Planning Industrial Arts Facilities

EIGHTH YEAR BOOK 1959

AMERICAN COUNCIL ON INDUSTRIAL ARTS TEACHER EDUCATION

EIGHTH YEARBOOK — 1959 — AMERICAN COUNCIL

ON INDUSTRIAL ARTS TEACHER EDUCATION

Planning

Industrial Arts Facilities

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Foreword

The problem of planning industrial arts facilities has never been greater than at the present. With an increased enrollment already engulfing the nation's schools, it is hoped that Yearbook VIII will be timely and helpful to those responsible for developing industrial arts facilities. The principles and recommendations presented in this yearbook are intended to encourage the development and upgrading of uniform basic concepts throughout the nation.

Many complex factors contribute to a desirable physical setting for teaching. Since these factors are intricate and extensive, no single solution will fulfill the requirements of all situations. Therefore, the recurrent theme set forth by the authors and editors is one of flexibility, based on standards of sound educational philosophy, experience, and judgment.

Properly constructed school buildings are an investment of many years. Because the facilities determine to such a large extent the nature of the educational program, a great deal of responsibility is vested in those who must envision the educational world of tomorrow in the course of their planning. Radical departures in the design of industrial arts facilities are difficult to understand and to meet with acceptance in the average community. On the other hand, proposals reflecting only what has been done in the past fail to fulfill the function of leadership assumed by the American Council on Industrial Arts Teacher Education. The editors and authors of Yearbook VIII have attempted to carry forward this leadership function in a responsible manner.

It is once again a pleasure to express the sincere appreciation of the Council to the McKnight and McKnight Publishing Company for its great contribution to our profession in underwriting the yearbook program. The selfless efforts expended by the editors and authors in making this yearbook a reality are held in highest regard by every member.

The American Council on Industrial Arts Teacher Education is happy to present Yearbook VIII, *Planning Industrial Arts Facilities* to teachers, school administrators, supervisors, architects, teachers, teachers in preparation, and teacher educators.

John Fuzak, *President*
American Council on Industrial
Arts Teacher Education

Long Beach, California
April 22, 1959

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Ralph K. Nair
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September 26, 1958
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Table of Contents

Table of Contents (cont.)

CHAPTER I

Introduction

By: Ralph K. Nair
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I. EVOLUTION OF INDUSTRIAL ARTS FACILITIES

Determined by Acceptability in Education.

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 becoming a part of general education. Industrial arts is vital to the educational 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. Plans for the future prove stimulating and challenging, yet the problem of providing for the needs of oncoming generations involves great responsibility.

Industrial arts began in boiler rooms and basements, often utilizing unused rooms delegated to the school custodian. Teaching in these early classes often involved formal exercises or repair of school equipment. Consequently, industrial arts was "in the basement" as far as acceptability in education. Some educators and traditional academicians believed this intrusion an imposition and labeled the area as "manual training", a work for the hands rather than the mind. Criticisms included lack of intellectual content, employment of a shop setting, use of tools and materials rather than pencil and paper, and emphasis on specific skill and proficiency. Although the old classical curriculum and formal discipline of those times left much to be desired, industrial arts in its earlier forms had formidable room for improvement.

Reflected in Changing Philosophy.

It is fortunate we have been pragmatic to alter our attitudes, beliefs, ideas, and ideals, as indicated by the history of the nation. In our society freedom to experiment, change, and develop has made possible some of the most rapid advances of civilization. To be sure errors and occasional regression have occurred, but the venturesome spirit has decreed that "nothing ventured is nothing gained." This doctrine permeated our religious, political, social, and economic life, as well as our educational system. It is to this freedom that we owe the progress made in industrial arts.

In the history of education we find that earlier versions of industrial arts, known as "Sloyd" and "Manual Training", developed from ideas borrowed from Europe, although drawing was taught in the public schools of Massachusetts by 1870.[1] "Sloyd" was a type of craft activity, while "Manual Training" was an approach to technical education. Introduced in America in the late 1870's as a rigid set of exercises, "Manual Training" nonetheless exemplified the educational philosophy of the time. Typical facilities for "Sloyd" in early elementary schools constituted the use of the regular classroom and simple woodworking tools, whereas separate rooms or shops were employed for advanced grades. Utilizing the basement room in the secondary school, "Manual Training" employed more extensive equipment, primarily in the area of woodworking. However, metal work was sometimes included as a separate activity.[2] With this era came the introduction in the school setting of large and heavy production types of machines, actually developed for production industries.

As time progressed, the movement became known as "Manual Training", gaining reluctant acceptance in some locales. Significant among the reasons for this grudging acknowledgment are the following: (1) a belief by some educators that all students should know some of the basic tool processes, (2) considerable pressure from industry to teach vocational skills as a supplement to the limited supply of trade apprentices, (3) recognition of the need of the non-academic student, and (4) a belief by many that a liberally educated person should have a greater appreciation of his environment as a participant in an industrial society.[3]

[1]Lewis F. Anderson, *History of Manual and Industrial School Education.* New York: D. Appleton and Company, 1926, pp. 155-188.

[2]Charles A. Bennett, *A History of Manual and Industrial Education 1870-1917.* Peoria, Illinois: Manual Arts Press, III, Chapter X.

[3]H.H. London, *Industrial Education at the University of Missouri* (A bulletin, University of Missouri, 1948).

A changing philosophy within the field resulted from the criticism that too little attention was directed to artistic and practical qualities of projects. Though recognized as a means of providing desired experiences, completed items were often inferior in design. Beginning in the 1890's, more stress was placed on design, planning, and provision for drawing and sketching projects made in shops and laboratories.

Within the last fifty years the term "Industrial Arts" has been used to identify the field. One reason for the change is that the word "manual" carried the connotation of handwork as divorced from intellectual challenge. Probably more important is the fact that "industrial" typified classroom work and contained a more comprehensive breadth and depth. The term "arts" was retained because of the design aspect, with attention to aesthetic features of the products. In addition, teaching scientific knowledge is generally considered as an art in the field of education.

Today industrial arts is a subject area defined as dealing with the understanding and interpretation of industrial activity. As an important part of general education, industrial arts is concerned with materials, processes, and products of industry. The student of industrial arts not only seeks knowledge of the industrial society in which he lives, but also learns how to use tools, work with materials, and perform basic processes. Students define problems, postulate solutions by design and written description, develop solutions, and test products or manufacturing principles for validity. Sketching and design become the medium for thinking and communication, while the actual project developed experimentally tests the idea. The application of art and engineering to industry for the purpose of achieving greater beauty and utility at less cost is an objective of industrial arts.

Circumscribed by Teacher Ability.

Regardless of the subject matter field, educators usually agree on the importance of teaching ability in the learning situation. At the time of its introduction in public education, the industrial arts field did not have available the well trained and professional teacher of today. The school administrator found it necessary to secure a tradesman from industry, a local handyman, or perhaps the school custodian. Too, he was likely to be qualified in one field, teaching one subject such as wood, metal, or drawing.

Instruction of teachers in the use of industrial arts tools began as early as 1881, with professional preparation of teachers initiated at what is now Teachers College, Columbia University about ten years later. At the turn of the century, other institutions provided professional preparation for teachers of manual training and household arts. Among these were the Stout Institute, Menomonie, Wisconsin, (now Stout State College); Kansas State Manual Training Normal School of Pittsburg (known today as Kansas State Teachers College); and The Santa Barbara Manual Training Normal School (now the University of California, Santa Barbara).[4]

It was recognized at an early date that a well qualified teacher in industrial arts should possess: (1) an academic college education, (2) technical competence in his field, (3) some professional training, (4) industrial experience, and (5) interest and ability in working with young people.[5,6] Resulting competencies assisted in opening the way to teaching in several media at the same time and to the growth of the "general shop".

Diversified by New Tools and Materials.

Since wood was used widely in home and industry, was relatively inexpensive, easy to work, and necessitated only common hand tools, it became one of the early key materials for teaching industrial arts. Since paper and common drawing instruments also qualified for the same reasons, mechanical drawing also became a basic subject. With the increasing availability and use of metal, development of the automobile for transportation, growth of the graphic arts industry for the dissemination of knowledge, electricity for power and communication, a gradual introduction of these activities began in industrial arts education. In more recent years, new materials and processes, such as plastics, modern metal alloys, the transistor, photo-offset lithography, and light portable tools, challenge the teacher and the planner of industrial arts facilities.

[4] William T. Bawden, *A History of Kansas State Teachers College.* Topeka, Kansas: State Printer, 1952, pp. 80-81.

[5] James P. Henry, "Qualifications of a Teacher of Shopwork," *Manual Training Magazine,* I, No. 1, October, 1899, 37, 38 (A report, Sixth Annual Meeting of American Manual Training Association).

[6] Walter A. Edwards, "The Manual Training Teacher," *Manual Training Magazine,* I, No. 1, October, 1899, 47, 48 (A report, Department of Manual and Industrial Education, Meeting at Los Angeles).

II. EFFORTS TO PROVIDE AID IN PHYSICAL PLANNING

Governmental Agencies.

In 1938 the United States Office of Education Committee on Industrial Arts issued a bulletin entitled *Industrial Arts, Its Interpretation in American Schools.*[7] In a section on building and shop arrangement, this publication offered advice of a general nature on such topics as careful planning, working space, assembly space, storage, seating arrangement, toolrooms, lighting, ventilation, and safety.

Education Price List No. 31, distributed by the United States Superintendent of Documents and dated May, 1956, lists approximately a dozen government publications under a section entitled "School Buildings and Equipment."[8] These publications, produced by the United States Department of Health, Education, and Welfare, carry dates covering the past ten years and relate to school plans in general, rather than specifically to industrial arts. Reference is made to these titles in detail in selected bibliography.

State Departments of Education.

Although state departments of education have been prolific in producing materials on the objectives of industrial arts and suggested courses of study, they have treated the problems of planning shops and laboratories to only a limited extent. A survey of the recent literature available at the state level indicates a rapid growth of interest in planning within the past ten years.

An example of a state bulletin before World War II on facility planning is one developed by the Missouri State Office of Education, under the leadership of Dr. H. H. London and the late professor R. W. Selvidge, University of Missouri. An entire chapter was devoted to "Shop Planning and Equipment."[9]

More recent outstanding examples of state publications are those of New York and California. Through professional committees and sponsorship by the state department of education, both states in 1956 produced bulletins devoted entirely to planning industrial arts

[7]Maris M. Proffitt and others, *Industrial Arts, Its Interpretation in American Schools,* (U.S. Government Printing Office, U.S. Department of Interior, Office of Education, Bulletin No. 34, 1938).

[8]U.S. Superintendent of Documents, *Education Price List* No. 31. Washington, D.C.: 45th Edition, May, 1956, pp. 17-18.

[9]*Industrial Arts Handbook,* Practical Arts Bulletin 7B, Jefferson City, Missouri: State Department of Education, 1941, Revised 1945.

facilities. Titles of these studies are *Industrial Arts Shop Planning*[10] and *Guide for Planning and Equipping Industrial Arts Shops in California.*[11]

City Educational Systems.

Under the auspices of local educational systems, most of the materials prepared have been limited to a particular area and frequently have been in mimeographed or unbound form. An example of this source of material is found in the Kansas City, Missouri, public schools in the early thirties. Among topics covered were standards of "Selection of a Shop Room," "The Selection of Equipment," "Principles of Space Division and Arrangement," and "Methods of Storing Tool Equipment."[12] Local compilation of this type of material has resulted in: (1) discovery of facilities needed, (2) acquainting personnel with building codes, (3) orientation of new teachers, and (4) a congealing force due to group action in accomplishing a task.

Undoubtedly, two outstanding publications produced recently by a city system are those of the Los Angeles City schools. With the fantastic growth of school enrollments in southern California, Los Angeles in particular, the completion of these guides is indicative of the fine facilities being constructed. Prepared in separate volumes and covering not only industrial arts, but also the complete school complex, one deals with junior high school housing facilities,[13] while the other covers senior high construction.[14]

As indicated by Ellis A. Jarvis, superintendent of the Los Angeles City schools, in the preface for the senior high guide:

> Adequate school facilities are essential to an effective educational program. These facilities are planned to provide for the needs of pupil and school personnel, to meet the requirements of present day school activities,

[10]*Industrial Arts Shop Planning.* Albany: University of the State of New York, State Education Department, Division of Industrial Education, Bureau of Industrial Arts Education, 1956.

[11]*Guide for Planning and Equipping Industrial Arts Shops in California Schools.* Sacramento: California Industrial Arts Shop Planning Committee, State Department of Education, 1956.

[12]Verne L. Pickens and others, *Shop Organization, Rooms and Equipment.* (Kansas City, Missouri Public Schools, Division of Practical Arts, Mimeographed, Not Dated).

[13]*A Guide for Planning Junior High School Housing Facilities,* (Los Angeles City Schools, Business Division, 1957).

[14]*A Guide for Planning Senior High School Housing Facilities,* (Los Angeles City Schools, Business Division, 1958).

and to serve the community of which the school should be an integral part. Large sums of money have been spent and will continue to be expended for school construction which should provide the best school facilities possible at the most economical cost. It is on these premises that careful schoolhouse planning is being emphasized in the Los Angeles City schools.

This guidebook, with emphasis on space relationship between the educational program and physical facilities, is the result of cooperative planning with teachers, supervisors, administrators, architects, and technical experts. It is a compilation of the educational specifications and mechanical drawings designating the space and facilities for each activity. It constitutes the basic standards of buildings and equipment necessary to meet the educational requirements of the senior high school program.

State and Local Building Codes.

Influenced by such organizations as the National Board of Fire Underwriters, the National Safety Council, local governmental agencies through their boards of health, have been concerned with the construction of school facilities. Examples of influential publications within the past quarter century are: *Construction of School Buildings and Improvement of Existing Structures*[15] in 1937 and the *National Building Code*[16] by the National Board of Fire Underwriters. In addition, a number of similar publications covering specific installations have been sponsored by the association. An example is the *National Electrical Code, Standard of the National Board of Fire Underwriters for Electric Wiring Apparatus.*[17] Sources such as these have assisted in securing above minimal building standards. Of course, varying regional conditions such as temperature, humidity, air movement, earth tremors, and similar factors require different structural solutions and building regulations.

Data compiled by the National Safety Council dealing with state regulations governing industrial arts facilities are available in *Time-Saver Standards.*[18]

Although rigid building codes have been an asset in the assurance of health, safety, and convenience, some disadvantages have been

[15]National Board of Fire Underwriters, *Construction of School Buildings and Improvement of Existing Structures* (New York: 1937).

[16]National Board of Fire Underwriters, *National Building Code* (New York: 1949).

[17]National Board of Fire Underwriters, *National Electrical Code, Standard of the National Board of Fire Underwriters for Electric Wiring and Apparatus* (New York: 1951).

[18]*Time-Saver Standards.* New York: F.W. Dodge Corporation. A Manual of Essential Architectural Data, Third Edition, 1954.

encountered. Codes enforced by law often cause time consuming delays in approval and are sometime equally difficult to revise. Rapid strides in the development of new structural materials, design, and methods of construction are occasionally impossible to incorporate in modern structures because of obsolete regulations. Gaining the most modern facilities at an economical cost requires complete cooperation among teachers, supervisors, administrators, architects, technical experts, and government officials.

Professional Associations.

In the American Vocational Association, the industrial arts section has been active for more than thirty years in preparing and publishing materials related to the improvement of industrial arts teaching. Entitled *Standards of Attainment in Industrial Arts Teaching,*[19] the original publication of this group appeared in 1929. Although the bulletin was concerned primarily with objectives, curriculum, and teaching units, it seems apparent that publications of this nature were influential in improving industrial arts instruction, as well as the physical facilities employed. The most recent edition of the 1929 bulletin is titled *A Guide to Improving Instruction in Industrial Arts.*[20]

Evaluative Criteria of Industrial Education in the Secondary Schools,[21] part of which deals with physical facilities, is an example of recent work of this association through committee organization. A current committee of "Joint Architects", composed of representatives of the American Institute of Architects and The American Vocational Association including the industrial arts section of the Association, is studying educational areas such as industrial arts which require special laboratory facilities.

Early in 1957 the American Council on Industrial Arts Supervisors formed a committee to study the problem of planning facilities. A survey of available literature by this group has been valuable in the development of this yearbook.

Indicative of the changes in industrial arts laboratory planning during the past fifty years is a report presented by Marshall L. Schmitt, a specialist in Industrial Arts Education, U. S. Department of Health,

[19] *Standards of Attainment in Industrial Arts Teaching.* Washington, D.C.: Industrial Arts Section of the American Vocational Association, 1929.

[20] *A Guide to Improving Instruction in Industrial Arts.* Washington, D.C.: Industrial Arts Section of the American Vocational Association, 1953.

[21] *Evaluative Criteria of Industrial Arts Education in the Secondary Schools.* Washington, D.C.: Industrial Arts Section of the American Vocational Association, Mimeographed, Undated.

Education, and Welfare.[22] A summary of this report presented at the 1956 convention of the American Industrial Arts Association, is reproduced in Appendix A.

Industrial Firms.

Among the myriad producers and distributors of products, manufacturers of school equipment provide consultant services for selection, specification, installation, and servicing their products. Some of these firms have assisted to the extent of providing aid in industrial arts laboratory planning through widely distributed publications. Examples of these publications by commercial firms are *How to Plan a School Workshop,*[23] *School Shops for Today and Tomorrow,*[24] and *School Shop Planning Manual.*[25] In addition to industrial laboratory plans for facilities utilizing commercial equipment, these manuals present other instructional areas as well. Several include definitions of terms, principles of layout, procedures, plans, templates of equipment for individual facility planning, auxiliary aids, and references.

Some manufacturers of equipment provide scale models of machines and equipment usually for the cost of postage. Employed with scaled floor and wall plans, these provide a more realistic concept of the layout. Two dimensional layouts and templates are often difficult to visualize. A compromise between the flat two dimensional layout and the detailed three dimensional models is presented by J. Lyman Goldsmith in an article "3-D Block Layout and School Shop Planning."[26] Here blocks of wood are cut to scaled size to represent actual floor space and general overall shape. Additional refinements suggested are the use of scaled lines or the layout paper, permanent magnets embedded in the base of the blocks and metal clad plywood,

[22]Marshall L. Schmitt, "Discernible Trends in Industrial Arts Shop Planning for the Last Half Century" *Industrial Arts and Vocational Education,* Vol. 47, No. 5, pp. 141-145.

[23]*How to Plan A School Workshop.* Milwaukee, Wisconsin: The Delta Manufacturing Company, Undated.

[24]*School Shops for Today and Tomorrow.* Pittsburgh, Pennsylvania: Rockwell Manufacturing Company, Delta Power Tool Division, 1955.

[25]*School Shop Planning Manual.* Plainfield, New Jersey: Walker Turner Division, Kearney and Trecker Corporation, 1952.

[26]J. Lyman Goldsmith, "3-D Block Layout and School Shop Planning," *Industrial Arts and Vocational Education,* Vol. 44, No. 3, March, 1955, pp. 69-70.

color coding of equipment items, and scaled models of human figures at the work stations.

Teachers, supervisors, administrators, and others interested in planning and equipping industrial arts facilities have expressed gratitude for the assistance provided by industrial exhibitors at professional association conventions. Where permitted material aid has also been given by representatives of these firms by visits to schools to call attention to new products and services.

Some manufacturers have equipped trailers and trucks with their machines for demonstration purposes at the school. Those who are unable to attend professional conventions find this service invaluable.

Individual Writings and Research.

From a historical standpoint, many of the early articles in periodicals dealt with educational philosophy and the place of manual training in the program of the school. In addition, they devoted considerable attention to technical procedures and projects for shop work. However, pioneers in the field apparently were concerned with physical facilities for teaching, as attested by the following examples from the *Manual Training Magazine,* first published in 1899.[27]

Under "Quarries," a brief comment on tools and an equipment list in the July, 1900 issue, a "Drawing Holder" in October, 1900, and a "School Room Manual Training Bench" in January, 1901, were discussed.

Under "Reviews," the October, 1901, issue contained an evaluation of *School Sanitation and Decoration,* a book by Burrage and Turner covering school buildings, "their location, construction sanitation, decoration, and furnishings."

An example of early pictures of physical arrangements was a photograph portraying a metalworking room and published in the April, 1902, issue as a supplement to an article by the magazine's editor, Charles A. Bennett. Probably the earliest floor plans receiving national distribution in a periodical were submitted to the *Manual Training Magazine* by Oscar L. Murry of Chicago in January, 1903, presenting the main floor plan of the Chicago Teachers College, with arrangement of rooms devoted to the department of manual training.

[27] *Manual Training Magazine.* Chicago: University of Chicago Press, Vol. I, No. 4, July, 1900; Vol. II, No. 1, Oct., 1900; Vol. II, No. 2., January, 1900; Vol. III, No. 3, April, 1902; Vol. IV, No. 2, January 1903.

Through the years other periodicals in the field such as the *Industrial Arts and Vocational Education Magazine* and *School Shop* have carried contributions by many authors on physical facilities. Each has an annual issue largely devoted to planning and equipping the industrial arts laboratory.

In regard to research on planning physical facilities and related studies, the bibliography of summaries and annotations of studies in industrial education from 1930 to 1955 lists approximately thirty-five Master's degree theses.[28] Most of these research studies deal with problems of lighting, tool disbursement, acoustics, and similar problems. Apparently only a limited number of doctoral dissertations have been written on facility planning.

Several books and manuals dealing with school building and planning have been published in recent years. For the administrator, supervisor, or teacher, there is *Planning for School Buildings*[29] by James D. MacConnell, and for the architect and technical consultant, there are Ramsey and Sleeper's *Architectural Graphic Standards*[30] and Sleeper's *Building Planning and Design Standards.*[31] A manual entitled *Time-Saver Standards*[32] may be used as a quick reference of specific facts, figures and concise planning data.

III. INDUSTRIAL ARTS TEACHERS AND FACILITY PLANNING

Importance of Planning.

Fortunately, state and local laws require that school buildings must be preceded by drawings and specifications. In addition, insurance regulations necessitate certain standards. However, more is involved in an optimum facility than a floor, four walls, and a roof. True planning must identify educational philosophy, consider the number of

[28] *Research in Industrial Education, Summaries of Studies, 1930-1955*. Washington, D.C.: United States Government Printing Office, Vocational Division Bulletin No. 264, Trade and Industrial Series No. 65, 1957.

[29] James D. MacConnell, *Planning for School Buildings.* Englewood Cliffs, New Jersey: Prentice-Hall Inc., 1957.

[30] Charles G. Ramsey and Harold R. Sleeper, *Architectural Graphic Standards.* New York: John Wiley and Sons, 5th Edition, 1956.

[31] Harold R. Sleeper, *Building Planning and Design Standards.* New York: John Wiley and Sons, 1955.

[32] Time-Saver Standards, *Op. cit.*

students to be served, study financial assets, identify subject matter areas, and convert these factors into a graphic form.

It is assumed that all industrial arts facility plans must be based upon a proposed or established curriculum and the courses of study as component parts.

The location of a door, width of an aisle of travel, height of a window, placement of a tool panel, location of a machine, accessibility of an electrical outlet, and the convenience of a storage locker are important details.

Additional satisfaction will be gained in the use of instructional facilities from incorporating motion efficiency and economy factors. Instruction of a higher quality may be done with a greater safety factor as a result of teaching mechanical processes and practicing factors of motion economy.

The Role of the Teacher.

Probably no one in the educational program is better qualified to assist in the process of laboratory planning than the industrial arts teacher. Because of his training in drawing and design, understanding of spacial relationships and acquaintance with tools, materials, and processes, he is a unique asset as a member of the educational planning team. Because of industrial experience in architectural work or in the building industry, some may be more highly qualified. The industrial arts teacher is a specialist who knows laboratory requirements, can depict them graphically, and can assist or supervise the construction of three-dimensional models to assure understanding on the part of educational, technical, and lay groups involved. More specifically, as indicated in the California Guide:[33]

> The well trained and experienced shop teacher can be extremely helpful in advising the planning group regarding the various matters that should be given consideration in planning school shops, among which are the following.
>
> 1. Building Physical Features and Space Utilization
>   a. Types of shops (limited general, comprehensive general, unit)
>   b. Class size
>   c. Shop and room size
>   d. Number of work stations
>   e. Types of ceilings, floors, and walls
>   f. Height of ceilings
>   g. Size and spacing of windows
>   h. Type of lighting (artificial, natural)
> 2. Architectural Details
>   a. Entrance and exits

[33] California State Department of Education, *Op. cit.*, pp. 6-7.

b. Selection and placement of equipment
c. Auxiliary rooms
   (1) Classrooms and or conference rooms
   (2) Demonstration area
   (3) Finishing rooms
   (4) Locker space
   (5) Planning centers
   (6) Project and display facilities
   (7) Project storage
   (8) Storage facilities
   (9) Supply cabinets and cupboards
   (10) Teachers office
   (11) Tool panels
   (12) Visual aids room

3. Decorative Features
   a. Types of paint and finishes
   b. Color system for ceilings, floors, walls
   c. Color system for equipment and its use
4. Health and Safety Facilities
   a. Air compressors
   b. Drinking fountain
   c. Exhaust system (blowers and fans)
   d. Fire precautions
   e. Fire hoses and fire extinguishers
   f. Heating and ventilating
   g. Master control switch for power equipment
   h. Noise factors
   i. Soundproofing
   j. Toilet facilities
   k. Wash sink
   i. Other safety features considered essential
5. Communication Facilities
   a. Bells (fire and disaster warnings)
   b. Clocks
   c. Intercommunication system
   d. Radio
   e. Telephone
   f. Television

IV. PURPOSE OF THE YEARBOOK

Reference for Teachers in Training.

Undergraduate students majoring in industrial arts as future teachers often fail to realize they may be asked to assist in planning a school facility. Too often students feel that facility planning problems are too remote for their concern and fail to elect a course covering the problem. Because of the rapid growth and expansion of American schools from kindergarten to university, the young teacher soon finds himself involved in assisting in plans for a new facility or altering a laboratory already in existence.[34] In this respect the Yearbook presents principles and procedures for planning.

Handbook for Teachers in Service.

For the most part, teachers in service are heavily involved in day to day teaching problems such as lesson planning, presenting group instruction, assisting individual students, measuring achievement, and evaluating accomplishments. Yet they must be prepared to assume additional responsibilities in school planning. As stated by Ericson:[35]

> Every industrial arts teacher needs to become acquainted with modern trends and practices in school shop planning in order to be ready to respond to opportunities in connection with planning new shops or remodeling old ones.

Information on some modern trends and practices is one of the objectives of the Yearbook.

Aid for Industrial Arts Supervisors and Consultants.

Within the past decade there has been an accelerated growth in the number of supervisory and consultant personnel to plan, develop and operate industrial arts programs, not only at the local educational system level, but also at the county and state level. One of the important responsibilities cited by Bakamis[36] consists of buildings and equipment. Because supervisors at all levels are at the forefront in this field, the editors submitted a tentative outline of the current Yearbook to over a hundred men in these positions in this country and Canada. Resulting suggestions and constructive ideas have been incorporated here.

Guide for School Administrators.

As a member of a governing board or the principal of a school, the administrator has a complex array of responsibilities to students,

[34]Gordon O. Wilbur, *Industrial Arts in General Education.* Scranton, Pennsylvania: International Textbook Co., 1948, p. 253.

[35]Emanuel E. Ericson, *Teaching the Industrial Arts.* Peoria, Illinois: Charles A. Bennett Co., 1956, p. 307.

[36]William A. Bakamis, *The Supervision of Industrial Arts.* Milwaukee, Wisconsin: Bruce Publishing Company, 1954, pp. 36-39.

staff, and public. Key responsibility for planning and developing facilities is vested in the superintendent. As indicated by MacConnell,[37],

> The effective superintendent is involved with all agencies or individuals participating in school planning. He coordinates the efforts of the educational team, works closely with the members of the technical team, and does all possible to insure mutual cooperation.

It is hoped that Yearbook VIII may assist superintendents and staff members to understand the facility needs for industrial arts.

Information for School Architects.

As in the profession of medicine, law, and teaching, architecure has become increasingly specialized. Although school building planning and design is one of these areas of specialization, its enormity is seen in the levels of nursery school through university and in the variety of its curriculum offerings from (A)rt to (Z)oology. Many educational courses require special physical conditions to insure optimum learning conditions. Industrial Arts and its necessary laboratories fall in this category. To the architect, the American Council on Industrial Arts Teacher Education presents this Yearbook on *Planning Industrial Arts Facilities* as a guide in school planning.

[37]MacConnell, *Op. cit.*, p. 79.

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CHAPTER II

Industrial Arts in Modern Education

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The school today is a unique social institution for identifying the culture in respect to what it has been, what it is, and what it might become. It needs to function as an integrated community agency with the family, church, and other institutions for establishing values that hold and maintain a virile society. It needs to serve all levels of interest in a society where knowledge and thought processes are necessary for resolving problems and establishing goals in the interest and welfare of mankind. It must represent the group process wherein individuality may flourish for projection of new ideas, and yet serve as a medium for challenging those ideas in which the combined thinking of the group provides a basis for final concensus and acceptance. The school must provide an educational setting that is dynamic and representative of problems and issues today. It needs to provide equal opportunity for all our youth regardless of race, creed, and in accordance with differences in the human organism both innate and environmentally induced.

The school serves the progressing culture by helping each generation to adjust to the prevailing culture patterns.[1] The basic values of our culture were evolved in the colonial period of this country. The schools were conceived by the founders of the constitution as essential for the maintenance of good government.[2] The ideal of

[1]Ralph Linton, *The Cultural Background of Personality* (New York: Appleton-Century-Crofts, Inc., 1945.)

[2]R. Freeman Butts and Lawrence A. Cremin, *A History of Education in American Culture* (New York: Henry Holt and Company, 1953.)

freedom, equality, and self-government was instilled as a precept in the American conception of the good life. It is cherished and valued by Americans as a part of our national heritage.[3]

Education for citizenship is indigenous to the American way of life. Organizations and individuals have endeavored through the decades to point out the importance of citizenship education for understanding rights and responsibilities in a democracy. The complexities of a highly industrialized society have broadened the needs of people in many areas of human endeavor.

Democracy has become more than a form of government. It is a way of life which appears most promising for the greater number of people to fulfill their needs. Democracy is a way of life with political, economic, social, and moral aspects. It is a great social faith for securing the rights to life, liberty, property, work, and the pursuit of happiness through the development of those instruments of social arrangement in which these rights may be realized.[4]

The modern school derives its purposes from the nature of our democratic way of life and the nature and needs of the individual. The school has a leading role in transmitting the democratic way of life, in developing the skills and knowledges, and in the utilization of many methods, including the scientific approach of helping youngsters to meet present day problems.

PURPOSE OF THE MODERN SCHOOL

Many terms are used in education, such as aims, goals, values, choices, and preferences, which give direction to the type of terminal achievements desired for the schools. There are a wide variety of definitive statements as to the purpose of general education; however, they should stem from the tenets of a democracy valued by individuals. Conant says:[5]

> The nearer we approach, through the management of our schools, to our goal of equality of opportunity (which, however, admittedly never can be reached) and the better we teach the basic tenets of American Democracy, the more chance there is for personal liberty to continue in the United States.

[3]"Public Education and the Future of America," *Educational Policies Commission,* (NEA) (Washington, D.C., 1955.)

[4]"Policies for Education in American Democracy," *Educational Policies Commission,* (NEA) (Washington, D.C.: 1946.)

[5]James Bryant Conant, *Education and Liberty* (Cambridge: Harvard University Press, 1953.)

These tenets underly the basic purpose of the modern school by preserving and extending the democratic idea.

Tenets of an American Democracy.

Our democratic way of life is expressed in certain fundamental beliefs we have inherited as the good life. We believe in the integrity and worth of the individual, as manifested in the optimal development of human personality. We believe and have faith in the function of intelligence for determining man's destiny and the solution of his problems. We believe in equal opportunities for all and in the inalienable rights of man, 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 for preserving these liberties. Evidence and testament in our society reveal this faith.[6]

The basic tenets of a democracy are the ideals underlying the structure of education. Implications for education can and must be derived from these. In the book *Policies for Education In American Democracy* similar tenets were listed as the loyalties of free men. The commission further says:[7]

> The entire program of the public school, the materials of instruction, the extracurricular activities, the method of administration, the human relations within the institution, and the connections between school and community should be deliberately designed to develop these eight loyalties (tenets) of the free men.

