is planned and equipped to teach two or more distinct types of shopwork at the same time under one teacher. (18, page 15)

<u>Unit Shop</u>: Shops which are equipped to teach one type of shopwork under one teacher. (18, page 18)

<u>Industrial Arts</u>: A phase of general education that concerns itself with the materials, processes, and products of manufacture, and with the contribution of these engaged in industry. The learning comes through the pupil's experiences with tools and materials and through his study of resultant conditions of life. (7, page 15)

<u>Unit General Shop</u>: A shop wherein related activities in a given field, as in wood fabrication with cabinet making, carpentry, pattern making, carving, bent wood forming, wood finishing, etc., as sub-divisions. (25, page 3)

<u>Organizing the Remaining Chapters</u>. Chapter two contains the history, objectives, and leaders of Industrial Arts. Chapter three contains the history of tools from Pre-historic

to Modern time. In chapter four, a course of study is given which includes teaching problems, class organization, time available, shop controls delegated to the pupils, methods of teaching, starting the class, factors determining grades in industrial arts, methods of selection of shop subjects to be included in the general shop, the history of the general shop, and the outline of instructional units for machine shop, sheet metal, arc welding, and oxy-acetylene welding. In chapter five, the safety rules for a general shop are presented. In the sixth and last chapter, the summary and recommendations are given.

CHAPTER II

HISTORY AND OBJECTIVES OF INDUSTRIAL ARTS

The Industrial Arts program cannot be justified as an integral part of general education until the instructor has familiarized himself with the history and background of industrial arts. It is of utmost importance to know the factors that have influenced the direction of industrial arts in America. Although not organized until the nineteenth century, industrial arts of some form, either consciously, or unconsciously, has been applied. This chapter is devoted to the history, objectives, and some of the early leaders of industrial arts.

Part A

Early History of Industrial Arts

During the primitive times, man learned how to use hand tools in providing for food and shelter. The main objective in their education was almost exclusively for the purpose of self-preservation.

Primitive Education. In this system, the parents were the teachers. The school was always in session, and death was the penalty one had to pay for failure to learn the lessons well.

Apprenticeship. After the Fall of Rome, during the Dark Ages, apprenticeship was the main source of education for the people. To help raise the standard of workmanship, the Craft Guilds were established. "By apprenticeship, is commonly meant an understanding, written or implied, between an employer and an employee, whereby the latter is to receive instruction in a specified trade, craft, or business". (24, page 139)

Sloyd. This system was first introduced in Sweden to improve the traditional domestic handwork in the working of wood of the Swedish peasants. Salomon was in charge of the school, and in 1874, he offered classes for teachers who were already teaching Sloyd, but did not have the background to be good school masters. As a result, it was here that some of the early American manual training teachers received their training and brought this system to America.

Part B

History of Industrial Arts in America

When most people think of industrial arts, they think of it as a recent added subject to the curriculum. It has been found in documents that industrial arts dates back several hundred years. In the early days industrial arts was considered for those who had to make their living by doing manual labor, and was thought of as a lower class occupation. Industrial arts was first known as Manual Training, and was changed to Manual Arts in the late nineteenth century. In 1904, Charles Russell Richards advocated the changing of the name "Manual Training" to Industrial Arts". He was very successful in getting people to use the name, "Industrial Arts".

Early Leaders of Industrial Arts in America. The early leaders of industrial arts discovered the new methods of teaching the subject as it is known today, at the Russian Exhibit, when the Centennial was held in Philadelphia in 1876. The development of industrial arts in America was influenced much by the great changes that took place in Europe. It had its real beginning in the United States as a school subject in the early part of the nineteenth century, through the efforts of these capable leaders:

Calvin Milton Woodward (1837-1914). In the late nineteenth century, Calvin M. Woodward was responsible for the introduction of instruction in handiwork into the secondary schools as a part of the general education for all boys. Under his leadership, the first manual training school in the United States was organized and erected in St. Louis, June 6, 1879. For this, he is known as the "Father of Manual Training in the United States".

Frederick Gordon Bonser (1875-1931). Dr. Bonser was very influential in the changing of the name of Manual Training to Industrial Arts. Although he was never a teacher, or supervisor in industrial arts, he has contributed much to the program. He is the author of two books: Industrial Arts for Elementary Schools, and Industrial Arts for Public

School Administration.

John D. Runkle (1822-1902). John D. Runkle discovered the correct method in teaching the use of tools at the Russian Exhibit at the Centennial held in Philadelphia. He had discovered that the students who entered into mechanical engineering courses had no knowledge of shopwork. His first job was to build a series of shops to teach the mechanic arts just as laboratories were teaching chemistry. He is the author of The Manual Element in Education.

Charles Russell Richards (1865-1936). Charles R. Richards organized the National Society for the Promotion of Industrial Education, while head of the manual training department at Teachers College, Columbia University. He advocated the changing of the name "Manual Training" to "Industrial Arts".

Charles A. Bennett (1864-1942). Charles A. Bennett received his Bachelor of Science degree from the Worchester Polytechnic in 1886. Mr. Bennett began his career as an educator as principal at St. Paul Manual Training School in St. Paul, Minnesota. He accepted a position as head of the manual arts department at Teachers College, Columbia University, in 1893. He was founder of the Manual Training magazine in 1889; the name was changed to The Industrial Education Magazine in 1922. He was also the founder of the Manual Arts Press, and the author of several books.

Part C

Objectives of Industrial Arts

What are the objectives of industrial arts? A careful analysis of the objectives of any subject will indicate that behavior changes are what are really desired. The student's behavior after he has finished the course should be different from that when he started. If this is not the case, learning has probably not taken place. Since behavior changes are the desired outcomes, the objectives should be analyzed in terms of such changes as appear desirable. In other words, the teacher may well look at each objective and ask himself, "Just what behavior changes do I expect from my students as evidence that this objective has been attained?" This is a step which cannot be ignored of concrete importance, and tangible results are desired from each of the accepted objectives. Too frequently aims and purposes remain vague and unattainable because their true significance is not disclosed by a searching study of what is required in the way of behavior changes. The desired behavior changes will differ between grade levels and among the different types of industrial arts organizations. Each subject taught in a public school must have its own specific objectives. With each objective there will be expected behavior changes from the students; the following examples are given, to make clear just what is meant by an analysis of objectives in terms of desired behavior changes.

Oklahoma State Department of Education Bulletin No. 105, lists these objectives.

1. Industrial arts is complementary to other school subjects and provides opportunity to apply knowledge learned in other school subjects.

2. Develops an appreciation of applied knowledge and skills.

3. Provides a knowledge of industrial drawing, the language of industry, and methods of expressing ideas by means of drawings.

4. Contributes to later vocational efficiency.

5. Stimulates students' knowledge and appreciation of good design.

6. Instills a satisfaction in personal creative achievement.

7. Develops the ability to analyze a job into its processes and organize them into correct procedure.

8. Contributes to consumer knowledge and induces an appreciation of the value of industrial materials and the need for their conservation.

9. Trains in industrial and home safety (including fire prevention).

10. Acquaints students with industrial information and induces a recognition of the standards of industrial attainment.

11. Develops avocation interests.

12. Trains individuals to be more resourceful in dealing with the problems of life.

13. Stimulates correct attitudes toward an orderly shop and home and their environment.

14. Aids in making vocational choices.

15. Develops qualities of leadership.

16. Develops cooperative attitudes in work habits.

17. Develops an appreciation of the dignity and importance of the occupation of one's neighbor. (20, page 5)

William E. Warner, in his book titled _Policies In Industrial Arts Education_, lists these objectives.

1. Exploratory or findings value which relate to the detection, discovery, or tryout of interests and aptitudes.

2. General guidance, both education and vocational, gained through broad contacts and studies of industrial vocations.

3. Household mechanics of the development of handyman abilities around the home.

4. Avocational opportunities for the development of hobbies, or a sideline interest.

5. Formation of desirable personal and social habits and insights which will influence conduct.

6. Consumers or utilizers knowledge and appreciations of the products of industry.

7. Development of a degree of skill with tools and in tool or machine processes commensurate with the ability of the pupil and incidental to the completion of a project or activity which seems to have "education" value.

8. Correlation of integration with other studies and interests both in and out of school.

9. Vocational purpose in the definite preparation for a future industrial vocation. Applicable to form 0 to 16 per cent of the average junior high school group where the occasional boy has to drop out of school. (26, page 44)

Louis V. Newkirk, and William H. Johnson, in their book, The Industrial Arts Program, list these objectives.

1. Develop the ability to plan and complete projects using a variety of tools and construction materials in a workman-like manner.

2. Give experiences that will increase understanding of modern industry and that will lay the foundation for and help determine vocational interests.

3. Develop the ability to recognize quality and design in the products of industry.

4. Develop the ability to read and make working drawings, charts, and graphs.

5. Develop the ability to maintain and service in a safe and efficient manner the common products of industry.

6. Provide an objective medium for expression in mathematics, science, language, arts, and social sciences.

7. Develop an interest in crafts as a valuable medium for creative expression in leisure time.

8. Give experiences that will develop social understanding and ability to work efficiently with others either as a leader or as a member of the group. (19, pages 134-136)

John R. Ludington, in an article published in _School Life_, May 1949, listed these objectives.

Orientation and Common Understanding. Experiences in industrial arts should help youth become better oriented in an industrial society by exploring many types of tools, materials, processes, products, and occupations.

Technical Competency. Industrial arts programs should provide as many opportunities as possible for pupils to spend at least a year in a phase of work where initial orientation and exploration may help to define specialized interests that can be pursued with profit.

Consumer Education. Industrial arts experiences can help pupils develop intelligent attitudes, understandings and skills involved in the selection and use of the products of industry.

Avocational Interests. Many pupils are interested in creative activities which involve the use of tools, simple machines, and materials as leisure-time pursuits or hobbies.

Social Responsibility. Because of the nature of industrial arts shop and laboratory activities, desirable social habits and attitudes can be developed. (16, pages 12-13)

Gordon O. Wilber, in his book, _Industrial Arts in General Education_, lists these objectives.

1. To explore industry and American industrial civilization in terms of its organization, raw materials, processes and operations, products, and occupations.

2. To develop recreational and avocational activities in the area of constructive work.

3. To increase an appreciation for good craftmanship and design, both in the products of modern industry and in artifacts from the material culture of the past.

4. To increase consumer knowledges to a point where students can select, buy, use, and maintain the products of industry intelligently.

5. To provide information about and insofar as possible, experiences in, the basic processes of main industries, in order that students may be more competent to choose a future vocation.

6. To encourage creative expression in terms of industrial materials.

7. To develop desirable social relationships, such as co-operation, tolerance, leadership and followership, and tact.

8. To develop a certain amount of skill in a number of basic industrial processes. (27, pages 42-43)

It is the author's opinion, that whether the objectives of industrial arts or any other subject are given, they would be incomplete without the <u>Seven Cardinal Principles of Education</u>, as listed by Ericson. These are given below:

1. Health.
2. Command of fundamental processes.
3. Worthy home membership.
4. Vocation.
5. Civic Education.
6. Worthy use of leisure time.
7. Ethical character.

Not all leaders in industrial arts will agree on the objectives that have been listed above; however, most will agree that the philosophy of industrial arts, from the beginning until now, has remained basically the same.

Industrial arts has long been an important factor in the development of mankind. The primitive man hunted, trapped, and killed for the necessities to satisfy his needs. From that primitive man to our modern man, many changes have been made in the processes used and the advantages made in industrial technology. The factories have made decisive changes in converting raw material into a finished product.

