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# A Guide for Establishing a Machine Metalworking I and II Laboratory for the Secondary High School in Texas

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by

Alfonso Demarcus Royal Jr.

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Alfonso D. Royal

# FOREWARD

Machine metalworking I and II are areas of speculation in the industrial arts machine metalworking program, which should teach industrial experiences that have been transposed into learning units that are practical for school laboratories.

The many changes in industry and the new goods and services brought to bear on our society demands that industrial arts change along with its subject matter material. Industrial arts cannot continue to utilize out dated methods and materials in their instructional procedures.

Probably one of the most important aspects of this thesis is to find out what should be taught, another is to designate the needed equipment and last, offer a floor plan that should house the needed faculties. However, before any of the above can be accomplished, the objectives for such a program must be established.

The writer has attempted to solve the above problems and offer a sound program of instruction, with facilities and a floor plan that could be used in establishing a machine metalworking I and II laboratory.

This thesis is a probable guide for teachers, architects, school administrators, and supervisors in planning and evaluating advanced machine metalworking laboratories.

Alfonso D. Royal Jr.

Galveston, Texas
April 14, 1967

TABLE OF CONTENTS

# CHAPTER I

## INTRODUCTION

Something is wrong with industrial arts. Is it the selection of subject matter material? Is the equipment inadequate to do the type of training? Are laboratories designed to accommodate the desired type of activities? Are the auxiliary facilities for laboratory planning inadequate? These are but a few of the significant issues facing the industrial arts profession today.

When industrial arts was first initiated in the secondary schools of our nation in the earlier 1880's, many authorities were aware of its need and the way of life that was transmitted because of it. They could visualize the dual role for transferring learning experiences from the master to the student, then from the student to the project. However, during the earlier periods students only copied and duplicated projects made by the master, therefore, free expression and creative construction were not permitted. The teaching, in contrast to this period was simple because the economy was predominately agrarian, however, there were some factories located in the East and Middle West.

Today there are many industries, but a great segment of our economy is derived from educational experiences in science and technology. The importance of technology in attaining our standards of living was expressed by Elgin Hunt.[1]

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[1] Elgin F. Hunt, <u>Social Science</u>, (New York: The Macmillan Company, 1955), p. 73.

> As long as we continue to make technological progress we are likely to enjoy a constantly raising standard of living. Most inventions have one of two immediate purposes: either they are intended to create entirely new products for direct satisfaction of human desires; or else their purpose is to produce familiar products more efficiently, with a smaller expenditure of time, effort, and materials. Radios and television sets illustrate the first purpose. They are relatively new products which were invented to satisfy consumer wants. The power loom, the cotton gin, and reaper illustrate the second purpose. They were invented, not for the direct satisfaction of wants, but to increase productive efficiency so that familiar goods like cloth, and wheat could be produced at lower costs and in greater quantities. By providing for our enjoyment both new kinds of goods and greater quantities of goods, it is clear that technological progress has greatly raised our standards of living.

Futhermore, because of these advanced technological progressive changes, America has become a cybernetic nation. This progress must continue in outer space and on earth. The new goods and services are good examples of Hostetler's statement, "technology is knowledge in action."[2] He goes on to say, "if industrial arts reflect technology as we say it does, it must rid itself of some of the handicraft elements carried over from an earlier culture."[3]

Industrial arts programs must be current, and thus transmit an appreciation and use of goods, tools and services. Industrial arts should have breadth and depth in the selection and presentation of subject matter materials. Charles Shoemaker stated that:

> Changes in industrial arts cannot afford to lag behind changes in industry. It is unrealistic for

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[2] Ivan Hostetler, "Today's Industrial Arts Teaching Lags Behind the Needs of Today's World," <u>School Shop</u>, XXIII, (September, 1963) p. 14.

[3] <u>Ibid</u>., p. 15.

> students to be studying and practicing procedures out dated by changes in industry. Equipment, tools and materials become obsolete. New and more effective ways must be found to make learning more meaningful in a laboratory situation.[4]

Change is obviously needed in the industrial arts metalworking program because of the volume of products utilized. These products must be appreciated and understood as being an important part of our culture. Therefore, industrial arts programs should help the individual in understanding this phase of his development.

Machine Metalworking I and II as described by the Texas Education Agency[5] are advanced coursed in the secondary high schools. These courses are designed to give the students additional skills in the use of machine tools such as the lathe, the milling machine, the shaper, the drill press, and the surface grinder. The prerequisite for Machine Metalworking I was General Metalworking and for Machine Metalworking II, Machine Shop I.

In contrast, to approving the course contents, standards for accrediting, industrial arts laboratories were not included. However, in an earlier report by the Texas Curriculum Study Commission recommodations were made, but not specified for Machine Metalworking I

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[4] Charles Shoemaker, "The Industrial Arts Laboratory Must Be Flexible," Planning Industrial Arts Facilities, VIII Yearbook, The American Council on Industrial Arts Teacher Education, (Bloomington, Illinois: McKnight and McKnight Publishing Company, 1959), p. 32.

[5] Texas Education Agency, Principles and Standards for Accrediting Elementary and Secondary Schools and Description of Approved Courses, Grades 7-12, (Austin, Texas: Texas Education Agency, 1961), p. 149.

and II laboratory facilities.

Machine Metalworking I and II should have the necessary facilities that would aid in creating an atmosphere that is conducive to learning. These laboratories should be planned in such a manner that the student should not have to leave the area once he is in class. Futhermore, these laboratories should be comfortable and to accommodate each class period activity.

Machine Metalworking I and II should select its subject matter material from basic experiences of an industrial nature in the metal-working industry. Teachers should put emphasis on individual and group planning, also problem solving. It should be emphasized however, that although a high level of skill is attained in these courses, they are of a nonvocational nature. After completing such courses, students have been known to seek and acquire gainful employment in those and related industries.

Today's society has become industrialized, through efforts of science and technological advances in the machine metalwork industry. This technology must be transmitted to today's youth if he is to take an active role in this progress. He must understand and develop his innate abilities, and add to this program in the new age, thus turning the cycle and transmitting a more modern concept to a more advanced generation.

## STATEMENT OF THE PROBLEM

The State of Texas does not have a guide for developing a model floor plan supplemented by a list of model physical facilities, and laboratory equipment which should be used for establishing a laboratory for teaching Machine Metalworking I and II in the secondary high schools.

It is the purpose of this study to futher develop and explore the following statements and questions:

1. Define the purpose of education, industrial arts education and metalwork education.

2. Define the nature of metalwork and machine working in industry.

3. Develop criteria for Machine Metalworking I and II.

4. Determine basic standards for developing floor plans, designating physical facilities, and selecting equipment for Machine Metalworking I and II.

5. Utilization of data in the development of floor plan, equipment and physical facilities.

## LIMITATIONS

This study is limited to establishing basic standards for developing course content, floor plans, physical facilities and the selecting of a model list of equipment for a Machine Metalworking I and II laboratory.

## DEFINITIONS

General Metalworking - is designed to give students an opportunity to acquire skills, appreciation and understanding of basic concepts, designs and fabrication of metals. Students enrolled in this course are not to develop specific skills in any one phase of the program. This course is to function with at least four units of the metalworking program.

<u>Machine Metalworking I</u> - whose prerequisite is General Metalworking is an area of specialization. This course is designed to give students basic skills in the understanding, use and appreciation of machine tools. The machine tools would include the drill press, the lathe, the milling machine, and shaper.

However, related information is an important phase of this course, and the writer will not develop this part of the course.

<u>Machine Metalworking II</u> - whose prerequisite is Machine Metalworking I, is designed to give students an opportunity to develop precision skills in the use, appreciation, and understanding of basic machine tools. This course would include the selection of projects, which require students to develop multiple operations on several machine tools. Students in addition to comprehensive use of machine tools are to utilize shop manuals, handbooks and tool designs. These things are essential for understanding and development.

## METHOD OF PROCEDURE

1. Collect, analyze and draw conclusions for data on the purpose of education, and industrial arts education.

2. Collect, analyze and draw conclusions for data on the nature of metalwork and machine metalworking in industry.

3. Collect, analyze and draw conclusions for data used in course contents for Machine Metalworking I and II.

4. Collect, analyze, and draw conclusions on establishing and developing basic standards for floor plans, designating physical facilities, and selecting needed equipment.

## NEED FOR THE STUDY

Machine Metalworking I and II are advanced courses in the secondary high schools of Texas, and tentatively approved by the Texas Education Agency.[7]

In contrast to approving and describing the courses the agency did not make specific recommendations for the adequate facilities and standards for initiating the program.

The physical plants that house the laboratories should not be developed by trail and error methods. These laboratories should have definite standards to adhere to in planning. These laboratories should be planned by those persons who are well acquainted with the type of activity and laboratory problems involved.

This model was designed in the hope that school administrators, planners, teachers, and architects would use this material in laboratory planning and evaluating facilities and equipment.

Although this material was compiled for establishing a Machine Metalworking I and II laboratory, it is hoped that other laboratories and facilities can be planned in a similar manner.