If we believe in the inalienable rights of the individual, for example, the modern school must open all avenues of learning. Similarly, the school must allow for individual differences, if it is to provide for the optimal development of human personality. The curriculum must be flexible to provide for the wide variety of needs and interests of youngsters.

Environmental Aspects of the Culture.

The modern school plays an important part in helping youngsters to live together in harmony. The human organism is born into the culture which has patterns of social, economic, and civic import. Much of his early learning is in the socialization processes. In the process of being indoctrinated by many educational influences, the individual adjusts and adapts to the mores and values of the culture,

[6]"Forces Affecting American Education," *Association for Supervision and Curriculum Development,* 1953 Yearbook (Washington, D.C.)

[7]"Policies for Education in American Democracy," *op. cit.*

yet he experiences many activities for developing his motor coordination and challenging his thinking.

Change develops through the challenging and testing of new ideas and the application of new principles. The many problems in the socio-civic and economic areas of the environment require the problem-solution approach as a means of improving our way of life. The modern schools must be a place of meeting dynamic problems and finding solutions through study and research.

Our society is becoming increasingly complex. The patterns of American economy are changing. Scientific research and technological development tend to place our material culture ahead of our social and economic planning. When industrial changes from innovations far exceed our ability to adjust, integrate, and assimilate them socially into the culture, then our value system develops many contradictory aims. For example, there is the possibility of automation producing more goods, but créating temporary unemployment of unskilled individuals unable to buy these goods. Unless there can be a compounding of conflicting values and the establishment of new values consistent with cultural change, our society may result in social disintegration.

It becomes increasingly difficult for youngsters to understand the numerous facets of the economy. Therefore, the need for co-operative and interrelated functioning of all educational aspects of the environment is paramount. Our schools must extend into the community and wider world in order to help each individual to understand the economic, social, and civic structure of the culture. Each youth must be expected to participate in these areas as an effective citizen.

The home, school, church, local and national government, places of work and leisure, and widening community interests are immediate influences of the environment that must be educationally conscious of the needs of youngsters. As the individual reacts to these institutions in the course of living, he develops understandings and concepts to direct his behavior toward satisfying his needs. The level of learning is tempered by the necessary adjustments and the degree of self understanding. Insight through learning and maturation makes adjustive processes more rational. The understanding of self and environmental influences should be sought as an outcome of education. The modern school needs to establish those objectives leading to the preservation, improvement, and extension of the democratic ideal.

Objectives of Modern School.

Objectives are necessary to the modern school as criteria for the selection of subject matter and teaching methods. Such objectives should reflect the democratic values, upon which the American way of life is based.[8] Objectives should consider the contributions the modern school can make to society, to the needs of the students, and to the improvement of mankind. The over-all school objectives should not preclude the establishment of immediate subject objectives. In fact, workable course goals should parallel the school philosophy and policies.

Many organizations and individuals have stated objectives of secondary education since publication of the "Cardinal Principles" by the Committee on Reorganization of Secondary Education written in 1918 to give unity to educational purpose. Various statements of purpose tend to emphasize four general aspects of life; (1) the individual, (2) the interaction of individuals or social, (3) the economy, and (4) government. The Educational Policies Commission, for example, has described four aspects of educational purpose as Self-Realization, Human Relations, Economic Efficiency, and Civic Responsibility.[9] A recent statement was made by the White House conference on Education in 1955 that the schools should continue to develop:

1. The fundamental skills of communication — reading, writing, spelling as well as other elements of effective oral and written expression; the arithmetical and mathematical skills, including problem solving.
2. Appreciation for our democratic heritage.
3. Civic rights and responsibilities and knowledge of American institutions.
4. Respect and appreciation for human values and for the beliefs of others.
5. Ability to think and evaluate constructively and creatively.
6. Effective work habits and self-discipline.
7. Social competency as a contributing member of his family and community.
8. Ethical behavior based on a sense of moral and spiritual values.
9. Intellectual curiosity and eagerness for life-long learning.
10. Aesthetic appreciation and self-expression in the arts.
11. Physical and mental health.
12. Wise use of time, including constructive leisure pursuits.
13. Understanding of the physical world and man's relation to it as represented through basic knowledge of the sciences.
14. An awareness of our relationship with the world community.

To achieve these outcomes for every child the schools must have an effective program of guidance and counseling in preparation for the world of work.[10]

These objectives are an expression of the values in a democracy, and they are suggestive of the type of educational experiences to

[8] Chester T. McNerney, *The Curriculum* (New York: McGraw-Hill, Inc., 1953.)

[9] "Policies for Education in American Democracy," *op. cit.*

[10] "What Should Our Schools Accomplish," *White House Conference on Education,* Report of Topic I., (Washington, D.C.: November 29, 1955.)

achieve them. Industrial Arts can contribute to these objectives by defining its immediate goals in agreement with them and by its unique contribution to youth.

INDUSTRIAL ARTS EDUCATION TRANSMITS A WAY OF LIVING

Following the turn of the century, industrial arts became vital subject matter in the schools because of a need to familiarize youngsters with our way of life. As industry became the dominant influence in the economy through a wide variety of job opportunities and consumer gains, the need for the study of the "technics" of man and their influence became apparent to many. Technics are the way in which man has been able to increase his standards of living. The rate of industrial growth has been linear with the development and refinement of technics. Each generation must transmit to its people the technical and scientific "know how" which includes tools and machines, production processes, power resources, raw materials, and theoretical possibilities, if present or higher standards of living are to be attained. Hornbake defines these technics:[11]

> Technics include tools and machines, materials of production, processes of manufacture, power, the skills of those who do the work, the aesthetic, mathematical, and scientific principles which underly our industries, and the human relations and human motivations which make work meaningful.

These technics can be extended and developed by providing our youth with an understanding of the nature of the economy in manufacturing, construction, transportation, communication, and power. In addition, an opportunity should be provided to explore and experiment in aspects related to these basic industrial areas. The understanding of technics alone are not sufficient without an understanding of the social significance and far reaching effect of people. Mumford[12] has emphasized that new industrial processes do not materialize on a large scale without a reorientation of wishes, habits, ideas, goals, and values of people. Mechanization of the laborious tasks of living has given the individual more free time or freedom. How will he utilize this freedom?

[11]R. Lee Hornbake, "What Do We Believe and Why," (Unpublished presentation at the American Industrial Arts Association Convention, April 25, 1956.)

[12]Lewis Mumford, *Technics and Civilization* (New York: Harcourt, Brace and Company, 1934.)

Economic Aspect of Living

Changes in technics mean changes in other aspects of our economic life. New occupational structures resulting from new industries, inventions, or materials often mean changes in job opportunities, required skills, hours of work, financial return, leisure pursuits, retirement, and other related services. Methods of investing, in sales, distribution of goods, handling management-labor relations, and a myriad of other related aspects are influenced by new innovations. Industrial arts education must help youngsters solve their problems resulting from such changes by aiding them to perceive these changes and to plan in accordance.

Social-civic Aspect of Living

Progress takes place in an atmosphere of freedom where individuals, singularly or collectively, are able to pursue areas of interest and curiosity. Social-civic responsibilities of a democracy can be practiced in industrial arts education to develop these characteristics which exemplify fullest participation of all individuals for the common good. Youngsters need to experience group processes of cooperating and sharing. They need to set rules of work and conduct and accept such restraints that provide for the group as a whole. They must learn to respect the rules, even though they seek to change them by parliamentary means.

The Material-Cultural Aspects of Living

The economic structure of the nation is based on its material and human resources. Conservation of natural resources and the development of new materials from undeveloped sources are imperative to an industrial nation. Salvage of scrap materials and utilization of existing raw materials should be of concern. Industrial Arts education must help boys and girls to appreciate the value of raw materials to our economic well being. Economy of raw and semi-manufactured materials of industry must be practiced and studied through industrial arts. Greater emphasis must be given to the design and function of products with reference to possible material shortages.

Our civilization has been enriched by the contributions of many in the arts and sciences. A wealth of scientific and technical information has been handed down through the centuries by the written and spoken word. The skills and knowledges necessary to build the future have been recorded as the basis for educating our youth to raise the level of understanding beyond the present limits of human knowledge. Those who contribute to world living need also to appreciate the contributions of others. The material-cultural refinements of the past and the prospects for the future must be included in industrial arts education to develop respect and appreciation for those who have contributed to changing technics.

INDUSTRIAL ARTS EDUCATION DERIVES ITS GOALS FROM THE CULTURE

Life situations to be faced by coming generations will become more complex by a higher level of mechanization. Everyone must be able to deal with complex problems of family life, work, leisure time, and other social-civic pursuits. The schools should set goals to provide flexibility in the programs for experiences exemplifying present day problems. The habits, attitudes, ideals, character traits, skills, and knowledges in the educational process would provide those problem situations to develop "thinking" pupils. Industrial arts education must develop its goals with reference to the problems set forth by industrial changes and in accordance with the preferred values of a democracy.

Objectives of Industrial Arts

The first objective of industrial arts is to help each student understand American industry. This should include such phases as organization, location, raw materials, products, labor-management relations, distribution and sales, design-planning-research, financial structure, processes, operations, occupations, and advertising.

It is apparent that technical development will bring changes in patterns of employment, type of skills needed, basic materials, products, methods of distribution and sales, plant construction and maintenance, plant management, and management-labor relations. Effects on family life as a result of changed hours of work, income, and perhaps some labor mobility should be problem areas for school study. The industrial arts program must be flexible to meet these problems.

The second objective of industrial arts is to present consumer education so that each student may select, purchase, use properly, and maintain the products of industry. Industrial arts should teach a student to discriminate between similar products, comparing value with reference to cost, quality of construction, types of materials, durability, design, function, and anticipated maintenance.

The variety and kind of industrial products will continue to expand. The ability to make wise choices among many products will require a knowledge of materials and fabrication. More materials in semi-manufactured form are appearing on the market for the "do-it-yourself" person. Selecting materials with reference to cost and function is no easy task under present varieties of brand names and material substances. Skill in planning a project, purchasing materials, and following manufacturer's directions is necessary for many who cannot always afford to hire skilled labor. Evaluating the quality of workmanship of hired-skilled help is difficult for the untrained. Selec-lection and use of tools and replacement parts is a requirement today.

The third objective of industrial arts is to develop the wise use of leisure in constructive pursuits and to enjoy the satisfaction derived from useful creativity.

The trend in hours of employment indicate a shorter week of work for many. Early retirement and longer span of life are providing many with problems in the use of leisure. Problems of juvenile delinquency indicate that leisure hours can be degenerative when interest and ability are not developed along constructive lines. A balance of work and leisure is essential for good mental and physical health. Opportunities in constructive work of a technical nature are numerous as leisure activity. Development of basic skills and experimentation in the crafts areas of industrial arts can lead to avocational pursuits.

Industrial arts facilities should be opened for adult programs for those who desire skills and information for leisure. Since social participation is important to many during leisure hours, group activities may begin in industrial arts. Hobby clubs, craft clubs, or other organizations should be developed as a medium for those who feel a need for developing social skills.

The fourth objective of industrial arts is to help each student understand the world of work and himself with aims of realistic selection of occupational choice.

Youngsters are concerned about the role they will play in the world of work. They need guidance in selecting occupations with reference to needs, interest, and abilities. They need occupational information on requirements of job interests, further education, nature of work, opportunities for advancement, and the like. They often need try-out experiences to test dexterities and interests and to evaluate successes in industrial arts experiences. They need to see how job fields are related to school subjects. Industrial arts can help students explore areas of work, types of employment, working conditions, and other aspects of employment in order to plan their education in line with personal ambitions and qualifications.

The fifth objective of industrial arts is to encourage each student to think through problems, plan procedures for solution, test conclusions, and make recommendations.

Progress in an industrial society is consonant with free people committed to solve problems by the scientific approach. Reflective thinking, planning, and evaluating are thought processes resulting from experiences in solving problems by research, study, trial and error, and reasoning. Faith in the intelligence of the human being is based on belief in rational ways of thinking through problems.

Industrial arts education provides many problem situations in planning, construction, and organizational procedures. It is a study of industry, figuring costs, experimenting with and testing materials, and comparative analysis of products. Youth need to use various media for expressing thought processes and giving direction to the solution of problems. Industrial arts education means the use of such media as sketches, models, working drawings, written reports, photographs, notebooks, charts and graphs, and sample materials as a means of communicating research results. Prescribed and orderly ways of efficient performance are practiced in classwork.

The sixth objective of industrial arts is to develop personal-social qualities through democratic practices in the shop or laboratory.

The cultural patterns of any society express rules by which people can live in harmony. Such values set limits on human conduct yet provide for self-satisfaction, and self-realization. Industrial arts education helps youngsters develop attitudes of cooperation in group undertakings. Opportunities are provided for students to experience working together toward group approved and accepted goals. Leaders and followers are developed through qualities of social living. Such personal-social qualities as responsibility, reliability, resourcefulness, initiative, perseverance, and tolerance are developed with respect to the rights of others.

The seventh objective of industrial arts education is to develop safe work habits and concern for the safety of others, to follow sound principles of mental and physical health, and to recognize the importance of maintaining a balance of leisure and work.

The level of mechanization in all areas of living can be expected to increase. The accident rate will probably increase, because human judgment must be more acute and decisions must be made more rapidly. Equipment is often used by those unfamiliar with the energy output or unaware of the danger, if used incorrectly. The automobile, power lawn mowers, outboard engines, chain saws, hedge clippers, electric drills, and portable saws are often examples of devices of high accident potential. Youth need to be familiar with this type of equipment and know the full range of their operations.

The eighth objective of industrial arts education is to develop an aesthetic appreciation for creative ability and to practice aesthetic values in daily living with reference to form, color, texture, design, styling, and function.

Not all youth have the capacity, ability, or interest to create and develop new ideas or to improve old ideas. The semi-manufactured materials of today offer opportunities to adapt such materials to improve and enrich home living. Industrial arts must provide familiarity with these materials and the opportunity to work with a wide variety in a safe manner.

The ninth objective of industrial arts education is to develop skills in the use of tools, equipment, and materials in a technological age.

Technically trained personnel are needed to maintain an industrial economy. The demand for all types of skilled workers will continue. Everyone needs fundamental skills to use effectively the mechanical and electrical devices available. Effort decreases as success increases when workers use tools in accordance with their function. The right tool for the job often means the difference between success and failure. Industrial arts is a laboratory of tools where youth learn to use them properly for all kinds of problem situations.

Summary

Teaching is purposeful. Objectives indicate that results are expected from teaching, yet they are difficult to identify, unless these purposes can be clearly defined in the form of behavior changes in youth.[13] Techniques of evaluation, as well as the scope and sequence of the learning experiences, can be planned more realistically when the objectives of industrial arts education are identified by the desirable behavior changes in youth. The facilities of the industrial arts laboratory, activities of the teacher and students, books, magazines, films, architecture of the facility, record system, and administrative procedures should be planned to achieve the objectives in the form of behavior changes.[14]

INDUSTRIAL ARTS EDUCATION SERVES ALL LEVELS OF INTEREST

Children, adolescents, and adults of both sexes can find rewarding and satisfying experiences in manipulative and investigative

[13] Ralph Tyler, "How Can We Improve High School Teaching," *School Review,* 56:7, September, 1948.

[14] "Teachers for Democracy," *Fourth Yearbook of the John Dewey Society* (New York: D. Appleton-Century Co., 1940.)

activities of a technical nature. The need for activity is paramount at all levels of maturation and growth. Children of the elementary school level are constantly developing motor skills in all forms of trials and tests. Adolescents of the early secondary levels are learning to extend and refine their abilities in activities of close manipulative nature. Physiological skills are learned and refined throughout the school years by activities of manipulative nature. Success helps youngsters develop confidence and provides a basis for further motivation. The varied opportunities in industrial arts education offer a measure of success for everyone. Other personal-social needs can be achieved in a laboratory setting.

The general nature of the industrial arts program provides opportunities for varied abilities and interests. The work can be challenging to the exceptional pupil and the youth of lower intellectual ability. Interest in technical work can raise the need for greater skill in the fundamentals. Students often find it necessary to increase communicative skills to solve problems in the laboratory through reading and investigation. Problem situations in industrial arts accompany knowledges and communicative skills studied in the classroom. A high level of integration can be achieved through coordinated efforts.

Specific or more immediate needs of adults beyond secondary education can be served through adult programs geared to social, psychological, and economic goals. Skills for maintenance of the home, care of mechanical devices, recreational activity, and satisfaction of technical curiosity are some of the drives satisfied through the industrial arts adult programs. Those who failed to secure technical knowledge in secondary education will continue to find the adult program in industrial arts more attractive as a means of fulfilling adult requirements.

The handicapped can find creative outlets through their interest in industrial arts. Crafts and technical experience have therapeutic value to those impaired by disabilities restricting activity. The value of such activity was well proven during World War II.

Both boys and girls need technical competencies and understandings to utilize products of industry. The many appliances in use today require technical knowledge to maintain and operate. Success in operating the automobile, washing machine, electric mixer, sewing machine, and similar technical devices can be more effective if basic technical principles are understood by both sexes.

Industrial arts should be extended into higher education other than in teacher preparation. Young adults preparing for business and other forms of social work would be better prepared to meet human problems if their general education were extended into the technical areas. Working with tools and materials and understanding the economics of industry are necessary for handling the varied problems in an industrial age.

INDUSTRIAL ARTS EDUCATION IS LABORATORY EXPERIENCE

The laboratory setting of industrial arts provides a unique learning situation in that the learner is directly involved with problems lending themselves to a variety of solutions such as experimenting, reading, testing, writing, construction, disassembling, repairing, and reconstruction. Many methods of problem solving are evolved through a laboratory setting emphasizing many ways of doing. Direct and related instruction are used to develop fundamental skills, yet provide horizons for individual initiative in unknowns. The interrelation of materials, processes, and industries make the laboratory experience essential to encompass the scope of our industrial technology.

Industrial Arts Reflects Industrial Technology.

The present emphasis in industrial arts is toward basic industries of wood, metal, electricity, plastics, textiles, ceramics, graphic arts, transportation, and communication. Equalization of efforts in these areas need to be achieved on a higher scale, if the programs are to be brought into balance. Other industries such as petroleum, rubber, chemical, and food processing should appear in the program. The laboratory setting should be organized to insure a study of industry in terms of general organization, names and location of current plants in major industries, distribution and sales of products, typical processes and operations, labor-management relations, general financial structure and stock market securities, securing of raw or semi-manufactured materials, product analysis, subsidiary contracts, types of industrial research, patent procedures, and the like. In order to teach and learn of the current industries it is necessary to have resources such as maps, charts, graphs, films, vertical files, models, mock-ups, raw materials, and products. The laboratory setting should be conducive to work beyond the purely manipulative aspect of industry.

Laboratory Facilities are in Line with Student Welfare and Conditions of Learning.

Equipment, tools, and materials in the industrial arts laboratory must be secured, arranged, and changed with the student's welfare in mind. Variances in levels of maturation and growth will be found in students at different grade levels. Facilities need to be established with reference to variances in strength, coordination and control, height, and other physical differences in students. Factors of health and safety need to be considered in placement, and use of equipment, materials, and tools. Precautionary and protective measures need to be planned with reference to dangerous and hazardous elements. Teaching aids such as projection equipment, chalk boards, display boards, and models need to be placed with reference to conditions of learning and free utilization. Demonstration areas, lighting, seating, ventilation, and heating are examples of specific considerations in respect to conditions of human growth and development at all levels.

The Industrial Arts Laboratory Must be Flexible.

Changes in industrial arts cannot afford to lag far behind changes in industry. It is unrealistic for students to be studying and practicing procedures outdated 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. Teaching procedures will be modified by new data from the biological sciences and by changing technics.[15] Industrial arts must change concurrently with changing technics and its own findings in the areas of learning. Further study, research, and experimentation should bring to light needed changes in the laboratory to meet the needs of students and should be published in professional papers so others may gain from such experiences.

[15] Hornbake, *op. cit.*

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CHAPTER III

Types of Industrial Arts Programs and Laboratories

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Industrial arts has been developed along three organizational patterns in this country: the unit, the general unit, and the comprehensive general shop or laboratory. Innovations, such as kits of tools and mobile units, have been employed in teaching industrial arts activities at the various school levels.

The terms "shop" and "laboratory" are used synonymously when referring to the industrial arts facility. Although "shop" is used extensively, there is an increased tendency in some sections of the United States to employ the term "laboratory". This has been due to a changing philosophy of industrial arts. During the "Manual Training Days", when the educational emphasis was upon discipline through making and repairing projects, "shop" was the nomenclature. Impetus to the employment of the term "laboratory" was given by the statement of William E. Warner [1]:

> A laboratory shall be thought of not only as a place for making projects, but equally as a place for planning, investigating, testing, experimenting, consulting, evaluating. . . . . In short, the laboratory shall be thought of as a place for thinking as well as feeling and doing.

FACTORS AFFECTING TYPES OF LABORATORY ORGANIZATION

A number of factors have helped determine the organization of individual laboratories. Five of these have been selected for discus-

[1] William E. Warner and others. "Principles of Industrial Arts Planning," Columbus: The Ohio State University, Mimeographed Bulletin, (Undated).

sion: (1) curriculum including the objectives, (2) school size and the industrial arts program, (3) size and general educational program of the school, (4) age and needs of students, and (5) funds available.

Curriculum Including Objectives.

The curriculum is an educational routing of experiences leading to definite goals and objectives. The organization of each industrial arts laboratory is affected directly by the nature of instruction implied in stated objectives of the program. If the major objective is to provide a broad, exploratory type of program with emphasis on elementary experiences and understandings of industry, the laboratory should provide opportunities in a variety of industrial areas. When the major objective is to provide a more advanced type of industrial arts with a more concentrated emphasis, the subject matter is confined to a single field. This frequently will be a general unit shop. In smaller schools where a number of different subject matter fields are taught in a single laboratory, the organization will be the comprehensive general shop.

Community Size and Socio-Economic Background.

The type of industrial arts laboratory organization will also be influenced by the population of the community and determined by the number of students enrolled in the school. The occupational life of the community, industries, employment patterns, and industrial opportunities will have some influence on the content of the program. If the major occupations are concerned with electricity, emphasis probably will be placed on electronic activities. If the community is agricultural, activities will be reflected to a degree by rural life. In the rural areas the consolidation of schools provides numbers allowing for the construction of more extended facilities. The program will reflect to a degree the activities of the broad community.

School Size and the Industrial Arts Program.

A school in a small community may not have sufficient enrollment to justify industrial arts in a series of general unit shops. It may be found more feasible to provide a comprehensive general shop in which activities may be offered in a number of areas to meet the needs of students and to serve the community.

The place of industrial arts in the educational program at the junior high school level must also be considered. If industrial arts is required for junior high school students, facilities should be available for broad, exploratory activities. As a required course, the equipment, supplies, and content should be of sufficient quality and quantity to provide for the number of students. In an elective course, the laboratory organization may be arranged to meet the interests of those students who choose industrial arts.

In the senior high school educational program, general unit type laboratories will probably be utilized for six- or nine-week rotational exploratory courses in the smaller community. The laboratories are equipped for prevocational industrial arts activities at the lower grade level, as well as for advanced training at the upper grade level. This particular organization is usually found in large schools located in large cities, or in some consolidated schools where the enrollments are sufficient to justify this organization.

Age and Needs of Students.

There has been an attempt in many schools to organize laboratories in terms of the age and needs of the students. The equipment in elementary and junior high school programs is usually smaller and largely of the hand tool variety, because the emphasis is upon a general understanding of industry.

Programs concerned primarily with senior high school students provide experiences of greater depth and complexity with a degree of concentration in an area. Equipment is selected to meet these requirements. Shop activities and classroom procedures are structured to more nearly reflect the practices in industry.

The junior college has evolved into an institution for meeting two separate purposes: (1) terminal education and (2) general education or liberal arts courses offered as the first two years of a four-year college program. The latter is intended to be transferable to a four-year institution. The facilities should be planned to accommodate both of the stated purposes.

At the college level, especially where teacher preparation receives a major emphasis, the program is usually organized in terms of typical laboratory situations, similar to those graduates will meet in a teaching situation. College and university programs may provide experiences in unit, general unit, and comprehensive general laboratories.

Funds Available.

The request for funds to build the proper facilities for industrial arts programs should be based on many facts, such as: philosophy including the curriculum, number of students to be served, and anticipated growth of the school. Since the cost of construction or equipment may be more or less in some locales than others, a comparison in dollars is not the only standard for judging a program and facilities. The attitude of the school trustees and the administration towards industrial arts will reflect and finally determine the budget available with which to build and operate the program.

TYPES OF INDUSTRIAL ARTS LABORATORIES

The three major types of laboratory organizations for the teaching of industrial arts are the unit, general unit, and comprehensive general shop. These are considered more applicable on the secondary level. Some modifications of these types may be the result of selected facilities which appear physically different, yet accomplish the same purpose in education.

The "classroom activity" type of organization is employed principally at the elementary school level and is enhanced through several modes of facilities. One of these modes is the "mobile units", utilized in the teaching of industrial arts activities in rural areas at the elementary level, and in some cases through the eighth grade. (See Figures 1, 2, and 3.)

The Unit Laboratory.

Industrial arts laboratories equipped for a single, undivided area of instruction such as cabinetmaking, machine shop, sheetmetal, or other single industrial occupations are "unit shops". Many adults will recognize it as the older type "manual training shop". Today one hears the terms machine shop, print shop, and other such designations when reference is made to either unit or the general unit laboratory. Under some curricular organizations these laboratories are utilized to provide exploratory experiences by rotating students through the individual laboratories. For example, a student may spend six weeks in each of the following laboratories: woodwork, graphic arts, general metal, drafting, electricity, and handicrafts.

Purpose and Advantage. The major function of this type of organization is to provide a concentration in one industrial arts area. The facilities to be planned for this type of laboratory are confined to the single subject matter field.

Limitations. The chief limitation of this type of laboratory for teaching industrial arts is its scope, because it is equipped for achievement and proficiency in a single industrial arts activity. When instruction becomes concentrated to this extent, the emphasis may be vocational.

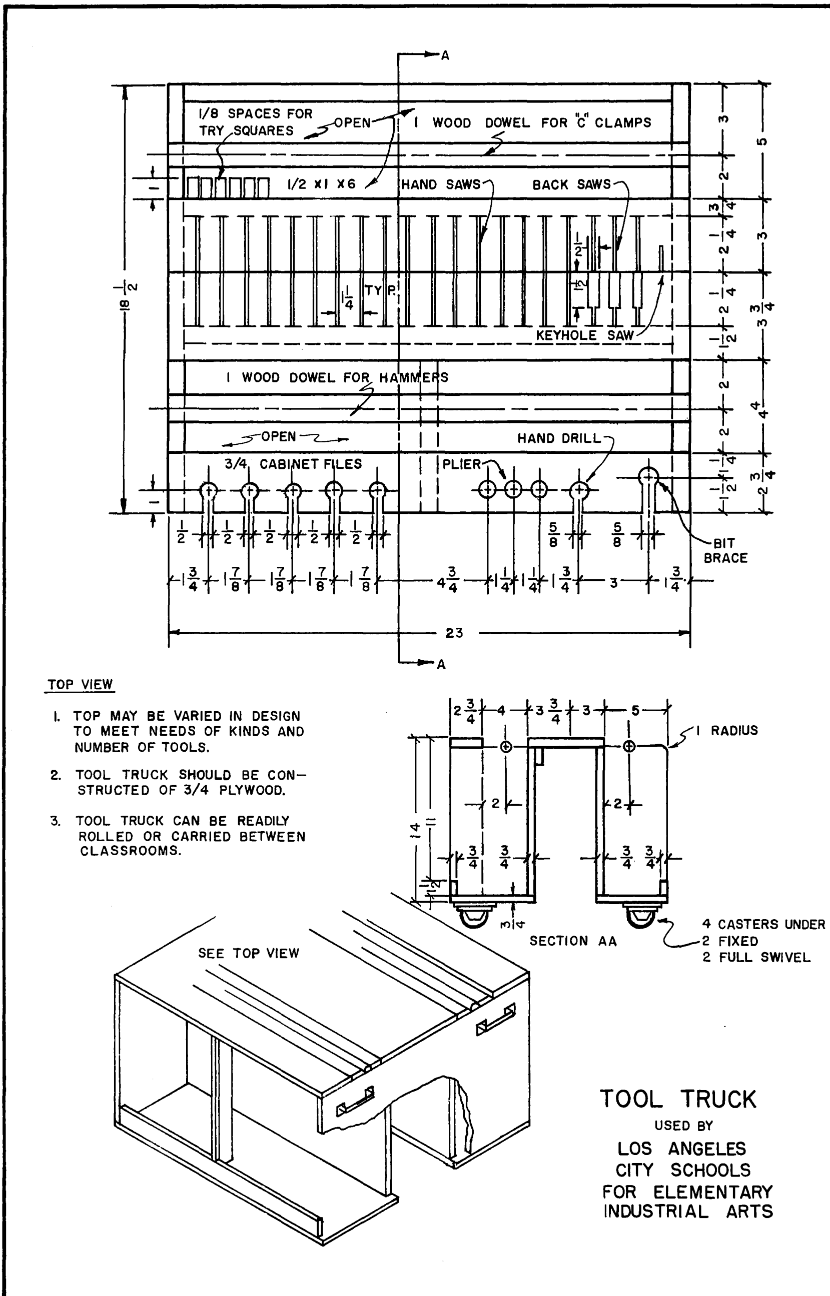


Figure 1. Tool Truck (Courtesy Los Angeles City Schools)

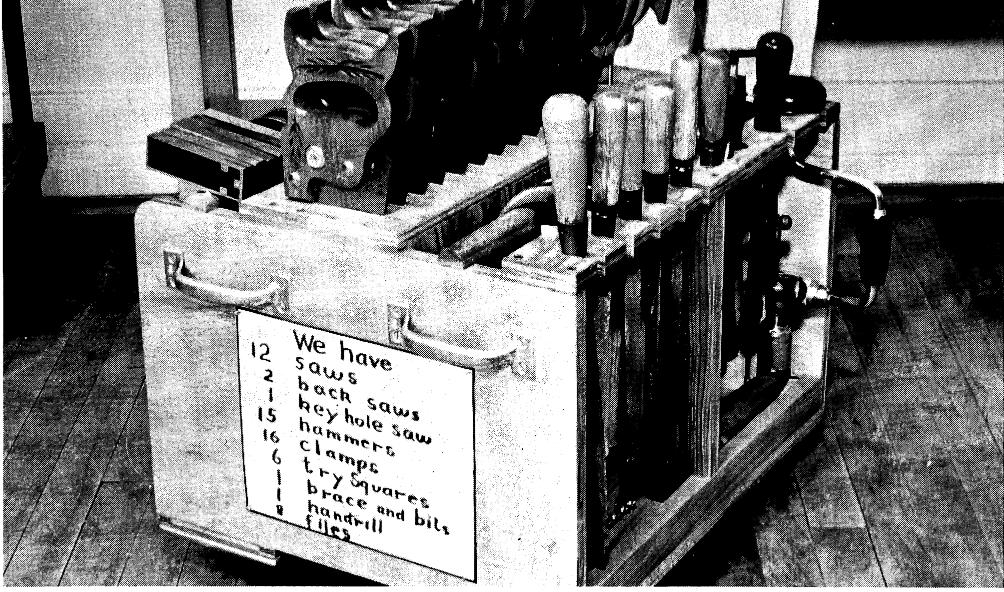
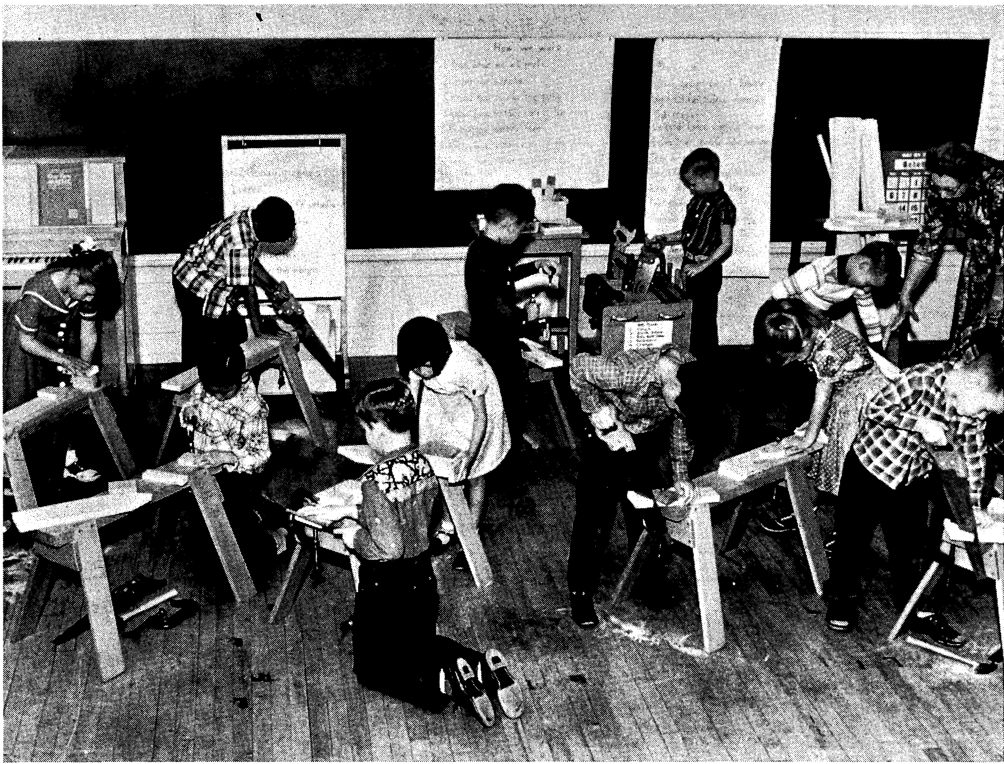