CHAPTER III

HISTORY OF TOOLS

Early primitive man had no tools other than his bare hands. The first hammer was probably a stone fastened to the end of a stick. The first knife was a sharp edge stone. Even the saw was first made out of bits of stone. These tools were invented thousands of years before writing originated and records were kept.

As iron came into use, tools improved. Then came the application of mechanical energy in the power-driven tools and machines.

Stages of Culture. The names of the different periods on the following chart are words formed from the material chiefly in use at the times in question. They are: Lower Palaeolithic, Upper Palaeolithic, Palaeolithic, Neolithic, and Lithic. Another system of nomenclature is topographical and the names of the sub-periods are derived from places where discovered objects specially characteristic of the particular state of culture at which man has arrived in each of these sub-periods. (5, page 42)

The chart given on the next page gives a general scheme of prehistoric periods with order, their nomenclature, and approximate dates in round numbers.

TABLE I

GEOLOGICAL PERIODS OF DEVELOPMENT

GEOLOGICAL TIME	ROUGH ESTIMATES OF TIME SINCE BEGINNING OF STAGE	CULTURAL STAGES	TYPE OF CULTURE
MODERN	1945	Atomic Age	Technological development of power equipment
	1750	Machine Age	
RECENT	1400 B. C.	Iron Age	Uses of metals, beginning of history
	3000 B. C.	Bronze Age	Agriculture and animal domestication
	5500 B. C.	Neolithic	
	8000 B. C.	Mesolithic	Readaptation to past glacial condition by food collectors
UPPER PLEISTOCENE	40,000 years ago	Upper Palaeolithic	Blades, fine flakes. Modern man. Aurignacian. Solutrian Magdalenian
	100,000 years ago	Middle Palaeolithic	Transitional blending of ancient types of tools. End of ancient man. Mousterian
MIDDLE PLEISTOCENE	800,000 years ago	Lower Palaeolithic	Ancient man-ancient tools. Hand axe-cultures of western and southern Europe, Africa; Acheiclean proceeded by Abbevillian. Flake and chipping tool culture of northern Europe. Clactonian, Levallosian.
LOWER PLEISTOCENE	1,000,000 years ago	Pre-Palaeolithic	Crude beginning to use of stone and pebble tools

The period of time between the Later Palaeolithic and the Older Palaeolithic, or "Middle Palaeolithic" is of utmost importance. During this period a new and superior race made its appearance, and the older race seems to have died out. The products of human industry took new forms, and employed new material and processes, and in every way made an advance toward civilization.

The exact time we may never learn, but perhaps a million years ago one class of creatures on the state of life underwent specific evolutionary changes, and mankind emerged.

The major change referred to was the pelvic bone. It became shorter and more nearly upright. Because of this, beings evolved that walked erect, their hands free; capable of grasping and using objects of wood, bone and stone as tools and implements in their own behalf. The hands became more adept; the opposable thumb of greater use. New ways and means were found for employing the fabulous advantages to be derived from tools. Then came speech; gradually language developed, and this was something of great importance, for language is not only an instrument for relating experiences and imparting thoughts; it is also an instrument for thought and the development of the brain.

In the beginning man and woman were strictly food collectors. They hunted small animals, and birds; they fished and foraged for berries, fruits, and grains in order to survive.

<u>The first tools</u>. Though human industry took new forms during this period, the staple product remained the flint

implement. This implement assumed many varied forms corresponding to an ever-increasing number of purposes which these implements had to serve as well as to different technical methods of fabrication. (15)

The Palaeolithic tools that survive to our day are made of stone or flint, and bone, horn or ivory. Man used stone for his implements in all ages, when the more easily worked flint was not obtainable. In Neolithic times, when he learned to polish his implements, he frequently preferred a hard tough igneous rock to the more brittle flint. In older times however, chipped implements of stone, even of chert or quartzite, are seldom characteristic as the material does not lend itself to delicate work.

Flint is a varying mixture of crystalline and amorphous silica. It is brittle, fractures easily and lends itself to the manufacture of delicate tools. Natural flint occurs in bands or layers at several horizons of the Cretaceous chalk.

Operational principles. Six operational principles were listed by Van Nostrand in 1938 as characterizing the function of modern hand tools and machinery. They are percussion, cutting, scrapping, detruding, shearing and molding. All of them were discovered by early man.

The largest and most powerful drop forge, steam, pneumatic, and trip hammers of today are obviously outgrowths of the stone age hand gripped and hafted percussion tool. Metal hammers of the present age are of innumerable varieties dependent upon the task they are to perform. It is interesting to note, in passing, that the prototype of the common claw and sledge hammers were uncovered in the ruins of Pompeii.

The evolution of the chisel group (i.e. adze, gouge, and plane) falls into the usual pattern of hand held stone, hafted, chipped and ground specimens, copper, Egyptian bronze and finally Hallstatt iron.

It is true that the drills from the primitive era have a double working edge. This is true of any primitive drill be it a stone pointed hand-held, or hafted "T" shaped specimen, a strap or bow drill of the Eskimo, or any Egyptian (bronze) or Roman (iron) implement. The wimble scoop, practically obsolete in this country, is an unmodified form of the same tool uncovered in the ruins of Troy.

Abrasion is another age-old method of removing matter. The small electric grinder of the model maker and the ponderous internal and external grinders are rapid moving versions of the primitive hand operated sand-stone abrader. Files are distinctly scrapers, characteristic of the Iron Age. (22, page 160)

The saw is a necessity in everyday operational procedures in manufacture and construction with wood and metal. This tool is a link between the chisels and scrapers. It is impossible to establish the point in relation to exact time when the rudely chipped stone knife of the Lower Palaeolithic operated as a knife or a saw. The first saw was undoubtedly of stone chipped with a row of teeth. The first true saw was discovered in Swiss Neolithic remains. In this period, microliths were set as teeth in a wooden saw and evolved through bronze and iron up to the Roman period in which one of the buck saws of the present style was established. The steel awl of today is separated from the first one of thorn or splintered bone by thousands of years. The intermediary of sharpened bone is commonly found in North American sites of Indian occupations.

Shearing, classified separately by Van Nostrand, as a method of changing the size and shape of matter is actually a cutting process. The cutting type of action is exemplified by scissors, shears, snips, pliers, (pinchers) in which two bi-beveled (pinchers) or single beveled (scissors) blades oppose each other. The first evidence of shears is found in the Roman material culture.

Molding of matter in the past, as it is at present, has been pressure and percussion for solids and by trowell and molds for plastic substances. Percussion may be direct or conveyed through a swage. This classification of molding naturally could not have been practiced prior to the discovery of metals. Pressure moulding by pliers and related tools also came into the forefront with copper, bronze and iron. Arrow shaft straighteners found in some mid-western sites demonstrates that pressure was a technique known to prehistoric natives of America. Molds produced pottery is characteristic of many American pre-Columbian cultures. (22, page 157)

Coming of the Machine Age. Substantially all the basic machines were realities by the year 1850. The majority of this equipment saw its beginning close to the turn of the 19th century. Since this time, progress in machine tools has continued with emphasis on functionality.

Undoubtedly, the stimulant that caused the remarkable machine tools beginning was the advent of the Industrial Revolution. The transference of skills from manual dexterity to the machine that identified this epoch, can correctly be credited with having furnished the needed impetus of the Artisans of that day for new methods and means of performing work of a character and at a speed never before considered necessary or possible. There were two novel requirements, first, the machinery-equipment was to be constructed from metal, and it must be of a character that bordered on precision.

The majority of machine tool development occured in England, although America was not remiss in it's obligations. The metal planer was developed in England about the same year Eli Whitney invented the first milling machine in America.

The initial efforts in machine tool building were made in England with America contributing in a major way. The machine tools of early vintage have been improved and revised since this inception largely by American ingenuity. However, the splendid efforts of France, Germany, Switzerland, England, and Scandanavia must not be overlooked. They are continuing progress in their countries with machine tools. However, America has the largest engineering manufacturing industries, and in consequence, the major market for machine tools.

<u>Industrial center</u>. Geographically, this industry in America started in New England, but spread out more and more as America became settled. Although several major cities have contributed their share of American-made tools, the

machine tool manufacturers, for the most part, remain at the sight of their founding. The continuing trend of greater work load for the machine tool, with lessend effort required from the worker per unit of production, has characteristically changed machine tool production design trends during the past half century. Perhaps of even greater importance than increased production is the high degree of precision that present-day machine tools are capable of maintaining.

In order to see the development, the comparison of the belt driven machine built in 1900, and the motor-driven one may be used. The motor-driven one is the current model of the former. Undoubtedly, the next fifty years will witness a continuation of the development and improvement in machine tools that have been a characteristic of this industry since its conception.

Machine tools have met every challenge that technological development has posed for them. Every improvement in tooling material has been matched or surpassed by advanced machine tools. New power applications have been engineered into machine tool drives. Power and operating controls that lessen worker fatigue and contribute to quality production are further advancements built into modern machine tools.

Above all, the capabilities of present day machine tools to produce more products with greater precision at lower unit cost is the enviable historical record belonging to this industry. The ingenuity, industry, and determination of machine tool builders is the reassuring com-

TABLE II

MAJOR CONTRIBUTIONS TO THE FIELD OF TOOLS

Stone and Wood Hand Tools Agriculture about 5,500 B.C.	Metal Hand Tools Improved hand tools about 4,500 B.C.	Power Tools Machine tools introduced about 1,800 A.D.
Over 500,000 years ago using tools for hunting wild game, and food gathering	4,400 B. C. copper tools	1769-Arkwright Spinning machine
Over 400,000 years ago tool making	4,200 B. C. Villages	1775-Wilkinson boring mill
Over 250,000 years ago making fire	4,000 B. C. Signs-basic of alphabet	1776-Watt steam engine
Over 15,000 years ago making bow and arrow	3,500 B. C. Wheeled vehicles, beasts of burden	1791-Whitney cotton gin
Over 15,000 years ago spear throwing	3,500 B. C. Pottery wheel	1800-Maudslay screw-cutting
Over 10,000 years ago, beads, pendants, clay figures	3,000 B. C. Cylinder seal	1801-Whitney duplicate part production
Over 12,000 years ago carefully done animal drawings	2,600 B. C. Mathematics	1817-Roberts Planer
About 8,000 years ago animals domesticated	2,500 B. C. Irrigation	1818-Whitney milling machine
About 8,000 years ago sickle for harvesting	1,500 B. C. Trade spreads civilization	1831-McCormick reaper
	1,450 B. C. Gutenberg Press	1840-Nasmyth
	1,400 B. C. Iron from ore	1845-Howe sewing machine
	850 B. C. Stone roads	1855-Oliver chilled steel plow
	468 B. C. Fundamentals of architecture	1855-Bessemer steel
	First century A. D. Pulley and cords as gearing	1859-Drake oil well
	100 A. D. Compound pulley	1876-Bell telephone
		1885-Mergenthaler linotype
		1884-Parsons rotary turbine
		1888-Band saw
		1892-Duryea automobile
		1894-Thompson D. C. generator
		1896-Johannsen gage block

bination that forecasts better living for society. (23, page 46)

CHAPTER IV

A COURSE OF STUDY IN GENERAL METAL

To have a successful and complete course of study, much time and effort is required in the preparation of such an undertaking.

Due to the variety of activity the general shop offers and the gratifying results which are attained, some teachers of industrial arts subjects find it one of the most satisfactory of all courses to teach.