## SURVEY OF RELATED LITERATURE

In recent years many books have been written on industrial arts laboratory planning standards. Many of the authors are quoting each

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[7] Texas Industrial Arts Association, Metalworking, Grades 7-12, A Tentative Bulletin, (Austin, Texas: Texas Education Agency, 1964), pp. 27-31.

other, thus contributing nothing original in attempting to offer practical solutions that would redefine and fulfill the objectives.

Establishing a guide that could be used for planning both new and existing industrial arts laboratories is not new. Bateson, in a study, developed standards for establishing new, and evaluating old industrial arts laboratory facilities. Industrial arts facilities were classified into five major headings. Specialists in each of the five major headings were selected. The result of the study was a check list for the evaluation of physical facilities for industrial laboratories.[8]

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[8] Willard M. Bateson, "Standards for Physical Facilities of School Shops Developed in Research Study," Modern School Shop Planning, IV Edition, (Ann Arbor: Prakkens Publication, Inc.), p. 33.

## CHAPTER II

## TRENDS IN EDUCATION IN OUR SOCIETY

The democratic form of government is by far the most important factor in the American educational structure. In this particular form of government each individual has the right and responsibility for expressing such a right as long as he does not infringe upon the rights of others. It is because of the basic rights of man, and the freedom he displays in developing his potentials, that a way of life emerged. The democratic way of life is expressed in the beliefs, dignity and worth of the individual. Shoemaker states that:

> Our democratic way of life is expressed in certain fundamental beliefs we have inherited as a good life. We believe in the integrity and worth of the individual as manifested the optimal development of human personality. We believe, and have faith in the function of intelligence for determining mans destiny and the solution of his problems. We believe in equal opportunities for all and in the unalienable rights of man's civil liberties. We believe in respect for the rights of others and in concern for the common good. We have faith in the school as a formal agency and for preserving these liberties.[1]

Each succeeding generation is confronted with problems and needs that are more complex and difficult than those encountered by each preceeding generation. Every generation is obligated to transmit

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[1] Charles Shoemaker, "Industrial Arts in Modern Education," Planning Industrial Arts Facilities. VIII Yearbook, The American Council on Industrial Arts Teacher Education. (Bloomington, Illinois: McKnight and McKnight Publishing Company, 1959), p. 20.

values and culture, and insure the maximum development of its young.[2]

In the existing society the individual's needs, development, and adjustment are of great importance in the continuing and advancing of the democratic way of life. Earlier educational leaders foresaw many difficulties and complexities, in human development. Therefore, provisions were made for dealing with human difficulties steeming from tutoring to private and public schools.

## SIGNIFICANT DEVELOPMENTS IN EDUCATION

General education whose purpose is to develop within the limits of each individuals capacity all of those learning experiences that are common to all individuals in a democratic society. In general education all phases of the programs are designed to broaden the individuals intellectual horizon. Education for the masses, the great American experiment, is best described by Hunt when he said:

> Education, especially free public education, has made great contributions to the growth of American democracy. First, by training the masses of our citizens to read, to communicate with one another more effectively beyond the local community, and to learn something of politics and public policy by reading newspapers and magazines. While this does solve all the problems of a democratic government, it has enabled our people to vote more intelligently, and to choose leaders more wisely that would otherwise could have been possible. Second, the public schools teach children to get along with different kinds of people. In many areas the children who attend these schools come from widely varied social economic, and national and racial backgrounds. . .
>
> Finally, . . . our public schools system has enabled us as a nation to make more effective use of

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[2] Gordon O. Wilber, Industrial Arts in General Education, (Scranton: International Textbook Company), p. 1.

> our human and natural resources. In the public schools we discover, even from unfavorable social backgrounds, many children who have unusual ability. Most such children would never be brought to light if it were not for our free public schools. . . Our public schools system is by no means a perfect instrument, either for achieving complete equality of educational opportunity or for enabling us to make great strides towards both of these objectives.[3] Presently the nation is engaged in activities to provide equal opportunities for minorities, in an effort to totally utilize available human resource.

In general education of all phases is based upon the need of the individual. The objectives of each specific course in the educational program is so drafted that it may even be a guide towards fulfilment.[4]

Many leaders in American education have expressed different view-points concerning the purpose of education. Education, like advancing technology must keep abreast with the times. The educational objectives must be current and the needs of the individual must therefore, be perfect in the establishment of programs to fulfill the objectives.

The Commission on the Reorganization of Secondary Education in 1918 formulated the Cardinal Principles of Education. The Commission, perhaps one of the earlier leaders in education, spelled out what schools were to do. It stated "such reorganization that secondary education may be defined as applying to all pupils of approximately twelve to eighteen years of age."[5] The seven cardinal principles were

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[3] Elgin F. Hunt, Social Science, (New York: The Macmillan Company, 1955), p. 396.

[4] Chris A. DeYoung, American Education, (New York: McGraw-Hill Book Company, 1960), p. 129.

[5] Ibid., p. 129.

expressed from the above statement.

Many of the more recent concepts in education can be traced back to this famous educational development.

The Educational Policies Commission in 1944 undertook a study that was to establish guidelines for all education. The study, revised in 1952 stated that:

> Schools should be dedicated,. . . to the proposition that every youth in these United States regardless of sex, economic status, geographic location, or race ... should experience a broad and balanced education . . .[6]

This commission went on to say that, "it is the duty of a democratic society to provide the necessary opportunities for its youth."[7] Also, youth should take advantage of the opportunity and parents should assist and support the school and youth in meeting these objectives.[8]

The American Association of Administrators Yearbook Commission in a study on the high school in a changing world expresses the purpose of education as follows:

> This Yearbook Commission acknowledges and supports, as the legitimate and critically important goals of our secondary schools: The maximum development of all the mental, moral, emotional, and physical powers of the individual, to the end that he may enjoy a rich life through the realization of worthy and desirable personal goals. .. The maximum development of the ability and

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6 Ibid., p. 130.

7 Ibid., p. 130.

8 Ibid., p. 130.

> desire in each individual to make the greatest possible contribution to all humanity through responsible participation in, and benefit from, the great privileges of American citizenship.[9]

The White House Conference on Education in 1956 met and formed a committee to study and reasses the purpose of education in the modern secondary high schools. This committee developed fifteen statements that were necessary for reassessing modern secondary school objectives. The range of the programs involved in the study, emphasized the physical and social sciences, vocational, educational, domestic skills, leisure time activities, health services, reading difficulties, physical education, geopolitics, mental health and safety education. This conference spelled out the extent to which the needs of the community are intergrated into the total educational program.[10]

In analyzing the purposes as expressed by the various committees and commissions they emphasized the individual, his abilities and his adjustment in a democratic society and as a productive member of that society. The fact that not all of the trends were not in total agreement illustrates the need for continuous improved school services. It also illustrates that the needs of youth constantly change and that programs are modified to meet the needs. Never the less, in analyzing the views as expressed by the committee and commissions that assessed the purpose of general education as follows:

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[9] Ibid., p. 131.

[10] The Committee for the White House Conference on Education, A Report to the President, (Washington: Government Printing Office, 1956), pp. 8-9.

1. To develop each individuals abilities to its maximum.

2. Civic and social responsibility.

3. To stimulate and encourage ethical, spiritual values and moral character.

4. Stimulate critical and rational thinking.

5. Economic values

6. Whomesome leisure time activities.

7. Command of fundamental processes.

8. Vocational efficiency.

9. Worthy home membership.

10. Reverency for those things that are good and beautiful in life.

11. Organized recreational, personal hygiene and health activities.

INDUSTRIAL ARTS A PART OF EDUCATION

General education covers the total educational program in the secondary high schools. However, education today is departmentalized. Each department in the school has specific objectives that support the major objectives. This was done because of the complexities due to progress and demands that society placed on the educational system.[11]

Today's educators are confronted with many problems brought on by technological development. It is the basis for our high standard of living and it should be interpreted to today's youth. Youth must understand how technology effects society and the limitations and handicaps

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[11] Gordon O. Wilber, Industrial Arts in General Education, (Scranton: International Textbook Company, 1959,) p. 1.

it has on man as an individual.

The handicraft era previously performed in the home, has been moved. This addition to general education is not called industrial arts. Nair expressed the importance of industrial arts to general education as follows:

> The acceptability of industrial arts has been justified in part by its continuous growth and integration within the educational process. This progress has been made as a subject matter field in its own right in becomming a part of general education. Industrial arts is vital to the education picture, since it teaches the application of the arts and sciences of our fast moving contemporary culture through experiences with tools, materials and processes. As the world of tomorrow increases in mechanization, so will the need for industrial arts as a part of general education.[12]

The range and depth of industrial arts programs depends, upon course objectives and the type of industries in the area.

Many authorities in the field have expressed numerous and varied views as to the purpose of industrial arts. However, accordingly to Geachind and Gallington, the purpose of industrial arts is as follows:

> 1. To provide experience in correctly performing operations involving basic industrial hand tools and common machines.
>
> 2. To acquaint the students with the various fields of industry, including the materials, products, and employment opportunities.
>
> 3. To develop desirable work habits and ability to work cooperatively.
>
> 4. To develop safety habit with individual hand tools and common machines.