Figure 2. Portable Tool Cart (Courtesy Los Angeles City Schools)

Elementary Pupils Using Portable Tool Cart (Courtesy Los Angeles City Schools)



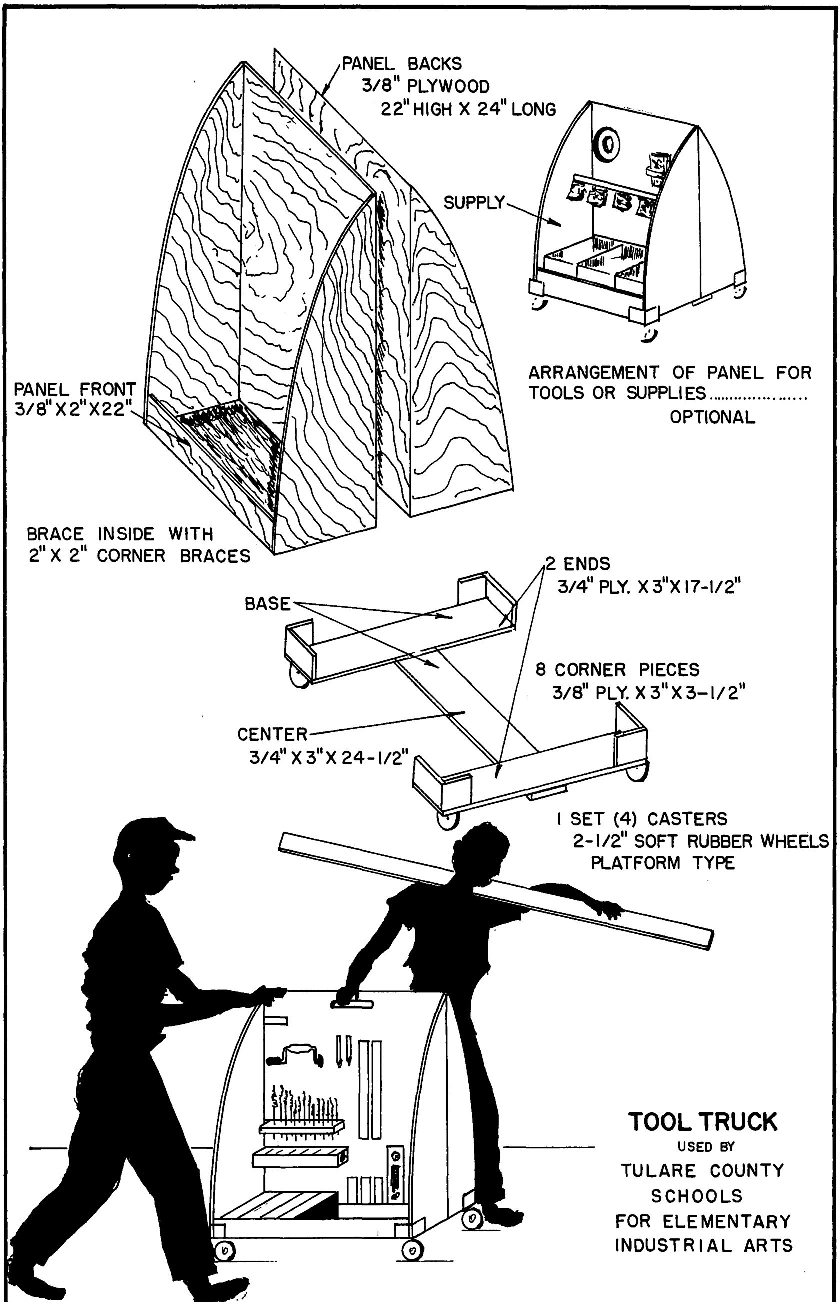


Figure 3. Tool Truck (Courtesy Tulare County Superintendent of Schools)

Basic Considerations. A unit laboratory must be adequately planned, equipped, and organized for a single industrial area. Laboratory facilities should be sufficient to provide for the equipment and auxiliaries needed. The equipment should definitely be representative of the instructional area.

The General Unit Laboratory.

This is an industrial arts laboratory which is equipped to provide instruction in two or more phases of a single industrial area. The name of the industrial area is often inserted in the title following the word "general". For example, a laboratory which is a *General Metal Laboratory* usually will include such areas as sheet metal, bench metal, art metal, forging, welding, foundry and machine shop work. A *General Graphic Arts Laboratory* may include silk-screen printing, linoleum block printing, bookbinding, photography, drafting (mechanical, architectural, etc.) and general printing. A *General Wood Laboratory* may provide instruction in cabinetmaking, patternmaking, furniture reproduction, upholstery, model making, wood carving, wood finishing, or other activities related to woodworking.

Purpose and Advantages. This type of laboratory makes it possible for a school to offer a more varied program than is possible in a unit shop. Students may be rotated through the various areas offered with increased concentration provided for as may be needed.

Limitations. This type of organization offers a greater variation of experience than is offered in the unit laboratory. It requires a broader selection of equipment of small size than the unit type laboratory.

Basic Considerations. The same general conditions for a unit laboratory apply to this type of laboratory. A general unit wood laboratory, for example, probably should be equipped for, among others, cabinetmaking, patternmaking, upholstery, wood carving, and wood finishing.

The Comprehensive General Laboratory.

The terms "composite" and "multiple activity" are used to identify this type of organization. A laboratory with either of these designations is organized to provide subject matter experiences which have been selected from a wide variety of activities and arranged into a unified course to meet student needs and interests. The selected activities are usually carried on simultaneously in one room under one or more teachers. Partial partitions may be used to separate areas. The general laboratory may have provisions for instruction in wood, metal, drafting, electricity and power, transportation, ceramics, plastics, leather, and graphic arts; organized and planned so that one or more teachers may handle the areas simultaneously. Usually, however, not more than three to five are offered at one time, depending upon the background and qualifications of the teacher. There are variations which are currently employed in the teaching of the comprehensive general laboratory, namely: (1) to have more than one teacher, (2) to provide a single unit of instruction during a given period, and (3) to have sufficient work stations in each area so that the teacher may offer two or more activities simultaneously.

Purpose and Advantages. The major purpose of the comprehensive general laboratory is to provide industrial arts experiences in as wide a variety of industrial activities as the facilities will permit. Some of the major advantages of this type of shop organization were advanced by Louis V. Newkirk and George D. Stoddard as follows:[2]

(1) It is well adapted to the organization of industrial arts content in the light of the general education, exploration, and 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 thru manipulation of a wide range of materials, tools and processes.

(4) It offers an economical way to gain experiences 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.

Limitations. The limitations of the general shop are confined to the more elementary skills of each activity included in the curricula. This is most evident from a physical facility observation viewpoint. Since students will practice basic experiences in several different areas, the limitation of time will greatly effect the facilities needed. An additional space requirement will be required in this type of laboratory as compared with the others previously discussed.

OTHER PRACTICES

Classroom Activity Area.

This type of laboratory organization exists when work space and tools are provided for industrial arts activities in individual classrooms.

[2]Louis V. Newkirk and George D. Stoddard, *The General Shop.* Peoria: The Manual Arts Press, 1929, pp. 14-15.

Various types of classroom organizations are in current use in the elementary grades. These range from classrooms equipped with benches and tools to those in which desk tops are used and tools are made available through the utilization of portable units. Instruction is usually conducted by the classroom teacher in the classroom rather than by an industrial arts instructor in a specially equipped room.

Purpose and Advantages. The major purpose of this organization is to permit the classroom teacher to integrate the use of tools and materials within the curriculum which grow out of the needs and interests of students. For example, children studying early colonial life in this country may plan and construct related projects using tools and materials available in the classroom without having to go to a separate laboratory.

Limitations. The classroom activity area may not lend itself to the construction of large projects, because of limited space for laying out and assembling.

Basic Considerations. The classroom must be arranged so that students will be able to work safely and must have immediately available tools which will be suitable for use on a variety of materials. It must have an area of sufficient size to accommodate the projects which students will make. The tools should be limited to those which are basic and should be of the small size adaptable to the age level.

Portable Units.

Small and compact kits of tools or materials which are utilized in the teaching of industrial arts classes are herewith classified as portable units. They have been used principally at the elementary school level. The units are usually carried by hand, or they are moved about on rollers.

Years ago Louis V. Newkirk illustrated and discussed a "desk tool kit"[3] which contained hand tools commonly used at the elementary school level. This kit would also provide working area for the student when placed on a desk or table. Also referred to was a "room tool kit"[4] which contained larger tools that would be needed infrequently by students.

Louis V. Newkirk and William H. Johnson presented a "movable craft cart"[5] which contained tools that are used only occasionally.

[3]Louis V. Newkirk, *Integrated Handwork for Elementary Schools.* New York: Silver Burdett Company, 1940, pp. 37-38.

[4]*Loc. cit.*

[5]Louis V. Newkirk and William H. Johnson, *The Industrial Arts Program.* New York: The Macmillan Company, 1948, pp. 21, 23-24.

The writers' suggested that this cart could be used to supplement the tools contained in the desk type tool kit.

Fred W. Culpepper, Jr., described a "toolmobile" which was used in Suffolk, Virginia. The portable unit was used in a two-month experiment and featured (1) a workbench, (2) a tool panel with sufficient tools to equip a class of thirty to forty students, and (3) sufficient storage space to contain materials for the operation of the program. According to Culpepper:[6]

> Materials in most instances consisted of scrap material obtained from local industry and the high school shop. Such materials included in the toolmobile were: scrap leather, scrap wood, scrap metal, scrap plastics, scrap cloth, string, assortment of nails, assortment of screws, tacks, sandpaper, wire, clay (moist in plastic bag), needles and thread, construction paper, cardboard, shellac (mixed in bottle) with brush and rubber cover, tempera paint, crayons, colored chalk, paste, wood glue, straight pins.

The administration and control of the "toolmobile" was as follows:

> The toolmobile was kept in the class just outside the library and was considered a part of the library. Any teacher in the school could *check out* a tool in the same manner as she checked out a book, and use it in her classroom. The keys for the toolmobile were kept in the custody of the librarian.

Claude E. Nihart, in an article on industrial arts in the elementary schools of Los Angeles City Schools stated that:[7]

> Three full-time supervisors served the elementary schools. With kits of tools, materials, and sample projects they visit schools, where they assist with classroom problems, give manipulative demonstrations, and conduct in-service training for teachers.

Purpose and Advantages. Kits of tools and materials have been developed in an effort to make it possible for a larger number of students to learn how to handle tools and enjoy the experience of creative expression through the use of various materials. They can be utilized by a greater number of students and teachers while reducing the cost of financing the industrial arts program. At the elementary level kits permit more tool instruction to be carried on in individual rooms, because shop activities at that level usually grow out of the curriculum experiences of the students.

Basic Considerations. The tools and equipment included in portable units should be simple, practical, and suited in size to pupil age level. They should be of excellent quality and should be kept in excellent working condition at all times. Included should be tools

[6]Fred W. Culpepper, Jr., "The Elementary Industrial-Arts Experiment at Suffolk, Virginia," *Industrial Arts and Vocational Education.* Vol. 41, March, 1952, pp. 88-90.

[7]Claude E. Nihart, "Industrial Arts in the Elementary School," *Industrial Arts and Vocational Education.* Vol. 40, October, 1951, p. 303.

necessary to conduct the activities outlined in the program. The units should be of a size which can be transported easily.

MOBILE UNITS. Transportable shops which are installed in a bus, trailer, or on a truck are classified as mobile units. Such units have been used in a teaching of industrial arts for a period of years. A Newkirk and Stoddard publication of 1929 revealed:

In certain localities *the equipment for different divisions has been mounted on trucks* especially equipped for the purpose. The work is so organized that one teacher visits several schools in a single day, thus distributing the burden of supporting one good teacher over several communities.[8]

Notable among the mobile units is the one developed at Iowa State Teachers College at Cedar Falls by the Late Harold G. Palmer and Willis A. Wagner. According to Pierre E. Rubsam, industrial arts curriculum coordinator for San Diego County in southern California, the mobile shop has efficiently provided industrial arts experiences to outlying schools. See Figure 4.

Another mobile unit, a power workshop, was developed in California by the Santa Clara County School Department to supplement the small woodworking shops of some of the rural schools. According to Satterstrom[9] one four-inch jointer, four jig saws, one two-stone grinder, and two Shopsmith multi-purpose units, were placed in a retired commercial type bus and provided for eight work stations. The four smallest schools served by this unit were thirteen, sixteen, twenty-nine, and forty-one students. At least a portion of one day each week, pupils at these schools were able to use power equipment. The unit was operated by four part-time industrial arts instructors. The influence of this mobile unit was summarized by Satterstrom as follows:[10]

In addition to producing an almost immeasurable increase in student interest in industrial arts by giving them an opportunity to work with this equipment, the new unit has helped instructors by providing power tools for preparation of stock. The quality of the work produced in the small rural shops has improved markedly. This is probably as much due to the increased enthusiasm of students and instructors as it is to the additional equipment provided.

By no means the smallest benefit derived from the unit has been the assistance it has provided for advancing the cause of industrial arts in Santa Clara County. School administrators, once discouraged by lack of equipment and generally lacking in enthusiasm about the addition of industrial-arts courses in their schools, are now competing with each other to obtain more

[8]Newkirk and Stoddard, *op. cit.*, p. 13.

[9]John Satterstrom, "Mobile Unit Workshop Goes to Rural Schools," *Industrial Arts and Vocational Education.* Vol. 39, September, 1950, p. 262.

[10]Ibid., p. 263.

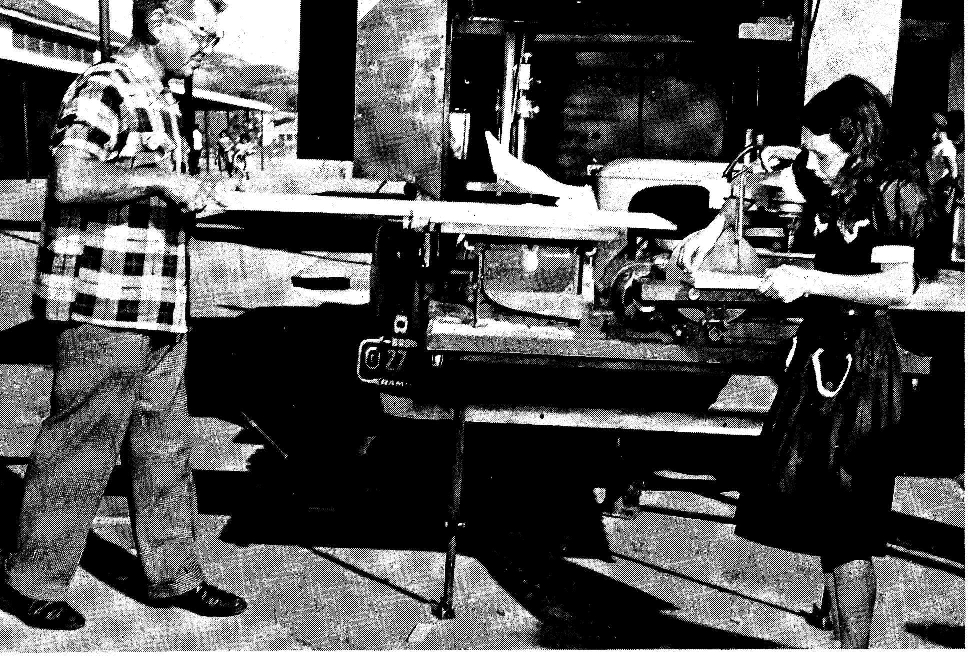
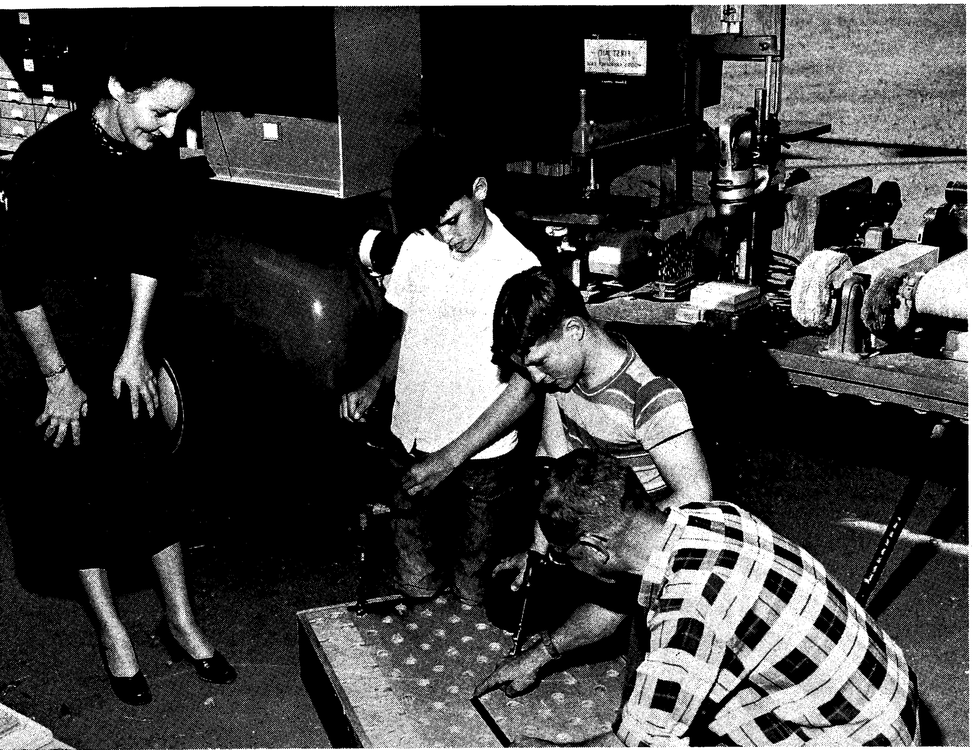


Figure 4. Industrial Arts Mobile Unit in Use (Courtesy Office of Superintendent of Schools San Diego County California)

Industrial Arts Mobile Unit in Use (Courtesy Office of Superintendent of Schools San Diego County California)



frequent visits from the mobile unit. The enthusiasm of the students has proved to be contageous in enlisting the support of parents, school board members, and other civic groups. There is reason to believe that many schools will eliminate themselves from the group requiring the services of the mobile shop by acquiring adequate facilities of their own. By thus eliminating itself, the mobile unit will serve its highest purpose in the minds of its creator.

Purpose and Advantages. The principal purpose of mobile units is to provide, or supplement, industrial arts activities in rural areas. Through their utilization, it has been possible for some boys and girls to have opportunities to use industrial tools and equipment under the guidance of trained instructors. For some, the units have provided experiences which may not have been available otherwise.

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CHAPTER IV

Principles of Laboratory Planning

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The current trend in principles of laboratory planning demands physical facilities providing for flexibility and versatility. Laboratory planning will achieve its function relative to philosophic beliefs and professional considerations by providing for worthwhile educational experiences. Performing its function, laboratory planning is confronted continually with a compromise between what is *ideal* and what is *feasible* in a particular situation.

Since some of the principles of laboratory planning appear to conflict in practical situations, they should be given an importance rating according to the situation. It will then be possible to judge priority of principles. For example, arrangement of equipment should be determined by considerations of safety, instructional efficiency, industrial, and general practice, in the order listed.

The principles of planning should apply in all circumstances, rather than in a specific instance. In general, it is from fundamental principles that rules are derived.

Discretion should be used in the application of principles of planning to practical situations. Each principle should be considered in its context and in the light of the above-mentioned conditions.

GENERAL PLANNING

Nature of Instruction

Laboratory planning should start with such philosophical considerations as the curriculum, including the objectives of industrial arts. From the curriculum it is possible to establish behavior changes expected of each learner who achieves the desired objectives. From an analysis of the environment needed to change behavior patterns, activity areas and equipment needs may be determined.

Nature of Equipment

Equipment should be adapted to the age and maturity level of students. The height of working surfaces, such as bench tops and machine surfaces, should not exceed the elbow height of learners. Safety in relation to the maturity level of students should be a primary consideration.

Nature of Activities

The industrial arts are usually organized in activity areas with facilities representing one or more basic industrial services, tools, machines, materials, and processes. To provide balance the establishment of these activity interest centers should be governed by a requirement of a maximum number of activities.

Space Considerations

The size and shape of the laboratory is determined by a synthesis of the conditions of laboratory use and the basic shape of the structural plan. Such factors as the types of classes, the number and length of class periods, and class size should be noted. Space needed for each student should be calculated in terms of work stations. It is generally considered practical to provide more work stations than the number of students enrolled. The ratio of the number of work stations to class enrollment varies in each of the activity areas as follows: drafting laboratories, a ratio of $1\frac{1}{4}$ work stations to 1 student enrolled; wood, electricity, and power mechanics laboratories, $1\frac{2}{3}$ to 1; general metals, graphic arts, and handicrafts laboratories, 2 to 1. This allowance provides time during class to lay out work on certain machines and equipment in connection with work in progress at bench work stations. Estimates of the most economical use of equipment in relation to student-teacher time range from 40 to 60 per cent of class time.

Space needed for equipment is partly determined by its arrangement. Often space is utilized for several purposes by providing portable equipment that can be rolled into position for use, such as a portable shorts rack.

Storage space is needed for those tools and materials used daily by students and instructor. Student lockers are sometimes provided in cabinets beneath benches for storage of unfinished work. This type of storage is usually known as *live* storage.

Live storage is useful and valuable only when it has a quick and convenient source of supply. Dead storage space should be provided for each of the materials maintained in live storage and may be in the same space. This is of particular importance in schools where purchasing is made annually or where deliveries are slow.

Consideration should also be given to space needs for student book lockers and washing facilities. These book lockers are sometimes provided in corridors adjacent to the laboratory, in a central location, or near the exit to a corridor.

Allowance should be made for flexibility and growth, since modern technology moves ahead at such a rapid pace that it is not possible to anticipate exact space needs for future developments.

Flexibility and Versatility.

Modern concepts of industrial arts require physical facilities where emphasis is placed on adaptability and mobility. Partitions and service outlets within a laboratory should provide for change with a minimum of expense. To maintain unity in a laboratory plan it is desirable to have as few partitions as possible. Certain pieces of equipment should be mounted on casters for removal to unused space when not in operation. Special cabinets on wheels should be provided for storage and movement of projection equipment.

The design of cabinets, lockers, shelves, and work benches should be standardized as much as possible to provide for rearrangement due to changing conditions. Shelving in cabinets, lockers, and storage areas should be adjustable, unless safety requires fixed shelving. The design of tool boards and tool hangers should facilitate changes.

Vista

All parts of the laboratory should be visible to the teacher. Partitions should be held to a minimum and should be constructed with clear glass, ranging from thirty-six to forty-two inches from floor to near the ceiling.

Instructor's desk, if not in an office, should be centrally located and near entrance to corridor, if possible, with an unobstructed view of major portion of laboratory.

Teaching Center Arrangement.

Determination of areas of instruction from philosophic analysis should be followed by a placement of areas of instruction in the space, with consideration for the working relationship between areas. The relationship of the planning center, instructor's desk, and instruction area to all other areas in the general comprehensive laboratory is peculiar to this particular type. Since these control areas are the nerve center for the operation in this type of laboratory, they should be centrally located. The theoretical sunburst layout, Figure 5, illustrates the application of this principle. Figures 6 and 7 show the application of the "sunburst" for two suggested plans including the placement of equipment. The location of the teaching center in the unit and general unit laboratory may be varied depending upon individual arrangements such as those suggested in Appendix C. .

Teaching Facilities.

Provision should be made for conducting such teaching activities as student-teacher planning, conferences, and demonstrations, including motion pictures and other visual aids. Furnishings should be adapted to these activities. Adequate bulletin board space should be located at strategic points in the laboratory. Chalk boards are needed in the instruction area. Teacher's desk, demonstration benches, portable folding chairs, and cabinets for storage of charts and teaching aids are also needed. In schools where no central projection room is available motion picutre projection equipment should be located in a portable cabinet containing all accessories. A roller type screen should be mounted in a dark area, yet visible to all students. Dark shades are needed. See Figure 8.

Lighted exhibit and display cases should be provided in strategic locations in the laboratory and in central locations of the school plant.