Part A

Teaching Problems

Many of the disadvantages of the general shop have been overcome in the years since the general shop program began. It is true that not all of the disadvantages have been overcome, nor will they be, as long as the instructor is working with boys.

Since the general shop is of shorter units, it is usually easier to hold the interest of the students. The shop teacher who uses instruction sheets should find that the general shop will function well, since many of the instructions must be provided by instruction sheets.

Class Organization. As a rule, the teacher of general shop courses use some method of rotating the students at regular intervals, on the different units of work. Some ways of determining the rotation of the students are: the number in the class, the amount of equipment, the number of units of work included, and the chronological age of the students. According to the author's opinion, the best method of rotation is to require each student to complete certain units in each experience area before moving to the next. This plan should be flexible enough to make allowances for individual differences and for the preferences of the members of the class if possible.

Time Available. This course of study is to be completed in one year. Class periods are to be held one hour a day, five days a week. One period out of each week will be devoted to demonstrations, class talks, discussions, reports, field trips, and audio-visual education.

Shop Controls Delegated to the Pupils. Shop duties will be assigned to the student and are to be alternated by the instructor. These duties will consist of checking tools, cleaning machines after use, straightening up the stock and material in storage, and maintenance of hand tools. These duties will be performed under the supervision of the instructor. Students are to report any unsafe working conditions found in the shop to the instructor.

Each boy has the responsibility of cleaning his own work station or machine and putting away tools and materials with which he has worked. The other duties may be designated by a shop organization roster or chart that may be rotated or placed on the bulletin board. Definite instructions are given and emphasis placed on the promptness, care, and accuracy with which they are performed.

Methods of Teaching. It is recommended that this course of study be taught by a combination of lectures, printed instructions, visual-aids, demonstrations, classroom discussions, textbook assignments and tools. In addition, the student experiences the cycles of studying, analyzing, planning, and construction of a project suitable for the course.

Starting the Class. The first day: Check the class roll, aims, safety, standards of attainment, shop routine, rules, conduct, placement of tools, and assign students to their work stations.

Factors in Determining Grades in Industrial Arts. The final grade of each student will be determined with the following factors in mind: achievement, scores in tests, and written work, quality of work, work habits and attitudes, and attendance.

Achievement. Specific standards of achievement must be established in form of manipulative and written work.

1. Minimum requirements for the course are to be determined by the instructor. However, meeting these requirements does not assure a student of passing as many other factors must be considered.

2. The highest grade is to be established by the best performance in all phases of shop work including work habits, attitudes, and attendance.

3. Absence should be made up; this can be done only within the time specified by the instructor.

4. Extra credit will be given for work done by the students. The standard for this work will be established by the instructor.

Tests and Written Work. The learning of skills and techniques is important. Tests and other forms of written work are necessary to measure the achievements of the student. A grade for this work can be easily determined.

Quality of Work. Work done by the student should be of his best all the time, regardless of the type of project or projects undertaken. This is expected of all students in the shop.

Work Habits and Attitudes. To form good work habits, the work must be well planned so the maximum amount can be done in the time alloted. All projects must be completed before credit can be given for the course.

Attendance. Regular attendance is necessary in order to receive the full benefits offered in the way of visual-aids, lectures, and tests, which are required for completion of the course.

Equipment Available. The shop has metal work benches that will accommodate the students. Each bench will be equipped with two metal vises. The hand tools will be kept on a portable tool board that may be rolled into the storage room after classes. The general equipment is kept in the tool room or cabinets and is checked out by the instructor or the tool room clerk as it is needed.

The shop is equipped with the following machines and equipment:

a. Drill press, floor type, automatic
b. Drill press, bench
c. Grinder, floor type
d. Grinder, floor type
e. Grinder, bench type

f. Grinder, bench type
g. Arbor press
h. Power hack saw

Sheet Metal

a. Brake
b. Squaring shears
c. Bar folder
d. Pipe folder
f. Burring machine
g. Turning machine
h. Double seaming machine
i. Wiring machine
j. Sheet metal bench with bench plate and stakes

Machine Shop

a. South Bend Lathe, $14\frac{1}{2}$" swing, 8' bed
b. South Bend Lathe, 13" swing, 6' bed
c. South Bend Lathe, 10" swing, 4' bed
d. Micrometers, 1" and 2"

Welding

a. A.C. Welder
b. A.C. Welder
c. D.C. Welder
d. Cutting torch with tips
e. 7 torches with tips
f. Oxygen and Acetylene regulators

Methods of Selection of Shop Subjects to be included in the General Shop. It would not be advisable to attempt the inclusion of all the many types of work in one general shop. To determine what type of work would contribute most to the development of the shop program, one must first study the over-all objectives of the industrial arts curriculum. The second step should be a careful study of the industry of the surrounding area and the interest of the majority of the people who are served by the school. To help the parents and the students to better understand the shop program, a survey was made in the Bristow, Oklahoma school district. Here are the results of that survey:

Automobile Mechanics -------------------48

Machine Shop ---------------------------28

Welding ---------------------------------40

Sheet Metal ----------------------------11

Electricity -----------------------------39

Other problems to be considered in the selection of the shop subjects are: the number of students to be enrolled, the cost of the course, the space requirements, and the availability of teachers who are properly trained for the work. The results would seem advisable to add a general or unit general shop course to the school curriculum, rather than a unit shop.

Objectives of the General Shop

1. To introduce common materials in industry.
2. To acquaint students with the basic tools and processes of industry.
3. To provide pupils of all degrees of aptitudes an opportunity to engage in wholesome, creative endeaver.
4. To develop in each pupil a certain degree of skill in the hand processes of industry.
5. To provide related information incident to the manufacturing and building industries.
6. To develop in each student attitudes of pride and joy in wholesome accomplishment.
7. To develop in each pupil consciousness, and thoughtful procedure.

8. To provide a teaching situation of cooperative group activities. (28, page 307)

Advantages of the General Shop

Louis V. Newkirk, in the book Organizing and Teaching the General Shop, lists these advantages.

1. It is well adapted to the organization of industrial arts content in the light of the general education, exploration, and the guidance aims of the junior high school.

2. It permits students to be treated as individuals with due respect for their differences in interest and capacity.

3. It enables a student to discover his abilities and aptitudes through manipulation of a wide range of materials, tools, and the processes that go with them.

4. It offers an economical way to gain experience in many activities.

5. It makes possible an adequate industrial arts program for the small school.

6. It stimulates the setting up of a well-planned shop and a carefully organized teaching content.

7. It increases teacher efficiency. (18, page 19)

Arthur Luehring, and Sylvan Yoger, in their article "A General Shop, Its Equipment and Suggested Curriculum for the Small High School", published in Teachers College Journal in 1936, listed these advantages.

1. Pupils can have an experience with a greater variety of materials.

2. Makes possible a contact with a greater variety of tools and tool processes.

3. Makes a provision for taking care of individual differences.

4. Makes possible a closer connection between the school and home through home mechanics.

5. Participation in several activities requires a wide range of thinking, thus it is more educational.

6. Provides a better opportunity for pupils to discover their own interests, aptitudes, and capacities.

7. No loss of time in the completion of a project in more than one material.

8. It makes possible the development of initiative and stimulates individual thinking on the part of the pupils.

9. It makes for economy in both equipment and teaching force.

10. It makes possible the more extensive use of the project method of teaching.

11. It eliminates waste of time caused by a duplication of processes in the one industry shop.

12. It enables a pupil to learn to do a great many things which all men should know and be able to do without respect to their vocations. (17, page 53)

HISTORY OF THE GENERAL SHOP

Since 1910 when Russell and Bonser thought of the idea of a general shop, this type of program has increased rapidly. The general shop was adapted for the junior high school; this is true because it is the age level when the students need to make a choice in fields of work. Many small schools of today have this type shop, and many advocate that this is a type of shop suitable for a small high school. The unit shop changed very slowly to the general shop, because the teachers knew very little about this plan. But the teacher education institutions are establishing better facilities for the training of teachers in this field. Gradually more schools, especially the junior high and small high school are using this type of plan.

TEXTBOOKS USED IN THIS COURSE OF STUDY

Machine Shop - Machine Shop Technology, by C. A. Felker

Sheet Metal - Sheet Metal Shop Practices, by Leroy F. Bruce

Welding - Manual of Instructions in Welding and Cutting, by Boniface E. Rossi

REFERENCE BOOKS USED IN THIS COURSE OF STUDY

Machine Shop -
1. Machining Of Metal, by Robert E. Smith
2. Engine Lathe Operations, by Whipple and Baudek
3. Lathe Work, by Delmar Publishers
4. Metalwork Technology and Practice, by Oswald A. Ludwig

Sheet Metal -
1. Machine Processes, by Delmar Publishers
2. Hand Processes, by Delmar Publishers

Welding -
1. Gas and A.C. Welding and Cutting, by R. F. Jennings
2. Basic Welding Principles, by Emanuele Stieri

Part B

Instructional Units for the General Shop

The outline of instructional units is used to assist the instructor in conducting a course in the general metal shop of a senior high school. The instructor will make arrangements to meet the different units at various times.

The problem of making a course of study in industrial arts is probably greater than any other general education course, because of the rapid changes being made in this field of work. The manipulative and informative content must be kept up to date in industrial arts courses.

INSTRUCTIONAL UNITS IN SHEET METAL

In the following outline there are nine units of work. Each unit of instructions or each learning unit is described in two separate headings: "A" indicates the manipulative operations or processes required in the unit; "B" indicates the essential supplementary and related information necessary or desirable as a part of this learning; and when there is a part "C", projects or exercises are listed.

Each of these divisions of the learning unit is presented in the textbooks listed below. The textbooks are referred to in columns with headings as follows:

Column No. 1 - Sheet Metal Shop Practice, by Leroy F. Bruce

Column No. 2 - Machine Processes (Sheet Metal Series), by Delmar Publishers

Column No. 3 - Hand Processes (Sheet Metal Series), by Delmar Publishers

Outline of instructional units	1	2	3
Unit I - Sheet metal working tools and machinery			
A. Learn to identify the following tools and machinery: Scratch awl, steel square, trammel points, rules, punches, hand groover, rivet set, chisels, hammers, snips, pliers, hand seamer, soldering coppers, hacksaws, files, bench stakes, stake holders, bench machines, floor machines.			
B. What rule is used for finding circumferences of a circle?	3		55
Name four common types of punches.	4		
Sketch a riveting hammer, a setting hammer, a ball peen hammer and a raising hammer.	6		9
Where and when should a mallet be used?	7		44
What type of shears is used in cutting inside circles?	7		
What type of	7		

Sheet Metal Units (con't)	1	2	3
shears is used in cutting			
outside circles and disks?			
Name five different types	8		
of tin snips. Name three	9		12
types of pliers common-			
ly used by sheet metal			
workers. Name two kinds	10		115
of hacksaw frames. Name	2		
three different types of			
scratch awls. Name three	11		48
uses of a file. Name	11		49
five shapes of files.			
Name two different file	12		50
cuts. Name ten different	13		34
bench stakes. Why is the			
end of a wrench at an			16
angle?			
C. In the first unit there will be no project required.			
Unit 2 - Soldering Coppers			
A. Tinning and forging the soldering copper			
B. What is the purpose of	140		
a ferrule on the solder-			
ing copper handles?			
Name five different sizes	140		57
of soldering coppers.			
Why should a soldering	143		
copper be filed before			
forging? How hot should	143		57
the soldering copper be			
for tinning? How are			
soldering coppers sized?			57
What is meant by a dip?	145		56
What is meant by the	150		
term sweating? Name three			66
commonly used soldering	150		
coppers.			
C. Tin and forge a soldering copper.			
Unit 3 - Soldering			
A. Soldering of the common-			

Sheet Metal Units (con't)	1	2	3
ly used metals			
B. Name two general classes	137		64
of soldering. What is	137		64
the melting temperature			
of half-and-half solder?			
Name the two general class-	138		65
es of fluxes. Name one	138		
type of each. Which type	138		66
is a corrosive flux? Which	138		66
type is non-corrosive flux?			
What is the commercial name	138		
for hydrochloric acid? What	138		64
is the purpose of a solder-			
ing flux? What are the prop-			
erties of soft solder? What	138		64
is meant by half-and-half			
solder? Name two forms of	138		64
solder. What type of flux	146		66
is used in soldering copper?	146		66
What type of flux is used	146		66
in soldering galvanized iron?			
What type of flux is used	146		66
in soldering black iron?			
What type of flux is used	146		66
in soldering brass?			
C. Use the correct flux in soldering galvanized iron, copper, brass, black iron, by using two pieces of metal 2" x 4", punch one hole 3/4" from end and using 1/8" rivet, drill one hole 3/4" from the other end and use 1/16" rivet.			
Unit 4 - Sheet metal materials and supplies.			
A. Design and make template of a box of your choice.			
B. What is the purpose of	28		2
zinc? How is the thick-	29		3
ness of sheet metal de-			
termined? What is gal-	29		
vanized iron coated with?			