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[12] Ralph K. Nair, "Evolution of Industrial Arts," Planning Industrial Arts Facilities, (VIII Yearbook of American Council on Industrial Arts Teacher Education. Bloomington, Illinois: McKnight and McKnight Publishing Company, 1959), p. 1.

5. To develop an appreciation of good craftsmanship.

6. To provide opportunities that satisfy creative desires.

7. To develop the ability to think rationally, to plan shop work wisely, execute plans effectively, and appraise finished products intelligently.

8. To develop the ability to select and use wisely the products of industry.

9. To develop ability to select and use wisely the products of industry.

10. To develop a basic understanding of labor-management-consumer relationship in our industrial society.[13]

The views and concepts expressed by numerous authorities on the purpose of industrial arts are all emphasizing the ability of students to understand industry, use tools, materials, and to coordinate these into useful projects.

The objectives listed further illustrate the importance of industrial arts in general education. Industrial arts is not a special subject but an established phase of the total educational program.

Industrial arts objectives cover the full range of the program. There are specific phases of the program whose objectives support the objectives of both industrial arts and general education.

## PURPOSE AND CONTRIBUTIONS OF THE METALWORK PROGRAM

Metalwork education one of the specific areas in the industrial

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[13] W. F. Geachind and Gallington, Ralph O., Industrial Arts and Vocational Education, (Chicago: American Technical Society, 1961), pp. 70-71.

arts program is designed to give pupils an understanding and appreciation of metal products, tools and materials.

In the United States, our standard of living rests on the progress that has been made in improving metal products on this vast industry. The American industry is best expressed by Olsen when he stated that:

> The people who run today's American industry believe that what man can conceive, industry can produce. With this spirit, nothing seems impossible ... In the United States we have 80 percent of the world's automobiles, we have 50 percent of the radios and 60 percent of the telephones. No where else can one live so easily, comfortable and healthy. Why is all of this possible? The answer lies largely in the nature of our people. . . We are free to invent and discover new things. The drive is always for something better. This keeps our technology changing. The key to American industrial development is the constant search for better materials, processes, and products. . . .[14]

Metalwork education, probably one of the most important and recent additions to the industrial program, has been interpreted by many authorities to express many different viewpoints.

The purpose of the metalwork educational program as expressed by Ferier and Lindbeck is as follows:

> It teaches students about the metalworking industry including the source of raw materials how they are processed, how metal products are designed and produced, and how people can earn a living in metalworking. It is a study of our most valuable raw material used in our largest manufacturing industries.[15]

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[14] Olson, Kelmar W., Industrial Arts for the General Shop, (Englewood Cliffs: Prentice-Hall Inc., 1961), p. 1.

[15] Ferier and Lindbeck, op. cit., p. 3.

1. It teaches students how to design, plan and carry through a project. It encourages problem solving. With the aid of tools, materials used in metal work.

2. It teaches basic hand and machine skills that are useful to every one regardless to his vocational aim in life.

3. It encourages students to develop their own talents and interest as they relate to metals both vocationally and advocationally.[16]

In contrast to metalwork objectives there are specific course objectives. The specific objectives support the general educational objectives, of all citizens in a democratic society. The needs of today youth multiplies as the nation progresses. This progress must be interpreted into meaningful educational programs. To interpret all elements of society, the educational programs just have reasonable objectives that encourage everything in society and help the student in the understanding and adjustment that would fulfill such objectives.

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[16] *Ibid.*, p. 3.

# CHAPTER III

## DEVELOPING COURSE CONTENT FOR MACHINE METALWORKING I AND II

Machine Metalworking I and II are advanced and tentatively approved specialized courses in the secondary high schools of Texas. Both courses function as a part of industrial arts machine metalworking program.

Machine Metalworking I being the first of the two specialized courses is designed to give students an opportunity to develop skills in the use, appreciation and understanding of basic machine metalworking principles. The prerequisite for this course is General Metalworking.

Course criteria for Machine Metalworking I calls for students to utilize basic machine tools in all project construction. This course should also include related technical information, which is vital to the understanding and assembling of projects. Related information will not be developed in the thesis. The writer feels that it should be developed in another study.

Machine Metalworking II, an area of specialization is designed to give students an opportunity to develop precision skills in the use, appreciation and understanding of machine tools. This course was initiated for students who wanted to specialize. The prerequisite for Machine Metalworking II is Machine Metalworking I.

Course criteria and operational procedure call for very close tolerances in all project construction. In addition, the student must utilize all machine metalworking equipment and related technical information necessary in the construction of the project. Thus providing an opportunity for predetermined experiences to become more obtainable and a reality.

## GENERAL CHARACTERISTICS OF THE METALWORKING INDUSTRY

To understand metalwork one must understand the basic principles involved in the shaping or working of metals.

Metals, after being extracted from their ores, are shaped or formed by many basic processes before securing a finished product. These basic principles occur in both commercial and production, large and small shops.

Metalwork principles have been expressed by many authors, some general and others more specific. However, basic principles of metalwork as stated by Rusinoff were as follows:

> Metal processing may be divided into four types of operations. Namely casting, hot working, cold working and machining.[1] (Casting is achieved by) ... pouring molten metal into the prepared mold. When the metal has solidfied, the casting is shaken out of the mold and sent on for further processing.[2] Hot working, the mechanical working of metal at temperatures sufficiently high to keep them in a state of plasticity ... some commonly practiced

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[1] S. E. Russinoff, Manufacturing Processes, (Chicago: American Technical Society, 1962), p. 323.

[2] Ibid., p. 10.

> operations of this nature are rolling forging, upsetting, drawing, extracting, piercing pipe welding, and swaging.[3] Cold working, metal is usually done at room temperature but, for steel the temperature mat ascend to a point somewhat below the critical range ... metal cold-forming operations may usually be identified with one, another of these work operations, rolling, drawing forging, upsetting, extracting, spinning, snaging and press operations.[4] Machining operations consist of removing the metal chips to produce a small surface which assures proper fit of the matching part, within the tolerances specified. The type and size of chips removed by machining depends upon the materials of which the part and the cutting tool are composed.

The writer, however, is only interested in further persuing only one aspect of the four basic principles of machining.

Man has perfected many devices in metalworking. Even automobiles were made by hand labor. Earlier methods were time consuming, tolerances were problems and electrical power was inadequate. Glover and Cornell stated that:

> The ability to make metal products with machines instead of by hand, including the making of machinery itself with machines, was one of the most important of the revolutionary accomplishments that marked the transition into the industrial era. It ushered in the greatest period of technical advancement and brought the world the highest standard of living it has yet known.[5]

The earlier development of machine tools was slow. However, as Dr. Dexter S. Kimball of Cornell University has put it, the machine tools are "the master tools of industry."[6]

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[3] Ibid., pp. 156-157.

[4] Ibid., p. 130.

[5] John G. Glover and William B. Corness, The Development of American Industries, (New York: Prentice-Hall, 1941), p. 55.

[6] Ibid., p. 55.

Machine tools being the basis for success in the metalworking industry, is often classified in terms of the nature of the work performed.

The definition for a machine tool varies, however, the characteristics were more in agreement, also the basic machines that constitute the machine tool group. However, accordingly to Ludwig, a machine tool is defined as follows:

> A machine tool is a power driven machine that shapes metal by cutting thin strips or pieces of metal called chips. The characteristics of machine tools are:[7]
>
> 1. Hold the work.
> 2. Hold the cutting tool.
> 3. Drive either the cutting tool or the work.
> 4. Feed wither the cutting tools into the work or the work into the cutting tool.[8]

The nature of the machine metalworking is characterized by the type of equipment used. Although, there were many variations combinations and overlapping in some operations most of the equipment used is designated as being machine tools.[9] However, the basic machines that constitute the machine group are:

1. Drill press
2. Lathe
3. Milling machine
4. Shaper
5. Precision grinder

The success of machine metalworking and our higher standard of

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[7] Earl A. Lundwig, Metalwork Technology and Practice, (New York: McKnight and McKnight Publishing Company, 1962), p. 455.

[8] Ibid., p. 455.

[9] Glover, op. cit., p. 558.

living is due primarily to the technological progress made in the development of other machine tools from the basic machine.

Machine metalworking in industry has become the process by which thousands of accurate and precision parts are made. Most castings and other methods of forming metals have to be machined in order to achieve the closest possible tolerances. As stated earlier in the chapter machine tools may vary but the basic principles of machining are common to all machine tools. Glover expressed the five basic arts of machining metals as follows:[10]

> 1. Milling, which consists of machining a piece of metal by bringing it into contact with a rotating cutter with multiple edges.
>
> 2. Planning, which consists of machining a surface by moving the work back and forward under a stationary cutting tool. This classification includes shaping, in which the tool moves in a straight line over a stationary piece of work.
>
> 3. Turning, which consists of shaping a rotating piece by means of a cutting tool, thus generating a cylidercal surface. This process is exemplified by the ordinary lathes...
>
> 4. Drilling or boring, which consists of cutting, enlarging, or finishing a round hole by means of a rotating cutting tool. . .
>
> 5. Grinding, which consists of shaping a piece by bringing it into contact with a rotating abrasive wheel. . .[11]

The five basic arts of machine metals introduced some special machine tools along with according definitions for each machine within

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10 Ibid., p. 558.