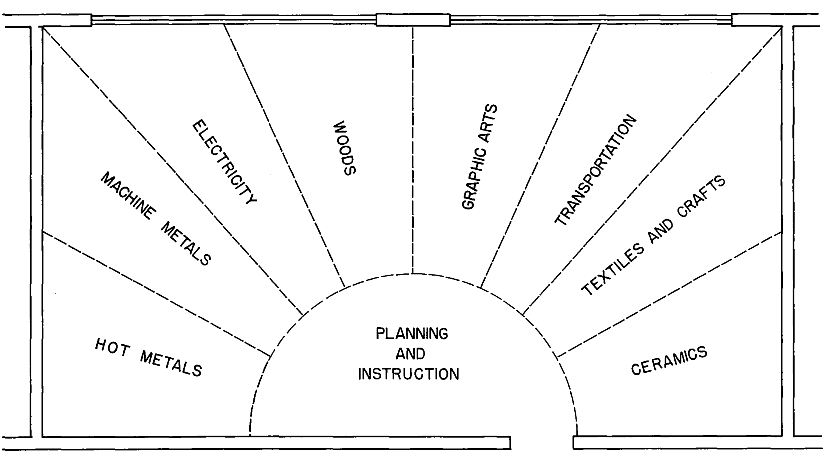


Figure 5. Theoretical Sunburst Layout

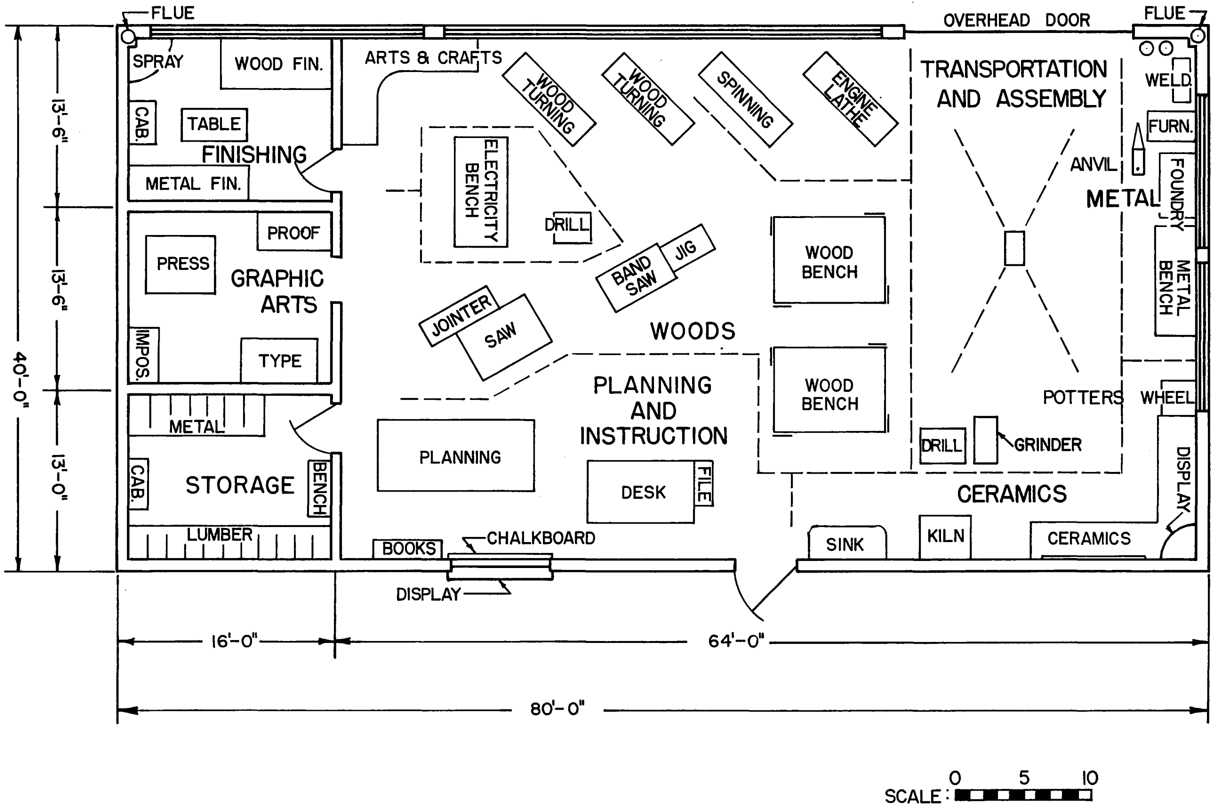


Figure 6. Application Sunburst Layout

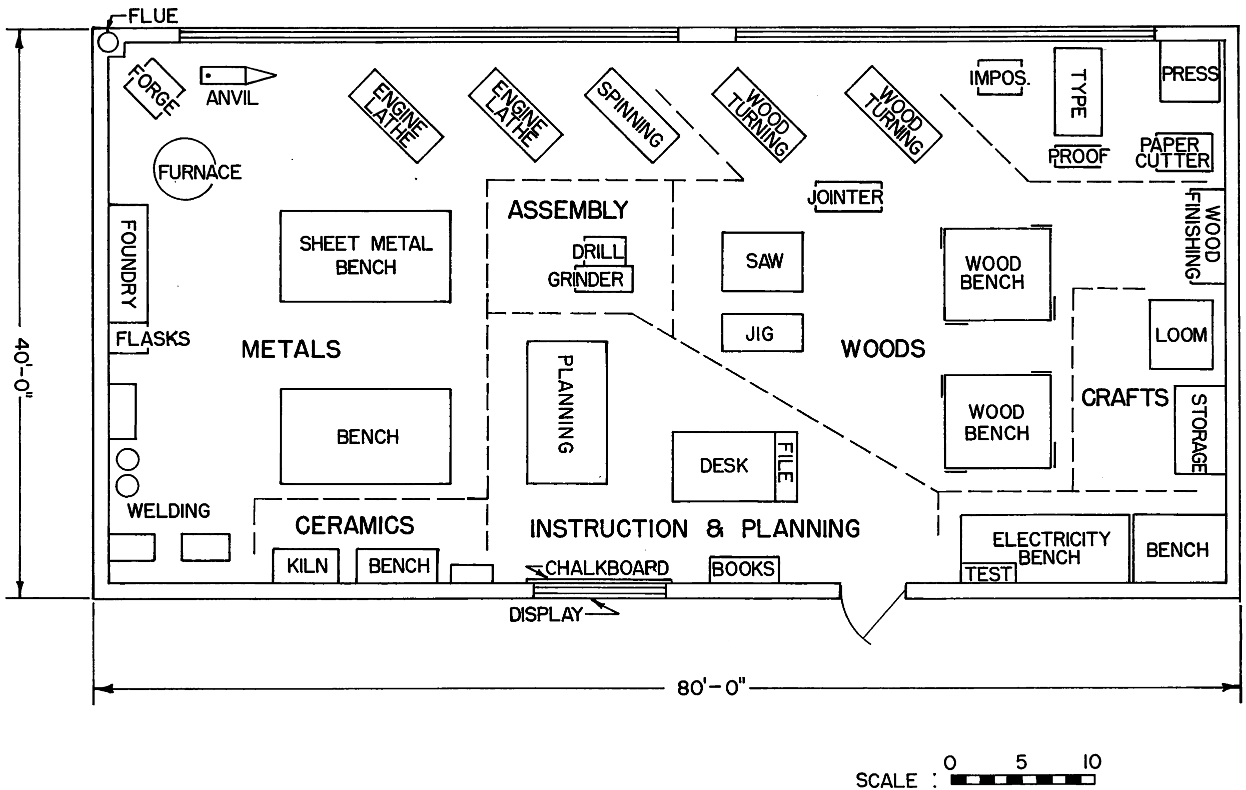


Figure 7. Application Sunburst Layout

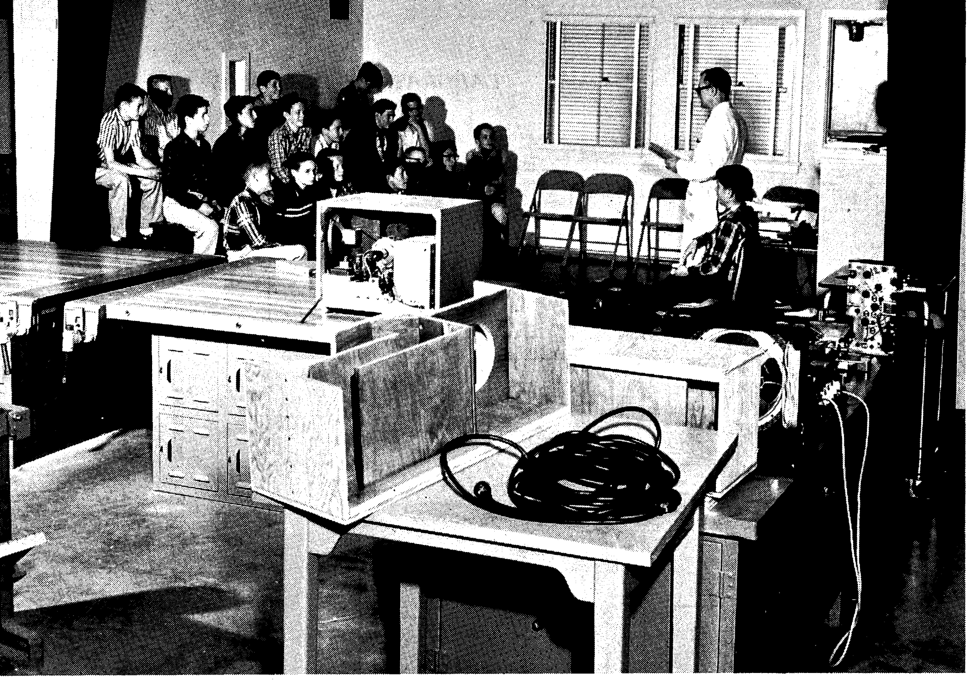
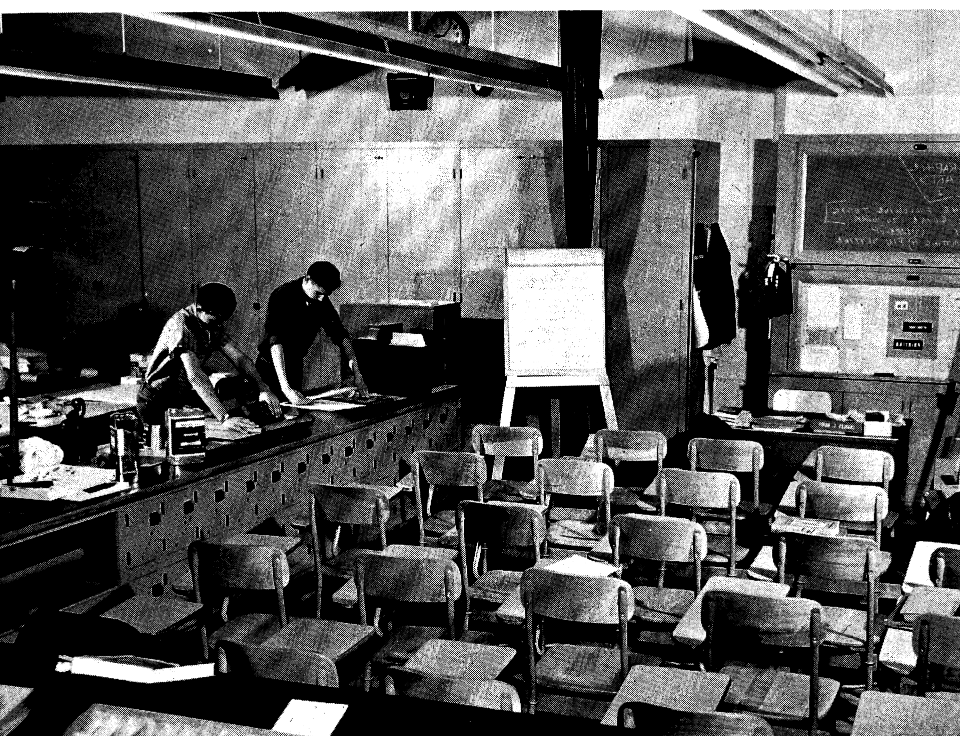


Figure 8. Classroom Alcove Equipped for Audio-Visual Equipment (Courtesy Los Angeles City Schools)

Demonstration Area in Laboratory With Audio-Visual Equipment (Courtesy Los Angeles City Schools)



Library and Planning Center.

The type of work done in the planning area requires the use of reference materials by students and instructor. Reference materials should be housed in enclosed bookcases and shelves, and filing cabinets for easy access of plans and drawings are essential. A reading table is needed for student research and small group conferences. Small drafting tables or their equivalent should be provided. Other useful pieces of equipment for this area are tracing boxes and an opaque projector for enlarging well-designed magazine plans and drawings. In many of the newer plans the library and planning are incorporated with the teacher's office and is glass enclosed.

Future Needs and Developments.

Allowance should be made for future expansion to provide for changing needs resulting from cultural and technical progress. Adaptability and flexibility of laboratory arrangement make possible changes to provide space when needed.

PLANNING DEALING WITH EQUIPMENT AND MATERIAL AREAS

Laboratory Arrangement.

A scale model or flat cutout of each major piece of equipment should be placed on a scale plan and studied in its relationship to other equipment in the vicinity. Working space needs around each piece of equipment should be determined in respect to general traffic control. Aisles of travel may then be determined for main arteries of traffic between areas of instruction and between benches, machines, and tool storage. Feeder traffic lanes may then be determined as each major piece of equipment is placed in its natural position in relation to other equipment.

Tools and materials should be located in each area where they are used. Those of a general nature should be centrally located, if possible. Some areas of instruction, such as woods and metals, are also service areas for the entire laboratory. It is common to find textile looms or graphic arts silk screen frames under construction in the wood and metal areas. Electrical projects frequently involve considerable wood and metal work. Work stations should be placed so that related activities are in close proximity. Some work stations serve many areas.

Space Needs.

Determination of over-all space needs is generally calculated from the space needed per student. However, space needed per student varies with the type of activity, since more space per student is needed in those activities involving large pieces of equipment and materials. Activities in auto and power mechanics, general metal, general wood, and comprehensive general shop are examples. When per student space is considered on an average for all areas, estimates result in shop sizes ranging from 1200 to 3600 square feet for twenty-four students in a general shop. Storage space is not calculated in this figure but is found in a separate column. In some cases a need for special rooms occurs. This is found in the right hand column of the chart by Dr. Paul L. Scherer and shown as Figures 9 and 10. At the bottom of Figure 10 is another chart showing desirable additions to all laboratory areas if applicable.

Traffic Control.

In general, the purpose of traffic control is to prevent the interference of one student working near another or traveling between work stations. Lines of travel from individual work stations to general work stations and to storage areas should seldom cross similar lines of travel. Student paths should fan-out, rather than criss-cross. Distinct aisles of travel should be provided for free flow of student traffic among all areas and points of common usage, such as storage rooms, planning center, common machine areas, and work sink. Aisles of travel should be no less than four feet wide.

Space between benches, machinery and equipment should be sufficient for safety and free passage. This is determined by the nature of the activity and the equipment involved. Feeder aisles should be at least three feet wide.

Machines should be placed so that danger areas around machines do not overlap other work areas or aisles of travel. Interference from students traveling near machine operators create hazards. In addition, machines should be arranged to promote safety and afford the smooth flow of materials.

Storage facilities should be planned with regard to traffic control to prevent bottlenecks and loss of time waiting for tools and materials. Tools should be provided in each area where they are needed. Each activity area should be as self sufficient as possible.

Equipment Considerations.

The location and installation of machines is one of the most critical tasks of laboratory planning. Even after the machine has been placed in the area, care must be exercised to position it correctly so that it is accessible. The direction of light, both natural and artificial, in relation to the operator should be considered and the machine revolved to bring light to the work area without contrasting shades or shadows. Each machine should be studied in its relationship to other machines in the area, particularly those used in combination, such as circular saw and jointer. The routine of operation should be considered in this type of planning.

In the normal flow of wood from the stock room to the work bench, operations are performed in the following order: cut-off saw, planer, jointer, and circular saw. The position of wood stock during and after these operations should be considered with regard to the need for revolving the stock to work with the grain. This requires considerable space around each machine.

Adequate clearance should be allowed between machines. Usually a minimum working space of three feet is needed, and working space should be provided for the operator. All of the above principles should be considered in locating motors and start and stop switches on the machine along with the "Square D" type safety box and the availability of a master control panel. Careful advance planning will enable the architect to provide power where needed.

Each work station should be studied with regard to work space needed for operations to be performed. Analysis of the clearance needed around the work station will forestall interference with other activities. (Refer to figures in Chapter V relative to work clearances.) The position of the work station should be adjusted to eliminate objectionable shadows. The operation level of equipment should be set at the average elbow height of students.

Planning and Related Studies.

Provision should be made for student research and student-teacher planning by a space in the open laboratory area or a small classroom, adjacent to the laboratory and separated by glass.

Assembly Area.

An open area in the laboratory should be reserved for assembly of larger projects in general wood, general metal, and transportation laboratories. Such projects as boats, soap box racers, and large furniture need this type of space.

Dark Areas.

Special attention should be given to the assignment of space with regard to the natural and artificial light available. Those areas

KEY TO SPACE

SQ.FT. OPEN SHOP AREA
SQ. FT. PER PUPIL
SQ. FT. STORAGE
SPECIAL ROOMS

Sq. ft. open shop area	Sq. ft. per pupil	Shop / Grade level	Sq. ft. storage	Special rooms	Special room
MINIMUM		SHOP GRADE LEVEL	MINIMUM		SPECIAL ROOM
ADEQUATE			ADEQUATE		
DESIRABLE			DESIRABLE		
2400	100	AUTO MECHANICS SENIOR HIGH	200	225	CLEANING ROOM
3000	125		225	250	
3600	150		250	275	
1800	75	POWER MECHANICS JUNIOR HIGH	175		NONE
2400	100		200		
3000	125		225		
1800	75	ELECTRICITY & RADIO SENIOR HIGH	125	180	3 SOUNDPROOF TEST BOOTHS
2400	100		150	210	
3000	125		175	240	
1200	50	ELECTRICITY JUNIOR HIGH	100	60	I SOUNDPROOF TEST BOOTH
1800	75		125	70	
2400	100		150	80	
1800	75	GRAPHIC ARTS SENIOR HIGH	225	125	PHOTO LAB
2400	100		250	150	
3000	125		275	175	
1200	50	GRAPHIC ARTS JUNIOR HIGH	200	125	PHOTO LAB
1800	75		225	150	
2400	100		250	175	
1800	75	DRAFTING SENIOR HIGH	150	125	BLUEPRINT OR OZALID ROOM
2400	100		175	150	
3000	125		200	175	
1200	50	DRAFTING JUNIOR HIGH	100		NONE
1800	75		125		
2400	100		150		

Figure 9. Space Allocation Chart (Courtesy Paul L. Scherer)

1800	75	GENERAL WOOD SENIOR HIGH	275	125	FINISH ROOM
2400	100		300	150	
3000	125		325	175	
1200	50	GENERAL WOOD JUNIOR HIGH	250	100	FINISH ROOM
1800	75		275	125	
2400	100		300	150	
1800	75	GENERAL METAL SENIOR HIGH	225	125	FINISH ROOM OR PROJECT STORAGE
2400	100		300	150	
3000	125		325	175	
1200	50	GENERAL METAL JUNIOR HIGH	200	100	FINISH ROOM OR PROJECT STORAGE
1800	75		225	125	
2400	100		250	150	
2400	100	COMPREHENSIVE GENERAL SHOP SENIOR HIGH	275	125	FINISH ROOM AND PROJECT STORAGE
3000	125		300	150	
3600	150		325	175	
1800	75	COMPREHENSIVE GENERAL SHOP JUNIOR HIGH	250	100	FINISH ROOM AND PROJECT STORAGE
2400	100		275	125	
3000	125		300	150	
1800	75	HANDICRAFTS SENIOR HIGH	225	125	GLAZE AND FINISH ROOM
2400	100		250	150	
3000	125		275	175	
1200	50	HANDICRAFTS JUNIOR HIGH	200	100	GLAZE AND FINISH ROOM
1800	75		225	125	
2400	100		250	150	

DESIRABLE ADDITIONS TO ALL SHOP AREAS IF APPLICABLE

OFFICE	SEPARATE CLASSROOM OR PLANNING AREA	EVENING SCHOOL STORAGE
125	400	125
150	450	150
175	500	175

Figure 10. Space Allocation Chart (Courtesy Paul L. Scherer)

with less light are useful for activities where colors of heat are to be observed. Ideally, no laboratory should contain dark corners or areas. Welding booths, forging, and heat-treating furnaces may well be placed in these areas as well as individually lighted machines such as grinders and buffers.

Projection screens should be located in an area that can be darkened, and the screen surface should not face window light. Even though a screen is located in a dark area, any light on the screen will reduce its efficiency.

Since artificial light is adequate for stock racks, wash basins, project storage, and student lockers, these may be located in dark areas. However, overcast days and night use of facilities demand that artificial lighting be provided throughout the laboratory.

Housekeeping Considerations.

Needs for maintenance of the industrial arts laboratory should be anticipated and discussed with the architect before the plans are drawn. Provision should be made for such utilities as water, gas, compressed air, electric outlets and drainage of waste disposal. A washing station should be provided for every five students in such laboratories as wood, metal, and graphic arts. Hot water should be available in all laboratories.

Compressed air should be made available at convenient locations in the laboratory with diaphragm valves to control the pressure. The air compressor should be outside the laboratory.

Dust collection systems are needed in wood and metal areas, as well as fume exhaustion systems in hot metal areas, plating or where acids are used. Space should be allowed for waste and refuse containers and for safety cans to hold oily rags. If there are large amounts of waste, containers should be mounted on casters.

Equipment and benches should be arranged to facilitate easy cleaning. If possible, bases for cabinets, benches, and machines should be enclosed to the floor, with an allowance for toe room for the comfort of the worker.

Live Storage.

All immediate needs of students and teacher for tools and materials should be met with facilities for live storage. All wall or open floor benches should have built-in storage facilities with locked doors. Since it is difficult to locate expediently tools and materials placed in drawers, cabinets are recommended. Drawers enable a careless student to create storage problems by opening the top drawers and scooping tools, materials, and waste into top drawers during a hurried clean-up period.

Student lockers are needed to store partially completed projects and personal belongings. The locker area should be located so that it can be readily supervised by the instructor at the beginning and end of regular class periods.

Supply rooms should be located for easy access without crossing paths of other students. It is desirable to make a complete plan of traffic control by over-laying the laboratory layout with tracing paper and drawing lines of travel for various work activities to determine the extent of cross-traffic. It is desirable to analyze traffic at the beginning of work session, during the working period, and at clean-up time. Such a traffic analysis usually reveals that the most convenient location for supply and storage rooms is at the ends of the main laboratory area. Ease of storing and issuing supplies should be of prime consideration in locating supply rooms.

Supply storage rooms should be equipped with adequate racks, shelves, and cabinets designed specifically for storing the type of supplies used in the particular industrial arts laboratory. Bar metal may be stored either vertically or horizontally, while small hardware and fittings should be located in bins. Paints and other canned supplies should be located on narrow shelves or in cabinets. Metal cabinets should be provided for storage of combustible materials.

Special racks or shelving should be provided for storage of lumber, bar steel, plywood, and other bulky supplies. It is sometimes possible to locate these items in a natural alcove provided by the architectural arrangement of the building. Such practice prevents lumber racks from appearing to protrude into the room.

Machines used primarily in roughing out stock should be placed near storage. Circular and cut-off saws should be convenient to lumber racks. The power hack saw should face an aisle leading from the bar stock rack.

Special tools should be stored in cabinets convenient to the location where they are to be used. Labels and signs should facilitate quick location of special tools. A teacher demonstration of special tools should include "where to find tools when needed".

Space for assembly of large projects should be provided in laboratories where large projects such as boats or soap box racers are expected. Usually they are most conveniently stored in the same location where assembled.

The problem of storage of student projects in progress of construction increases as classes grow larger. Student interest in a project can be maintained only if his project is protected. Separate locked storage spaces are preferred for each class to prevent careless handling of projects belonging to another class. Special attention should be given this problem in the wood finishing room.

Dead Storage.

Adequate dead storage should be provided for all supplies used in live storage. When supplies are exhausted in live storage, additional replacements should be easily available. It is not always feasible or economical to purchase supplies as needed. Since larger purchase orders are more economical, many schools require the major portion of supplies to be ordered annually. These bulk supplies need locked dead storage space so that quantities will be available throughout the entire year. Outside access should be available, if possible for heavy and bulk material.

Every laboratory or group of related laboratories should have its own supply storage room, size to be determined by the nature of laboratory work, number of students, and type of supplies to be stored.

Analysis of the types of dead storage space needed, which may be locked in cabinets in the live storage area, reveals that space should be provided for: raw materials (lumber, bar stock); supplies (glue, chemicals); hardware (machine screws, wood screws); extra tools (planes, chisels, hacksaws); finishing materials (varnish, paints); and oils and greases (lubricating greases, quenching oils).

Adult Evening Classes

Separate supply and project storage should be provided in laboratories used extensively for adult evening classes. It is imperative to provide separate storage if different instructors are employed in evening school than in day school. Separate lockers should be provided for adult evening classes.

PLANNING BASED ON ARCHITECTURAL AND CONSTRUCTION CONSIDERATIONS

Laboratory Space.

The size and shape of an industrial arts laboratory should be determined by philosophical considerations and adjusted to meet architectural and construction restrictions. Diversified activities in laboratory work revolving around a planning area as the nerve and control center occasionally dictate an approximately square laboratory. However, structural feasibility usually necessitates a 2:3 or 1:2 ratio of length to width.

Problems of noise, ventilation, accessibility, and sufficient floor space should be considered early in the planning procedure. After building contracts are awarded, changes are extremely expensive. Building codes should be consulted before installing heavy equipment.

Machinery should not be mounted on columns or against pipes if these will transmit noise to other parts of the building. Machines creating a vibration problem should be cushioned with some type of shock absorbing material. If possible, accoustical tile and/or plaster should be used on ceilings to reduce noise.

Artificial lighting should be of sufficient intensity and quality to meet accepted standards of fifty foot candles or above. One-hundred foot candles are sometimes needed.

Full advantage should be taken of natural lighting through maximum window area. Bilateral and overhead lighting north and east are preferable. High windows with sills six feet above the floor provide wall space for tool boards and wall displays, yet a few low windows are needed for an outside view.

All shops should have at least two exit doors. Some shops require overhead or double-type doors to allow entrance of large equipment or projects. These large doors may be considered as one of the exits, if not contrary to local fire regulations. Open spaces near exits and entrances eliminate congestion.

For future expansion and development, plans should be adjusted to provide flexibility and adaptability. Allowances should be made for changes due to new technical developments and new techniques of production.

Power and other utility services should be based on a liberal rather than restricted estimate of future needs and placed to allow maximum flexibility in laboratory arrangement. Later changes in equipment and arrangement will require electric outlets uniformly spaced throughout the laboratory. Extra outlets are installed most economically at the time the building is constructed.

Industrial arts laboratories should be located with respect to the need for community use of facilities beyond the regular day school program, so that this section of the building may be opened for evening use without opening the entire school. The plan for evening school use should also be integrated with other subject matter areas likely to be used for evening classes.

New Construction Materials.

Maximum use should be made of modern advances in construction materials to provide for better sound absorption and light reflection. Ease of maintenance and cleaning should also be considered in choosing materials.

An improvement in artificial lighting is the addition of reflected light from the ceiling. The color of the artifical light should be considered as a part of the room color scheme. Warm light provided by flesh-colored fluorescent lights is generally preferred to the cold blue sometimes found in fluorescent installations.

PLANNING BASED ON LEGAL CONSIDERATIONS

Safety and Protection.

Perhaps one of the most important considerations in school laboratory planning is protection of the learner from hazards. The school laboratory should have built-in safety features and safeguards. The instructor and laboratory planner must provide safeguards and instruction to impress the learner of the presence of the hazard *before* he starts working. For example, safety shields should be in place and goggles provided when operating buffers and grinders.

Power and light controls should be centralized on a locked master control panel with pilot light and located near the teaching center. Remote control safety switches should be placed in several convenient locations in case of emergency.

Provision should be made for the location of a first aid kit near the wash area.

Fire Hazards and their Safeguards.

Protection against fire should be provided in all areas of instruction. Finishing rooms should be provided with suitable air-tight storage and disposal cans for waste rags saturated with finishing materials. Forging areas should be provided with quenching baths of high flash-point oil and air-tight covers to smother automatically any accidental fires. Foundry areas need asbestos gloves, aprons, and leg guards, as well as eye and face shields for pouring hot metals. Graphic arts areas should be provided with non-explosive cleaners and thinners for printer's ink and silk-screen paint. All combustible liquids should be stored in safety-cans, clearly marked and color coded.

Gas welding tanks should be stored outside the laboratory close to driveway or loading area.

Fire extinguishers must be located near danger points and labeled conspicuously. Carbon-dioxide extinguishers seem best for all around use. However, each fire extinguisher should be planned for a specific use, according to the fires likely to occur in the area.

Color Coding and Safety Marking.

Dangerous parts and machines must be marked with a color-coding similar to that recommended by the National Safety Council. Dangerous areas around machines should be marked off with color coding.

A scientifically arranged color scheme should be planned for the entire laboratory. Such plans as those developed by Dupont or Pittsburgh Paint companies are suitable. It has been demonstrated in industrial shops and school laboratories that the use of color improves the efficiency of the worker.

A uniform color for denoting electrical outlets and switches should be used to indicate caution.

Working Conditions.

Control of sound influences the safety of learners. Large industrial organizations have found that the control of sound has a pronounced influence on worker productivity, morale, efficiency, and safety. Machines should be mounted on sound absorbing bases to prevent the transmission or amplification of noise.

Adequate heat, light, and ventilation should be provided in accordance with the requirements of local building codes. Special ventilating facilities are needed for wood or metal finishing, hot metal furnaces, heat-treating equipment, welding booths and auto exhaust. A separate dust-proof finishing room equipped with an independent exhaust system should be provided for wood or metal finishing laboratories.

A drinking fountain should be located with the wash sink, or adjacent to it, to eliminate congestion.

CHAPTER V

Equipment Selection

By: Paul L. Scherer
University of California, Santa Barbara

In spite of the tremendous growth of industrial arts, many laboratories are still handicapped by inadequate size, arrangement, or type of equipment. It is hoped that the following recommendations will aid those planning new facilities and remodeling laboratories already constructed, where mistakes or lack of funds have hampered the development of a modern industrial arts program.

Basic principles of selection and purchase of school equipment should be determined by the type of educational program desired by the community and its curricular requirements. These policies may be determined individually or jointly by the following groups:

1. State requirements set forth by the State Board of Education and State Division of Schoolhouse Architecture, as, for example, laws governing types of exhaust systems, relationship of window space to floor space, or room sizes as determined by ceiling span.

2. Community requirements as reflected by the local Board of Education. For example, industrial arts laboratories may be used for adult evening classes. All teaching in transportation shall be of a "dead car type", rather than repair of student cars.

3. Recommendations of an advisory committee to reflect community industrial needs. For example, a community having aircraft production might desire a unit laboratory on sheet metal fabrication. A community with industry producing radio or television equipment might desire multiple courses of basic and advanced electricity.

4. Correlation of sequential industrial arts programs by supervisors and principals to eliminate duplications of program and equipment. For example, if mechanical drawing is required of all junior high

students, the first course in high school should not duplicate the junior high course but should become a second course. A junior high laboratory in metal should prepare the student on basic machines, leaving those more specialized to the high school.

5. Recommendations of the classroom teacher based upon his teaching methods and his individual course of study. For example, some teachers use a total class project method with all students performing the same operations. If this approach is used, a far greater outlay for tools and equipment will be necessary. If more demonstrations are employed, a more elaborate setup for this kind of equipment and its storage will be necessary. If the teacher requires the student to solve a problem in creating his project, the class will progress at varying speeds and makes duplication of some tools unnecessary. More attention should be devoted to solving basic problems or concepts. Often this may be achieved with equipment not too large but with greater versatility.

SELECTION OF EQUIPMENT IS CONTROLLED BY OBJECTIVES

Methods and Procedures Employed in Teaching.

Any method or procedure in teaching can be efficiently carried on if machines are of standard design, small or medium in size, and typical of the type used in the same area in local industry. If purchased and properly amortized, machines can be replaced more frequently with later models or improved designs. The fact that a machine still runs does not guarantee its value as a teaching tool. The selection of such equipment should typify the best in construction with the greatest possible safety factors, as well as ease of operation and low maintenance costs.

The Selection Should Reflect Attitudes to be Taught.

Selection of equipment should reflect objectives in the development of attitudes and applications of basic knowledge under varying conditions. For instance, equipment should be properly spaced and adequately marked for location of start and stop buttons and moving parts. This will aid in developing safety attitudes. The laboratory should offer a variety of makes, sizes, or styles to increase the breadth of educational background and to provide for more flexibility in the student's solution of his problem. This develops the quality of versatility. Special features of one machine may not be available on another.

A few special tools and machines with accessories may challenge the upper level of the instructional range. This will help the development of self-reliance.

Design and Development of the Project by the Student.

When the instructor provides ready made plans or a stack of cut to order stock, the student is robbed of the opportunity of doing any creative thinking or problem solving. The student should relate the problem of designing his project to the operations the available machines will perform. He should learn to perform all the operations of which the machine is capable. Equipment size and power available must be adequate for the size of project planned for the laboratory. Often principles could be taught in the construction of a scale model at little cost and with greater speed than a semester project with tedious hand processes. It is more stimulating to solve a problem in which one is interested. Multipurpose equipment is favored by some and opposed by others. They are a solution to laboratory bottlenecks where there are periods of heavy use on a particular machine. Machines should be used primarily for the purpose for which they were designed, but imagination and inventiveness may be stimulated by experimenting on uses outside the normal functions of the machine. For example, a drill press can also be used as a shaper or mortiser, allowing a creative twist, or a milling operation might be achieved on a machine lathe. Development of insight and understanding by the student rather than a rote series of exercises should be the prime consideration.

Schools must consider requirements of space for machines, storage space for project materials, and space required for assembly of projects. By reference to Figures 9 and 10 in Chapter IV we may see that if a school is building a room of minimum size, equipment should be small and practical. Instructors must plan projects in conformity with the small assembly and storage space available. A minimum wood laboratory is not the place for production band saws, thirty inch planers, eighteen inch jointers, and the building of ten dining room tables at one time. Since the amount of space for each student to work will be almost minimum, over-sized equipment and storage will rapidly produce unsafe practices and uncooperative student attitudes.

Many school systems begin with well planned rooms, only to omit later, because of financial need, some storage and auxiliary areas also serving as assembly areas for projects. As an economy measure, oversized second-hand equipment is purchased, which consumes valuable floor space resulting in a second class laboratory.

Far more sensible would be an investment in the proper sized room for the activity planned, making ample provision for *space.* For a year or two the instructor can teach the same principles by means of small projects completed with hand tools, gradually adding through his yearly budget items too expensive for the original equipping of the space. One superintendent of a large system made it a practice to purchase an item only after it had appeared in the budget requisition for three consecutive years. Since a new item might frequently appear on the second year's request, it is logical to assume that the original item was not essential to the program. A special tool for each operation may make the student dependent on tools rather than his ingenuity and thinking processes to solve a problem.

Quality of the Equipment.

It is essential that the equipment be capable of producing a fine quality of work. No one would argue that a hand made miter box should be substituted for a mechanical one in the school laboratory. However, the student should discover he can construct a temporary box to serve his purpose, if a mechanical one is not available. Similarly, many tools for home workshop use will give years of excellent service but cannot sustain the daily and multi-period usage of a school situation. The value of some multi-purpose machinery in the laboratory is the transfer, especially from the safety factor, into his possible use of such equipment in the home workshop.

The quality of the machine does not necessarily govern the quality of the student's work. Good teaching and good student performance will usually produce within the necessary tolerances. Some student using the largest and best precision model available will still produce inferior work. If exploratory experiences rather than finished craftsmen are objectives of industrial arts, equipment costs may be lowered and more space provided for satisfactory working conditions and safety. The trend today is towards miniaturization and precision work on small objects.

TYPES OF EQUIPMENT

Power Driven Machinery.

A careful check should be made of the percentage of use of equipment in relation to the amount of floor space it will occupy. Limited use machines should be eliminated unless the laboratory is classified as a maximum space type. Consideration should be given to the type of laboratory. For example, a small tilting arbor bench saw may prove adequate for a crafts laboratory or a general comprehensive program, but in a general unit wood laboratory a larger floor model would be necessary.

Selection of the correct size and type of motor is of prime importance. Local availability of power circuits should be checked before specifying a 110-220 single phase or a 220-440 three phase type of installation.

All necessary or desirable accessories must be specified, if they are not included in the basic item. Such items as guards, lights, and a variety of blades must be ordered. Design of the machine must insure long life under rugged shop conditions and performance with an economy of operating cost and replacement parts. Availability of service and replacement parts is essential.

Many school systems do not prepare a proper requisition for ordering power equipment. Such a requisition should include:

1. The name and address of the preferred dealer.
2. The desired date of delivery.
3. The requisition number of the local board of education.
4. A *complete* description of the machine, quantity desired, horsepower and phase of the motor, type of connection, and complete descriptions of blades, chucks, rests, or any other accessories pertinent to operation of the equipment. Catalog number with date of publication and page numbers from which the item was selected. Listing of the unit price, price of accessories, cost of delivery, appropriate taxes, and a total price.

Special notes should be added indicating the reason for requesting a specific make or type of tool and for refusing substitutions. For example, the instructor wishes a specific lathe, since it has accessories to perform operations his present lathe will not do. It would be useless to just specify a 12″ lathe. The basic price of an item may seem lower than another, but the price is made up in the accessories. A total check of the entire item is advisable.

The following is a verbal and diagramatic review of planning principles which should be observed in the placement and use of power equipment.

The Milling Machine. Figure 11.

The operator works from both sides of the frontal arbor area. This machine like the shaper is best placed at a 45 degree angle to the natural light and just far enough from the window wall to allow for the operator. This distance will be determined by the length of travel of the table. If the machine is thus properly placed it will also discourage the use of this frontal area as an aisle. If artificial light is used it should fall on the cutter area and adjusting wheels. On the back side only enough clearance to get to the service-access doors is necessary. Chip guards should be provided as a safety precaution.