Sheet Metal Units (con't)	1	2	3
What are the standard sizes	29		
of galvanized iron? Name	38		
three ways that sheet			
metal may be fastened to-			
gether. Name two general	45		
methods of finding the cir-			
cumferences of a cylinder.			
Name four different tin	47		27
snips. Name three types	56		106
of punches. Name four com-	60		106
monly used types of rivets.			
How is the size of tinner's	61		107
rivets determined? How is	62		
the width of the lap on a			
riveted seam determined?			
What is the purpose of the	62		108
hole in the side of the			
rivet set? What is the	62		110
purpose of the hole in the			
end of the rivet set?			
C. Make a small box with a hemmed edge.			
Unit 5 - Notching, clipping, and wiring			
A. Design and make template of a box with a wire edge, with riveted corners.			
B. What is meant by notching	116		
a pattern? What is meant	118		
by clipping a pattern?			
What are the common types	119		121
of wire used in the general			
sheet metal shop? What	119		
tool is used to measure			
the diameter of wire? What	119		
tool is used to find the			
gage number of the wire?			
Name five parts of the mi-	120		
crometer. How much material	121	10	122
is allowed for an edge to			
be wired? When wiring a	122	28	
cylinder having straight			
sides, is the wired edge			
made before or after it is			
formed? What machines are	123	56	

Sheet Metal Units (con't)	1	2	3
used to turn a wired edge?	123	56	
What machine is used to complete a wire edge?	123		
What tool is used to bend over double seam corners?	132		
What type of hammer is used to hammer the edge of metal over the wire?			126
C. Make a small box with a wire edge.			
Unit 6 - Basic principles of pattern development			
A. Design and make template of a box with flaring sides.			
B. What is the purpose of the	175		
T Square? Name two triang-	175		
les necessary in sheet			
metal drawing. What is the	177		
purpose of the protractor?			
Draw two parallel lines two	178		
inches long. Draw a horizon-	178		
tal line 1 3/4" long. Draw	178		
a vertical line 1 1/2" long.			
Draw a perpendicular line	178		
1 1/4" long. Draw a right	179		
angle, with one line 1 1/8"			
long and the other line			
1 3/8" long. Draw an acute	179		
angle, with one line 5/8"			
long, and the other line			
1 7/8" long. Draw an ob-	179		
tuse angle, one line that			
is 2 1/16" long and one line			
that is 2 3/16" long.			
C. Make a small box with flaring sides.			
Unit 7 - Forming, crimping, beading and grooving			
A. Design and make template of a cylindrical project.			
B. Can a cylinder be formed	106	28	

Sheet Metal Units (con't)	1	2	3
with a wired edge in the			
slip roll forming machine?			
Why is it necessary to crimp	107	45	
one end of a length of pipe?			
Why is a bead on but one end	107	38	
of a length of pipe? Name	107	38	
three standard shapes of bead			
that can be made by the bead-			
ing machine. Why is a sheet	110		71
of metal turned over after a			
section of tapered pipe is			
put in the squaring shears?			
C. Make a small drinking cup			
or a cooky press.			
Unit 8 - Folding edges			
A. Design a waste paper			
basket of your choice			
and lay out pattern on			
metal.			
B. Name six parts of the bar	73	3	
folding machine. What type	83		
of a seam is used in join-			
ing light sheet metal to-			
gether? What is the form-	83	71	
ula for finding the proper			
amount of material for a			
grooved seam? Name three	84	131	
commonly used seams.		135	
		142	
C. Make a waste paper			
basket.			
Unit 9 - Turning, burring and raising			
A. Make a funnel of the size			
desired. Make templates			
after drawing the two			
different views. (1-171)			
B. What is the purpose of a	156		
spanner wrench? What mach-	158	61	
ine is used to turn burrs			

Sheet Metal Units (con't)	1	2	3
on discs? What type of tool	163		
is used to scribe around a metal pattern? What tool is	166		138
used to bend over a double seam? What type of soldering	167		57
copper is used to solder around the bottom of a pail?			
How is the metal used in making a funnel softened before being formed into shape?	171		
What stake is used to form the funnel?	171		40

C. Make a funnel.

INSTRUCTIONAL UNITS IN OXY-ACETYLENE WELDING

In the following outline there are ten units of work. Each unit of instructions or each learning unit is described in two separate headings: "A" indicates the manipulative operations or processes required in the unit; "B" indicates the essential supplementary and related information necessary or desirable as a part of this learning, and when there is a part "C", projects or exercises are listed.

Each of these divisions of the learning unit is presented in the textbooks listed below. The textbooks are referred to in columns with headings as follows:

Column No. 1 - Manual of Instructions in Welding and Cutting, by Boniface E. Rossi

Column No. 2 - Gas and A.C. Arc Welding and Cutting, by R. F. Jennings

Column No. 3 - Basic Welding Principles, by Emanuele Stieri

Outline of instructional units	1	2	3
Unit 1 - Setting up apparatus			
A. Become acquainted with oxy-acetylene welding apparatus and to make	71	11	22

Oxy-acetylene Welding Units (con't)	1	2	3
a study of the setting up			
of its component parts.			
B. What does the apparatus for	71		
oxy-acetylene welding con-			
sist of? If an operator is			
capable of operating one type			
of torch, should he be able			
to use any other type equally			
well after a few minutes of			
examination? What are the dif-	71		22
ferent steps in setting up			
the apparatus? What does the	71		22
term "crackling" mean? Should	72		
connections always be tight?			
Should the regulator or hoses	72		18
be interchanged? What are the	72		18
colors of acetylene and oxygen			
hoses? What is the procedure	73		
for lighting the torch? Is	74		
it advisable to follow the			
manufacturer's recommenda-			
tions? When stopping for	75		29
lunch or overnight, where			
should the gasses be shut			
off? When welding is stopped	75		29
a few minutes, where may			
the gases be shut off? Is			
the oxygen cross bar turned		11	
to the right or left to in-			
crease the pressure? Why		13	
should oil never be used on			
any of the apparatus parts?			
What should be used to lub-		13	
ricate the thread on the			
cross bar of the regulators?			
What lubricants should be		13	
used on screwed joints in			
pipe lines carrying oxygen			29
and acetylene? What is a			29
backfire? A flashback?			
Unit 2 - Depositing beads on a flat surface without using a filler rod.			
A. Develop a definite torch	76		
"feel" and a welding tech-			
nique that best fits the			

Oxy-acetylene Welding Units (con't)	1	2	3
individual operator.			
B. What is a neutral flame?	76	19	29
What are its characteris-	76	19	29
tics? What is a carburizing	76	19	29
flame? What are its char-	76		
acteristics? What is an	76		
oxidizing flame? What are	76		
its characteristics? What	76		
type of flame will produce			
clean and sound beads?			
What is the effect of us-		19	
ing a carburizing flame?			
What is the effect of us-	76	19	
ing an oxidizing flame?			
What controls the speed of	76		
welding? What is the ap-	76		
pearance of a weld proper-			
ly done? For a majority of		19	
welds, what type of weld is			
used?			
Unit 3 - Making corner welds without using a filler rod.			
A. Make corner welds without using a filler rod.			
B. How much penetration should	77	21	
be obtained in a corner			
weld? What should be the	77		
appearance of the fusion			
on the bottom of the weld?			
At what angle should the	77		
torch tip be held? How	77		
fast should the torch be			
moved? How should the torch	77		
be held in relation to the			
base metal and the filler			
rod?			
Unit 4 - Depositing beads on a flat surface with a filler rod.			
A. Deposit beads on flat steel by using filler rod.	78	23	92

Oxy-acetylene Units (con't)	1	2	3
sections? Explain your answer. What should be the motion of the torch tip for the welding of heavy sections?	80		
C. Sketch a small project, which will include welds made in past units. Have instructor to check the sketch.			
Unit 7 - Making lap welds			
A. Make lap welds on sheet metal strips as well as on heavier plates.	81		77
B. In a lap joint, will the top piece melt before the bottom piece? How should the torch be held when welding is started? How should the torch be held in proceeding with the bead?	81 81 81		
Unit 8 - Making fillet welds on tee joints			
A. Make fillet welds on tee joints with filler rod.	81	27	94
B. In making fillet welds on tee joints, on what piece should most of the heat be played? Should the filler rod and workpiece start to melt at the same time? At what angle should the tip be held? Should only forehand welding be done? Should a large welding puddle be carried? Explain your answer.	81 81 81 81 81		
C. Sketch a small project, which will include welds made in past units. Have instructor			

Oxy-acetylene Units (con't)	1	2	3
to check the sketch.			
Unit 9 - Welding in the vertical position			
A. Make welds in the vertical position.	82		87
B. Should vertical welds be deposited by welding upward or downward?	82		
Is the welding procedure for making corner and fillet welds similar to that used for making butt welds?	82		
What should be the procedure for making vertical welds on heavier plates?	82		
What happens when the filler rods used are too large or when the flame is held too long at one spot?	82		
What should be the angularity of the torch tip and filler rod in relation to the workpieces?	82		
Unit 10 - Oxy-acetylene cutting of plates and pipes.			
A. Make cuts on pipe and mild steel plate.			
B. What does oxy-acetylene cutting principally consist of?	98	33	55
What is the general procedure for cutting?	98		
Is it possible to start cutting at a point away from the edge of the workpiece?	98		62
What procedure should be used to do so?	98		
How should the cutting torch be grasped and operated?	98		58
What determines the size of the tip to be used?	98		55
What should be the appearance of a cut surface?	99		
What is the procedure used in adjusting the flame for given	99		

Oxy-acetylene Units (con't)	1	2	3
characteristics? At what distance from the metal should the tip be held for cutting?		34	

INSTRUCTIONAL UNITS IN ARC WELDING

In the following outline there are ten units of work. Each unit of instructions or each learning unit is described in two separate headings: "A" indicates the manipulative operations or processes required in the unit; "B" indicates the essential supplementary and related information necessary or desirable as a part of this learning, and when there is a part "C", projects or exercises are listed.