11 Ibid., p. 558.

the machine tool group. As stated earlier there may be many variations and combinations, but the basis machine tools shall remain constant. Therefore, the basis for establishing a program for Machine Metalworking I and II is a machine metalworking which is expressed by the use of machine tools.

## MACHINE METALWORKING I COURSE CONTENT

In order to put this phase of the thesis in its prospective it is necessary to bring into the picture general metalworking. In general metalworking a student is not achieving a high degree of specialized skill. He receives a general knowledge concerning all aspects of the total metalworking program, and the use of the machine tools are limited.

In as much as Machine Metalworking I is a specific course in the industrial arts program and with general metalworking as a prerequisite, a student may become highly proficient in the use of the machine tools.

The machine tools utilized in each course are expressed as follows.

TABLE I

MACHINE TOOLS UTILIZED IN MACHINE METALWORKING I

| Machine Tools | General Metalworking | Machine Metalworking I |
|---|---|---|
| Lathe | X | X |
| Drill Press | X | X |
| Horizontal Milling Machine | X | X |
| Shaper | | X |
| Total | 3 | 4 |
| Percentage | 60 | 80 |
| Grade Level | 9-12 | 10-12 |

General metalworking being the prerequisite of Machine Metalworking I utilizes three pieces of the total number or 60 percent of the machine tools. Machine Metalworking I as stated earlier is a specific course and therefore, should utilize more of the basic machine tools. Thus in Machine Metalworking I 80 percent of the total number of basic machine tools are to be utilized.

In assessing course content for Machine Metalworking I the writer could not find any hard lines to follow. However, being a specific course students are afforded an opportunity to develop skill in the use, understanding and appreciation of machine tools, materials, and metal processes of machining metal. Where as in General Metalworking students are afforded an opportunity to develop skills in the use, understanding and appreciation of machining metalworking principles.

A. Subject Matter Material

I. Drilling Machines

A. Introduction

1. Types of drilling machines
2. Parts of the drilling machine
3. Sizes of drilling machines
4. Drill press construction

B. Drills

1. Types of drills
2. Parts of drills
3. Materials from which drills are made
4. Sizes of drills
5. Measuring drills
6. Sharpening drills
7. Drill clearance angles
8. Drill selection
9. Drill points for different materials

C. Work-holding devices

1. Drill press table vices
2. V-blocks and clamps
3. T-bolts
4. Strap clamps
5. Step blocks
6. Angle plates
7. Parallels
8. Drill gigs
9. Fixtures

D. Drill holding devices

1. Type of drill shanks
2. Drill chucks
3. Drill press spindles
4. Sockets and sleeves
5. Drift keys
6. Drill stops
7. Use of tool maker buttons

E. Speeds and feeds

1. Speed conversions
2. Cutting speeds
3. Cutting feeds
4. Speeds and feeds of twist drills

F. Drill press operations

1. Drilling holes
2. Boring
3. Reaming
4. Center drilling
5. Counterboring
6. Countersinking
7. Spotfacing
8. Tapping
9. Polishing
10. Grinding
11. Drilling with trist drills

G. Drill press table manipulation

1. Vertical adjustments
2. Angle adjustments

H. Cutting oils and coolants

1. Cutting oils
2. Coolants

I. Drill press safety

1. Hold work securely
2. Wear correct clothing
3. Wear proper goggle
4. Use sharp drills

II. The Metal Lathe

A. Introduction

1. Basic machine of industry
2. Function of the lathe
3. Function of the lathe parts
4. Types of lathes
5. History and development
6. Importance of the metalworking lathe to society
7. Cleaning, oiling and maintenance of the lathe
8. Coolants and cutting lubricants
9. Leveling of the lathe
10. Mechanical features
11. Lathe classifications
12. Lathe sizes

B. Lathe cutting tools

1. Shapes of cutting tools

2. Composition of cutting tool blanks
3. Parts of the cutting tool
4. Types of cutting tools
    a. Carbon steel
    b. Cemented
5. Clearances on cutting tools
6. Right and left hand cutting tools
7. Grinding of cutting tools

C. Cutting speeds and feeds

1. Cutting speeds
2. Calculating cutting speeds
3. Feeds
4. Depth of cut
    a. Rough
    b. Finished
5. Simple gear trains
6. Gear box

D. Name and function of the basic lathe accessories

1. Three jaw chuck (universal)
2. Four jaw chuck
3. Collects and draw-bars
4. Lathe cutting tool holders
5. Jacob chuck
6. Lathe dogs
7. Face plates
8. Lathe centers
9. Lathe stops
10. Lathe rests

E. Measuring Instruments

1. Micrometers
    a. Inside
    b. Outside
    c. Depth
2. Calipers vernier
    a. Inside
    b. Outside
3. Fixed gage
4. Block gage

F. Lathe operations

1. Facing
2. Parting
3. Center drilling

3. Center drilling
4. Cylinderical turning
5. Taper turning (off setting tailstock method)
6. Countersinking
7. Turning between centers
8. Boring
9. Reaming
10. Spherical turning
11. Knurling
    a. Kinds of knurls
    b. Alignment of cutters
    c. Lubrication
    d. Speeds and feeds
12. Turning shoulders
13. Filing
14. Polishing
15. Burnishing
16. Machine tap and die threading
17. Chuck work
18. Drilling
19. Turning
20. Expansion of metal between centers
21. Turning an angle

G. Mounting and removing chucks

H. Coolants and cutting lubricants

1. Classes of cutting fluids
2. Materials to be cut

I. Lathe belts

J. Lathe safety

K. Research and development

III. The milling machine

A. Introduction

1. History and development
    a. Mills of the past
    b. Mills of the present
    c. Mills of the future

2. Kinds of milling machines
    a. Horizontal
    b. Plain
    c. Universal
    d. Manufacturing
    e. Knee and column

B. Parts of the milling machine

1. Table
2. Spindles
3. Overarm
4. Knee and column
5. Saddle
6. Feed and speed control levers

C. Milling cutters

1. Type of cutters
2. Classification of cutters
3. Mounting cutters
4. Kinds and use of cutters
    a. Plain milling
    b. Side milling
    c. Half side milling
    d. Angular cutter
    e. Metal slitting saw
    f. End milling
    g. Face milling
    h. Formed milling
    i. T-slot milling
    j. Dovetail milling
    k. Woodroff keyseat
    l. Radius cutter
    m. Fly cutter
    n. Stagger tooth
    o. Slab milling cutter

D. Methods of cutter rotation

1. Conventional or up-hill climbing
2. Climbing or up-milling

E. Cutter holding devices

1. Arbors
2. Draw-in-bar
3. Installation and removal of cutters and arbors on horizontal milling machines
4. Installation and removal of cutters and arbors on vertical milling machines

F. Work holding devices

1. Kinds of vises
    a. Flanged
    b. Swivel
    c. Universal
    d. Rotary

2. Placement of table
3. Use and care of vices
4. Simple jigs and fixtures

G. Placement of cutter over material

1. Use of edge finder
2. Use of mill wiggler
3. Use of dial indicator

H. Cutting speeds and feeds

1. Cutting speeds
   a. Calculating cutting speeds
   b. Depth of cut

2. Feeds

   a. Calculating feeds
   b. Table manipulations
      1) Automatic
      2) Standard

I. Milling operations

1. Face milling
2. Peripheral milling
3. Milling flat surface
4. Squaring stock
5. Side milling
6. Straddle milling
7. Sawing
8. Boring
9. Drilling
10. Slotting
11. Milling keyways
12. Step milling

K. Milling machine lubrication and cutting fludis

L. Milling machine safety

M. Research and development

IV. The shaper

A. Introduction

1. History of development
2. Shaper construction
3. Parts of the shaper

4. Shaper size
5. Kinds of shapers
6. Other planning machines
7. Shaper safety

B. Shaper cutting tools

1. Kinds of cutting tools
   a. Kinds of cutting tools
   b. Clearance angles
   c. Tool grinding
   d. Cutting tool shapes

2. Tool holding devices
   a. Universal tool holders
   b. Lathe tool holders

C. Working holding devices

1. Clamps
2. Blocks
3. Angle plates
4. Planner jack
5. T-bolts
6. Swivel vice
7. Universal vice
8. Parallels

D. Cutting speeds and feeds

1. Cutting speed
   a. Kind of material
   b. Desired finish
   c. Depth of cut

2. Cutting feed
   a. Kind of material
   b. Desired finish
   c. Depth of cut

E. Table adjustments

F. Ram adjustments

G. Head adjustments

H. Precision measuring devices

1. Dial indicator
2. Micrometer collars

I. Shaper operations

1. Machining a horizontal surface
2. Machining a vertical surface
3. Machining an angular surface
4. Machining a contour or form material
5. Machining square stock
6. Machining keyways
7. Squaring stock

J. Research and development

## MACHINE METALWORKING II COURSE CONTENT

Machine Metalworking II is similar to Machine Metalworking I. However, in Machine Metalworking II, students are to utilize and develop a high degree of proficiency in multi-machine tool operational skills. The project selections are of high quality requiring precise accuracy in all places of machining.