The Power Cutoff Saw. Figure 12.

This machine should be placed close to the metal stock storage area. It is approached mainly from the front and left side but because the cut off stock falls to the right there should be plenty of room for the operator to get all around the machine. The space to the left of the machine for inserting long stock to be cut should not extend through any aisle area. Light, either natural or artificial, should fall on the cutoff saw and on the speed adjustment controls. When cutting the full range of metals, different resistances are set up between the saw blade and the metal to be cut. It is therefore essential that a chart be placed near the speed controls so that the operator may make the adjustment to the proper rate of cutting speed. This prevents the saw teeth from loading up and causing a variety of poor results such as the teeth digging into the metal and snapping, overheating of the blade area, and freezing the blade in the metal which will result in unsafe practices.

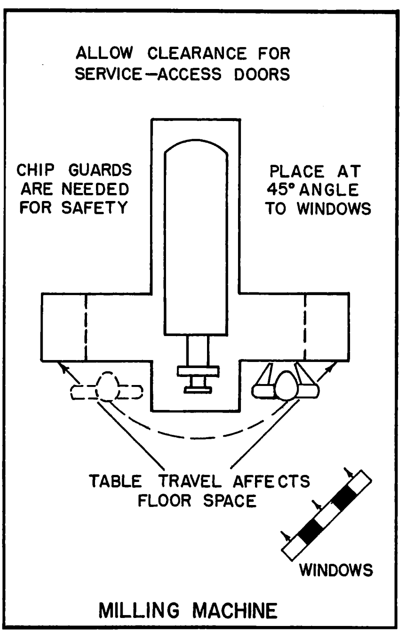


Figure 11.

(Courtesy Rockwell Manufacturing Co.)

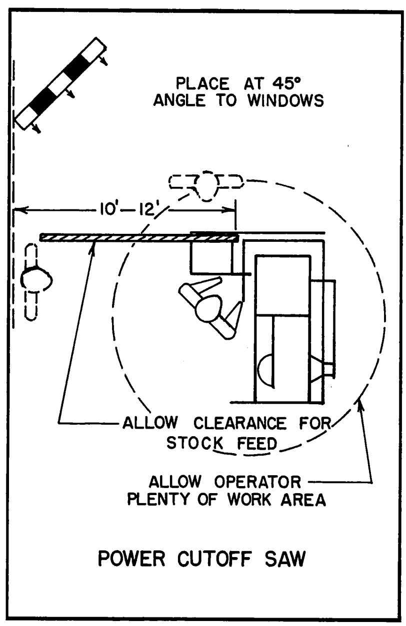


Figure 12.

Belt Sander. Figure 13.

This machine is approached only from the front and should have a four foot aisle provided on that side. Enough space should be allowed at each end to accommodate long stock. Regular cabinets are not recommended as they may interfere with the tilting of the table into the 45 degree position. Light should come from above and slightly behind the operator. Some method of dust collection should be used.

Disk Sander. Figure 14.

The approach to this machine is from the front and to the right of the sanding disk. A four foot aisle at the front of the machine will help protect the operator from being bumped. If the disk is rotating clockwise, space should be allowed to the right side of the machine for positioning work on the disk. Light should come from the left hand side and onto the disk. Some method of dust collection should be used.

Combination Sander.

There are some combination belt and disk sanders incorporated into one machine. This machine requires more space as the approach is from all sides of the machine. The size limit of the belt on these machines is usually between twenty-four and thirty inches of usable area. There is sometimes a tendency to get a sag on this type of belt sander where there is no supporting table.

The Wood Planer. Figure 15.

The planer is usually used immediately after the cut-off operation and so should be relatively close to the lumber storage area. Ample clearance must be provided at the infeed and outfeed sides to take long stock. No work station should be in line with the infeed side because of possibility of kickback. Warning signs on feeding short stock should be continually in view of the operator. The light source should provide ease of reading of the dimensional settings and also so that the operational levers and wheels may be easily observed and safely handled. A chip collecting device should be installed with this machine.

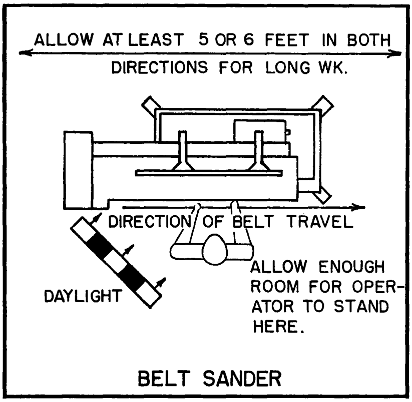


Figure 13. (Courtesy Rockwell Manufacturing Co.)

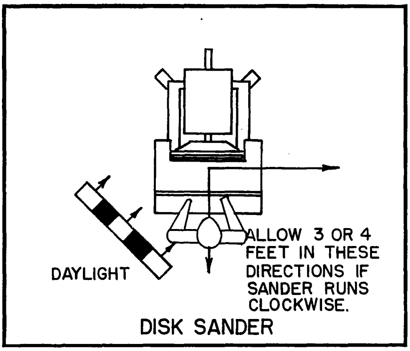


Figure 14. (Courtesy Rockwell Manufacturing Co.)

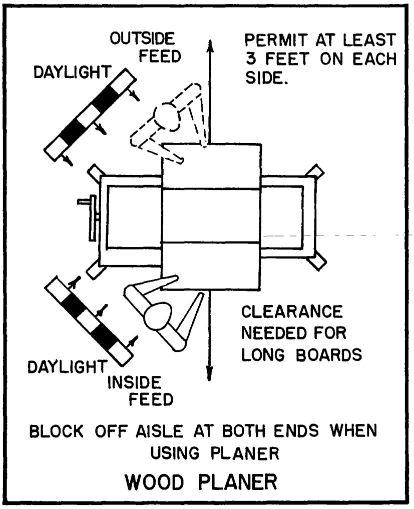


Figure 15. (Courtesy Rockwell Manufacturing Co.)

The Tool Grinder. Figure 16.

Work on this machine is usually small in nature and a four foot aisle on the operator's side is all that is necessary. It should be placed relatively close to the drill press and the lathes as it is used most often to sharpen the tools for these machines. Grinder wheels must always be guarded. It can back up against a wall or post and needs only enough room on the sides for servicing and changing the wheels. Illumination should be artificial and concentrated upon the point of work. If this machine is used near finishing or polishing operations, a suction system should be installed to carry off dust and small chips plus the worn wheel parts.

The Metal Shaper. Figure 17.

The metal shaper is approached from three angles at the front of the ram as shown in the diagram. For best natural light the machine is placed so there is just enough aisle space for the operator to work between the machine and the window wall with the machine at a 45 degree angle. This permits the ram to operate without blocking the aisle. On some shapers the ram's back stroke will extend beyond the base of the machine and must not be allowed to extend into a traffic aisle but rather be backed up to another machine.

Press Brake or Power Shear. Figure 18.

This machine may be approached and used from the front with a six foot radius in a one hundred and eighty degree arc. This is necessary for the handling of occasional large sheets of stock or long pieces. This area must also be kept clear and not used as an aisle. Natural light should fall onto the table area from the right or left of the operator.

Figure 16.

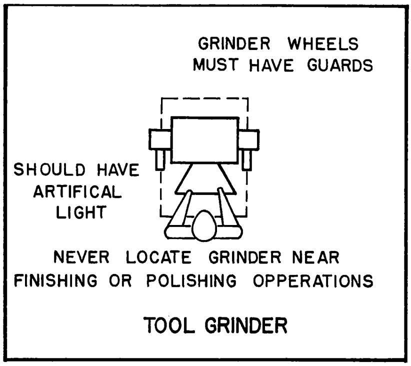


Figure 17.

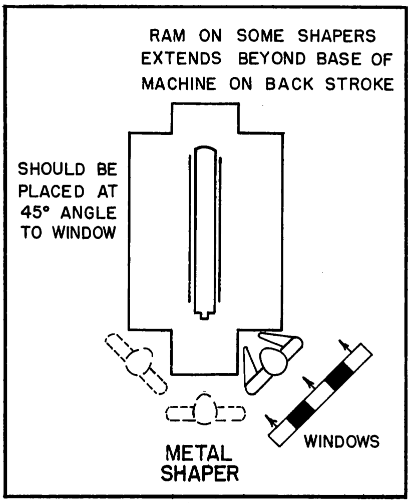
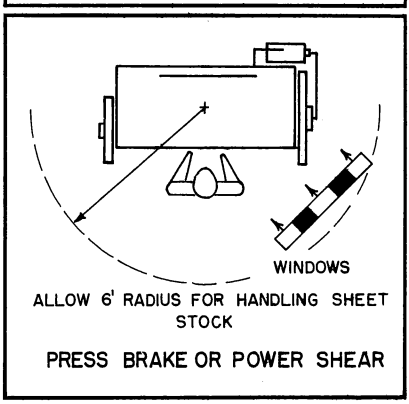


Figure 18.



The Scroll Saw. Figure 19.

This machine is approached from the front and this area should have at least five to six feet of clearance space which is not part of an aisle. An aisle may be placed at the back of the machine or it may be placed against a post, wall or back of another machine. It should be centrally located in the shop as it is one of the most frequently used machines. Because so much of the work on this machine is of a fine nature, an individual light mounted to the left of the blade is usually provided so that natural or artificial light is of little importance. A blower attachment to remove the debris from in front of the blade also improves the efficiency of the machine.

The Wood Shaper. Figure 20.

The student approaches the shaper from the front and also needs working space on both right and left sides. It should be placed where there is no danger of interference from other students. If possible, nothing should be lined up with the shaper on either side; should something go wrong and a piece of wood become caught and thrown out, it will not injure another student. Light, both artificial or natural, should come from the front and both sides, therefore artificial light is much better. If only small projects are to be designed it may be placed in a corner next to a window, but if long pieces of molding are to be run, then it is best placed along a wall with bench space on each side which may be temporarily cleared.

The Band Saw. Figure 21.

The operator approaches the machine from in front of the blade. A wide space should be allowed at the front and right side of the machine for the operator to maneuver his material. An aisle may be close to the left side of the machine or five to six feet behind the machine. Be sure there are no work stations in line with the travel of the blade. The band saw should have its light coming from the right hand side both for natural or artificial. Many of the newer machines come equipped with an individual light attachment which eliminates the importance of the other light sources. A blower attachment to remove the debris from in front of the blade also improves the efficiency of the machine.

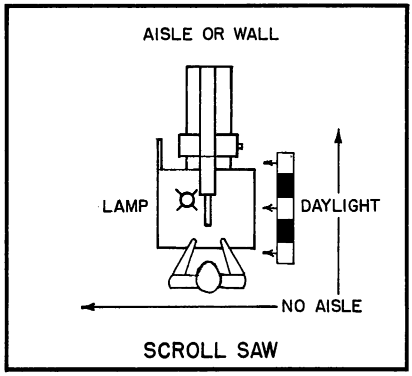


Figure 19. (Courtesy Rockwell Manufacturing Co.)

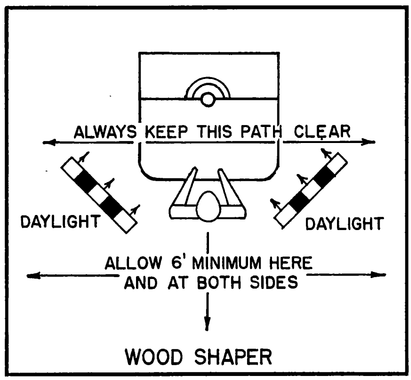


Figure 20. (Courtesy Rockwell Manufacturing Co.)

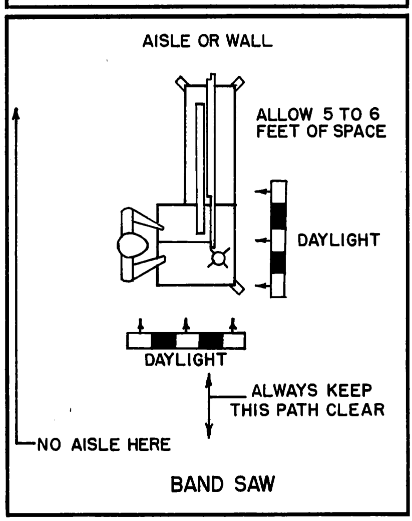


Figure 21. (Courtesy Rockwell Manufacturing Co.)

The Circular Saw. Figure 22.

This machine should be approached from the left side with stock from the radial arm saw, storage area, or from the student work area. A wide aisle space should be provided at the front and back of the machine to allow the ripping of long boards. No work stations should be placed in line with the saw travel so that if a student is careless and a piece is kicked back it will be out of range of other student work stations. Less aisle room is necessary at the sides as extremely long boards should be cut on the radial arm saw placed adjacent to the lumber rack. The circular saw should have both natural and artificial light coming from the left hand side and the rear.

The Grinder. Figure 23.

The grinder is approached and used from the front. It may be placed against a wall or post or if small may be bench mounted. It is usually found in the metal shop or the craft shop where it has many uses for removing excess metal. If two grinders or a grinder and another machine are placed back to back a protective screen of wire glass or plywood should be placed between. As most of the work done on the grinder is small, an aisle may be placed behind the operator. Lighting is done artificially either by small spotlights or by lighted shields so that general lighting is rather unimportant. The grinder should never be located near finishing or polishing operations.

The Jointer. Figure 24.

This machine should be placed to the left and ahead of the circular saw so that work finished on it may flow logically to the jointer for its next operation. If an aisle is used on the left it should be wide so that students in passing will not interfere with the operator. The jointer may be placed within three feet of a wall to the left so that students will be discouraged from passing on that side when an operator is working. Space should be provided both ahead and behind the jointer to accommodate long boards. The right side of the machine may be placed against a post, wall, or back side of another machine as long as enough room for cleaning is maintained. Both natural and artificial light should come from the left and back of the machine.

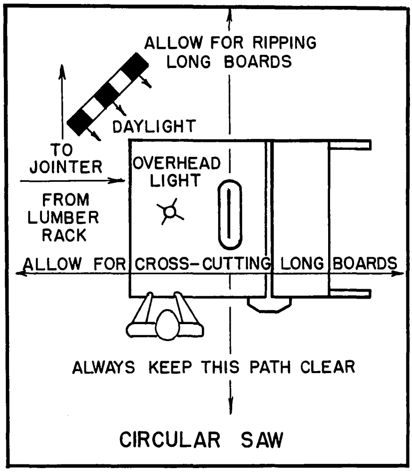


Figure 22. (Courtesy Rockwell Manufacturing Co.)

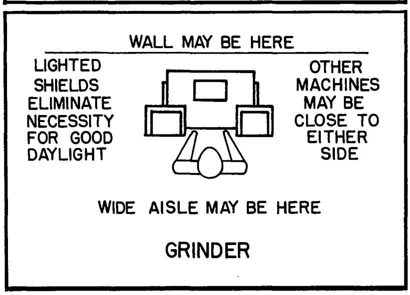


Figure 23. (Courtesy Rockwell Manufacturing Co.)

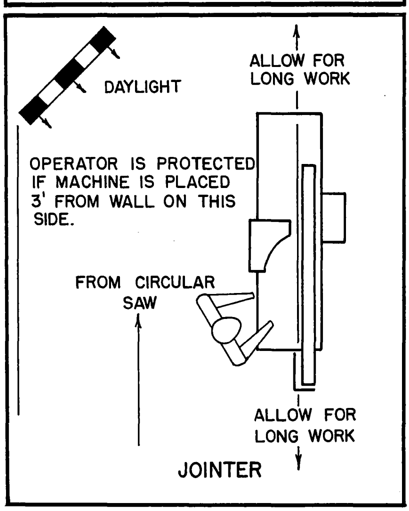


Figure 24. (Courtesy Rockwell Manufacturing Co.)

The Bench Lathe. Figure 25.

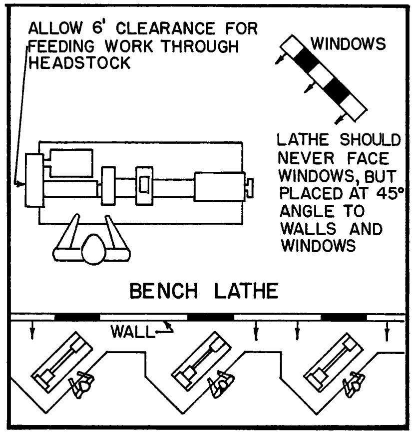
The operator works along the front of the bed which should be placed at a 45 degree angle to the window wall. This diagonal position is recommended to insure that work, if thrown from the lathe, will not be in line with other operators. The small diagram of the three lathes shows an ideal setup which gains additional storage space for tools and small projects beneath the lathe area while giving good light and safe operating areas.

The Engine Lathe. Figure 26.

The operator works along the front of the bed which should be placed at a 45 degree angle to the window wall. This diagonal position is recommended to insure that work if thrown from the lathe will not be in line with other operators. A long space to the left of the headstock and in line with the bed should be left clear for long stock which is fed through the headstock. This should not be in an aisle space for in many instances a pipe stand to support the end of the stock will be in this area. Natural light as well as artificial should light the entire lathe bed and fall upon the headstock area. There should be at least four feet of space between lathes at all points.

The Wood Lathe. Figure 27.

The operator works along the front of the bed which should be placed at a 45 degree angle to the window wall. This diagonal position is recommended to insure that work, if thrown from the lathe, will not be in line with other operators. Space must also be allowed at the front of the lathe if the headstock swivels for faceplate turning of large diameters. A tool post stand is then usually used. Natural light as well as artificial should light the entire lathe bed and fall upon the headstock area. There should be at least five feet four inches of space between lathes as shown.



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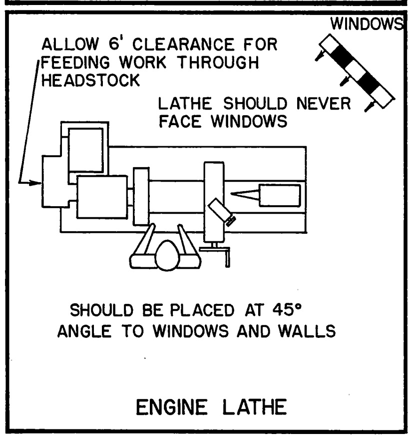

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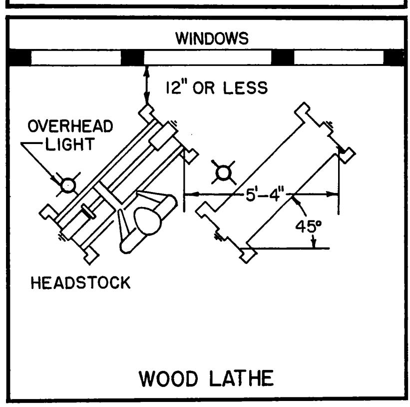


Figure 27. (Courtesy Rockwell Manufacturing Co.)

The Radial Arm Saw. Figure 28.

This machine should be placed near the wood storage area. It is best positioned into the wall cabinets so that the table is flush with the cabinet height. The operator should have a wide aisle behind him to insure that when pulling the saw towards him he will not be bumping into other workers. This saw has complicated setting dials for angles and depths and should be well illuminated for ease of reading. The illustration shows a rolling metal rod type of counter top to the right of the operator in contrast to the ordinary bench top to his left.

The Drill Press. Figure 29.

The operator usually works close in to the front of the machine but needs five to six feet of work space in a one hundred and eighty degree arc for manipulation of material. In the wood laboratory an additional usage may be that of a mortising operation which will require additional space on both sides of the machine. It may be backed against the wall, a post or another machine. Since drill press work requires accurate attention to detail and layout markings the provision of a positive, built-in artificial light source will permit the machine's location in less desirable areas of the laboratory. If natural light is used it is best coming from the left hand side of the machine.

The Engine Stand. Figure 30.

The main difficulty in many auto laboratories is that engines are placed too close together, allowing crews working on adjacent engines to bump into one another. There should be a floor suction system if the engines are to be operative. Good general illumination is necessary plus outlets for attaching extension cords.

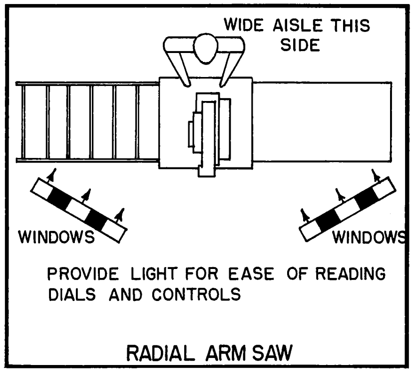


Figure 28. (Courtesy Rockwell Manufacturing Co.)

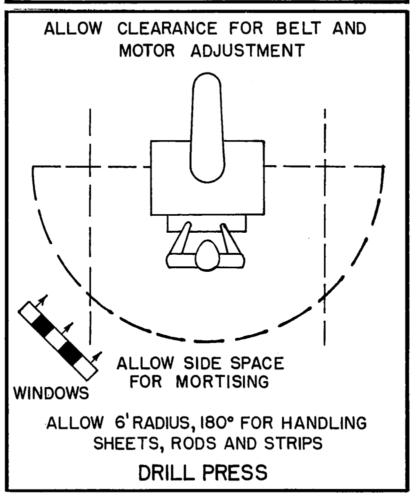


Figure 29. (Courtesy Rockwell Manufacturing Co.)

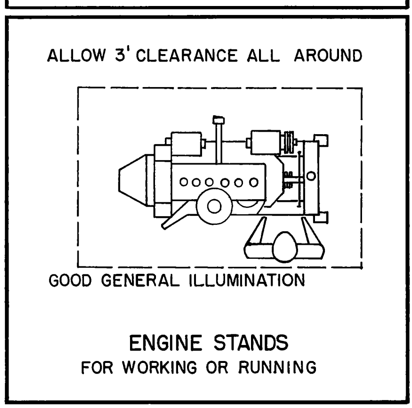


Figure 30.

The Squaring Shear. Figure 31.

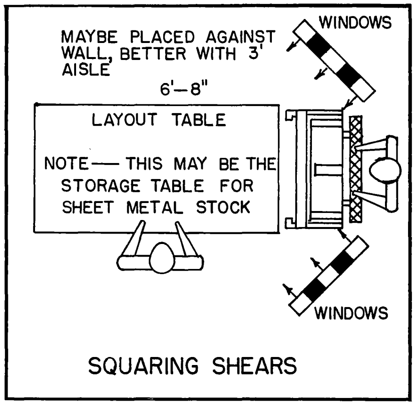
One of the methods of stock storage at point of use, gaining rapidly in popularity, is the use of the metal storage table. This table acts also as a layout table from which pieces of metal may be slipped into the squaring shear. Small pieces left over can then be placed back in the table for use without running into a stock room. These tables come with screened panels along the side with lock control if desired. The light on the squaring shear should come from behind the operator.

The Bar Folder. Figure 32.

The operator of this machine many times has awkward shaped pieces to handle and should therefore have room entirely around the machine to manipulate. Light is best coming over the operator's shoulder from right or left. This machine may be either a floor model or may be smaller and set on the front edge of the bench.

The Sheet Metal Brake. Figure 33.

The operator of this machine has many awkward shaped pieces to work with at times and should have a wide aisle behind the operator's position as well as adequate room to get around the entire machine. The brake may be set up at the end of a layout table similar to the squaring shear. Illumination should come from the right or left over the operator's shoulder.



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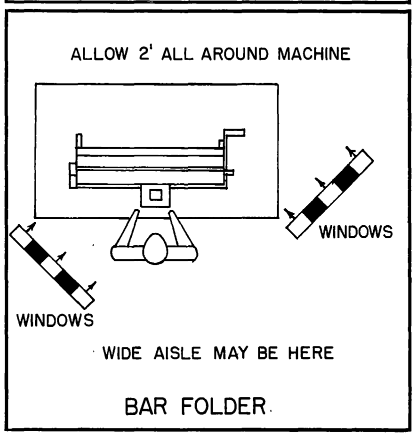

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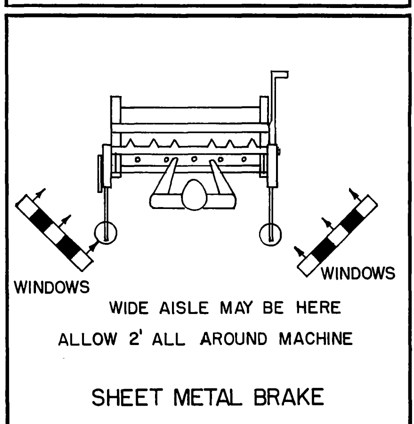


Figure 33.

The Potters' Wheel. Figure 34.

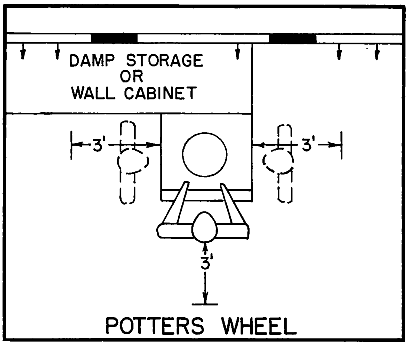
The potters' wheel should be open for use on three sides so that the operator may work from several positions. Light should come from the fourth side. The arrangement shown here with the damp storage cabinet adjacent is a fine solution. Placing the wheel at the end of a table is also another way of getting to it on three sides. A sink in close proximity is very handy.

The Paper Cutter. Figure 35.

The hand operated cutter takes additional space on the left side of the machine to accommodate the cutting handle. The operator works from the front and this area must be well lighted to see the fractional settings on the cutter tape. The bed of the table is sliding from front to back to get the desired lengths of cut so should not be placed too tight to the wall. The operator should have a wide aisle behind him and a table to the right or left on which to place the stock and to do jogging.

The Platen Press. Figure 36.

The operator works from the front of the press and should never face directly into strong light. He should have a wide aisle behind him with no chance of other students interfering with the rhythm which he develops in feeding the press. For cleanup work, good general illumination is a big help, along with space to get around the entire press.



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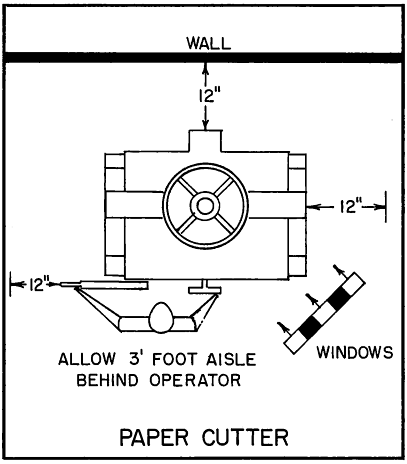

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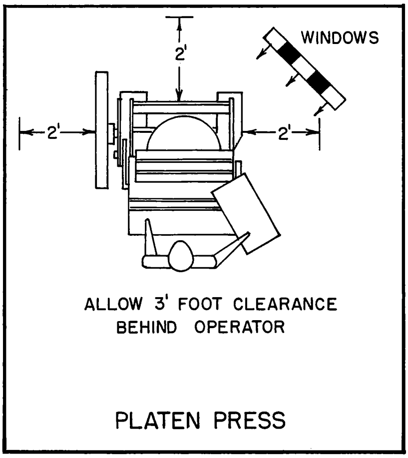

Figure 36.

Non-Power-Driven Equipment.

The bulk of this type of equipment falls into the category of work benches, both individual and group, as well as continuous wall benches. The major consideration is floor space. Single station benches develop a pride in possession and maintenance, but economy is evident in floor space resulting from six four-station rather than twenty-four single station benches. A second consideration in the selection of benches is a greater variety of storage compartments in size and shape with a system of adjustable partitions. Provision at time of purchase for lock control is an added but justifiable expense.

It must be called to the attention of administrators and boards of education that a *work station* does not mean added space for an extra student. For example, a drill press is considered a work station, yet many students will operate it from another work station at which their major work is done. In some laboratories it is necessary to provide twice the number of work stations as students in the class, while in others such as drafting only one-quarter more stations are required.

In addition to benches, some types of non-power driven equipment will include hand operated metal equipment, such as bar folders, squaring shears, brakes, rollers, and benders, as well as such items as pottery kick wheels, anvils, glue tables, paper cutters, hand printing presses, and storage racks for metal and lumber.

Paint cabinets should always be fireproof in construction and provided with a pan at the bottom to catch spilled paints or cleaning fluids. Any laboratory requiring the use of such materials should be provided with metal waste cans for the safe storage of paint saturated rags or other flammable materials.

Hand Tools.

One of the greatest variables in the entire equipment catagory is hand tools. There is almost no common agreement as to the basic tools needed in a particular laboratory area such as wood, metal, or graphic arts. Within an area there is wide variation in the number of tools needed in relation to curriculum and class size.

For commonly used tools it would seem that between half and three-quarters as many tools as individuals are required. Sometimes three to six are sufficient for a class of twenty-four, and often a single tool may be sufficient. Teachers generally recommend more specialized tools at one each rather than individual tools for each class member. This would indicate that the teacher is beginning to encourage each student to design and plan his project, utilizing tools available. By this means students "learn how to plan their work and work their plan", according to the writer of the *E. H. Sheldon Catalog.*[1]

The size of tools for beginning junior high student differs from those needed for the high school senior. Although an increased skill in higher classes demands a higher quality of tools, the use of tools extremely poor in construction, quality of handles, steel, or fabrication should not be tolerated at any level. The sizes and weights of tools for use in the elementary industrial arts program are especially important. Listed in Appendix "D" are tools basic to the primary and intermediate grades.

Provision should be made for replacement due to normal wear, and additional tools should be held in reserve for immediate replacement. If a tool is broken or lost, another should occupy its space immediately to facilitate checking.

SOURCES OF EQUIPMENT INFORMATION

Manufacturers.

Manufacturers of school equipment and supplies have catalogs and brochures giving definite specifications as to their lines of equipment. These will be supplied if requested on school stationery. Many manufacturers exhibit at state and national industrial arts conventions, providing pertinent information and trained personnel to confer with the teacher, supervisor, or administrator. Many standard and new machines are demonstrated. Upon request most manufacturers will write a standard specification to use in ordering their equipment.

Some manufacturers have research staffs working on plans and layouts of school shops. Examples of excellent published material of this type for the teacher, supervisor, and administrator to aid them in the planning of a new facility are: *How to Plan a School Workshop*[2], *School Shop Planning Manual*[3], *School Shops for Today and Tomorrow*[4],

[1]E. H. Sheldon and Company, *Industrial Arts Equipment.* Muskegon, Michigan, 1957.

[2]Delta Manufacturing Company, *How to Plan a School Workshop,* Milwaukee, Wisconsin, Delta Manufacturing Company, Undated.

[3]Kearney and Trecker Corporation, *School Shop Planning Manual,* Plainfield, New Jersey, Educational Department, Walker Turner Division, Second Edition, 1952.

[4]Rockwell Manufacturing Company, *School Shops for Today and Tomorrow,* Pittsburgh, Pennsylvania, Delta Division, 1955, 47 pp.

Planning Kit for Industrial Arts[5], *Industrial Arts Equipment*[6], *Arts and Crafts Furniture*[7], *School Shop Planning Guide*[8].

Magazines.

Magazines are one of the best sources of information on equipment. Practically all national and local magazines of an industrial, industrial arts, or professional education nature, carry advertisements of products by leading companies, where they may be seen, and what literature is available.

Certain magazines such as *Industrial Arts and Vocational Education, School Shop,* and *American Vocational Association Journal* devote either an issue or carry periodically equipment lists or a directory of manufacturer's products.

Check lists of equipment and non-consumable supplies are numerous, published by manufacturers, suppliers, professional and trade magazines, and state and local school systems. Each laboratory planned must first meet the curricular needs of the courses to be taught, and selection of equipment must be harmonious to these needs. Secondly, the general and specific background of the instructor who will teach the laboratory and his teaching methods must be considered and his needs met wherever feasable.

Appendix "D" is a listing by areas of equipment and non-consumable tools and supplies. These items are so listed because of varying interpretations by boards of education business offices as to what price demarcation constitutes equipment, non-consumable tools and supplies, and consumable supplies. Shifts from one list to the other may be made according to local practice.