Each of these divisions of the learning unit is presented in the textbooks listed below. The textbooks are referred to in columns with headings as follows:

Column No. 1 - _Manual of Instructions in Welding and Cutting_, by Boniface E. Rossi

Column No. 2 - _Gas and A.C. Welding and Cutting_, by R. F. Jennings

Column No. 3 - _Basic Welding Principles_, by Emanuele Stieri

Outline of instructional units	1	2	3
Unit 1 - Striking an arc and depositing short beads			
A. Striking an arc and depositing short beads.	3	67	166
B. How is the welding arc established?	3		162
How many methods are there for striking an arc?	3		
What are they? What happens at the instant the electrode touches the plate?	3		
What are the results?	3	68	162
What should be done if the electrode sticks?	3		
After the arc is established, is it necessary to move the electrode downward? If so, why? What	3		165

Arc Welding Units (con't)	1	2	3
is the approximate temperature of the arc? What is the effect of the high temperature of the arc? After	3		
striking an arc, why must the electrode be held at the starting point for a short period of time? How	4		
must the electrode be advanced? What happens if the electrode is advanced too slowly or too fast?	4		
Unit 2 - A study of electrodes of different sizes, arc length, welding current, and arc voltage.			
A. Acquaint the operator with the sizes of welds deposited with electrodes of various sizes and with the effects of different arc length, welding currents, and arc voltages.	7	71	
B. What factors are essential	7		
to ensure the most satisfactory welds? How is the proper arc recognized during the	7	68	
welding? What are the re-	7		
sults of a long arc? What	7		
does the proper current depend upon? How can the proper current for a given set of conditions be determined?	7	71	
Does the speed of deposit and the size of the deposited bead depend upon the	7		
size of the electrode used? Is all the electrode deposited	7		
as a weld metal? Are there any losses? If so, what are they?	7		
Unit 3 - Effect of polarity on bead.			
A. Study the effect of polar-			

Arc Welding Units (con't)	1	2	3
ity on bead.			
B. What is straight polarity?	8	67	
What is reversed polarity?	8		
What method may be used to determine the polarity setting of a welding machine?	8		
Unit 4 - Making single-vee butt weld in the flat position			
A. Make a single-vee butt weld with coated electrodes.	33	74	176
B. In making a single-vee butt weld, what should the angularity of kerf surfaces be?	33		176
Explain your answer. Should the slag be removed from each layer before depositing the next? Explain your answer. Are downhand or all-	33		
position-type electrodes used more widely for single-vee butt welds in the flat position? Explain your answer. For a 3/8" single-vee butt weld with downhand electrodes, how many passes	33		
should be used? Should string or weaved beads be	34		
used? For a 3/8" single-vee butt welds with all-position electrodes, how	34		
many passes should be used? How many bead sequences can	34		
be used? What are they?	34		
Where conditions permit, is it advisable to use backing strips with single-vee butt welds?		74	
C. Sketch a small project which will include welds made in past units. Have instructor to check the sketch.			

Arc Welding Units (con't)	1	2	3
Unit 5 - Making an outside corner weld in the flat position.			
A. Make an outside corner weld in the flat position.	35		
B. Is an outside corner joint weld similar to a wide single-vee butt weld?	35		
What is the beading procedure for welding an outside corner joint?	35		
How should the last pass be deposited?	35		
Unit 6 - Welding of lap joint in the flat position			
A. Make a fillet weld with coated electrodes between two lapped plates in the flat position.	28	74	184
B. Is a fillet weld easily made with a coated electrode?	28		
Explain your answer. What should the angularity of	28	74	
the electrode be? What determines the number of passes to be used for making fillet welds in lap joints?	28		
How should a single-pass	28		
fillet weld be made? A two-	29		
pass weld? A three-pass weld? In any case, should the rate of advance be uniform? Explain your answer.	29		
In making lap welds, what precaution should be taken at the root of the weld?	29		
C. Sketch a small project which will include welds made in past units. Have instructor to check the sketch.			
Unit 7 - Welding of tee joint in the flat position			

Arc Welding Units (con't)	1	2	3
A. Make a fillet weld in a tee joint in the flat position with coated electrodes.	30	75	182
B. Does a fillet weld in a tee joint differ much from a	30		
lap weld? What should the angularity of a coated electrode be for a fillet weld	30	75	
in a tee joint? How many passes should be used to make a fillet weld in a tee	30		
joint? What determines the number of passes to be used?	30		183
With a three-pass fillet weld, what should the sequences of the beads be?	30		183
Unit 8 - Making a single-vee butt weld in the vertical position			
A. Make single-vee butt welds in the vertical position with coated electrodes.	44		191
B. How many passes should be used to make single-vee butt welds in plates 1/4, 3/8, and 1/2 inch in thickness?	44		191
In the single-pass procedure, how should the elec-	44		191
trode be weaved? In the two-pass procedure, how should the first pass be deposited?	44		
Why is the proper control of arc, uniform weave, and rate of advance essential?	44 45		
Does the use of a backing strip and a wider root opening help to obtain more complete penetration? Explain your answer.	45		
C. Sketch a small project which will include welds made in past units. Have instructor to check the sketch.			

Arc Welding Units (con't)	1	2	3
Unit 9 - Welding of outside corner joint in the vertical position			
A. Make an outside corner weld in vertical position.	45		191
B. Is the technique for making an outside corner weld similar to that for making a single-vee butt weld? Explain your answer.	45		
How many passes may be used in making the finished weld?	45		192
In the three-pass procedure, how is each bead deposited? Should the plates be spaced? Explain your answer.			192
Unit 10 - Welding of tee joint in the vertical position			
A. Make fillet welds in the tee joints in vertical position.	40		188
B. In how many passes should a 1/4 in. fillet weld be made?	41		189
In how many passes should a 3/8 in. fillet weld be made?	41		
In depositing fillet welds, should one weld uphill or downhill? Explain your answer.	41		188
In depositing the first layer, how should the electrode be weaved?	41		
In depositing the second layer, how should the electrode be weaved?	41		188
What should the angularity of the electrode be?	41		
How long an arc should be held?	41		

INSTRUCTIONAL UNITS IN MACHINE SHOP

In the following outline there are twenty-three units of work. Each unit of instructions or each learning unit is described in two separate headings: "A" indicates the manipulative operations or processes required in the unit; "B" indicates the essential supplementary and related information necessary or desirable as a part of this learning, and when there is a part "C", projects or exercises are listed.

Each of these divisions of the learning unit is presented in the textbooks listed below. The textbooks are referred to in columns with headings as follows:

Column No. 1 - Machine Shop Technology, by C. A. Felker

Column No. 2 - Machining of Metal, by Robert E. Smith

Column No. 3 - Engine Lathe Operations, by Whipple and Baudek

Column No. 4 - Lathe Work, by Delmar Publishers

Column No. 5 - Metalwork Technology and Practice, by Oswald A. Ludwig

Outline of instructional units	1	2	3	4	5
Unit 1 - Safety					
A. Safety in the shop					
B. Is it dangerous to wear loose clothing around moving machinery? Explain your answer.				16	
What safety rule should you use when working on the grinding wheel?				16	
Should you wear rings when working in the shop? Is a machine usually oiled while in use?				16	
Unit 2 - Rules and scales	25		11	52	
A. Become acquainted with types of rules and scales.					
B. Is the rule used for rough measurements? How is a decimal rule graduated?		62			
What is the difference between a rule and a scale?		62			
Make a list of the consecutive fractions from 1/4 to 1 inch in steps of one-six-				52	

Machine Shop Units (con't)	1	2	3	4	5
teenth. What is the decimal value of 1/16? What is the value of 3/8? What is the value of 13/16? What is the value of 9/16 minus 1/32? What is the value of 3/8 minus 1/64? How many eighths in 1.250? (on worksheet)					
C. Make a drill gauge. (9, page 10)					
Unit 3 - Hacksaws					
A. Learn the proper way to use a hacksaw.					
B. What is the correct number of strokes per minute for a hand hacksaw blade?	4	75			
Name two kinds of hacksaw frames.		73			
Does the hacksaw cut on the return stroke? What is the usual width and thickness of a hand hacksaw blade?	5				
A power hack saw? When are fine teeth blades used? When are coarse teeth blades used? What is meant by "flexible back" and "all hard" blades?	5		153		
Does the blade cut a slot thicker than the thickness of the blade?		73			
What is meant by the set of a saw?		73			
How should thin stock be supported while being cut with a hacksaw?		75			
Name three causes for the breaking of hacksaw blades.		76			
How are the sizes of hacksaw blades specified? Which blade is considered superior for cutting in awkward or strained positions? Which blade is superior for the inexper-		73			

Machine Shop Units (con't)	1	2	3	4	5
ienced worker? In what	5	74			
direction should the					
teeth of the hacksaw					
point? What is the eff-		80			
ect of using coolant on					
a power hacksaw blade? Why		75			
should a new blade never					
be used in a cut made by					
an old blade? Name 8 shapes		79			
of metal and sketch how					
each is held in a vise					
when using a power hack-					
saw.					
Unit 4 - Files					
A. Learn the proper way to					
use a file.					
B. How is the length of a	7	89			
file measured? What is	7	92			
meant by double-cut and					
single-cut? What are the	7	89			
principal parts of a file?					
What is meant by draw-					
filing? Name three class-	8				
ifications according to					
coarseness of teeth.					
Name several common shapes	9	90			
of files. What is meant by	11	96			
cross-filing? Name three					
cuts found on files. What		90			
is a vixen file? Where is					
it used? Why should a file	11	98			
be cleaned occasionally					43
when filing a surface? How		93			
should files be kept?					
What is the use of the fer-		89			
rule on a file handle? Should					
the file be lifted on the					
return stroke in cross-					
filing steel? What is the					
effect of too much filing					
on the lathe? How much				85	
material should be left					
for finishing when filing					
on the lathe? For what					
are swiss files used? What					
are the four items that					

Machine Shop Units (con't)	1	2	3	4	5
must be indicated in purchasing files? What is a card file?	11	98			
C. Make a "C" clamp. (13, page 54)					
Unit 5 - Metal cutting chisels					
A. Learn the proper use, and to identify chisels.		83			
B. From what kind of material are cold chisels	14	83			
made? Name four types of		83			
cold chisels. How are cold chisels classified		83			
for size? What is a cold		83			
chisel? What is chipping?	14				
What safety factors should be observed in		84			
chipping relative to the operator and others around					
him? What is the angle	14				
of the cutting edge for average work? What is	14	84			
meant by a "mushroom head" on a cold chisel?					
What should be done about	14				
it? What part of the chisel should you watch while chipping?	15				
Unit 6 - Drills and Drilling					
A. Become acquainted with the proper method of drilling holes.		163			
B. How does a radial drill differ from multiple sp-	73	175			
ingle drill? Name four kinds of drills. Name the parts of the twist drill. When are tapered shank	76	163			
drills used? Name four systems of designating	78	165			