Students enrolled in this course are to utilize all of the basic machine tools which include the drill press, lathe, horizontal milling machine, vertical milling machine, shaper, and precision surface grinder.

In assessing the contents for this course the writer has taken basic machine tool metalworking principles and transformed the functions and operations into teaching units that are adapatable to school laboratories.

The writer feels that the drill press would not be included in this phase of the course. This was done because the operations and experiences learned in General Metalworking and continues in Machine Metalworking I should have become standard practice at this point. It should be further emphasized that the drill press is utilized in all types of machine work and like the pedistor grinder has become perhaps one of the most common machines in the shop. The following is the Contents for Machine Metalworking II.

I. The lathe

A. Introduction

1. Lathe history
2. Types of lathes
3. Lathe functions
4. Importance of the lathe in industry
5. Parts of the lathe
6. Care of the lathe and personal safety

B. Lathe cutting tools

1. Kinds of cutting tools
2. Cutting tool shapes
3. Cutting tool efficiency
4. Forces acting upon the cutting tools
5. Clearances on lathe cutting tools
6. Cutting tool design
7. Parts of the cutting tool

C. Cutting speeds, feeds and depth of cut

1. Cutting speeds
2. Power carriage on quick change gear lathes
3. Speeds of pulleys and gears
4. Power carrige on semi-automatic lathes
5. Revolutions per minut (rpm)
6. Cutting speed calculations
7. Cutting feeds
8. Multiple gear trains
9. Depth of cut

D. Name and function of the basic lathe accessories

1. Mandrels
2. Steady fests
3. Follow rests
4. Grinder attachment
5. Milling attachment
6. Independent chuck
7. Universal chuck
8. Jacob chuck

9. Stop blocks
10. Draw in collets
11. Spacing attachment
12. Taper attachment
13. Boring block

E. Precision measuring devices

1. Micrometer
    a. Inside
    b. Outside
    c. Thread
    d. Depth

2. Caliper (vernier)
    a. Inside
    b. Outside
    c. Depth

3. Fixed gages
4. Block gages
5. Sine-bar
6. Bevel protractor with vernier
7. Dial indicator

F. Lathe operations

1. Facing
2. Cutting off stock
3. Drilling
4. Reaming
5. Boring
6. Turning angles
7. Turning between centers
8. Centering stock
9. Knurling
10. Straight turning
11. Tap and die work
12. Polishing
13. Threading
    a. Standard thread forms
    b. Common taper standards
    c. Multiple thread cutting
14. Milling
15. Grinding
16. Eccrentic turning

G. Work holding devices

1. Chuck
    a. Independent (4-jaw)

b. Universal (3-jaw)
c. Mounting and removing chucks

2. Draw in collets
3. Face plates and dogs
4. Weights for counterbalancing face plate work
5. Mandrels
6. Arbors
7. Rests
   a. Steady
   b. Follower
8. Clamping devices (face plates)
9. Jigs and fixtures

H. Cutting oils and coolants

I. Research and developments

II. The milling machine

A. Introduction

1. Importance of the milling machine in industry
2. Name and function of milling machine parts
3. Care of milling machine
4. Classification of milling machines

B. Milling cutters

1. Type of cutters
2. Classification of cutters
3. Kinds and use of cutters
4. Work efficiency
   a. The machine
   b. The cutter
   c. The size and shape of work
   d. The finish desired
   e. The feed and speed of milling cutters
   f. Type of cutter teeth
      1. Saw
      2. Formed
      3. Inserted
5. Milling cutter material
   a. Tool steel
   b. Cast steel
   c. Sintered or cemented carbide
   d. Stellite
6. Cutter selection
7. Centering the cutter
   a. Edge finder
   b. Mill wiggler

c. Dial indicator
d. Paper

8. Sharpening cutters
9. Locating cutter central
10. Cutter manipulation
11. Special cutters
12. Cutter rotation
    a. Forward
    b. Reverse

C. Cutter holding devices

1. Standard end spindle
2. Draw in bolts
3. Milling arbors
4. Collet for taper-shank mills
5. Brown and sharp cam lock
6. Screw on cutters and arbors

D. Speeds and feeds

1. Cutting speeds
    a. Type of stock
    b. Depth of cut
2. Cutting speed calculations
3. Cutter lubrication
4. Feeds
    a. Depth and length of cut
    b. Type of stock
    c. Direction of feed

E. Aligning work

1. Dial indicator
    a. Clamped to machine arbor
    b. Clamped to milling cutter
2. Aligning vice to arbor
3. Aligning work with column
    a. Utilizing string and paper
    b. Squaring face of angle plate with column
4. Turning the face of angle with center line if spindle using dial indicator
5. Aligning milling machine head
6. Measuring angles using dial indicator, mill table, and right angle trigonometry
7. Finding center of holes with dial indicator
8. Use of alignment tools
    a. Alignment blocks
    b. Angle plates
    c. Alignment pins

    d. Alignment straps
    e. Solid squares

F. Work holding devices

1. Kind of vices
    a. Flanged
    b. Swivel
    c. Universal
    d. Rotary
2. Divider head and foot stock

G. Milling attachments

1. Index centers
2. Raising blocks
3. Tilting table
4. Vertical spindle
5. Universal
6. Slotting
7. Indexing head
8. Gear cutting
9. Spiral
10. Adjustable center rest
11. Table vices
12. Circular or rotary milling
13. High speed rack
14. Dividing head

H. Methods of indexing

1. Simple
2. Direct
3. Compound
4. Differential

I. Indexing

1. Parts of the dividing head
2. Division problems
3. Gear cutting
4. Cam cutting
5. Other division work

J. Indexing operations

1. Milling a square of a hexagon
2. Straddle milling
3. Rotary milling
4. Drilling
5. Machining gears

6. Fluting
7. Reaming
8. Taps
9. Differential

K. Care of index head

L. Machining gears

1. Types
2. Uses
3. Gear nomenclature
4. Gear tooth parts
5. Shape of gear teeth
6. Laying out bevel gear shafts at right angles
7. Laying out bevel gear shafts at other angles
8. Claculating bevel gear teeth

M. Milling machine fixtures

1. Special mill fixtures
2. Characteristics of a good fixture

N. Precision measuring instruments

1. Micrometer
    a. Inside
    b. Outside
    c. Depth
    d. Thread
2. Vernier caliper
    a. Protractor
    b. Height gage
    c. Micrometer
3. Gages
    a. Small hole
    b. Telescope
    c. Surface
    d. Thickness
    e. Thread pitch
    f. Height
    g. Go-No-Go
    h. Depth
    i. Drill
    j. Taper
    k. Center
    l. Tool makers buttons
4. Sine bar
5. Dial indicators
    a. Tool makers dial indicator
    b. Other dial indicators

c. Use of dial indicator with height gage
d. Solid square
e. Gear tooth caliper
6. Use of layout plate with measuring instruments

O. Milling machine operations

1. Plain or slab
2. Face
3. Finish
4. Form
5. Gang
6. Direct index
7. Angular
8. Flute
9. Straddle
10. End
11. T-slot
12. Routing
13. Squaring stock
14. Sawing
15. Boring
    a. Producing holes true in roundness
    b. Producing holes exact in size
    c. Producing holes that are straight
    d. Producing holes that have a good finish
16. Drilling
17. Reaming
18. Helical or spiral (gear cutting)
    a. Types of spiral
    b. Leads of the spiral
        1. Gearing
        2. Right and left hand
        3. Setting the table
        4. Shape of cutter
        5. Circular and normal pitch
        6. Calculating gears for spiral milling
19. Cutting a slot within tolerance
20. Milling keyways
21. Locating holes on a ball circle
22. Step
23. Index and divider head
24. Other milling operations

P. Work holding devices

1. Clamping work to table
2. V-blocks
3. Up-right parallels
4. Toe-dogs and poppets
5. Milling vices

a. Flanged
b. Swivel
c. Universal
d. Rotary
6. Straps and step blocks
7. Divider head and foot stock
8. Angle plates
9. Jacks
10. Index head
11. Fixtures

Q. Milling lubrication and cutting fluids

R. Milling machine safety

S. Research and development

III. The vertical milling machine

A. Introduction

1. Use of vertical milling machines in industry
2. Name and function of machine parts
3. Core of machine
4. Machine safety

B. Vertical milling cutters

1. Face milling cutter
2. Gear cutters
3. End mill cutter
4. T-slot cutter
5. Dovetail cutter
6. Plain cutter
7. Staggard tooth cutter

C. Cutter holding devices

1. Spindles
2. Tapered arbor

D. Work holding devices

1. Table vice
2. Step blocks and clamps
3. Rotary attachment
4. Inden centers

E. Head setting

F. Speeds

G. Feeds

H. Lubrication

I. Precision measuring devices

J. Research and development

K. Jugs and fixtures

L. Vertical milling operations

1. Face milling
2. Step milling
3. Gear cutting
4. Drilling
5. Cam-milling
6. Reaming
7. Countersinking
8. Counter boring