[5]E. H. Sheldon and Company, *Planning Kit for Industrial Arts,* Muskegon, Michigan, 1957.

[6]*Ibid.*

[7]Hamilton Manufacturing Company, *Arts and Crafts Furniture,* Two Rivers, Wisconsin, Catalog 219, 1957.

[8]John L. Feirer, *School Shop Planning Guide,* Kalamazoo, Michigan, Educational Dept. Atlas Press Company, 1952, 23 pp.

CHECKLIST

Considerations in Equipping and Planning the Laboratory.

1. Arrangement of machines and work stations should be determined by instructional efficiency, work procedures, flow of materials, and safety considerations.
2. Between auxiliary rooms, tool panels, and commonly used machines, aisles with a minimum of four feet in width will permit free flow of traffic without interfering with adjacent workers.
3. A minimum of three feet should be allowed between benches, machines, and other equipment to allow for safe and free passage. In some shops this may be increased because of the nature of the materials handled.
4. Machinery and equipment should be painted in colors conductive to eye comfort and safety.
5. The large machine body should be finished in a color to create a visual working area and minimize eye fatigue.
6. Certain operating parts should be finished in colors in strong contrast to the body color of the machine.
7. Start-stop switches on all machines should be painted black and red and located within easy reach of the student-operator.
8. High visibility colors should be used on control levers and switch boxes.
9. Safety lines should be painted or taped on the floor to designate non-operators' limits.
10. At least one laboratory door should be of the double type or should have a removable wall section adjacent to allow movement of large pieces of equipment.
11. Work benches with lockers below should be provided along the walls of the room. A variety of sizes and shapes of storage compartments and movable shelving will increase its efficiency.
12. Tall machinery should not obscure the vision of other parts of the shop.
13. Open floor spaces should be provided around exits and entrances to prevent congestion.
14. Open floor space should be provided in front of tool panels and entrances to auxiliary rooms.
15. Open floor spaces should be provided in those laboratories requiring assembly of projects.
16. Laboratories requiring delivery of heavy equipment and supplies should be provided with access to the street and a large door for unloading such materials as lumber, metals, paper, etc.

17. If lumber, bar stock, or sheet metal is to be stored in the open shop, clear space must be provided for the removal of this material from storage without interrupting work situations.
18. Cut-off machines and those used for roughing out stock should be placed near the storage areas.
19. Equipment, other than portable, should be mounted securely to the floor or bench.
20. Rubber mountings or other shock absorbing materials should be placed under equipment which vibrates or on which there is a pounding action.
21. Equipment should be placed to allow for ease of cleaning.
22. Toe strips should be provided for cabinets, benches, and all possible machines to allow for ease of cleaning and for the comfort of the worker.
23. The operating level of the equipment should be a comfortable working height for the student who will use it.
24. Power controls should be centralized in a master control panel that can be locked, has a pilot light, and is located at a point most frequented by the instructor. (Usually an instructional area, rather than in his office).
25. If the laboratory is large, the use of remote safety relay cutout switches controlling the main power supply may also be provided.
26. Shops using portable power tools should be provided with one double electric wall outlet for every ten feet of wall space, with provisions for a grounding cord.
27. If electrical risers are not brought up beside center benches, capped floor outlets should be provided for use of portable equipment on these benches.
28. If daylight is insufficient at a machine station, it should be reinforced with a concentration of artificial light.
29. If precision work is done on a machine, special lighting should be provided.
30. Adequate systems should be provided for the collection and disposal of dust, chips, and shavings. Mechanical exhausts should be provided for smoke, odors, fumes, vapors, and gases.

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CHAPTER VI

Architectural and Engineering Practices in Laboratory Planning

By Doyt Early, *Senior Architect*
Bureau of School Planning
California State Department of Education

In all areas of the United States, state and local precedent, easily available building materials, and current architectural fashion influence school building design.

CONDITIONS INFLUENCE PLANNING

There are several unique conditions which result in strong influences on all phases of school planning and on the architectural and engineering aspects of industrial arts laboratory planning. Since California is a state embracing most of the climatic and other physical conditions common throughout the nation, several examples and illustrations fitting to different sections of the country will be cited. It is true that local regulations will affect certain building conditions in respective states. One of these in California is the earthquake safety law requiring that school plans be prepared by an architect or structural engineer. Plans, specifications, and structural calculations must then be checked by the Division of Architecture, California State Department of Public Works. Construction is supervised by this office, and changes must be authorized.

During the twenty-four years this law has been in effect, at least two and one-half billions of dollars of school construction have been carried on under these conditions. Since an industrial arts laboratory is essentially a wide span building, structural requirements must be carefully considered. Some effects resulting from this law have been: no basement shops, few multiple story laboratories, use of rigid frames, homogeneous bracing systems, and relatively low units arranged like an entire box with each side bracing the other. Ingenuity shown in structural schemes will be discussed later.

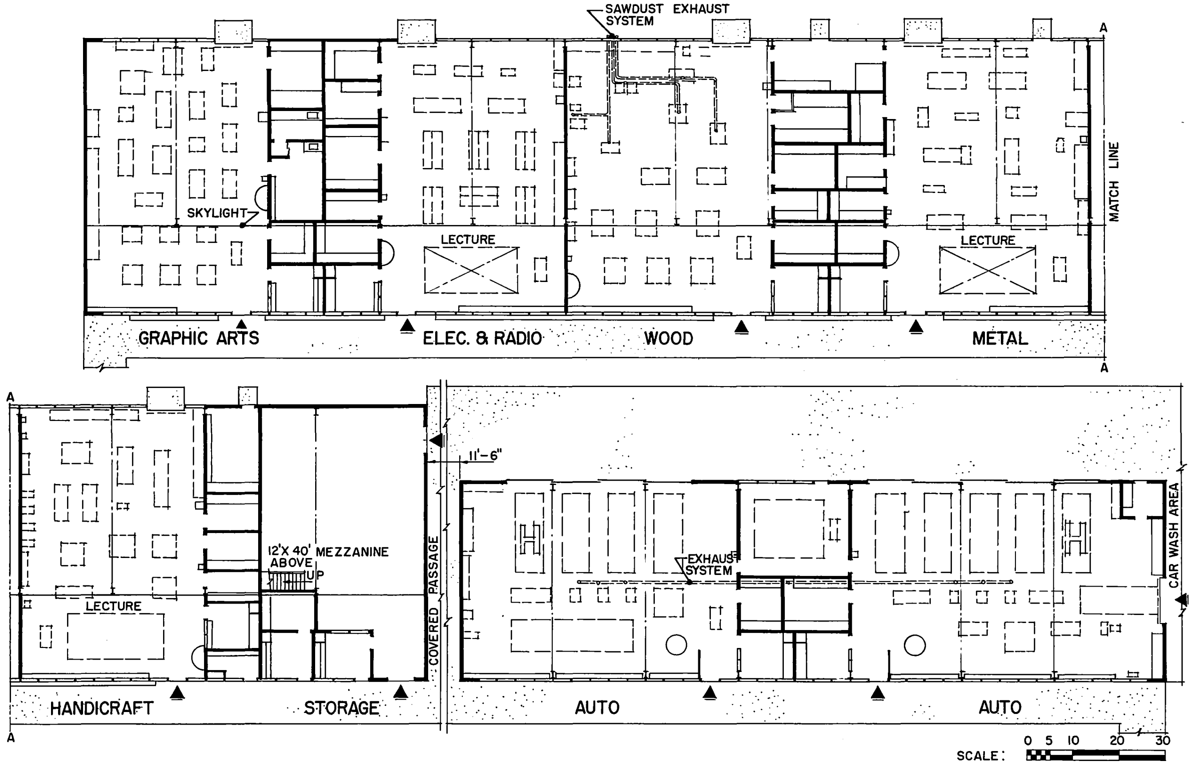
Some details of building under the rules of earthquake resistance include: continuous inspection from a resident inspector, testing laboratory reports on samples of concrete and steel, core sampling of reinforced masonry, special tests on welds, soil investigations, specification of nails at each joint, and attachments of walls to foundations to resist wind or earthquake stresses. As a result of exacting design, most architects employ many types of consultants, such as structural, mechanical, electrical, and acoustical engineers.

Before the earthquake safety law was enacted, substitutions were frequently made in materials during construction, and buildings were not designed with a horizontal resistance for wind or earthquakes. Since the primary criterion seemed to be economy, school buildings, with their wide spans and many windows, often collapsed with frightening regularity during earthquakes.

FINANCIAL ASSISTANCE

Another influence is state assistance for school building, available only to districts unable to finance their own needs. A common yardstick of building adequacy has been thought to be seventy square feet per pupil in elementary schools over 300 pupil capacity, 100 square feet in junior high school, and 110 square feet per student in high school of over 700 students. Under state aid, only fifty-five, seventy-five and eighty square feet, respectively, are allowed. Because these are such limited amounts, an additional 10,200 square feet is allowed for high schools. Under such limitations, the physical education and industrial arts laboratories are frequently diminished. If high school districts are financing their own needs, a common yardstick is six industrial arts laboratories for a school of 1,500 students. The Hiram Johnson High School in Sacramento with 110 square feet per student does not have an auditorium and provides eight laboratories for the design capacity of 2,000 students. This district is at approximately the state average wealth per student. Because of its importance as a median, the floor plan is shown in Figure 37.

Except for city school districts, plans for all school buildings and all buildings under state aid must be approved by the Bureau of School Planning. To approve plans for school buildings, the Bureau participates in the preliminary or basic phases of planning.



HIRAM JOHNSON SENIOR HIGH SCHOOL

Figure 37.

BROAD STEPS IN PLANNING

School planning has as its objective planning a functional building within the required area and within the permitted cost. The procurement of a site and its approval by the responsible agencies is first action in school building planning. A master plan development of a site, even though the first unit seems relative unimportant, has proven to be wise in the long term school building. This master plan presupposes a school of definite ultimate size.

At the first premonition of building need, the district is advised to contact field representatives of the bureau to begin a series of conferences to develop building needs, school population trends, financing schemes, and planning procedures. Other members of the team are the architect and representatives of the district, including the school board, the superintendent, and committees from the school staff. Here communication between these representatives is of utmost importance. One of the functions of school planning is familiarization with trends in the planning field and particularly in the immediate problem of planning a complete high school. Another function is to develop the problem so that a succession of teachers will be satisfied with the facilities.

Considering the planning function from the team angle permits the staff to develop educational needs. The architect and his consultants can develop more successfully the manipulation of space, choice of architectural materials, conformity to the budget, and a number of similar aspects.

The area of greatest skill needed by the planning group for a industrial arts laboratory will be the development of educational specifications. These laboratories should not be located at too great a distance from the other school facilities. Some teaching methods are unique to industrial arts. The answer to an algebra problem is always the same everywhere, but the problems explored in industrial arts may have unique solutions.

If the facility is to be properly planned, allowance for adequate planning time must be made, most junior colleges have allowed three years to plan and build. Two years is too short a time to allow for a large high school where many contingencies may arise. Where there is a building program of any magnitude, particularly in a large city district, several years may be required.

THE INDUSTRIAL ARTS FACILITIES

If one of the functions of our educational system is to train children to enter a problem-solving culture, the industrial arts area seems peculiarly well suited to develop such a point of view. Planning laboratory facilities from any other point of view would permit the substitution of stock plans, packaged buildings, and other nominal shortcuts resulting in inferior teaching.

Success in planning is commensurate with the realization that the school laboratory is a teaching station. Equipment and its arrangement may be similar to that used in industry, but the difference lies in the use. The school laboratory must be designed to permit change of station at the beginning and end of the period. It must be located so that service is accessible for supply and waste pick up. It must be designed to incorporate all the aspects of a good classroom for supervision and communication, including provision for teaching aids, projection, display, protection from fire, wind, earthquake, electrical shock, and typical laboratory hazards. The plot plan of Hiram Johnson High School, Figure 38, shows the industrial arts facilities as part of the classroom complex. Allowance has been made for truck service.

The classroom should allow freedom for rearrangement, permitting the introduction of new tools or processes. The well planned laboratory has great implications, not only as to the space itself, but as to engineering treatment of the acoustics, electrical systems, heating, plumbing, and special needs such as piped air ventilation and dust collection. The space requirements of seventy-five or 100 square feet per student, depending on the type, involve 2,500 square feet, in addition to the needs of supplementary spaces such as storage, office, and finishing. Obviously, such space becomes a problem when it is unduly long, narrow, cluttered with columns or "L" shaped providing spaces not visible at a glance.

SELECTION OF MATERIALS

Implications for fire, safety, and sound isolation stimulate choice of heavier forms of construction. Rarely seen in modern buildings are the trussed roof with waste space in the roof construction and the conventionally framed wood joist floor construction. Almost all floors are concrete slabs finished with what finances may dictate. Rigid steel or concrete frames, with reinforced masonry, concrete walls, laminated wood, lift slab, and steel decking for the roof are commonly used.

Precast concrete frames are frequently used in modern construction. Curtain walls combining glass with prefabricated wall panels speed construction. Building simplification to reduce man hours devoted to special fitting preserves quality and reduces cost. The use of steel frames in the Hiram Johnson School, cross sections shown in Figure 39, is typical of today's laboratory planning. Sections

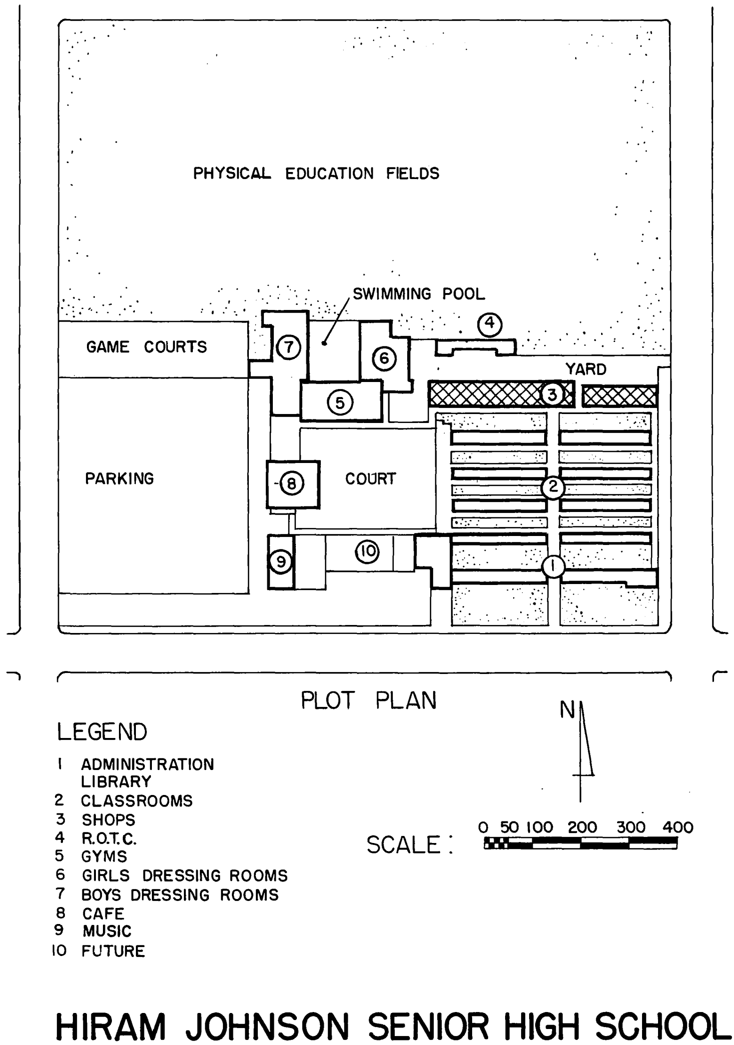
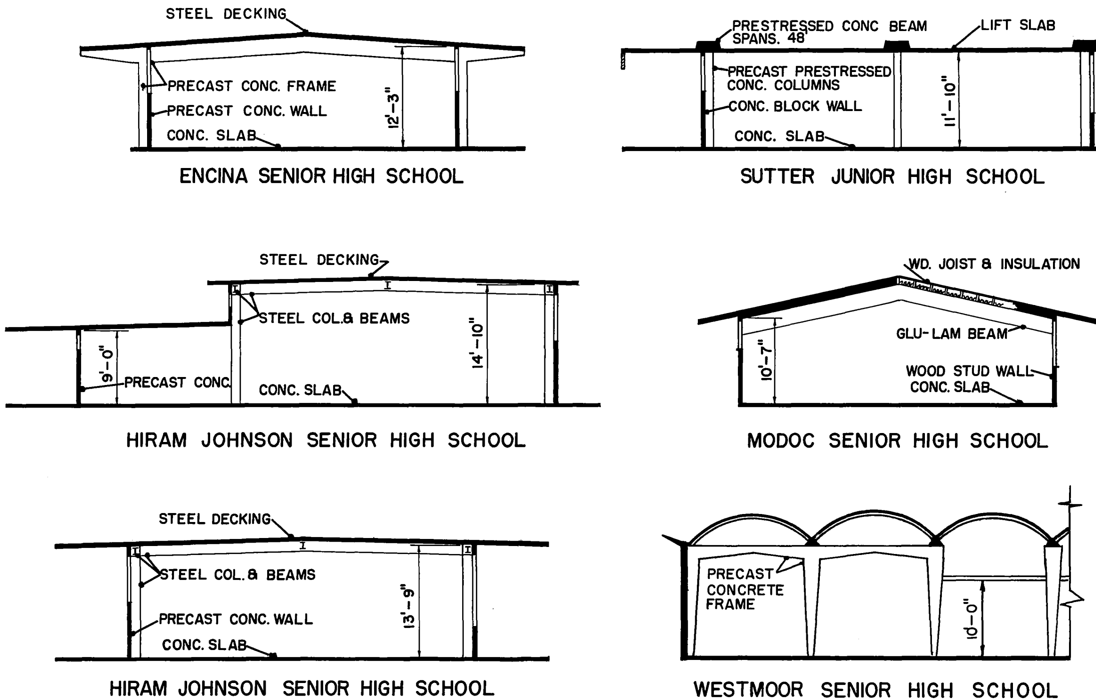


Figure 38. Plot Plan



CROSS SECTIONS SHOWING CONSTRUCTION DETAILS

Figure 39.

and plans of this school may be compared with those of Encina, by the same architect, also those of Modoc, and Westmoor Senior Highs and Sutter Junior High.

Encina Senior High School employed precast concrete frames and tilt up panel walls. Sutter Junior High School facilities, employed a precast roof slab poured on the floor slab and lifted by jacks on prestressed concrete block masonry. Growing in popularity are precast units like the semi-cylindrical concrete shells used on the Westmoor High School, Figures 40, 41 and 42.

There is evident a growing dissatisfaction with low quality construction requiring a high maintenance cost. Wood frame and stucco involves high fire risk and high insurance rates. Although school districts do not maintain accurate records of maintenance expenditure, it is agreed that painting is probably the most costly item of maintenance.

A stud and stucco wall is constructed by a variety of trades: concrete footings by one sub-contractor, studs with blocking, bracing and diaphragming of sheathing, and plywood by the carpenter contractor, flashing by the sheet metal contractor, and plastering by another. If the entire wall could be constructed by a single trade, savings in cost may result.

Currently available are wood panel units, concrete block and steel panel units, panels of porcelain enameled steel, insulated panels of aluminum combined with glass, and tilt-up concrete panels poured in forms. Concrete units of many types are cast, such as semi-cylindrical shells, tent or dome shapes, arch forms, and many variations. Some of these are given special treatments to develop color or texture. One of the best recent treatments is apparently the prestressing of reinforcing bars in the concrete. In prestressing concrete, wires are put in tensile stress and held there by hydraulic jacks until the concrete is cured. When the jacks are released, compressive stresses are exerted, offsetting the usual stresses. By these methods, enormously strong columns, beams, or other units may be developed. In Sutter Junior High School, Figure 39, the interior ceiling is flat, while the beam section extends above the roof. The fact that the columns are spaced up to forty-eight feet apart suggests the possibilities of these structures.

Pouring slab at grade level simplifies concrete pouring, requires a minimum of forms, and simplifies the work of other trades. Vibration of the concrete during pour makes a dense and hard slab. Engineering aspects of the concrete would have been incomprehensible only a few years ago. Water-cement ratio, void analysis, concrete design, steam curing, and all the controls of modern concrete technology permit closer tolerances than are found in many other trades.

Figure 40. Concrete Roof Shells

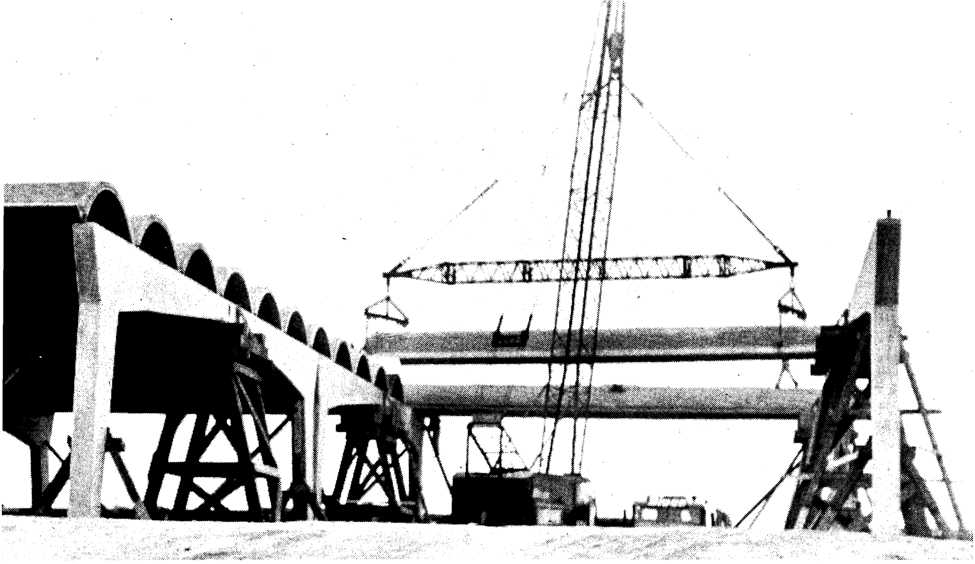
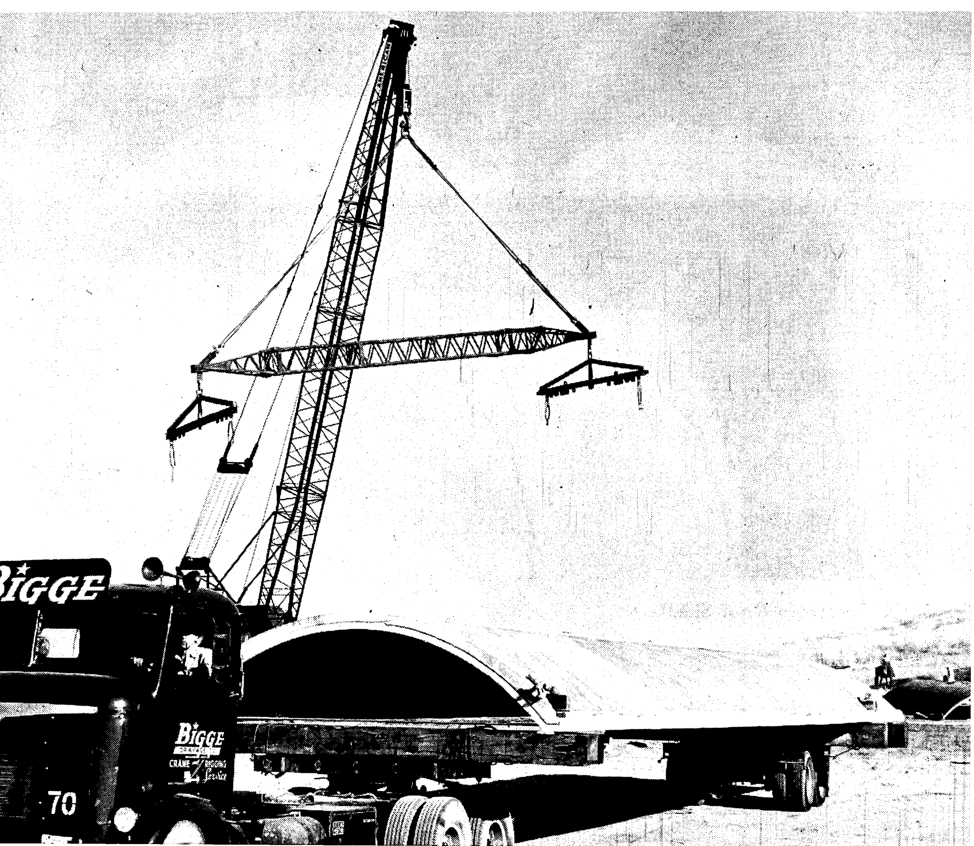


Figure 41. Erection of Concrete Shells

Figure 42. Crane and Truck Used in Transportation and Erection



THE SUTTER JUNIOR HIGH SCHOOL

The multiple laboratory plans, which occur in almost any large high school, show how broad span framing contributes to the simplicity of planning. Accompanying plans show that the laboratory wing is planned along with other classrooms for simplicity of scheduling. Following are some detailed observations on school plans.

The first of these is Sutter Junior High School Laboratories, Sacramento City Unified School District, Gordon Stafford, Architect, Harry J. Devine, Supervising Architect, and shown in Figure 43. In this plan the lobby joins with the ground floor access area under the two story classroom wing. Stairs give access to the classrooms above. Since graphic arts and mechanical drawing are relatively quiet activities, they should give little disturbance to other classrooms.

The wood and metal areas are accessible only from the outside corridor. Auxiliary rooms are placed between the laboratories to reduce sound transmission. In these facilities all floors are concrete, except graphic arts, where the covering is plastic tile. The office is placed near the door, making it unnecessary to walk by machinery when entering or leaving the room. Service entry gives access to lumber storage. The paint room is placed on the outside wall for better light and ventilation. Most of the machine tools are placed around the walls for access to electric wiring in walls.

MODOC COUNTY HIGH SCHOOL

An example of a building material adapted to a geographical area is Modoc County High School, Alturas, California, Howard Perrin, Architect, Klamath Falls, Oregon, Figure 39 (section only). Modoc County High School is notable for the relatively low height of its wood laboratory. Since the school is remotely located in the northeast corner of California, the "Glu-Lam" beams will probably be fabricated elsewhere and trucked to the school site.

As in many sparsely populated areas of the United States, this area has few fabricators of steel and concrete. Specialized tests would be expensive. Concrete is usually limited to foundation beams and footings. More workmen are available for wood construction.

Windows are low on the north side and high on the south side where they are shaded by the roof overhang. Light entering these high windows is principally reflected from snow or the light colored soil. In small high schools using a comprehensive general laboratory, sixteen students is a good figure. In multiple laboratory schools, twenty-four students per class is a desirable size.

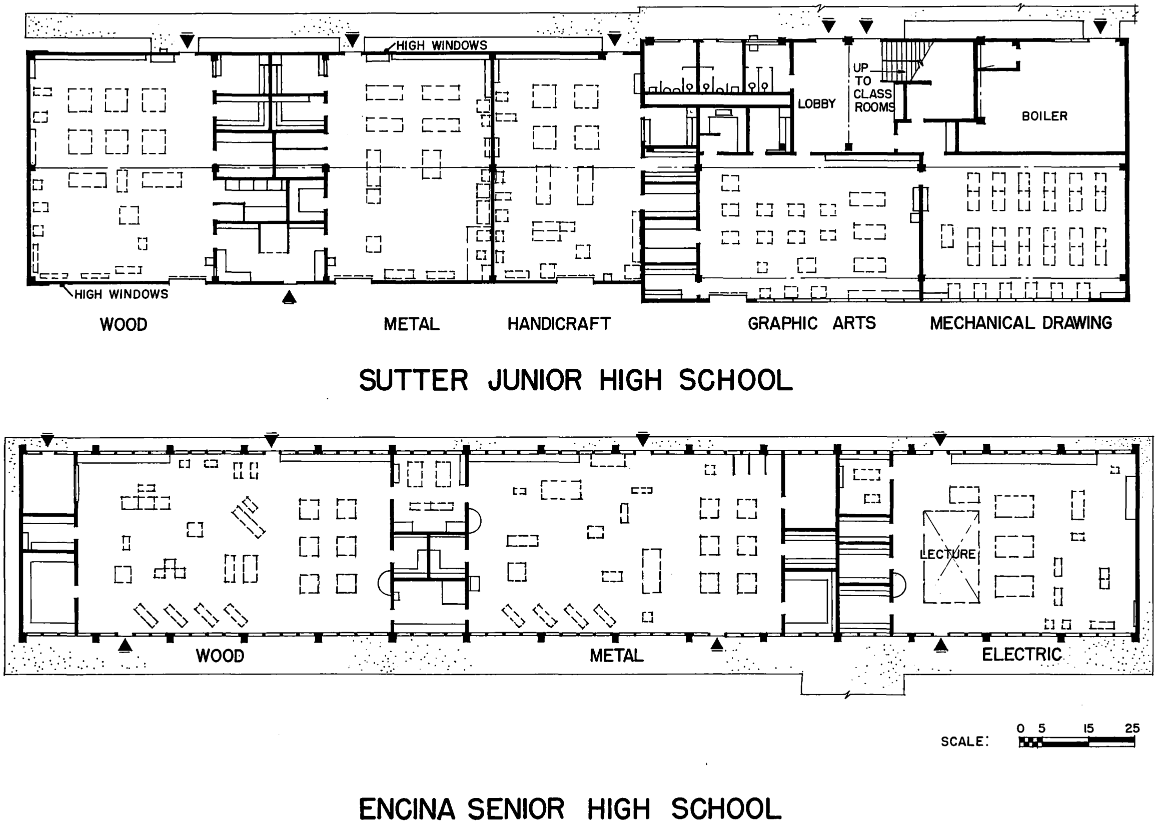
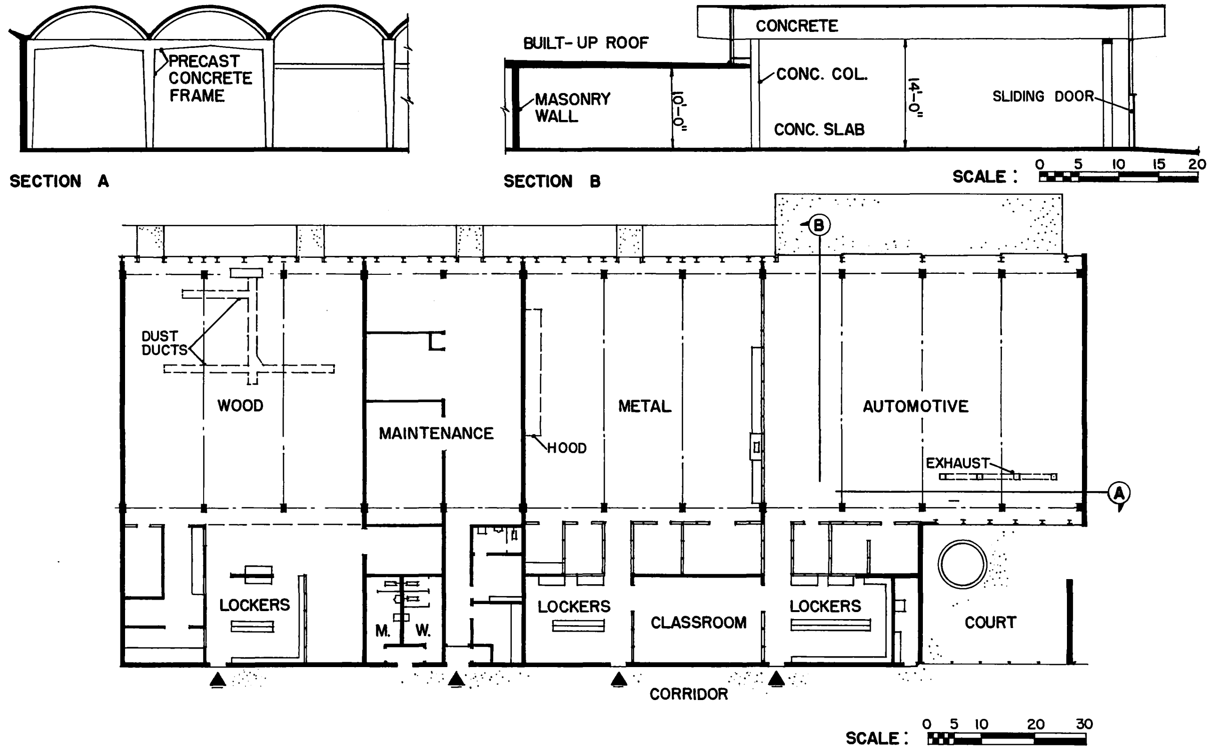

HIGH WINDOWS
LOBBY
UP TO CLASS ROOMS
BOILER
HIGH WINDOWS
WOOD
METAL
HANDICRAFT
GRAPHIC ARTS
MECHANICAL DRAWING
SUTTER JUNIOR HIGH SCHOOL
LECTURE
WOOD
METAL
ELECTRIC
SCALE: 0 5 15 25
ENCINA SENIOR HIGH SCHOOL

Figure 43.