Machine Shop Units (con't)	1	2	3	4	5
drill sizes. What types	79	164			
of shanks are found on					
twist drills? Name three	80	170			
methods of holding drills.					
To what included angle					
is a drill point ground					
for general work? What is	80	170			
the approximate angle to					
grind the lip clearance					
of a drill? Why is it nec-	80	170	28		
essary that the two lips					
of a drill be ground at					
equal angles? How is a	84				
taper shank drill prevent-					
ed from rotating within					
the spindle? What is the		192			
difference between counter-					
sinking and counterboring?					
What is a drill drift? Is	84	190			
slow speed used for soft					
metals? Is high speed used		185			
for soft metals? Is slow		185			
speed usually used with					
large drills? Is high speed					
used with small drills?					
How is the center punch	96		31		
used in drilling holes?					
How is round stock held	92		30		
while being drilled?					
Name two coating materials	96				
used by the layout man.					
What is meant by "drawing	97	187	30		
a drill back on center"?					
What is the difference	111	193			
between counterboring and					
spot facing? What is meant		187			
by laying out a hole to					
be drilled?					
Unit 7 - Taps and dies					
A. Become acquainted with		209			
cutting internal and ex-					
ternal threads.					
B. Name three sets of taps	36	209			
and dies found in the					
average shop. What is a					
tap extractor? What is		205			

Machine Shop Units (con't)	1	2	3	4	5
a tap? What is a die?	36				
If the exact size tap					
drill is not available,					
would it be better to use					
a larger or smaller size					
drill? What are taper,	36				
plug, and bottoming taps?					
What are the four kinds		203			
of threads used in this					
country? What are the	37				
serial taps? Give approx-					
imate taper of each. What	38	194			
precautions must be taken		209			
when tapping is regarded					
with speed, lubricants, etc.					
Why is the tap drill small-					
er than the tap? Does it					
damage a die to turn it					
over to cut threads? How		209			
can you identify a left-					
hand tap? Why is a tap	38				
worked back and forth					
when cutting threads? How	38				
does tapping holes in					
cast iron differ from					
steel? What is the differ-	39				
ence between a rod and					
pipe die? Why is it im-	39				
possible to reverse a					
pipe die? If you turned	40				
a rod die over, would you					
cut a left hand thread?					
C. Make a monkey wrench. (9, page 53)					
Unit 8 - Semi-precision tools					
A. Learn to identify semi-precision tools.					
B. For what purpose is a	19	46			
surface gage used? How	20	52			
are dividers used? What					
are the advantages of					
telescoping gages over					
inside calipers? Name	261	84	13		
several uses of a center		368			
gage. What are the prin-		43			

Machine Shop Units (con't)	1	2	3	4	5
cipal parts of the com-					
bination square? How is	266	201	13		
a screw pitch gage used?					
Name four semi-precision					
tools. What is meant by					
the expression, "getting					
the touch"?					
Unit 9 - Micrometers					
A. Become acquainted with the					
proper use of the microm-					
eter.					
B. Name four kinds of microm-		63			
eters. What range does					
an ordinary micrometer					
have? Name the important	161	63			
parts of a micrometer.					
Should moving work ever				16	
be calipered? How many	162	67	14		
threads per inch are there					
on the screw of a microm-					
eter? What is the differ-					
ence between regular mi-					
crometers and a ten-thous-					
andths micrometer? What is					
the decimal value of 1/40?	162				
If the stock to be measur-		64			
ed is 3/4" in diameter,					
what micrometer caliper					
will you use? What dimen-	67				
sion of the screw does a					
screw thread micrometer					
have? Do micrometers have					55
a range of measurement					
over one inch? How does					
the sleeve of depth microm-					
eter differ from a common					
micrometer in respect to					
graduations? What is meant		65			
by "feel" in regard to					
using micrometers? How may					
the accuracy of a one inch					
micrometer be checked? A					
two inch micrometer?					
Unit 10 - Cutting speeds and					

Machine Shop Units (con't)	1	2	3	4	5
feeds					
A. Learn to use the correct cutting speed and feed.					
B. A 4-step cone pulley and back gears have how many	123	362		10	
speeds? Should a rough cut be made slower than		362			25
a finish cut? Should a large piece be run slower than a piece with a small-		362			
er diameter? Are feeds set on a South Bend lathe in fractions or decimals?	133				
Does a slower feed produce a better finish on the work than a faster					25
feed? What is feed? What is cutting speed on a	133				23
lathe? What does FPM			40	39	23
mean? What does C.S. mean?			40	43	23
What does RPM mean? Are soft metals cut faster		362			
than hard metals? Name five factors that the cutting speed depends upon.	134		40		22
Unit 11 - Lathes					
A. Become acquainted with the various uses of the lathe.					
B. The lead screw has what	118				
type of threads? What are the purposes of the ways?		362		9	
Name five principal parts	118				
of a lathe. What is the use of the lead screw?	119			11	61
What graduations are found on the compound rest handle? List five types of work that can be done on				13	
the lathe. Name four parts	120			8	
of the carriage. Name the two things in which the size of a lathe may be de-		362			

Machine Shop Units (con't)	1	2	3	4	5
termined. Is the length of				8	
a lathe the same as the					
distance between the cen-					
ters? Explain your answer.					
What is the purpose of					
the back gears? Name two	130	363		10	60
types of gearing found on					
the feed mechanism of an					
engine lathe. Who invented			37		
the first screw-cutting					
lathe? How may the centers	146		51	21	
be checked for accuracy?					
Name three ways that	146		60		
stock may be held in a					
lathe. Name two types of					62
standard change gear lathes.					
Unit 12 - Basic lathe tool shapes					
A. To grind and become acquainted with the basic lathe tools.					
B. How is the "Hand" of lathe	169	366			
tools holders determined					
with respect to right and					
left? How is the "Hand"	169	366		46	163
of cutter bits determined					
with respect to right and					
left? Should a finish tool		365			163
have a sharp or round					
point? Name two metals		364	42	34	
used in lathe cutter bits.					
What is the purpose of	170		41		
side clearance? What is	170		41		
the purpose of front clear-					
ance? What is the purpose	170		41	37	
of side rake? What is	170		41	36	
the purpose of top rake?					
What is meant by the	170		41	36	
angle of keenness? How is			40	36	
the strength of the cutt-					
ing edge of a bit affect-					
ed by clearance? Should a	206		42		150
cut-off tool be set ex-					
actly on center? Name					
six common lathe tools.					

Machine Shop Units (con't)	1	2	3	4	5
Unit 13 - Coolants					
A. Learn the purpose and types of coolants.					
B. Why is a lubricant necess-	132				12
ary on the dead center?					
What are the purposes of	480			43	
a coolant? Why is water				43	
alone not a good coolant?					
Name a good lubricant used		139			72
in cutting threads on mild					
steel. Name a good lubri-		139		43	
cant used in machining a-					
luminum. Is a coolant ne-	480	139		43	151
cessary in machining cast					
iron? Should a cutting				44	
lubrication be used for					
lubricating oil? Why is				45	
it necessary to allow a-					
luminum to cool before					
taking an accurate mea-					
surement?					
Unit 14 - Locating and drilling center holes					
A. Become acquainted with locating and drilling center holes.					
B. Name three ways in which	140		47	19	5
to locate centers. Is	142	366	48	25	3
there any danger of drill-					
ing center holes too deep?					
Explain your answer. May	143	367	48	25	1
center holes be located					
and drilled in the same					
operation? If so, how?					
What is the included		368		22	76
angle of the lathe center					
point? What is the com-	143		48	25	1
plete name of the tool					
used to drill center					
holes for mounting work					
between centers on the					
engine lathe? How may the				21	6
accuracy of center holes					
be checked? Name three	147	166		27	2

Machine Shop Units (con't)	1	2	3	4	5
ways in which center holes					
may be drilled. How may				21	
center punch marks be					
checked for accuracy?					
Should the center hole					1
of stock 5/8" in diameter					
be drilled with the same					
combination countersink					
and center drill as a					
piece of stock 3" in diam-					
eter?					
Unit 15 - Straight turning					
A. Become acquainted with					
straight turning operations.					
B. What will happen if the	151				
dead center is not check-					
ed often during the pro-					
cess of turning? Can the		370			
full length of round					
stock be machined, when					
mounted between centers?					
Explain your answer. What	173	366		72	
is meant by facing the					
work? What will happen					
when taking a finishing					
cut if the feed is stopp-					
ed and the work continues					
to rotate? Name two meth-	176			51	
ods that may be used to					
measure the length of					
work. Why should the cutt-					
ing be from the tailstock					
toward the headstock? What	187	351		69	
is a radius gauge? What	200			116	
is the purpose of a man-					
dril? Is a mandril and an	201			117	
arbor press ever used to-					
gether? Explain. When is	202	371	57	75	
a follower and steady rest					
used?					
C. Make a lawn sprinkler.					
(9, page 55)					
Unit 16 - Shoulder turning					

Machine Shop Units (con't)	1	2	3	4	5
and undercutting					
A. Become acquainted with shoulder turning and undercutting.					
B. What is the difference	180				
between undercutting and recessing? What is meant by shoulder work? How	180				
much less than the diameter of the adjacent surface is an undercut usually made? What tool could you use to check the diameter of an undercut? How	184			133	
is undercutting accomplished? What is usually used for undercutting? Name	186		55	80	
two kinds of shoulders. Name two methods how you	186			76	
locate where to cut a shoulder.					
Unit 17 - Reamers					
A. Become acquainted with the types and their uses.					
B. Name two main classes of	42	191			
reamers. What precautions					139
should be observed when removing a reamer from the reamed hole? How is	43				
the power supplied to a hand reamer? What tool is	43				
used to hold the hand reamer? What is the purpose	104				
of the shell reamer? What	104				
is the purpose of the rose reamer? What is the	105			104	
purpose of the taper reamer? Name two materials	106				
reamers are made of.					
Unit 18 - Boring					
A. Learn the correct method					

Machine Shop Units (con't)	1	2	3	4	5
of boring on the lathe.					
B. Define the term "counter-boring". What is the diff-	109 184				136
erence between a recess and an undercut? Where					21
should you start when facing ends for a rough cut?					
A finish cut? What is the difference between boring and drilling a hole? Why	185				126
is it a good practice to face work before performing the boring operation? Describe the process of drilling and boring a hole on the engine lathe.					19
How can work that is set up for boring be checked for accuracy of setup?					110
What care should be exercised in putting a chuck on a lathe spindle?			61	91	106
What is the difference between an independent and	193	363	60	89	102
the universal chuck? Name three methods of holding work to be bored on the engine lathe.	215		66		

Unit 19 - Knurling

A. Become acquainted with the proper use of the knurling tool.					
B. What will happen if both knurling tools do not bear on the work equally?	188				55
Why is it important that the knurling tool be set	188			87	53
square with the work? Do both knurls have right hand helical teeth or	188				53
leads? Name three purposes					51
for knurling. Name three	189	372	59		52
sizes of knurls. What does the term "cracking" mean? Name two types or					52

Machine Shop Units (con't)	1	2	3	4	5
patterns of knurling.					
What is the danger of					
letting the knurling tool					
go past the end of the					
stock?					
Unit 20 - Tapers					
A. Become acquainted with					
common tapers.					
B. Name five standard tapers	220				
and give taper per foot of					
each. Name three ways to	221		70	113	
turn a taper. Name two					145
ways to check angle for					
taper. What are three	222		70		
methods to measure the					
tailstock off-set? What					76
is the included angle of					
taper on a lathe center?					
The angle of the center					
line? How is the accuracy	235			116	
of tapers checked?					
C. Make a jack screw.					
(13, page 100)					
Unit 21 - Threads					
A. Become acquainted with					
standard thread forms.					
B. Name five ways that screw	40				
threads may be produced					
commercially. What is the	249	201			66
pitch of a screw thread?					
The lead? Sketch a screw	249	22		120	
thread and name the parts.					
What is the purpose of a	251	199			
multiple thread? Name	257	203			
five thread forms. What					
is meant by N.F. and N.C.?					
At what angle should the	261	364	75		164
point of a threading tool					
be ground? Which way					69
should the compound rest					
be swiveled to cut a					