IV. The grinding machine

A. Introduction

1. Use of grinders in industry
2. History of development
3. Name and function of grinder parts
4. Name and function of accessory parts
5. Grinding terminology

B. Types of grinders

1. Cylinderical
2. Plunge-cut
3. Form
4. Internal
5. Centerless
6. Surface
7. Tool and cutter
8. Grinding on the lathe

C. Grinding wheels

1. Component elements of grinding wheels
    a. Abraisive grain
    b. Bonding material
    c. Grade
2. Grinding wheel structure
3. Shape of grinding wheels
4. Types of grinding wheels

5. Basis for wheel selection
6. Standard wheel markings
7. Safe (rpm) of wheels
8. Handling wheels
9. Inspecting wheels
10. Storage of wheels
11. Dressing wheels
    a. Mechanical
    b. Precision
12. Placement of wheels on spindles
13. Special grinding wheels
    a. Diamonds and diamond wheels
    b. Advantages of diamond wheels
    c. Care of diamond wheels
    d. Use of diamond wheels
14. Surface speed
15. Cutoff grinding wheels

D. Work holding fixtures
   1. Surface grinder
      a. Magnetic chuck
      b. Magnetic vices
      c. Parallels
      d. Back rests
      e. Electromagnetic chuck and table
      f. Clamps and bolts
      g. Fixtures

   2. Center type cylinder grinder
      a. Centers
      b. Mandrels
      c. Fixtures

   3. Internal grinder
      a. Chuck
      b. Collet
      c. Fixtures

E. Grinding practice

   1. Setting the work
   2. Setting the wheel speed
   3. Setting the work speed
   4. Setting the depth of cut

F. Grinding machine construction

   1. Types of grinders
      a. Cylinderical
         1) Plain
         2) Roll

3) Piston

b. Plunge-cut

1) Ordinary plunge-cut
2) Crank pin
3) Cam shaft
4) Piston

c. Form

1) Ordinary
2) Thread
3) Gear

d. Internal

1) Chucking
2) Planetary-spindles

e. Centerless

1) External
2) Internal

f. Surface

1) Horizontal spindle
2) Vertical spindle

2. Grinding terminology

G. Grinder operations

1. Cylinderical
2. Shoulder
3. External surfaces
4. Internal surfaces
5. Face
6. Cutter sharpening (including single point)
7. Gear grinding
8. Taper grinding
9. Angular grinding
10. Grinding irregular surfaces

H. Grinding coolants

I. Grinder safety

J. Research and development

V. The shaper

A. Introduction

1. History of development
2. Shaper classification
3. Types of shapers
4. Industrial applications
5. Shaper lubrication
6. Shaper safety

B. Shaper cutting tools

1. Types of cutting tools
2. Cutting tool parts
3. Grinding cutting tools
    a. Clearance angles
    b. Cutting tool shapes

C. Shaper tool holders

1. Regular lathe tool holders
2. Extention tool holders
3. Universal tool holders

D. Shaper work holding devices

1. Vices
2. Parallels
3. Angle plates
4. Shims
5. Toe-dogs
6. Index centers
7. T-bolts and clamps
8. Use of T-slots
9. Braces
10. Poppets
11. Hold downs

E. Shaper speeds, feeds and depth of cut

1. Cutting speeds
    a. Cutting speed calculations
    b. Adjusting stroke length
    c. Types of materials to be cut
2. Feeds
    a. Cutting feeds
    b. Amount of material to be removed
3. Depth of cut

F. Head setting

1. Horizontal cuts
2. Vertical cuts
3. Angular cuts
4. Cutting rectangular blocks or squares

G. Accuracy of work

1. Use of dial indicator
2. Use of try squares
3. Use of shims
4. Scrape vice faws
5. Use of protractors

H. Table manipulations

I. Shaper operations

1. Shaping flat surfaces
2. Shaping irregular surfaces
3. Squaring material
4. Cutting slots and keyways
5. Shaping dovetails
6. Finishing square shoulders
7. Shaping tongue and grooves
8. Spline shaping
9. Cutting material to dimension

J. Shaper safety

K. Research and development

# CHAPTER IV

## DEVELOPING A LABORATORY FOR MACHINE METALWORK I AND II

Industrial arts, being a function of general education must be current in order to effectively fulfill its purpose. The needs of the individual and the objectives of school programs change probable because of our expanding and complex economic structure. However, the main purpose for change in school objectives seem to develop within each individual those innate abilities, and to help that individual, through educational channels, to become a productive citizen in a democratic society.[1]

Industrial arts cannot properly function in an atmosphere that is not conducive to learning. Industrial arts laboratories should be well planned; for the comforts of both students and teachers. The planning should rest on sound objectives and provisions must be made for accomplishing those present and future goals.[2]

The laboratories for industrial arts activities goes beyond the normal plan of building for other parts of the school plant. These laboratories draw their subject matter material from industry. Industry through research and development designs, improves and markets

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[1] Gordon O. Wilber, Industrial Arts in General Education, (Scranton, Pennsylvania: International Textbook Company, 1952), p. 9.

[2] School Shop Staff, Principles of Good Shop Planning, Modern School Shop Planning, (Chicago: Proffins Publications, 1955), p. 16.

for public consumption, better goods everyday. This forces industrial arts to coordinate a large percentage of new materials and concepts into laboratory experiences for school use.[3]

Industrial arts courses are exploratory in nature, however, the breadth and depth of instructional material and problem solving is important to today's youth. To many of today's youth, tommorrows work experience shall have its beginning from a strong desire to construct and create. Both of these are desires within the student and are satisfied through his ability to construct and develop a satisfactory project.[4]

To meet and challenge the innate ability of youth and construct and stimulate creative thinking, school laboratories must be constructed and planned in such a manner that would seem to provide an atmosphere that is favorable to actual learning situations.

Huss states that "the current trend in principles of laboratory planning demands physical facilities providing for flexibility and versatility."[5]

School laboratories will vary in size and construction in different parts of the country. Many vary because of requirements in

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[3] Wilber, op. cit., p. 21.

[4] Ibid., p. 23.

[5] William E. Huss, "Principles of Laboratory Planning," Planning Industrial Arts Teacher Education, (Bloomington, Illinois: McKnight and McKnight Publishing Company, 1959), p. 48.

complying to state, local and federal building codes. When planning, situations are not in agreement there should be some priority principles that should assist in planning or determining a more practical laboratory. These principles are safety, instructional, efficiency, industrial and practical. The planning principles should be considered in the order listed.[6]

The primary responsibility of school plants is delegated to the superintendent of schools and his staff. The staff should be specialists in the field and should acquaint themselves with laboratory planning and class activity.[7]

GENERAL INFORMATION IN LABORATORY PLANNING

In laboratory planning, there are various standards adhered to by many authorities. Many of such standards are influenced by climate and areas of the country in which objectives, class activity, individual safety and others.

The writer could find no hard lines to follow in assessing general laboratory planning principles. The probable reason for this could be a more modern facility that utilizes modern sound absorbing materials and heating and air conditioning systems.

Nevertheless, the following is a list of standards that are to be considered and adhered to in a normal planning situation. As stated

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6 Ibid., p. 48.

7 School Shop Staff, "Planning the New School Shop," Modern School Shop Planning, IV Edition, (Chicago: Prokkens Publications, 1965), p. 13.

at the beginning of this topic, these standards will vary depending upon areas of the country and the climate in which the school is located.

| Space Standards | Standard |
|---|---|
| Minimum height of ceiling | 15' |
| Minimum width of shop | 30' |
| Minimum proportion of length to width | 1:1½ |
| Maximum proportion of length to width | 2:1 |
| Minimum floor space per student | 70 square feet |

| Floor Standards | |
|---|---|
| Laboratory floor | Concrete |
| Classroom floor | Concrete |

Wall Standard

When possible walls should be constructed to allow for versatility.

| Light Standard | |
|---|---|
| Lighting in the laboratory | 50' candles |

| Electrical Standards | |
|---|---|
| All motors and wall outlets | 3 phase |

| Plumbing Standards | |
|---|---|
| Drinking facilities | One fountain per 25 students |
| Washing facilities | One station per 10 students |
| Location of air compressor | Outside the shop |

| | |
|---|---|
| Exhaust system | Each area served by separate systems (overhead) |

<u>Heating System</u>

| | |
|---|---|
| Shop temperature | $68^{\circ}$ F. |
| Relative humidity of shop | Summer 50 percent, Winter 90 percent |

These are only a few of the major aspects of shop planning. These and many other monor planning principles will vary as stated earlier. However, these standards are to be considered in planning a Machine Metalworking I and II laboratory.

It is hoped that other industrial arts facilities can be planned in a similar manner.

## EQUIPING THE LABORATORIES

Machine Metalworking I and Machine Metalworking II are similar in nature, and where permitted should utilize the same laboratory facilities. However, in other instances such as a small school, the only specialized course in machine metalworking would be Machine Metalworking I. General metalworking would still be a prerequisite. But if student enrollment is large enough, machine Metalworking II and other advanced courses would function in the same laboratory at alternate periods.