WESTMOOR SENIOR HIGH SCHOOL

Figure 44.

WESTMOOR HIGH SCHOOL

Another school presented is Westmoor High School, Jefferson Union High School District, Daly City, California, Mario Ciampi, Architect, San Francisco, Figure 44. This is a building featuring an extensive use of plate glass in the exterior walls. The structure utilizes precast concrete units of many types, a trend gaining in popular usage. The school uses a loft plan layout with many interior classrooms. A feeling of openness is achieved by penetrations of the roof to produce interior courts.

ENCINA SENIOR HIGH SCHOOL

An illustration of modern laboratory framing is Encina Senior High School, San Juan Union High School District, Charles F. Dean, Architect (Deceased), Ivan Satterlee and Nicholas Tomich, Architects, Sacramento, California, Figure 43.

This school uses precast tilt-up rigid concrete bents to support the steel deck roof construction over which insulation is accomplished by 1½″ insulation board laid above the deck line. Tilt-up concrete wall panels, lower half Figure 46, are shown on the left side between the bents. Conduit for electrical outlets are shown stubbed up through slab floor.

HIRAM JOHNSON HIGH SCHOOL

An additional example of modern structure is Hiram Johnson High School, Sacramento City Unified School District, Charles F. Dean, Architect (deceased), succeeded by Architects Ivan C. Satterlee and Nicholas A. Tomich, Harry J. Devine, Supervising Architect. Figure 37. In this building the rooms are essentially forty by sixty foot spaces with rigid steel bents at twenty foot centers. The roof is spanned by Robertson Steel Decking with 1½″ fiber insulation board under built-up roofing. Walls are of tilt-up concrete panels, with the exception of wood frame supplementary rooms. The continuous framing of all laboratories in similar spans resulted in economical construction. The photograph, top half of Figure 45, shows the simple clean framing for the building. In the 24,000 square feet of the building, a single span and spacing pattern are followed.

The only mezzanine serves the receiving and storage room. Under the floor dust collection ducts in wood laboratory and engine exhaust in the auto facilities are provided. Similarity of these laboratories to those shown in the *Guide for Planning and Equipping*

Figure 45. Shop Framing Hiram Johnson Senior High School

Figure 46. Shop Framing Encina Senior High School

Industrial Arts Shops in California Schools is not surprising since several members of the city school planning staff also served on the planning committee of this publication.

LOCATION OF LABORATORIES

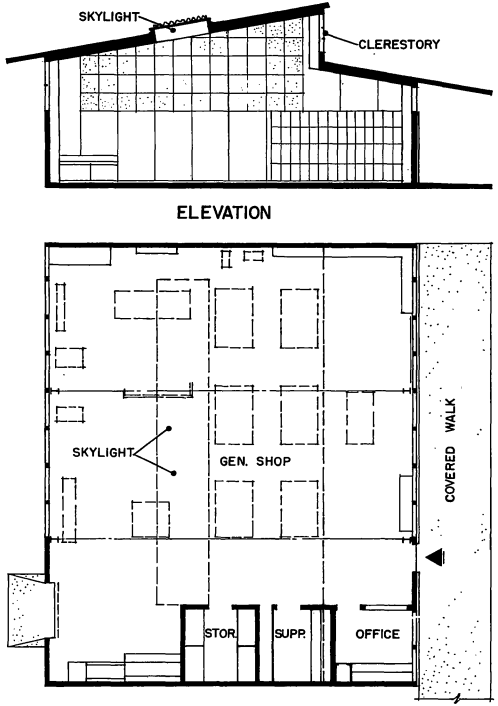
If a number of typical laboratories are located in a direct line, turning the room to make the longest dimension, the building span will decrease the over-all length of the building and reduce length of exterior walls and shorten mechanical runs. Auto facilities are an exception, since depth greater than forty feet is difficult to use efficiently, and the lesser amount of exterior wall space does not accommodate as many doors for cars.

Fortunately, one of the disappearing features of laboratories is the overhead balcony or storage loft. These may not be an economy in utilizing space. The height of the building may depend on air space in relation to acoustics, ventilation, type of activity, and size of projects. Sometimes high space is required for lumber storage, but that would hardly justify increasing the heighth over an area of 3,000 square feet.

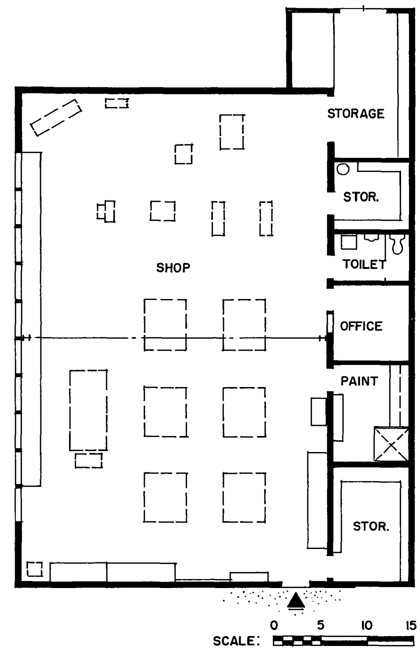
ELEMENTARY SCHOOL FACILITIES

The various grade levels of schools have respective complexities of structure. Separate elementary facilities are usually similar to conventional classrooms in construction, due to the principal use of hand tools, smaller projects, and smaller classes.

At the elementary level an example is the Willis Jepson School, Vaca Valley Elementary School District – Seventh and Eighth, Beland and Gianella, Architects – Vallejo, California, Figure 47. This shows the seventh and eighth grade laboratory at Willis Jepson School as a deceptively simple facility with one rigid steel frame crossing at midpoint. Two sets of three-by fourteen-inch joists on four feet centers span the two bays. Walls are mostly of tilt-up concrete panels. Foundations are beams poured on the engineered fill put in place before beginning construction of the group of buildings. Where foundation soil has little bearing value, new fill may be brought in, compressing the fill as it is laid. This is usually compacted to 95 per cent of its possibility. Footings can then be simplified. This laboratory may be compared with the Fern Bacon School, Pacific School District, Figure 47, built under the limitations of state aid.



FERN BACON
ELEMENTARY SCHOOL



WILLIS JEPSON
ELEMENTARY SCHOOL

Figure 47.

In the Fern Bacon School, planned by Koblik and Fisher, Architects, there is a seventh and eighth grade laboratory forty by forty-eight feet. It is lighted by well diffused daylight through a louvered skylight, eliminating direct sun entry with its heat and glare. Since there are no night classes this seems adequate. The building is framed on two steel bents.

An elementary facility which shows an almost ideal use of the outdoor classroom for industrial arts purposes is found in the Adams Elementary School, Santa Barbara School District, Chester L. Carjola, Architect, Figure 48.

One of the features of this arrangement is found in the full glass wall which separates the indoor from the outdoor classroom, thus giving the teacher full visual control at all times.

Classrooms are laid out in pairs in order to consolidate the heater space, cabinets, sinks, and other plumbing. Just outside the classroom door is a locked closet which contains storage facilities for wet clay, racks for storing lumber, tools, and other small materials used in construction such as prune boxes, orange crates, corrugated cartons and other miscellaneous supplies. Under the sink shelf two doors are large enough to permit the storage of four saw horses.

Sufficient space along the sink counter is provided so that small groups may do clay work on the tile topped area which is then easy to clean and confining this activity to the outdoor area.

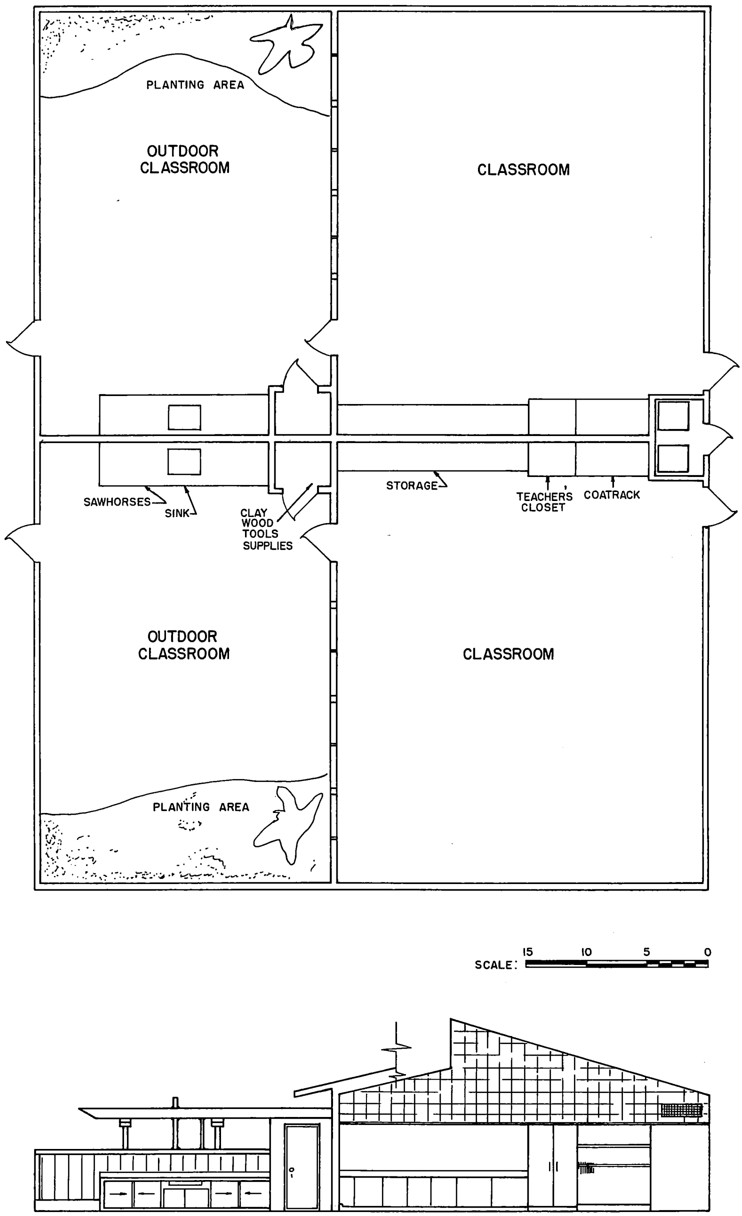
The surrounding wood fence, which is five feet high serves as a background for the construction of stores, postoffices, houses, and similar group projects, which then can be left in place for a period of time in order that class use for dramatic plays may be developed and presented.

An additional desirable feature is the planting area which also permits gardening activities to be easily correlated with classroom studies. The gardening tools are stored in the outdoor closet which has a full height door and providing full accessibility to the entire vertical space.

PLANNING FOR THE FUTURE

Speaking in general and from the architectural standpoint, the industrial arts facility consists of floor, walls, and roof construction, made rigid by bracing elements and diaphragms effecting a box with all sides intact, resisting great stresses with only slight deformations.

Acoustically, the walls and ceilings must serve as principal absorbing agent. Walls, floor and roof serve to define limits to enclose warm air in winter and to reflect light. Areas adjacent to walls



ADAMS ELEMENTARY SCHOOL

Figure 48. Plan of Two Classrooms and Section (Courtesy Paul L. Scherer)

will be used for storage, machine tools, and visual aids. Openings in the walls afford a view to the out-of-doors, and contain doors for passage of vehicles and personnel. Since the floor is the work-horse of the surfaces with many activities, care should be taken in the selection of excellent material. Consideration must be given to the possibility of rearrangement of space.

In the future, motors will probably be smaller but more powerful, and machines will probably cut faster, increasing in noise factor. Machines will be smaller, lighter, and more easily adjusted. Bases will be enclosed for easier cleaning.

Planning should include provision for more machines, performing new processes. In the future, all electric wiring may be in raceways under the floor, overhead, or around the wall.

A combination of patterns might prove most effective for long term planning. Since the heavier machines need foundation bolts, heavier wiring, and other mechanical connections, they may dictate the general plan of the laboratory. Service outlets should be in the floor. Wall outlets for small machines permit almost any rearrangement of machines, if they remain near the wall. If there are many small machines, overhead access may be best.

LIGHTING

Customarily, industrial lighting is supplied by the least expensive source and is directed downward. The upper part of the space is in darkness, and there are violent contrasts of light and dark. Recently broad area sources of light are being used. Light colored floors, walls, ceilings, and equipment reflect light most efficiently. As a result, lighting becomes more diffuse, and there are smaller brightness differences. Even if all available walls are filled with glass, the span may prevent daylight penetration to the center of the laboratory. Many have used roof monitors, north facing saw-tooth skylights, and flat skylights. Yet, these are often troubled by heat build up, glare, breakage, leakage, and harsh contrasts of strong light. Devices producing pleasant and relatively trouble free top lighting are directional and diffusing glass block or louver controlled skylights, as in Fern Bacon School, Pacific School District, Figure 47. Good lighting is also important for evening classes in adult education.

If electric fixtures deliver a minimum of half the light output upward, the planner must study the reflective character of ceilings, beams, and other elements of roof structure on which the light falls.

Obviously indicated are highly reflective paints approaching white in color. Daylight elements mentioned above may interfere with the electric illumination. In any type of illumination, even distribution is sought. This is a factor of fixture spacing and will depend, to a degree, on height of suspension above the typical working plane, the desired level of illumination, and the size and reflective character of the room.

The proposed maintenance level will also be taken into consideration. A common rule is that fixtures should not be spaced farther apart than twice the height from ceiling to working plane. Choice of fixtures, design, light level, and consequent spacing are usually a compromise among the architect, electrical engineer, teaching staff, cost of proposed units, cost conditions at time of bidding, and state of construction market.

A good facility will contain a regularly spaced unit with simple framed roof deck, easy to roof, drain, and maintain. The under surface should be utilized as lighting reflector, keeping the building envelop reasonable low and depending on regularly spaced electric fixtures for even distribution of electric light. A comparison with a saw-tooth roof would show roofing laid in small areas, complicated drainage system and flashing problems, and more involved framing with blocking, bracing and trussing problems. Since the roof deck is not continuous, it becomes necessary to establish horizontal trussing in the lower plane of the roof framing, usually by rods and angle bracing.

Windows on the sunny exposure will need control to prevent bars of sunlight. Standards of lighting developed by the Illuminating Engineering Society, National Council of School Construction, and American Institute of Architects, define light levels and brightness contrasts, as well as paint standards for efficient reflection. Highest brightness in the field of view shall not exceed ten times the brightness of the visual task. As materials used in industrial arts are rarely white, but of lower reflection factors, good lighting is imperative in reading scales, guages, and dials. Recent research indicates that if high brightness of the light source is visible to the eye, the light level must be raised.

In drafting rooms, tubes of louver bottom flourescent fixtures are often visible on T-squares, triangles and scales, producing a glare which makes pencil marks invisible. Broad source, indirect or luminous ceilings will correct this condition. Plans for some new office buildings call for light levels of 150 foot candles. Low transmission glass will be installed in the windows to achieve ten to one ratios of brightness. Light colored floors become important in the multiple reflection of light.

PAINTING

A good deal of publicity has been given to painting room interiors in such systems expressed as "Color Dynamics" and "Color Conditioning," but the conditions described may be accomplished with any reliable paint and principles referred to above. Formerly all machines were painted black, resulting in black masses overhead of belting, shafting, and pulleys. Currently machines are finished in relatively lighter colors with extremely light areas at the point of action or movement to insure a maximum of available light at the point needed. The desirable reflection factor of from 50 to 60 per cent for walls permits only a light tint. Ceilings should have reflection factors of 70 to 80 per cent and floors 30 to 40 per cent. If large areas of the laboratory are covered with unfinished lumber, which darkens with age, low light levels will result with unpleasantly contrasting light sources. All that has been said for walls and ceilings applies to floors, but here the problems of maintenance, durability, or low cost often dictate concrete.

FLOORS AND SAFETY

Various materials have been used for laboratory floors: an overlay on concrete with asphalt, magnesite, mastics, end grain blocks and various types of wood. Most are vulnerable under certain conditions. Since wood blocks may buckle under conditions of moisture, hardened treated concrete is perhaps least vulnerable. The perfect floor has not yet appeared. In the Hiram Johnson High School, vinyl tile has been used in the graphic arts laboratory.

Problems of safety are related to painting, and in turn related to standards of housekeeping. Attractive, light and well maintained laboratories promote an element of relaxation and a pleasant attitude toward learning.

HEATING AND VENTILATION

As to heating, some rooms have overhead gas heaters with noisy fans, drafts, or space-consuming heaters serving only a small part of the total area. Since World War II many schools have employed radiant heat. Probably no single scheme is satisfactory for all geographic locations with varying weather conditions and methods of laboratory practice. If the floors are warm and tools are comfortable to handle, the temptation to congregate around a heater has been removed. Warmth from the floor radiates and warms all the surfaces of the room.

Heaters at the floor level interfere with room arrangement. One of the problems of radiant panels is difficulty of room rearrangement. A relatively new system of heating employs a piping layout in the ceiling, with metal panels attached and bat insulation to prevent loss of heat through the roof. The heat is re-radiated from the surfaces of the room, until it is uniformly heated throughout. The advantage of the system is that machines occupying the floor may be rearranged without endangering the piping. Since there is no bulk of concrete to act as a reservoir of heat, heating controls become more simple. Such a heating system may be combined with areas of electric lighting or acoustical treatment as shown in Figures 49, 50 and 51. This shows the piping spaced to permit the snap-in-place metal panels, simplifying appearance and reducing the temperature of the radiant source. If desired, chilled water could be circulated through the same piping at little additional cost to cool the room.

Most mechanical engineers are convinced that classrooms usually constitute a ventilating or cooling problem with approximately thirty-five students in a space of 900 to 1000 square feet. A classroom has a volume of roughly 10,000 cubic feet, approximating 300 cubic feet per student. If the supply of fresh air is thirty cubic feet per minute, per student, the air will change in ten minutes, effecting six changes per hour. This is thought necessary due to the heat gain from body heat, electric lighting, and sun intrusion through windows. Most studies of typical classrooms show a need for cooling. Laboratories, however, have classes of twenty-four and floor areas of roughly 2400 square feet, affording a space of 1200 to 1600 cubic feet per student. If dust collection systems, exhaust piping for forges, welding or metal processes, spray painting or engine exhaust are provided, ventilation will be adequate without special air supply systems. These exhaust systems cause a replacement of the air through all the window and door cracks. They also simplify the housekeeping problem by permitting better maintenance of light colored surfaces. The mechanical engineer will compare design ventilation needs with the fresh air supplied by the exhaust fans to remove dust from principal machines, dangerous inflammable gases from spray booths, and engine exhausts.

Panel heating systems will provide the desired general heating, if they respond quickly to the daily temperature change. Reference is made later to the importance of opening doors and windows to ventilate laboratories.

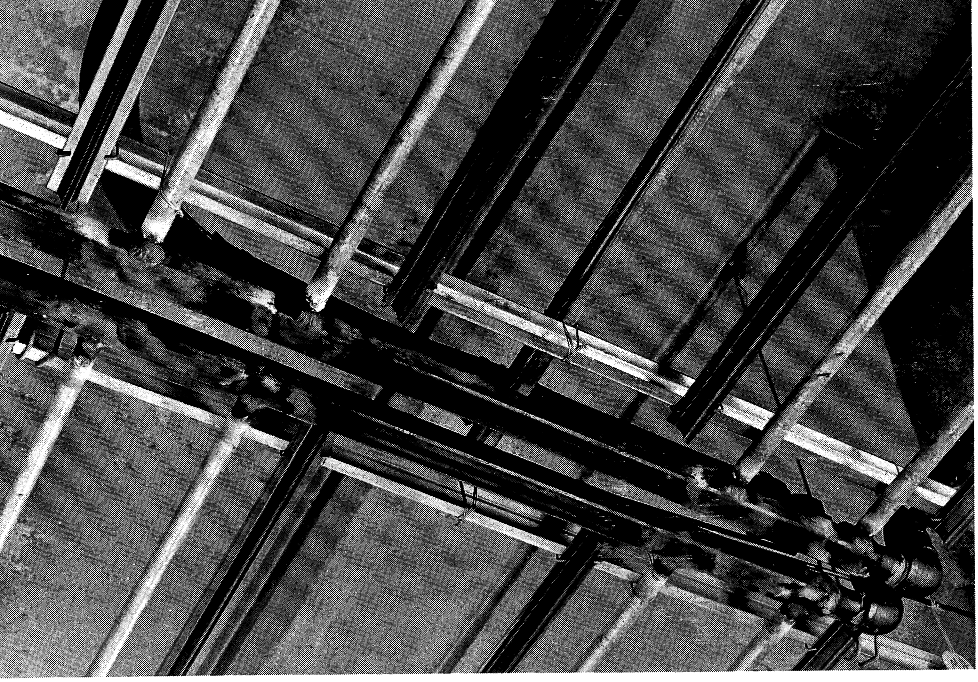
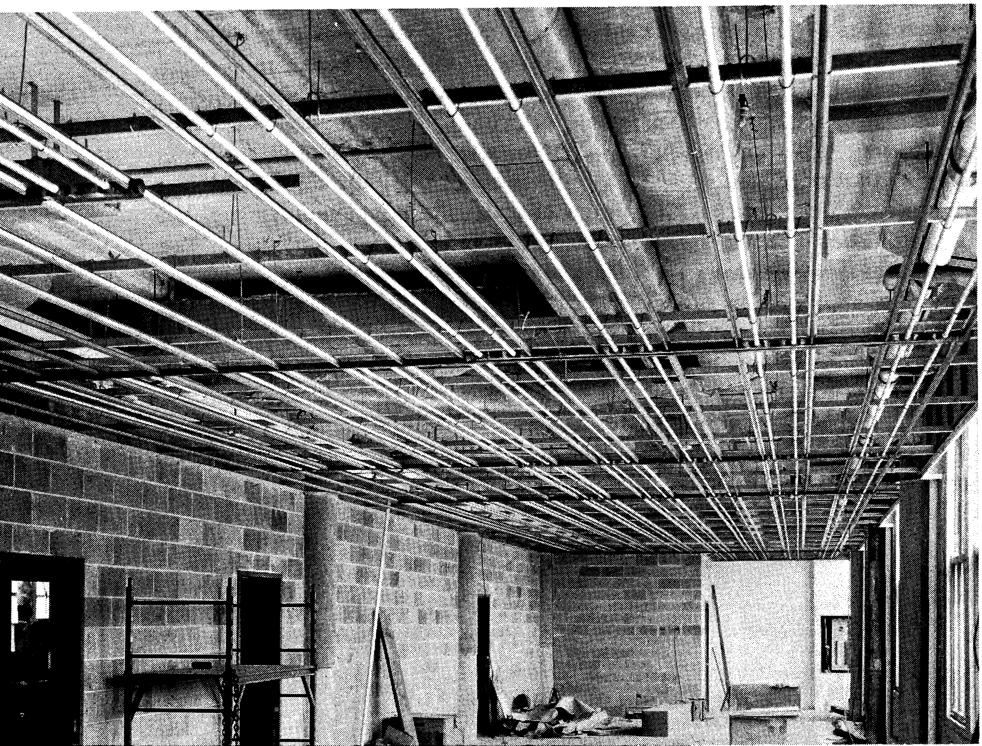


Figure 49. Ceiling Showing Heating and Electrical Conduits (Close Up)

Figure 50. Ceiling Showing Heating and Electrical Conduits (Complete Room)



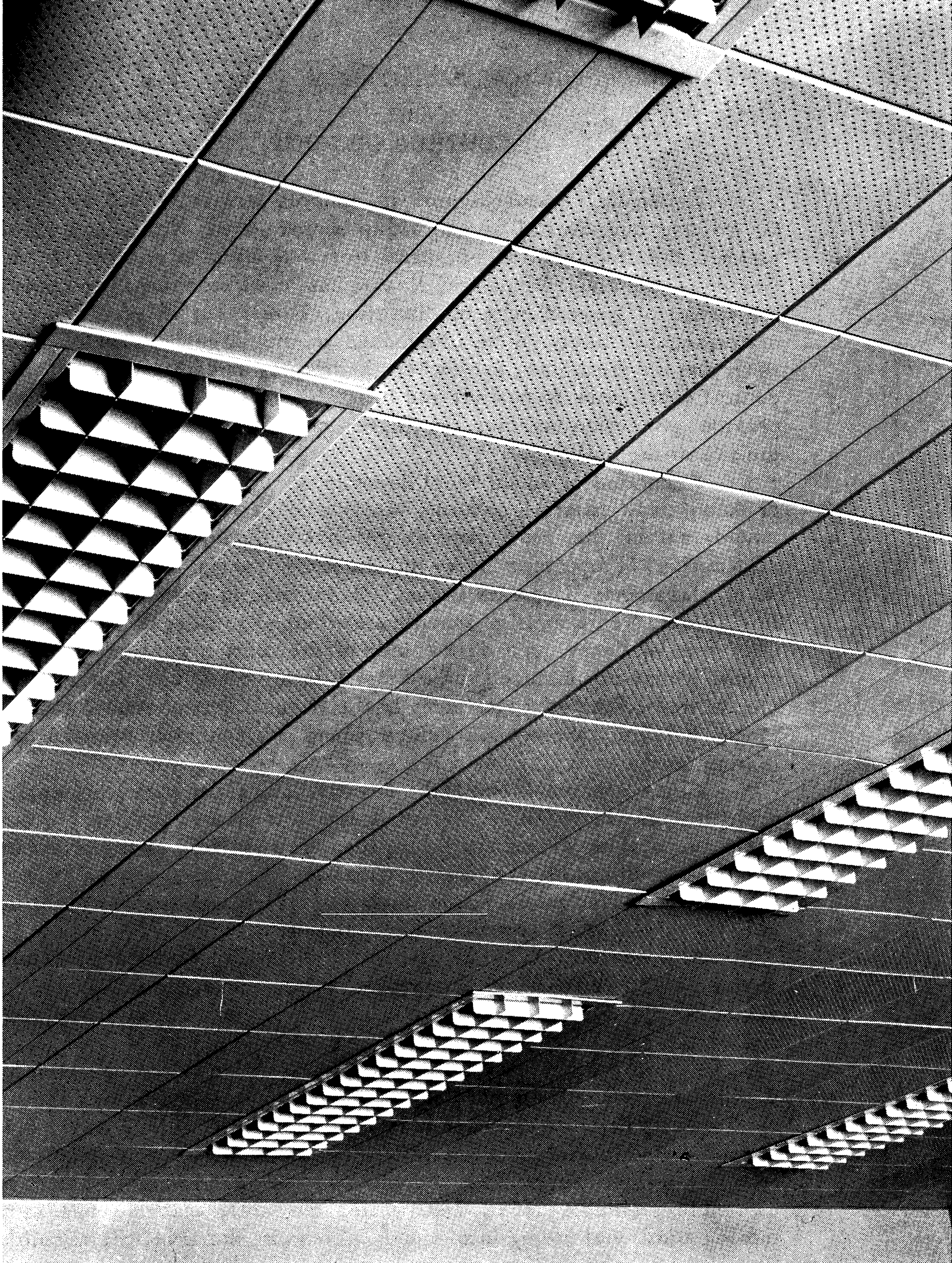


Figure 51. Completed Ceiling Showing Electrical Fixtures, Heating Panels and Accoustical Material in Place.

CONTROL OF NOISE

Generally, sound control in schools involves two problems: (1) to use and control sound within an enclosed space, and (2) to prevent the transmission of sound from one area to another. In the first case, the usual problem in classrooms or auditoriums is to control the sound to prevent echo or distortion. This is an objective in laboratories, but likely to be overlooked in the large problem of noise reduction to the noise level where hearing is possible at all. Sound control contributes to comfort and efficiency. Adequate treatment must provide protection against the higher noise levels expected during the life of the building.

Reduction of sound level depends on units of sound absorption or acoustical material covering walls and ceilings. Confinement of sound within the room implies relatively heavy construction and elimination of openings between classrooms or in the direction of other classrooms. Laboratories and classrooms in the Hiram Johnson, Encina, and Westmoor High Schools are arranged to meet this objective. Only regular doors open on the side of the room toward other classrooms. These are intended to be closed during class use. Large doors are located on the opposite side. In the Hiram Johnson School service rooms between laboratories reduce sound transmission between adjoining units.

Communication is one of the most typical aspects of laboratories made ineffective by noise. Safety becomes a greater problem: to become aware of an unsafe condition, to warn a student, or to correct an unsafe condition. Noise may create deafness as an occupational hazard to the instructor. School districts may be involved in liability suits in the future, if corrective measures are not taken.

Knudsen and Harris [1] list these noise levels of typical machines at three feet: lathes, eighty decibels; punch press, ninety-six to 103 decibels; planer, ninety-eight to 110 decibels; and circular saw, 100 decibels.

Only 3 per cent of the energy creating the sound is absorbed by a concrete wall, and 97 per cent is reflected. Due to the high inertia of the wall, little of the energy is absorbed by it. With a travel distance of twenty feet between reflecting surfaces, it would take 461 reducing reflections, or nine seconds, for the sound wave to decay to an unobjectionable level. Meanwhile, the same machine has been turning additional energy into sound, increasing the level. Permissible

[1] Vern O. Knudsen and Cyril M. Harris, *Acoustical Designing in Architecture,* New York: Wiley and Sons, 1950, p. 216.

speech interference level for laboratories is from forty to sixty-five decibels. The average male voice produces energy equivalent to sixty-five decibels at three feet. With sound level of the room at sixty-five decibels, the instructor would not be heard. With all wall and ceiling surfaces finished with absorbent material, seven to ten decibels loss may be accomplished, lessening the tendency of teachers and pupils to talk louder and louder in order to be heard. In an auditorium, sound of speech or music is usually generated in one part of the room, and sound waves traverse the room. If the room is properly treated, they do not decay until they have reached the last listeners. They are absorbed by the rear wall, so that reflections do not return to confuse listeners hearing later sound waves. In industrial arts areas the teacher may speak from any place within the room, making principles of sound treatment different from those applying to auditorium or lecture rooms.

The relatively low pitched sounds of the laboratory interfere most with voice sounds because they are so nearly the same pitch. The high pitched sounds provide the least conflict and are most effectively absorbed by conventional acoustical materials. While acoustical plaster is efficient in absorbing low pitched sounds, it may vary greatly in absorption, due to variables of mixing water content and troweling. Since it is difficult to apply, adulteration on the job may impair its value. *Tentative Architectural and Construction Standards* advises specifying "surface shall be able to take at least six repaintings with a paint and by a method as recommended by materials manufacturer without lowering acoustic absorption values."

Absorbent panels can be designed to meet special requirements. Perforated plywood panels over blankets or absorbent materials such as fiberglass are most effective for vibrations below 1000 per second. Lower wall surfaces may be so treated, while upper areas remain the same material held in place by wire fabric.

Shadowing some of the noisier machines with acoustical baffles will lower sound levels. These must be large because of the low pitch of the sound. They have large perforated holes in metal or other surface materials over fibreglass. If the machine is isolated in a separate enclosure, supervision difficulty is increased.

In preventing the escape of laboratory noise, tightness of construction is important. Since the sound level of a room is so high, considerable sound reduction must be made between the inside and the outside of its surrounding walls. This is usually referred to as

[2]*Tentative Architectural and Construction Standards,* Sacramento: Department of Public Works, Division of Architecture, Standards Section, State of California, 1958, p. 25.