Machine Shop Units (con't)	1	2	3	4	5
right-hand thread? A left					
hand thread? What is the	262		75		69
compound setting for cutt-					
ing and American Standard					
thread? For what purpose	262	365	75	130	68
is the center gauge em-					
ployed in setting a thread-					
ing tool? Why is this es-					
sential? What is a thread	265		77	126	65
dial and how is it used?					
What is the purpose of a	266	200		124	
screw pitch gauge? Which	271			142	
way is the rest swiveled					
to cut an internal thread?					
What is the purpose of a	274				
ring-thread gauge? Name	275			125	
two methods for accurately					
measuring threads.					
Unit 22 - Grinding wheels					
A. Install a grinding wheel					
the proper way.					
B. Name six kinds of grind-	425				
ing machines. What is a	446	327			
"loaded wheel"? How is it					
caused? What is a glazed					
wheel? Name two kinds of	448				153
abrasives used for grind-					
ing wheels. When are	449				
coarse grain wheels used?					
When are fine grain wheels					
used? What does a No. 70	449	317			
grain size mean? What is		325	20		
the purpose of a speed in-					
dicator? What is meant by	450				155
bond? Name six different					
kinds of bonds. Why is it	450				
impractical to make veri-					
fied wheels thin or large					
in diameter? Name six	451	319	178		
standard shapes of grind-		317	178		155
ing wheels. What precau-	454				
tions should be observed					
when mounting wheels?					
What two kinds of descript-					
ive dressing tools are					
widely used? What is the	456				160

Machine Shop Units (con't)	1	2	3	4	5
difference between dressing and truing a wheel? Name six types of wheel faces.					160
Name six things that should be stated when ordering a grinding wheel.		319	20		
Unit 23 - Heat treatment					
A. Learn the proper procedure in heat treatment of metal.					
B. What is meant by annealing? By casehardening? By hardening? By tempering?	471 471 472				
What is the difference between high speed steel and high carbon steel?					
What are the advantages of high speed steel over tool steel? What method do we have for testing the hardness of steel in the shop?	467 468				
C. Make a cold chisel. (8, page 44)					

To have a smooth operating general shop, much depends on how well the entire program is organized. After the program has been organized well, it is an everyday job to keep it that way.

After the instructional units have been tested, and tried, there will, no doubt, need to be some revision.

Each student has the textbook used, and at least one copy of each reference book will be in the shop library.

Time would not permit the drawing of the projects suggested in the units.

CHAPTER V

SAFETY RULES FOR A GENERAL SHOP

When working with boys in the high school level, safety is rarely overstressed. Each machine, or other type of equipment is a potential danger. Unless the rules for safety in the shop are properly learned and practiced, they are of little value. A student who has acquired a safety consciousness will observe personal caution at all times, will accept safety rules, that the experiences of others has proved to be important in preventing accidents. Although most manufacturers provide safeguards for their machines, the operator cannot be assured that these guards will give complete protection, especially if the rules for safety are not applied.

The safety instructions given below were taken from the School Shop Safety Manual of the New York City Schools, and Safety Education in the School Shops of Oklahoma, a bulletin published by the Oklahoma State Department of Education. The author has added a few rules of his own, which he learned from his experiences in the shop.

SAFETY INSTRUCTIONS IN WELDING

Arc Welding

1. Welding should be done in enclosed booths to pre-

vent other students from being exposed to arc glare. The booth should be well lighted and ventilated with a blower. An exhaust system should be used to remove fumes.

2. Suitable helmets with shade 9 or darker calobar lens and adjustable headbands should be used. These helmets should be inspected periodically for cracks or leaks in the lens that might leak light. Require onlookers to use hand shield.

3. All-leather gloves, gauntlet type, should be used while arc-welding.

4. Protective leather sleeves with detachable bibs should be worn while arc welding on vertical or overhead work.

5. Approved safety shoes or boots are desired for welding--they are no more expensive than good work shoes.

6. A cap should be worn to prevent sparks from burning the head.

7. Each machine should be connected through an approved switch box equipped with fusetrons.

8. Each welding machine should be well grounded.

9. Do not permit welding on a damp floor.

10. Electrodes should be stored in a dry place.

11. Clear safety goggles should be worn while cleaning slag from the weld and while grinding steel. All grinders should be equipped with guards and rest.

12. Never permit welding on containers which have held combustible liquids or gasses, such as gasoline tanks, acetylene generators, etc., unless containers are filled with carbon dioxide.

13. Do not permit welding on automobiles in the shop.

14. A fire extinguisher and a bucket of sand should be available in case of fire.

15. Make sure all connections on welding equipment are tight.

16. Always disconnect the switches when leaving the booths.

17. If the cable or electrode holder overheats, inform

the instructor.

18. Do not hook the electrode holder on the frame when through welding; suspend it by the cable or let it rest on the floor, not on the bench.

19. If you are arc welding with a portable arc welding machine, insert the plug in the power receptacle when the switch is in the off position. Remember you are working with 220 volt current which can cause severe injury.

<u>Oxy-acetylene</u> <u>Welding</u>

1. Individual welding tables with fire brick tops should be provided and must be spaced at least two feet apart to prevent students from burning each other.

2. Only double braid twin hose with standard fittings should be used, and this should be inspected for leaks at three-month intervals.

3. If acetylene is generated, the generator should be in a separate building, the installation to conform to the Board of Fire Underwriters regulations.

4. Use liquid detergents such as Joy to test for leaks.

5. Never use oil on any part of oxy-acetylene welding equipment.

6. A hydraulic seal should be provided for each bank of stations and each torch should have a station regulation and acetylene check valve.

7. Shade 4 or darker goggles with calobar lens should be used for acetylene welding.

8. Leather gloves and tongs should be provided at each welding station.

9. Each station should be provided with a flint lighter or some approved method of lighting torches.

10. Never use acetylene at a pressure exceeding 15 P.S.I.

11. Use safety goggles while grinding or buffing steel; all grinders should be equipped with guards and rests.

12. All oxygen and acetylene cylinders should be located at a remote distance from welding operations.

13. Keep blacksmith's tongs on each welding station, for use in handling hot pieces of metal being welded.

14. Non-arching lights and switches <u>must</u> be installed in the acetylene generator room. Perhaps the switch should be installed outside of the room.

15. Do not attempt to repair leaky hose with tape.

16. Do not rub the end of the tip over the table top.

17. The gas is under very high pressure, therefore, do not jar the cylinders or leave them near a hot furnace.

18. Shut off the gas at the tank when finished welding. This prevents waste from leaking, and avoids fire hazards.

19. Always keep the torch tip out of heat reflecting areas or holes.

20. Use correct colored hose for each tank, red for acetylene, and green for oxygen.

21. When lighting the torch, never open acetylene valve more than one eighth of a full turn.

22. Always be sure hose connections are tight before beginning to weld.

SAFETY INSTRUCTIONS IN THE MACHINE SHOP

Lathe

1. No adjustments of the cutting tool should be made while the machine is running.

2. The lathe should be turned by hand in removing and putting on a face plate or chuck. Never use power.

3. Be sure that the chuck key is removed before each machine is started.

4. Heavy face plate jobs will sometimes have to be balanced.

5. Always stop the machine for measuring the work.

6. When changing the chuck, the tool should be removed from the tool post to avoid personal contact with the tool.

7. Be very cautious in working close to the face plate to avoid being caught by the lathe dog. The left arm, especially, is likely to be caught.

8. The spindle hole should never be cleaned out with the fingers while the lathe is running.

9. One should never attempt to clean any moving part.

10. Chips should not be removed from the machine or from the work by hand.

11. Guard against wrench slipping and the hand striking the cutter.

12. Do not attempt to hold a drill back against the center by hand.

13. The lathe should not be reversed until fully stopped. The chuck may be unscrewed.

14. If you do not understand about some part of the lathe, ask the instructor.

15. Clamp the tailstock and adjust the tool rest before starting the lathe.

16. Remove the tool rest while sanding or polishing the stock.

17. Always use safe speed.

18. Always check to see that the carriage and compound rest will not engage the dog, face plate, or chuck, at/or near the end of a cut. This causes more damage to the machine than all others, and the operator is likely to be injured in attempting to stop the machine hurriedly.

19. Wear goggles.

20. Never leave the machine while it is running.

21. When removing chucks, use a chuck board on the ways which has approximately 1/4" clearance under chuck. This prevents damage to chuck and ways, and prevents finger and hand injuries.

22. Gears must not be shifted or changed while the lathe is running.

23. When holding work between centers, make sure tailstock is firmly bolted.

24. Do not place tools on a finished machine surface.

The Grinder

1. Always wear clean goggles when using grinder.
2. Emery wheels should be provided with steel hood and a heavy glass shield.
3. Do not stand directly in line with grinding wheel. Stand to one side.
4. The tool rest should be kept adjusted close to the grinding wheel. The distance from wheel should not exceed 1/8".
5. Get instructions on any special grinding job before starting. Example: Never hold with pliers any round or spherical object to be ground.
6. Keep grinding wheel properly trued, by frequent dressing.
7. Be careful not to overload the grinding wheel.
8. Be careful to keep the fingers clear of the grinding wheel.
9. Check grinder to see if it is rigidly fastened to its support.
10. Check grinder speed. Its peripheral speed should not be more than recommended speed by the manufacturer of the wheel.
11. When the wheel is cold, apply the stock slowly to let the wheel warn up to help avoid breakage.
12. Use the face, not the side of the wheel, while grinding heavy cuts.
13. Avoid letting one side of wheel get water soaked. It may make the wheel unbalanced.
14. Do not leave machine while it is running.
15. A grinder should have all safety features built in. If they are not built in the machine, they should be provided as quickly as possible.
16. When applying a new wheel to the spindle or replacing a used wheel, tap it lightly with a light hammer or brass rod to see if it gives off a ringing sound, indicating it is not cracked.
17. Use blotting paper washers between wheel and collars (both sides of wheel) before mounting.

18. Tighten spindle nut snugly, but avoid excessive torque on the spindle nut wrench.

19. Safety zones are painted around each machine. Only students operating the machine may be in the zone. Observers must stay outside the zone and not distract the attention of the operator.

20. Do not grind light sheet metal.

The Drill Press

1. Be sure that the chuck grips drill tightly and that the drill is centered in the chuck.

2. Be sure the chuck key is removed before starting the drill.

3. The eye should be protected by goggles when using a power drill.

4. Do not wear gloves when using a drill. Be careful that long hair is not allowed to get caught in the revolving shaft. Neckties should be removed or tucked in the shirt.

5. Avoid forcing a drill.

6. Do not attempt to hold small pieces by hand while drilling, if it is not possible to clamp it down or hold it in a vise, use long hand pliers for holding.