In equiping the laboratory for Machine Metalworking I and II, two general categories are to be utilized. Power tools would include the machine tools and other equipment that uses electric current as a source of power.

The machine tools to be utilized in both courses are to include all attachments when ordered. The writer will only select the size and quantity desired. Specific names of equipment and tools are to be determined by the planning committee or those individuals so appointed. The writer suggests that only proven name brands be used or selected.

| Power Tools | Quantity | Size |
|---|---|---|
| 1. Engine Lathe | 7 | 13" |
| 2. Engine Lathe | 1 | 16 |
| 3. Drill Press | 1 ½" chuck | 14 |
| 4. Drill Press | 1 3/4" chuck | 16 |
| 5. Milling Machine (horizontal) | 1 Semi-automatic | 32" table |
| 6. Milling Machine (vertical) | 1 Semi-automatic | 32" table |
| 7. Surface Grinder | 1 | 8"x24" |
| 8. Band Saw | 1 | |
| 9. Pedestal Grinder (Floor) | 1 | 10" |
| 10. Pedestal Grinder (bench) | 1 | 6" |
| 11. Hack Saw (power) | 1 | 18" blade |
| 12. Cut off Saw Grinder | 1 | 8" wheel |
| 13. Drill (portable) | 1 | 0-3/4 chuck |

| Hand Tools | Quantity | Size |
|---|---|---|
| Anvil | 1 | 150-165 |
| Hammers | | |
| Ball Peen | 12 | 16 percent |
| Sledge | 1 | 4165 |
| Soft face | 4 | |
| Chipping | 2 | |
| Press | | |
| Arbor | 1 | |
| Hydrallic | 1 | |

| Hand Tools (Continued) | Quantity | Size |
|---|---|---|
| Punches | | |
| Center | 6 | ½" shank |
| Prick | 1 | ½" shank |
| Vices | | |
| Combination Swivel Base | 8 | 4½" |
| Combination Swivel Base | 4 | 8" |
| Chisels | | |
| Cold | 8 | ½ |
| Cold | 2 | 3/4 |
| Cope | 6 | ½ |
| Files | | |
| Round | 6 | 5/16 |
| Mill Smooth | 12 | 12" |
| Sgvarf Bastard | 12 | 12" |
| Triangular | 12 | Assorted |
| Rulers | | |
| Tape | 1 | 6' |
| One foot Flexible | 12 | 8ths, 16ths, 32nds, 64ths |
| Drills | | |
| Counter Sinkers (set) | 12 | 3/16"-7/8" |
| Drill Set (twist) | 1 | |
| Counter broe (set) | 1 | 3/16"-7/8" |
| Drill Set Tapered Shank | 1 | |
| Reamers | | |
| Hand (tapered) | 4 | 7/16 |
| Machine | | |
| Holding Devices | | |
| C-Clamps | 12 | 6" |
| C-Clamps | 8 | 4" |
| Parallel Clamps | 8 | 6" opening |
| V-Clamp | 24 (sets) | 7/8" opening |
| Table Vices - Carillaress | 2 (sets) | 3" Maximum |
| Step Blocks and Clamps | 2 (sets) | 6" opening |
| V-Blocks and Clamps | 6 (sets) | 1½x1½ |
| Goose Neck Clamp | 3 | Small |
| Vise grip Clamp | 6 | 1½ R |

| Hand Tools (Continued) | Quantity | Size |
|---|---|---|
| **Gauges** | | |
| Plug Gauges | 4 | |
| Ring Guages | 4 | |
| Snap Guages | 4 | |
| Telescope Gauge | 7 (sets) | Set Standard Comb. |
| Screw Pitch Gauge | 3 | Set Standard Comb. |
| Center Gauge | 4 | Set Standard Comb. |
| Thickness Gauge | 3 | 31" |
| **Precision Measurement Equipment** | | |
| Micrometer | 4 | 1" |
| Micrometer | 2 | 2" |
| Micrometer depth | 2 | 6" |
| Vernier Protractor | 2 | |
| Speed Indicator | 2 | |
| Sine Bar | 2 | |
| **Lay Out Tools** | | |
| Combination Set | 6 | 18" ruler |
| Scribers | 12 | Steel Shank |
| Trammel Set | 2 | |
| Dividers | 12 | 10" |
| Layout Die | 1 gal. | |
| Tri square | 8 | |
| Soap Stone | 8 boxes | |
| Surtace Gaye | 9 boxes | |
| Surtace Plate | 3 boxes | |
| **Celipers** | | |
| Outside | 8 | 6" |
| Inside | 12 | 6" |
| Hermoidite | 3 | |
| 3 Ear Tooth | 4 | |
| **Wrenches** | | |
| Socket (set) | 1 | $\frac{1}{2}$-1" |
| Allen Wrenches (set) | 1 | 1/16"-7/16" |
| Spennet Hook | 1 | $1\frac{1}{4}$ Opening |
| Cresent | 16 | $1\frac{1}{4}$ Opening |
| Monkey | 2 | 5" Opening |
| Stilson | 1 | 3" Opening |
| Open End Set | 1 | |

| Hand Tools (Continued) | Qauntity | Size |
|---|---|---|
| Screw Drivers | | |
| Regular | 6 | 8" |
| Phillips | 4 | 8" |
| Off Set | 2 | 6" |
| Pliers | | |
| Chain | 3 | |
| Combination | 8 | 10" |
| Needle Nose | 4 | 8" |
| Diagonal | 3 | 8" |
| Vise Grip | 6 | $1\frac{1}{2}$" R |
| Drill Sharpener Attachments | | |
| Stamping Set (numbers) | 1 | (9-10) $\frac{1}{4}$" |
| Stamping Set (Alphabets) | 1 | (A-Z) $\frac{1}{4}$" |
| Tongs | | |
| Straight Lip | 4 | 18" |
| Curven Lip | 4 | 18" |
| Ese Out Set | 1 | 1/8-5/6 |
| Hacksaw (Hand) | 12 | Adjustable |
| Quenching Tub | 1 | 15 gallons |
| Hand Forge with Blower | 1 | |
| Wire Brush | 8 | 8" handle |
| Oil Stone (Combination) | 2 | 8"x2" |
| Arc Welding Machine | 1 | 235 Amps |
| Oxy-Acetylene Welding Set Up | 1 | 50" hose |
| Belt Hook Lacer Wire | 1 | 6 hooks |
| Air Compressor | 1 | 1 hp. |
| Tip Cleaner (set) | 2 | |
| Heat Treatment Furnace (floor) | 1 | |
| Gloves | | |

| Hand Tools (Continued) | Quantity | Size |
|---|---|---|
| Asbestoes | 1 pair | 14" |
| Leather | 1 pair | 14" |
| Goggles Clear (impact) | 24 pairs | Cover eye glasses |
| Face Shield Clear (impact) | 2 | |
| Welding Apron | 2 | Medium |
| Welders Shoulder Protection | 2 | Medium |
| Oil Cans | 8 | $\frac{1}{2}$ pint |
| Stone Dresser (white) | 2 | |
| Bench Brush | 12 | 8" |