7. Never attempt to stop work that has slipped.

8. See that the belt is well guarded.

9. Be certain that the table and head are secure before turning the power on.

10. Leave the table stationary while drill is in motion.

11. If the drill goes beyond the flutes, withdraw the drill frequently so the flutes can be cleaned of drill shavings.

12. Keep drills sharp.

13. Always stop the drill if you leave the machine.

14. Hold large pieces in drill vise bolted to table, especially when drills are 1/2" or larger.

15. Use cutting oil when drilling.

16. A specially ground drill is necessary for copper, brass, and other soft metals.

17. Large drills revolve at a slow speed.

18. Small drills revolve at a high speed.

19. Do not drill large holes in light sheet metal, especially long narrow strips as it may wrap around the spindle.

Power Hack Saw

1. Stand on one side of saw frame when you turn on power.

2. Do not bend over saw while it is in operation.

3. Work must be mounted only when the saw is stopped.

4. When long work is being cut, be sure to support the protruding end.

Arbor Press

1. Work must be securely set on bed or parallel from, and in perfect alignment with the pressure ram.

2. Provision must be made for catching shafts, pins, or other units that are forced out.

3. Keep your hands away from the pressure ram at all times.

4. Do not leave lever bar in a position where someone might walk into it.

5. Be sure that rachet is caught on gear before applying pressure on arbor press.

6. Do not use excessive pressure or try to increase the manufacturers leverage.

7. Make certain that all pins or locks have been removed before pressing out a unit.

8. When finished with arbor press, make sure that ram is down against press table.

Squaring Shears

1. Keep the fingers clear of the blade and all moving parts.

2. Keep the feet clear of the treadle.

3. Cut only one thickness at a time.

4. Only one person at a time may use this machine.

5. Do not cut wire on this machine.

6. Never reach behind the machine while stepping on the foot treadle.

7. Do not overload the machine by attempting to cut too heavy a gauge of metal.

8. The squaring shear should be guarded so that it is impossible to get fingers under the cutter. A piece of sheet metal may be installed behind hold-down fingers.

Brake

1. Keep the fingers away from the clamping bar and bending lead.

2. Do not overload the machine by attempting to bend metals of a gauge beyond the capacity of the machine.

3. Always make certain that no one is in the area of the lead bar or balancing weight when operating the machine.

4. Only one person at a time may use this machine.

5. Do not bend more than one thickness of metal.

Bar Folder

1. Hold the handle firmly and do not let it drop back.

2. The fingers must be kept away from the folding blade during the bending operation.

3. Do not allow anyone to stand too close to the operating handle while the machine is being used.

Slip Roll Former

TABLE III

SUGGESTED SAFE PRACTICES FOR FIGHTING FIRE

TYPE OF EXTINGUISHER	SODA-ACID Class "A" Fires	FOAM TYPE Class "B" Fires	CARBON TETRA-CHLORIDE Class "C" Fires	CARBON DIOXIDE Class "C" Fires
USE ON	Wood, trash, paper, waste, cloth	Gasoline, oil, oil base materials, varnishes, paint, grease	Electrical Fires	Electrical Fires, confine fires on oil, or ordinary combustibles
METHOD OF USING	Work close for penetration. Direct stream at base of flames.	Apply complete blanket of foam over surface. Avoid a direct stream on oil surface.	Apply at base of flames. Work with draft.	Apply so gas floods material in a wave, working with draft. Extinguisher lasts only a few seconds.
EFFECTIVE RANGE	30-40 ft.	30-40 ft.	10-20 ft.	3-6 ft.
PRINCIPLES OF EXTINGUISHMENT	Cools burning surfaces below ignition point. Any stream generated tends to smother flames. Practically no gas leaves nozzle.	Blankets burning material with froth or foam which excludes oxygen. Cools and insulates surfaces from heat. Blanket prevents flash-backs.	Flame is smothered by heavy blanket of non-flammable gas.	Flame is smothered by heavy blanket of non-flammable gas.
WARNING	Never use on charged electrical equipment, varnish, oils, or other fuels. Protect from freezing.	Same as column 1	Avoid breathing fumes of dangerous vapors or gases that may be liberated or produced.	CO^2 will not support life. Avoid extended exposure in area where it has been used, especially in pits.

1. Keep fingers and loose clothing away from the rolls.

2. The individual operating the machine should turn the crank, while the work is being fed into the rolls.

3. Feed the work carefully, to avoid catching the fingers between the rolls.

Gas Furnace

1. Light the pilot light first, then turn gas on.

2. Never keep your face close to the furnace.

3. Keep paper or other inflammable material away from the furnace.

4. Do not touch any part of the furnace, once it has been started.

5. Keep the cover in place, except when heating the soldering pot.

The safety rules on the preceeding pages were given in the belief that it may make each student more safety conscious.

It is of the author's opinion, that it is of utmost importance for the instructor to be aware of the safety rules for machines and devices used in the shop.

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

This report has revealed some of the developments of industrial arts in the European countries and the early development in America to the present time. Studies show that the present trend toward the general shop program has advanced considerably in the past few years.

Summary. The general shop is equipped to teach two or more subjects at the same time by one teacher. It is beleived by the author that industrial arts is a part of general education. After preparing this report, the author also feels he can offer a better general shop program in the Bristow Senior High School, and have as its goal the development of an individual who can live successfully in this modern society. Industrial arts presents a miniature of the production, consumption, and recreational aspects of the American way of life. Industrial arts provides for creative experiences which develop appreciation, elementary skills, and desirable habits. The general shop plays a very important part in the goals set up by industrial arts.

Although the general shop was first introduced on the junior high level, it has now changed to include the senior high school level, especially, the small high school.

The four working areas of units are: Machine shop, Sheet Metal, Arc Welding, and Oxy-Acetylene Welding. From the survey taken, these units were the ones most considered by the students.

In a small high school, there is not a sufficient number of students to justify establishing a unit shop, even in the areas listed above.

Recommendations. It is recommended by the author that 80% of the time will be spent in the shop, and the remaining 20% be taught as theory, visual-aids, reports, and demonstrations. It is also recommended that the course of study, especially the instructional units, be extracted from the report, and if necessary, revised to fit your need. It recommends also that the units be reproduced for use in the Bristow High School.

A SELECTED BIBLIOGRAPHY

1. Bawden, William T., Leaders in Industrial Education. Milwaukee, Wisconsin: The Bruce Publishing Company, 1950. 196 pages

2. Bennett, Charles, History of Manual and Industrial Education up to 1870. Peoria, Illinois: Charles A. Bennett Company, Inc., 1926. 461 pages

3. Bennett, Charles, History of Manual and Industrial Education, 1870 to 1917. Peoria, Illinois: The Manual Arts Press, 1937. 566 pages

4. Board of Education of the City of New York, School Shop-Safety Manual. 110 Livingston Street, Brooklyn 8, New York: 1948. 241 pages

5. Brown, G. Baldwin, The Art of the Cave Dwellers. R. V. Coleman Publishers, 1930. 280 pages

6. Burkett, M. C., Prehistory. Cambridge at the University Press; New York: The MacMillan Company, 1951. 347 pages

7. Cox, Phillip, The Junior High School and its Curriculum. Dallas, Texas: Charles Scribner and Sons, 1929. 416 pages

8. Delmar Publishers, Inc., Job Sheet Series, (Machine Shop Series). Albany, New York: Delmar Publishers, Inc., 1948. 50 pages

9. Embretson, Oscar A., and Henry J. Seymour, Instructional Units in Machine Shop. Milwaukee, Wisconsin: The Bruce Publishing Company, 1953. 63 pages

10. Ericson, Emanuel E., Teaching the Industrial Arts. Peoria, Illinois: The Manual Arts Press, 1946. 384 pages

11. Friese, John E., Course Making in Industrial Education. Peoria, Illinois: The Manual Arts Press, 1946. 259 pages

12. Giachino, J. W. and Gallington, R. O., Course Construction in Industrial Arts and Vocational Education.

13. Knight, Roy E., Machine Shop Projects for Trade, Vocational, and High School Shops. Bloomington, Ill-

inois: McKnight and McKnight, 1943. 112 pages

14. Kob, Howard, A Study of the General Metal Shop. A report, Stillwater, Oklahoma: Oklahoma Agricultural and Mechanical College, 1949. 67 pages

15. Leighton, Wilkie, "Civilization Through Tools". Wilkie Foundation, Des Plaines, Illinois.

16. Ludington, John R., "Enrichment of Pupil Experiences Through Industrial Arts", School Life, 31 (May 1949)

17. Luehring, Arthur H., and Sylvan A. Yoger, "A General Shop, Its Equipment and Suggested Curriculum for the Small High School", Teachers College Journal, 7:53, March 1936

18. Newkirk, Louis V., Organizing and Teaching the General Shop. Peoria, Illinois: Charles A. Bennett Company, Inc., 1947. 200 pages

19. Newkirk, Louis V., and William H. Johnson, The Industrial Arts Program. New York: The MacMillan Company, 1948. 357 pages

20. Oklahoma State Department of Education, Industrial Arts in Oklahoma, Bulletin No. 105, 1951. 129 pages

21. Oklahoma State Department of Education, Safety Education in the School Shops of Oklahoma, 1954. 56 pages

22. Praus, Alexis A., "Mechanical Principles Involved in Primitive Tools and Those of the Machine Age". ISIS. 38-157-58. 1947-48.

23. Schaller, G. S., "Machine Tool Origins". Tool Engineer, 27: 46-48. December 1951

24. Struck, F. Theodore, Creative Teaching. New York: John Wiley and Sons, Inc., 1938. 623 pages

25. Walker-Turner Division, Kearney and Trecker Corporation, School Shop Planning Manual. Plainfield, New Jersey: 1952. 21 pages

26. Warner, William E., Policies in Industrial Arts Education. Columbus, Ohio: Ohio State University Press, 1928. 90 pages

27. Wilbur, Gordon E., Industrial Arts in General Education. Scranton, Pennsylvania: International Textbook Company, 1948. 362 pages

28. Williams, Amos G., "Building a General Shop Curriculum", _Industrial Arts and Vocational Education_, 33:307-8. October, 1944.

29. Wood, Harold, _The Machine Shop in Industrial Arts Preparation_, A report, Stillwater, Oklahoma: Oklahoma Agricultural and Mechanical College, 1949. 72 pages

VITA

T. D. Bolinger

Candidate for the Degree of

Master of Science

Report: A COURSE OF STUDY IN GENERAL METAL IN THE SENIOR HIGH SCHOOL, BRISTOW, OKLAHOMA

Major Field: Industrial Arts Education

Biographical:

Personal data: Born near Locust Grove, Oklahoma, September 30, 1929, the only son of eight children born to Ted and Jewel Bolinger.

Education: Attended grade school in Murphy, Oklahoma; graduated from Locust Grove High School, Locust Grove, Oklahoma, 1947; received the Associate of Arts degree, Miami, Oklahoma, May, 1954; received the Bachelor of Science degree, Tahlequah, Oklahoma, January, 1956; completed requirements for the Master of Science degree at Oklahoma State University, July, 1957.

Professional experiences: Entered United States Air Force, September, 1948, spent two years in Alaskan Air Command, Anchorage, Alaska; honorably discharged in August, 1952; teacher of metalwork, Bristow Senior High School, January, 1956, to May, 1957.

Educational Organizations: Member of the Oklahoma Education Association, National Education Association, Oklahoma Industrial Arts Association, and Iota Lambda Sigma Fraternity.

Report Title: A COURSE OF STUDY IN GENERAL METAL IN THE SENIOR HIGH SCHOOL, BRISTOW, OKLAHOMA

Author: T. D. Bolinger

Report Advisor: John B. Tate

The content and form have been checked and approved by the author and report advisor. The Graduate School Office assumes no responsibility for errors either in form or content. The copies are sent to the bindery just as they are approved by the author and the faculty advisor.

Typist: Mary Bolinger