## FLOOR PLAN FOR INDUSTRIAL ARTS MACHINE METALWORKING I AND II

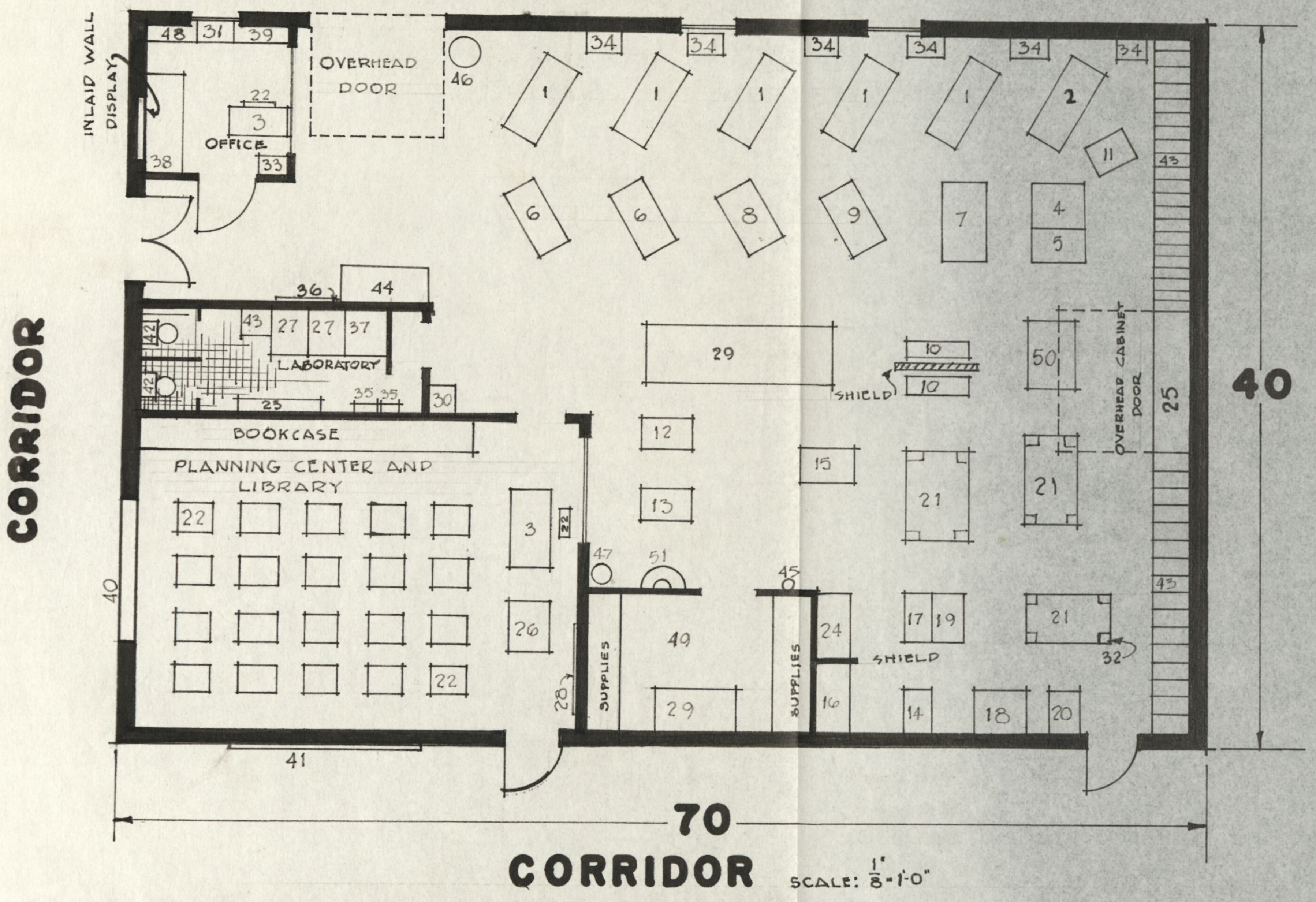
Floor plans should lend themselves to flexability, versatility and designed for individual comfort as well as mobility. Laboratory facilities should also be constructed as to permit the teacher to visualize all parts from a central location (the office).

Facilities such as planning and classroom areas should not distract teacher visability. Therefore, for these facilities sectional plate glass should be used in the construction.

The following floor plan is not intended to give the impression that it is the only possible arrangement for Machine Metalworking I and II.

The plan does, however, present practical and functional solutions for teaching both programs. The plan also is intended to present an atmosphere that is conducive to learning and teaching.

# FLOOR PLAN FOR INDUSTRIAL ARTS
# MACHINE METALWORKING I AND II




## CAPACITY 20 STUDENTS
**70 SQUARE FEET PER STUDENT**

# LEGEND

1. ENGINE LATHE 13"
2. ENGINE LATHE 16"
3. DESK
4. DRILL PRESS 16"
5. DRILL PRESS 13"
6. HORIZONTAL MILLING MACHINE
7. SHAPER
8. VERTICAL MILLING MACHINE
9. SURFACE GRINDING
10. PEDESTAL GRINDER
11. WET MACHINE SANDER
12. POWER HACKSAW
13. CUTOFF SAW
14. OXY-ACETYLENE UNIT
15. BAND SAW
16. CUTTING TABLE
17. WELDING UNIT (ARC)
18. HEAT TREATING FURNACE
19. QUENCHING TANK
20. ANVIL
21. WORK TABLE
22. CHAIR
23. LATRINE
24. ARC WELDING TABLE
25. TOOL CABINET
26. DEMONSTRATION TABLE
27. SHOWERS
28. BLACKBOARD
29. METAL RACK
30. WATER FOUNDATION
31. SINK
32. ARBOR PRESS
33. FIRST AID CABINET
34. SERVICE CABINET
35. FACE BASIN
36. WALL BULLETIN
37. HOT WATER HEATER
38. COT
39. FILE CABINET
40. WINDOW DISPLAY
41. WINDOW BULLETIN
42. WATER CLOSET
43. LOCKERS
44. SHORT STOCK
45. FIRE EXTINGUISHER
46. OILY RAG CONTAINER
47. WASTE BASKET
48. TABLE
49. STORAGE ROOM
50. TESTING TABLE
51. WASH STAND

## CHAPTER V

## SUMMARY AND CONCLUSION

Machine Metalworking I and II, an advanced program of instruction, whose subject matter has transposed from industrial machine metalworking principles into practical instructional units for use in school laboratories.

Machine Metalworking I is the prerequisite for Machine Metalworking II. Machine metalworking I affords students an opportunity to develop specialized skills in the use, understanding and appreciation of selected machine tools, materials and concepts. The machine tools that are propose for this course are the drill press, lathe, shaper and horizontal milling machine.

The writer shall make no attempt to select a method of teaching the subject matter material. However, the writer does recommend that field trips and audio-visual aids should make an important contribution to students ability to learn and retain units of instruction.

Machine Metalworking II, a more specialized area, affords students an opportunity to develop precision skills in the understanding, and appreciation of machine tools and materials that are utilized in the machine metalworking industry.

Students are to use all of the basic machine tools such as the drill press, lathe, milling machines, surface grinder, and shaper. These machine tools are by no means all of the machine tools that should be or could be utilized. The medium machine tools, their practical application to laboratories and obselence, were prime factors in making equipment selection. Schools cannot purchase large industrial equipment for laboratory. They must rely on other medias for teaching such programs. Along with a good research and development of materials, concepts of our industrial live would build a better and modern bridge between industry and the understanding of today's youth.

In the writers opinion, the floor plan supports the objectives of both courses. It may be stated that both course are to utilize the same laboratory. In some instances only one of the courses may be included. This would be determined by the student enrollment.

## CONCLUSION

The research material revealed some significant conclusions drawn from author analysis and course content for both courses.

Machine Metalworking I and II are specific and specialized courses in the industrial arts machine metalworking program. However, one is more specific than the others. Therefore, the separation of the courses is accomplished and set through course objectives and the number of pieces of machine tools utilized.

The selection of laboratory equipment and sizes that are weighed in school laboratories need not be any bulk in order to fulfill objectives. As stated in the summary, the purpose of industrial arts is not to prepare individuals for gainful employment, but to teach understanding, use and appreciation of materials and concepts. The machine metalworking courses should have breadth, and depth in all aspects of machining metals. The equipment listed in this thesis is in the writers opinion of minimum of equipment needed to adequately instruct and afford students learning experiences in machine tool operations and concepts.

The laboratory is designed for safety and comfort of the student. It is in the writers opinion practiced. The writer's opinion of a laboratory includes such auxiliary facilities as a laboratory, project storage, planning center office and library. The laboratory is to be totally air conditioned and centrally heated. The air conditioning will vary, depending upon the section of the country in which the school is located. However, central heat is standard. Nevertheless, the temperature in the laboratory should maintained between 68$^{\circ}$ and 70$^{\circ}$ in both winter and summer.

Specifics included in auxiliary facilities are as follows: lavatory should include hot and cold water, also wash basin in which the water faucets will be adjusted and then locked. Project storage lockers for each class period. In each row individual compartments are for projects. The size of these compartments is 2'x1'x1'. The extra lockers are used for adult evening classes.

Planning center and library are to include a window room display space. Chairs with arms, portable drawing boards, and the other items constitute the needed items. This facility is to be completely sound proof. That would enable various groups to use the laboratory while the other groups are utilizing the library or planning room. The walls of the planning center are to be constructed in such a manner as to permit the instructor to visualize most of the shop. This facility also has storage space for film, projector and other materials that are important to machining and related information.

The office is to be located at the front of the laboratory and shall be equiped with a sink, and a display case and other items that have become necessary.

In relation to this facility all teachers of industrial arts courses are to take first aid courses and obtain a first aid certificate. This would aid the teacher in treating small scratches and burns. More serious cuts should be reported to the school nurse if she is present. Otherwise, normal procedure should be adhered to. Other important features of this office are a file cabinet system and a telephone. The office should be sound proofed and so constructed as to allow visability throughout the laboratory.

Storage is a problem. However, this storage room is to include a rack for materials horizontially arranged by size. This room is to also include cabinets for ready supplies and assorted washes, bolts, nuts and pins. There should be space provided for spare parts or maintenance equipment.

The laboratory is equiped with an excellent exhaust system for the heat treatment area and an automatic sprinkler system that is set off tempertures of 150 degrees. This system is to include in the complete laboratory.

Laboratory equipment is to be equiped with safety guards and shields. The area around dangers should be color coded and these should be color codes for safety lines, 110 volt circuits, 220 volt circuits and movable parts of machines that may become hazardous to the student. The air compressor because of the noise should not be located in the laboratory.

The reader will note that approximately one half of the floor space in the laboratory is occupied by portable equipment. This makes future changes easy and thus increases mobility and versatility.

This laboratory offers a professional atmosphere and is designed to afford teachers an opportunity to present to the student a better organized and more efficient program of learning experiences.

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