"transmission loss." Rated transmission losses are given for various methods of construction and become greater as the weight and rigidity of construction increases. From thirty-five to fifty decibels represent maximum economic losses. Sound obviously escapes freely through open doors and windows, and a closed window is a weak barrier to sound. A window glazed with ⅛″ glass permits loss of twenty-seven decibels, but two ¼″ thick panels with 1″ separation, permit loss of forty-six decibels. Similarly, doors may transmit most of the sound with a small loss, while sealing the edges will materially reduce transmission. Sealed doors cause losses of from twenty-two to twenty-seven decibels, while "soundproof" doors are available with transmission losses of over forty-five decibels. Open doors, permitting sound to escape without continuing to bounce around inside the room, are a simple means of acoustic treatment.

Tentative Architectural and Construction Standards[3], states:

"The attenuation of sound by various masonry constructions varies so widely with density, thickness and finish on the wall or furred out from it inside or outside that in general, it is better to determine the type of wall on other criteria than that of sound transmission and then plan other methods of controlling the sound."

Unwanted sounds travel by less conspicuous means than doors and windows, such as vent ducts, piping, door frames extending from one side of the wall to the other, and open spaces over furred-down ceilings. Double-studded separate walls with blanket or insulation board in the cavity provides marked reduction of noise passage. Obviously, the problem demands professional assistance.

SUMMARY

This limited discussion of the engineering aspects of laboratory planning has attempted to emphasize that the results of team work in planning pay generous dividends through the many years the structure will be in service.

[3]Ibid; Section 44, p. 27.

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CHAPTER VII

The Procedure of Planning Physical Facilities

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This chapter is devoted to the development of a workable procedure for actual planning of physical facilities for industrial arts.

The importance of a carefully developed procedure cannot be over emphasized. The following suggested plan lists a series of steps in the planning procedure. It is not intended to give the impression that these are the only steps possible nor that they must be followed in the exact order given. However, these suggestions do represent a workable and efficient program of action for planning modern industrial arts facilities.

The steps of procedures have been grouped under major headings in accordance with the similarity of the nature of their purposes. These major headings include: educational and basic considerations; determining areas, equipment, and features needed; mechanics of planning the layout and making the drawings; and evaluation of the layout. It is assumed that anyone planning an industrial arts facility would begin by visiting exemplary programs and studying typical laboratory plans.

STEPS OF PROCEDURE IN PLANNING PHYSICAL FACILITIES

I. Basic Considerations

Purposes, Nature, and Place of the Industrial Arts in General Education.
Survey of Specific Needs in the Local School and Community.
Accepted Principles of Laboratory Planning.
Architectural Practices and Construction Materials.

II. Determining the Program, Its Areas, Equipment, and Other Features Needed.

Program for the Specific Situation.
Areas and Auxiliaries Needed for the Program.
Equipment Needed.
Architectural Features Including Utilities.

III. Planning the Space Layout.

Location, Size, and Shape of the Facilities.
Locating Various Areas and Auxiliaries.
Locating Features, such as Doors, Windows, and Utilities.
Making a Scaled Arrangement of the Layout.
Preparing Scaled Drawings and Perspectives.
Reproduction of Scaled Drawings.

IV. Preparing Equipment Lists and Specifications.

Preparation of Equipment Lists and Specifications.
Preparation of Architectural Specifications Including Built-in Facilities, and Utilities.

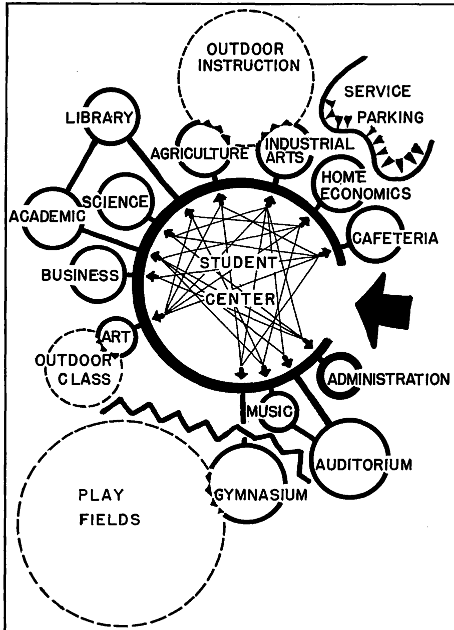
V. Evaluation of the Layout.

I. BASIC CONSIDERATIONS

A number of basic considerations must be faced before proceding with the actual mechanics of planning the layout. These should include a review of the purposes, nature, and place of industrial arts in the general education program; a survey of specific needs of the local school and community; a review of sound principles of laboratory planning; and a study of the latest architectural practices and construction materials.

Purpose, Nature, and Place of Industrial Arts in General Education.

Those concerned with planning a program of industrial arts should review the nature of the modern program of education for living in our industrial, technical and democratic society. One should examine the purpose and place of industrial arts in such a program, giving the learner experiences in meeting the problems of the society or culture in which he is living. In our industrial and technical society, the general educational experiences of students must include a rich program of modern industrial arts, an integral area of the school program.



SPACE RELATION CHART	SHOULD HAVE A PUBLIC ENTRANCE	SHOULD HAVE OUTSIDE EXITS	SHOULD BE NEAR A PARKING LOT	SHOULD BE CONNECTED TO OTHER ELEMENTS BY INDOOR OR OUTDOOR CORRIDORS	SHOULD HAVE A SERVICE ENTRANCE	SHOULD HAVE PREFERENCE TO THE BEST EXPOSURE	SHOULD BE IN A QUIET ZONE	SHOULD BE IN A MODERATELY QUIET ZONE	SHOULD BE IN A NOISY ZONE	SHOULD HAVE DIRECT ACCESS TO THE MAIN PLAYGROUND	SHOULD BE LOCATED WHERE IT CAN BE EASILY RECOGNIZED BY VISITORS	SHOULD BE AN ISOLATED UNIT
ADMINISTRATION UNIT	●		●	●				●			●	
ASSEMBLY UNIT	●	●	●	●	●				●		●	
PHYSICAL EDUCATION	●	●	●	●					●	●	●	
MUSIC UNIT		●		●					●			
ART UNIT				●		●	●					
BUSINESS UNIT				●		●	●					
SCIENCE UNIT				●		●	●					
HOME ECONOMICS UNIT				●		●		●				
AGRICULTURE UNIT		●			●				●			●
INDUSTRIAL ARTS UNIT	●	●			●				●			●
DINING UNIT	●	●	●	●	●			●		●	●	
STUDENT CENTER	●	●	●	●								
ACADEMIC UNITS				●		●	●					
LIBRARY	●	●		●		●	●					

Figure 52. (Courtesy Caudill, Toward Better School Design, 1954 F. W. Dodge Corporation)

One of the most significant implications for planning of physical facilities is that the laboratory should be housed in the same building with other areas to provide a close working relationship among all. Figure 52. The nature of modern education in meeting life problems and changes in industrial and technical life require a layout permitting flexibility of program and equipment.

Survey of Specific Needs in the Local School and Community.

After careful consideration of modern education and the place of industrial arts, the planner must analyze the nature of life in the community and the school situation.

It is important to know if the community is one in which the majority of students go to work immediately upon leaving school or if they plan to obtain some higher form of education. In the former situation, the program should be planned to introduce an understanding of technical, industrial and production courses. If the students are predominately college preparatory, the general educational aspect of the program will be emphasized.

The size of the high school will influence considerably planning for physical facilities. A one-teacher program will probably result in a comprehensive general laboratory including several areas. In a multiple industrial arts teacher situation, the program will probably include a number of general unit laboratories working together as an integral part of the total educational program. Enrollment is another factor determining the size of the facility; however, the size of the laboratory is also influenced by the number of areas and the amount of equipment. A small laboratory with small equipment may be very efficient whereas a small laboratory with large equipment may become congested causing a safety hazard. A very large laboratory is an invitation to increase the student-teacher ratio with congestion and confusion resulting. Many school systems have a maximum class size of twenty-four students.

The grade levels of the school program will also influence the nature of the laboratory and its planning, as well as choice of equipment. The elementary industrial arts program is usually an integrated classroom, affording simple experiences with tools and materials, whereas the junior high level offers wide exploratory opportunities in occupations, handicrafts, and manipulative experiences. Since the senior high school offers courses of increased difficulty, a greater number and more diverse type of tools and equipment are required.

Accepted Principles of Laboratory Planning.

Accepted principles of laboratory planning stress teacher-learner efficiency and safety, as well as a more pleasant laboratory environment. Plans should allow for main and secondary aisles of travel of adequate width, provide for equipment arrangement to permit efficiency in sequence of operations, and allow for flexibility in a changing educational program, thus providing for a variety of experiences. The arrangement should permit practices and processes accepted as efficient and safe in industry. The plan should provide features promoting physical and emotional growth and safety in the school.

Architectural Practices and Construction Materials.

Research in architectural practices and construction materials reveals the continual change in practices followed by modern architecture as well as additional materials available for construction purposes. By familiarizing himself with the latest practices he will be able to make use in his planning of what is best in floor plans including sizes; types of lighting; walls and floors, and placement of doors and windows; adequate utilities including air, electricity, gas, and water; and new practices in lighting, heating and acoustical treatment.

II. DETERMINING THE PROGRAM, ITS AREAS, EQUIPMENT AND OTHER FEATURES NEEDED

In the actual step by step planning process, first consideration is the nature of the program to be developed in the particular situation and the areas and auxiliaries to be used. (See Figures 9 and 10). Items of equipment needed for the program must be known, as well as any special features.

Determination of the Program for the Situation.

At this point, the first step in intelligent planning is the determination of the nature of the program. How many years of industrial arts will be offered in the school program? Is it strictly for senior high school students or does it also include junior high school? Is the school so small the industrial arts program will also serve the elementary school? Will there be an adult evening program? Is there a junior college program? How many industrial arts instructors will be needed? How many units of industrial arts are elective? Will the units be broad and considered as Industrial Arts I or Industrial Arts II, covering several areas, or are there several units in one area, such as Drawing I and Drawing II? Is the program of a technical nature primarily for students going immediately into industry? Is it geared to the needs of college preparatory students? Is it designed for a combination of industry and college preparatory students? The physical facilities can be planned more intelligently after such questions as these have been answered.

Areas and Auxiliaries Needed for the Program.

Closely related to deciding upon the program to be developed is the determination of areas and auxiliaries to be included. Will such areas as graphic arts, drawing, metal, wood, automotive or transportation, electricity, and communication be provided for in the program? Enrollment in the high school program will determine the number of teachers required and will influence the number of areas to be included in each laboratory. What auxiliaries will be needed such as material, tool, and project storage, welding booths, finishing and dark rooms, planning center, toilet and locker rooms, display areas, audio-visual centers, and teachers' offices. What amount of floor space will be needed for each of such auxiliaries? A list of the divisions or areas of instruction and of all auxiliaries anticipated should be made.

Equipment Needed.

In developing a list of all equipment needed in the proposed industrial arts program, the planner must know the number required of each item and the amount of floor space needed for each. Not only floor space required for the machines or other items of equipment, but also working space needed for safe operation must be considered. One should know approximately the number of hand tools to be used so that ample storage facilities may be provided.

Architectural and Other Special Features.

One must determine what special features will be needed. What utility facilities are needed for lights, electrical power outlets and control panels, gas lines, dust collecting lines, air, water, and disposal? What special windows or doors should be included? Are there to be large outside doors for trucks and automobiles, and are there double doors to all laboratories to facilitate the moving of equipment and other large items? Has provision been made for acoustics, floor treatment for special areas, wall treatment, color dynamics and lighting? What about glass partitions and doors between laboratory areas? Special teaching facilities should be determined at this time. These might include chalk, bulletin, and display boards, cabinets, facilities for audio-visual aids, a demonstration center, a library and planning area, and a material file and storage. Fire prevention and other safety features should be determined.

Figure 53. Experimental Layout Using Equipment (Courtesy Robert McCoy)

III. PLANNING THE SPACE LAYOUT

In planning the facility one must determine the location, size, and shape of the laboratory. There must be a location of the areas and auxiliaries to be included in the layout, including doors, windows, walls, and other architectural features. In addition one should experiment with layouts using equipment models until a satisfactory arrangement is obtained and finally make a finished drawing of the layout, Figure 53.

Location, Size, and Shape of the Facilities.

Since modern education considers industrial arts an integral part of the entire program, laboratories should be located in close proximity to the classrooms of other subject areas. (See Figure 52.). The ground floor has been found to be most satisfactory for industrial arts because of its use of equipment items as well as the need for automotive and other large service doors. Basement shops are to be avoided.

The size of the laboratory will be determined mainly by two factors: (1) the laboratory must be large enough to accommodate the number of students expected at any one time and (2) it must be large enough to house adequate equipment and to provide for the other necessary facilities. For suggested space requirements for open area, storage, and special rooms see Figures 9 and 10.

Usually a rectangular or square shape is preferred with proportions of 3:5, 2:3, 1:2 and even 1:1. If one starts with a square laboratory and places auxiliary rooms, such as the finishing, stock, and storage rooms along an inside blank wall, the result is still a rectangular space which is considered desirable. One is now able to sketch the outside walls of the laboratory to scale, showing the proposed location of the areas, auxiliaries, windows, and doors. The scale of ¼″ equal to 1′ is commonly used. All areas must be in a compatible arrangement.

Making A Scaled Arrangement of the Layout.

A common practice in arranging the layout is to employ ¼″ scaled pieces of cardboard for all items of equipment. If constructed of sheet plastic they may be used many times. The pieces of cardboard or plastic should be in a different color for each laboratory area such as blue for graphic arts, green for wood, and red for metal. Sometimes the top view of each machine is drawn or printed on the top of each piece it represents. Figure 54. Sometimes the actual name of the equipment is printed on the small pieces of cardboard. Some companies have, for loan, cast models of equipment to scale to be used in laboratory arrangement. In addition large sheets of quarter or eighth inch cross-sectioned paper may be used for the layout.

In arranging the cardboard patterns or models, one must provide main and secondary aisles for travel. The main aisle should be not less than four feet wide, and the secondary aisles three feet. One must allow adequate space between equipment for efficient and safe operation of all items. Machines should be grouped for the sequence of their operations and for safe usage. Storage of materials should be located close to the place they will be used. To the extent that light from outside windows is utilized, equipment should be turned advantageously.

Preparing Scaled Drawings and Perspectives.

The most common practice is to draw the layout to scale in pencil, using ¼″ equal 1′, and including all auxiliaries, items of equipment, and architectural details. The tracing of the layout may be reproduced by any one of the various printing methods.

Occasionally, there is a need for an interior three dimensional or perspective drawing of the laboratory layout to provide easier

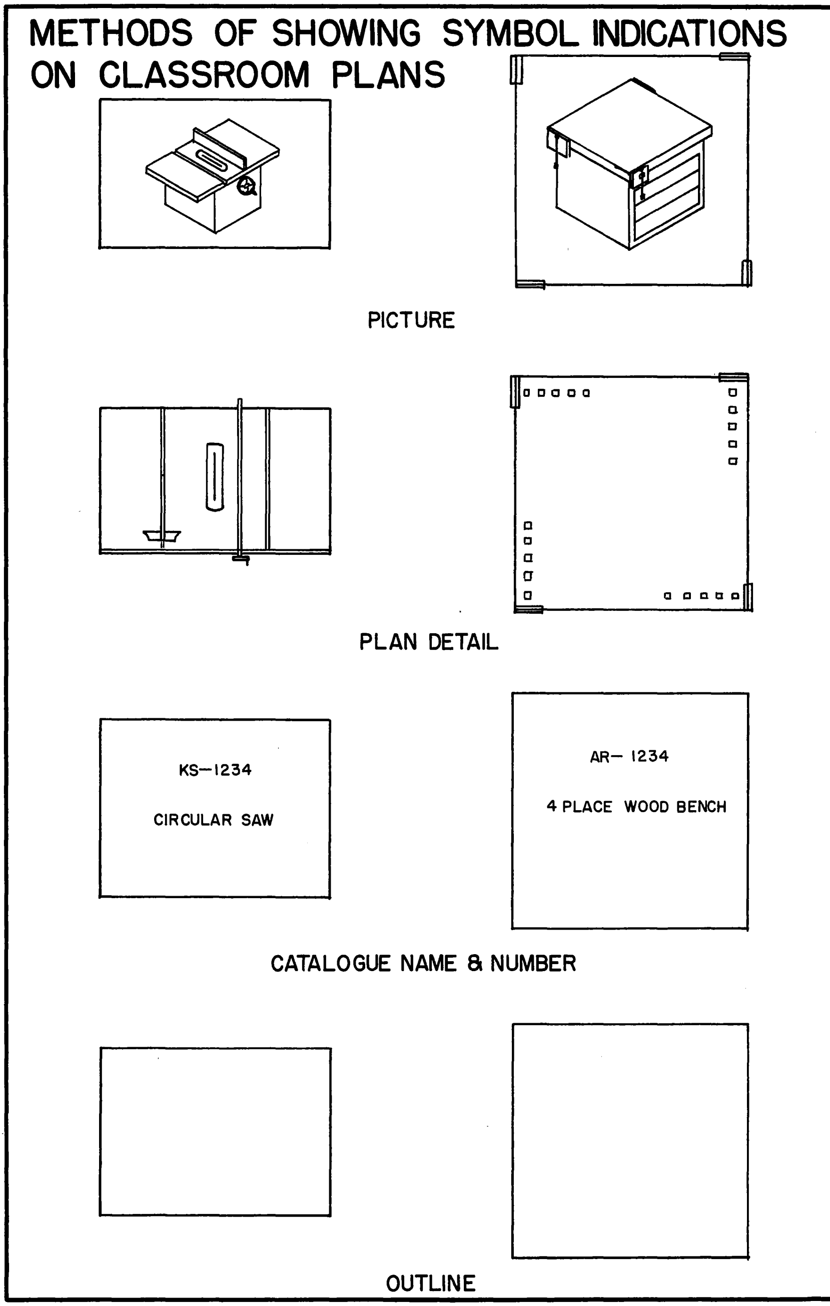


Figure 54. (Courtesy Paul L. Scherer)

visualization. However, the added difficulty of making such a drawing has prevented this procedure from becoming common practice.

Reproduction of Scaled Drawings.

The most common type of reproduced prints are blue or ozalid prints, requiring a tracing of the scale drawing. For sharpest results black India ink should be used, although pencil tracings are often used to conserve time.

A second type of reproduction is by photostating or other photographic copy methods. These techniques are especially suited to a situation demanding only one or two copies of high quality. Since they are more expensive, they are not employed for reproducing large numbers of prints. Such copies may be made from pencil drawings, but will be much sharper from inked drawings.

A third type of reproduction includes printing methods, most common of which is offset printing. The small offset duplicator, usually used in graphic arts programs is suitable for running large numbers of prints.

IV. PREPARING OF EQUIPMENT LISTS AND SPECIFICATIONS

Preparing of Equipment Lists and Specifications.

In one of the earlier steps discussed, the exact items of equipment needed for the program was determined. A complete list of this equipment with detailed specifications for each item must be prepared. (See Appendix "D"). Such a typewritten list should be prepared to accompany the plans for the industrial arts facility. Also, a detailed list of all areas and auxiliaries, specifications for any desired floor, wall, or other architectural treatments, and required utility facilities should accompany the finished plans. See Figure 55.

V. EVALUATION OF THE LAYOUT

Evaluation must be based on the aims and objectives. Any program of evaluation should be continuous throughout the planning operations, rather than at the close of the undertaking.

Throughout the planning of an industrial arts layout, one should study continuously these general questions:

1. How well do the plans permit the accomplishment of the aims and objectives of a modern program of industrial arts?
2. To what extent does the layout permit an efficient program of teaching-learning experiences?

PRELIMINARY ROOM DETAIL FORM

Room use ....

Approximate dimensions including auxiliary rooms ....

Number of stations .... Square feet per station ....

Number of students to be accommodated at one time ....

Courses to be taught in the room ....

Floor level preference ....

Special Room Requirements (Describe specific needs in detail)

Auxilary rooms needed:
- Planning room
- Classroom
- Stock Rooms
- Office
- Library
- Finishing Room
- Project Storage
- Night School Storage
- Others

Special room features:
- Type of lighting
- Color scheme of room
- Cork boards
- Blackboards
- Hanging strip or map rails
- Glass areas between auxiliary

Room and main laboratory
- Types of flooring
- Special cabinet tops such as:
  - Weldwood
  - Asbestos
  - Transite
  - Metal
  - Fire brick

Services and Utilities

(a) Electrical:
- 110 and 220 volt outlets, single and three phase in boxes
- 110 and 220 volt duplex service outlets
- Radio and television packs for antenna connections
- Floor outlets
- Ceiling outlets
- Bench outlets
- Panel box location
- Safety switch location

(b) Mechanical:
- Wash sink location and size
- Gas outlets
- Air outlets
- Hoods for fume ventilation
- Exhaust systems
- Dust and chip collectors
- Water outlets

Figure 55. (Courtesy Paul L. Scherer)

3. How well do the plans meet the specific needs of the local community?
4. To what extent are the plans in keeping with good principles of laboratory planning?
5. To what extent do the plans recommend the use of modern architectural practices and construction materials?
6. To what extent is there an adequate list of carefully specified equipment?
7. How adequate are the recommendations for utilities, auxiliaries, and architectural facilities?

CHAPTER VIII

Evaluation of Facilities

By
By Lynn C. Monroe
University of California
Santa Barbara

STATEMENT OF EVALUATION

The evaluation by administrators, teachers, and students of industrial arts facilities entails the factors of (1) adequacy, (2) availability, (3) utilization, (4) amount, and (5) the appraisal. Although many facilities may appear adequate, an analysis of component parts often indicate a need for improvement in one or more of the above considerations.

1. Adequacy

Determination of adequacy is dependent upon curricular offerings and anticipated expansion. What one community may have developed may not meet the needs of another. One constant factor is that found in the minimal requirements of state departments of education and of accrediting agencies. However, these should be recognized as minimum and not necessarily ideal.

2. Availability

Planning industrial arts facilities involves completing a unit of activity and avoiding partial equipment. For this reason, planners must evaluate present and future needs to determine which facility should be completed in its entirety, if funds are limited.

3. Utilization

The planner must consider the principles of utilization in determining the extent to which machines, handtools, and equipment will be used in a laboratory. As an example, a class of twenty-four does not necessarily need twenty-four tool items, when at times eighteen tool items may be adequate. On the other hand, a single item may be sufficient. The more closely the evaluation reaches 100% utilization, the higher the factor of evaluation.

4. Amount

Maturity of the student and the curriculum offerings will affect the need for differing types and amounts of facilities. For the junior high school beginning courses will demand tools and equipment of a given kind. By the same principle possibly less facilities of a given kind with a greater variety of equipment will be needed for advanced courses at the senior high, junior college, or university level. Curricular offerings change type and number of facilities needed, as, for example, the contrast in a general industrial arts laboratory and a unit laboratory.

5. Appraisal

After the planner has estimated needs of the proposed facilities, he must make an appraisal to determine strengths and weaknesses. As an aid, the major part of this chapter will be concerned with a rating sheet applicable to a set of plans or a facility in use. If used with the former, this evaluation may result in revisions of plans. Although a new facility should rate in the "A" group, a sacrifice may be necessary in the planning stage.

This chapter presents a series of factors for rating industrial arts facilities both before construction and after actual use.

Rating has been based on the two major considerations of adequate physical facilities and safety factors. Four levels of appraisal have been provided:

A – Highest or most excellent
B – Superior to the average but below excellent
C – Average, adequate for operation and use
D – Inadequate but useable

On each of these four levels are five degrees of variation within each level, indicated in the rating sheet by five squares. Within the range of these squares the user will check the degree of the factor to be appraised. Below each rating is a brief explanation to assist in selecting the proper position within range.

The following questions include some important points to be considered in planning industrial arts facilities. How is the learning of the student affected? Does the plan provide for adequate health and safety features? Has the plan placed a limitation on the amount to be learned or the number who can learn? Does it affect the habits of the learner? Is the plan in harmony with ideals as established?

The following factors or quality have been selecetd for evaluation of plans before the final plans are completed. And actual construction started. As indicated earlier the rating factors can be applied to existing facilities.

RATING FACTORS FOR INDUSTRIAL ARTS LABORATORY FACILITIES

Purpose

A	B	C	D
Purpose Clearly Stated. Curriculum is Adapted to The Purpose. Facilities Entirely Adapted to Intended Purposes.	General Intended Purpose Clear. Facilities Well Adapted to Purposes.	Available Space Well Adapted to Intended Purpose. Installation Appears Permanent.	Designed To Meet Temporarily the Intended Purposes. Installation Incomplete in Some Respects.

Level Learning

A	B	C	D
Facilities Planned for Specific Level. All Provisions Made to Meet Curriculum.	Facilities General. Must Be Adapted to Assigned Courses.	Facilities Planned for All Levels, from Junior High Through Junior College. To Be Used Concurrently.	Facilities Planned for a Designated Level and Used for a Different Level.

General Laboratory Arrangement

A	B	C	D
Laboratory arranged by units with related processes grouped. Excellent shadow-less lighting. Most used items centrally located. Wide established traffic lanes. Scientific color scheme.	Arranged by units Related processes not grouped. Good lighting. Most used items centrally located. Established traffic lanes. Good color scheme.	Arranged by units related processes not grouped. Fair lighting. Narrow traffic lanes. All equipment painted.	Heterogeneous arrangement. Inadequate lighting. Poor traffic routing. Machines poorly painted.

Room Safety

A	B	C	D
Above fire regulation code, heating, ventilation; excellent operational lanes marked clearly. Excellent construction of racks Accessible center control electrical switch panel. Non-skid floors. Stairway and ladders protected.	Meets fire regulation code. Adequate heating, ventilation, illumination. Operational lanes marked. Racks well constructed. Accessible control switch. Floors in good condition, stairways and ladders protected.	Meets minimum fire regulation code. Sufficient heat, ventilation, illumination. Few operational lanes designated. Mediocre construction of racks. Control switch inconventiently located. Floors in average condition. Insufficient protection for stairways and ladders.	Room below standard fire regulations. Heat, ventilation, illumination inadequate. Operational lanes not designated. Racks poorly constructed or none. Control switch inaccessible. Slippery floors. Unprotected stairways and ladders.

Machine Tools

A	B	C	D
Excellently located. Excellent working order. Individual illumination. Very accessible. Sufficient accessories. Well defined safety zones. Scientific color scheme. Adequate work stations to meet the needs of the size of class for which the facility is designed.	Proper Location. Good working order. Adequate illumination. Good accessibility. Enough accessories. Safety lines painted. Color conditioning minimum quantity.	Separate location. Some machines in adequate quantity, others not. No special lighting. Fair accessibility. Some safety lines. Consistent coloring, but not scientific. Condition, average.	Inadequate planning. Inadequate quality and quantity. Poor lighting. No accessories. No safety lines. Poor color scheme.

Tools

A	B	C	D
Scientifically located. Sharp edges well protected. Outstanding maintenance.	Properly located. Sharp edges protected. Suitably maintained.	Satisfactory arrangement. Protection for most sharp edges. Unwisely arranged. Sharp edges unprotected. Fair maintenance.	Unwisely arranged. Sharp edges unprotected. Tools generally in unsatisfactory condition.

Machine Safety

A	B	C	D
All operational controls designated by color code. Expertly guarded. Skillfully arranged. Excellent braking system. In first class repair. Individually lighted inside safety zones if room not in excess of 100 foot candles of illumination.	Most operational controls designated by color code. Adequately guarded. Proper braking. Well arranged. Maintenence above average. Some machines individually lighted. Inside safety zones.	Color code designated on few machines. Most equipment guarded. Braking devices fair. Average repair. Few machines individually lighted. Usually inside safety zones.	No color code designation. Inadequately guarded. Lack of braking method. Unwisely arranged. Loose and missing parts. No machines individually lighted. Not in safety zones.

Project Storage

A	B	C	D
Serves maximum needs of classes. Accessible to majority of class. Easily supervised by instructor. Maximum security of one class to another.	Serve general needs of class. limited accessibility. Good security. Location generally good for student and supervision by instructor.	Ordinary storage. Not readily accessible. Meets average need.	Open shelves Accessible to all classes. Total space inadequate.

Teaching Aid Storage

A	B	C	D
All teaching aids (Projector, screens, permanent, built-in, or readily available for use, charts, Models, Mockups), housed in centrally located facility. Built-in cabinets house each item.	General store room or closet available. Contents secure and protected. Few or no built-ins.	May be located in several places. Some machines may not be centrally located but available for laboratory use. May be covered and locked in place.	No provision to store teaching aids.

Washing Facilities

A	B	C	D
Superior washing facilities. Sufficient sinks. Hot and cold running water. Soap, towels, disposal. Sanitary drinking fountain.	Excellent washing facilities. Sufficient soap, towels, disposal. Drinking fountain.	Minimum washing and disposal facilities. Drinking fountain connected to a wash basin.	Inadequate facilities.

Health Precautions

A	B	C	D
Air conditioning. Sound-proof walls and ceilings. Dust collectors. Non-skid floors	Good, draft-free ventilation. Sound-treated walls. Non-skid floors.	Enough fresh air. No dust collection. Smooth concrete or wooden floors.	Little fresh air. Dust atmosphere. Walls reflect majority of sound. Poor floors.

Classroom Library

A	B	C	D
Glass enclosed. Shelves or stacks. Table space. Magazine racks. Blue print storage cabinets.	In open room. Built-in shelves or bookcases. Magazine racks. Blue print storage cabinets. Reading table.	Bookcases. No built-in features. Tablespace in open shop. Blue print storage. Open racks or frame.	No library facilities. Space for reading table.

Instructor Facilities

A	B	C	D
Glass enclosed. office space for files to house records, blueprints with visibility to all parts of laboratory. Demonstration bench close by.	Space for desk files. Cabinets. Demonstration bench.	Desk and wall cabinet.	Desk space out in adjacent room. Inadequate cabinets and files.

Bulletin and Chalk Boards

A	B	C	D
Scientifically located. Excellently cased. Neatly arranged. Current, pertinent materials. Cleverly displayed.	Well located. Appropriately cased. Good arrangement of displays. Materials of recent date.	Average location, fairly well cased. Arrangement not too attractive. Materials sometimes outdated. Ordinary display.	No display.

Cabinets

A	B	C	D
Best possible condition. Well painted. Labeled. Non-inflammable paint cabinet. Outstanding disposal facilities. Very orderly.	Adequate facilities. Painted and labeled. Paint cabinet in good condition. Proper disposal facilities.	Sufficient painting and labeling. Paint cabinet in fair condition. Average disposal facilities. Generally inadequate facilities. Lack of labeling. Fire hazard, no disposal. Poorly maintained.	Inadequate facilities. Lack of labeling. Fire hazard. No disposal. Poorly maintained.

RESEARCH – Rating of industrial arts facilities may furnish research data that will assist in the upgrading of laboratories. It is suggested that an evaluation of existing laboratories be made each semester. By continuing these checks periodically it is possible to note progress, to determine where improvement should be made, and what funds are necessary to budget for needed improvements.

By scientific evaluation over a period of years, evidence may economically justify some of the needs in a laboratory. This can be most helpful to the small school.

In the system where more than one school exists, an administrator or supervisor may gain a comparison of the needs in different schools by continuous periodic evaluations. Rapidly growing communities anticipating further development may find the results of such research enlightening when new facilities are planned or older ones are to be modified.

The use of these evaluation factors should serve as a check to balance the total facilities in planning new laboratories. Obviously a new facility should fall in the upper quartile, or the "A" division. If the rating factors check a remodeled laboratory, it is possible that the "B" division will be the highest attainable factor, due to limitations of the existing facility.

In making evaluations with the rating sheet of many existing facilities in use ten years or longer, it was found that most industrial arts laboratories of this type earn a "C" or average rating. Remodeling of these facilities should raise the laboratory to at least a superior status.

Finally, after all ideas are incorporated, including the opinions of faculty, administrators, trustees, community, and architect, the industrial arts facility should qualify for an excellent rating with satisfaction to all concerned.

CHAPTER IX

Planning Features and Details

By D. Arthur Bricker
Supervisor of Industrial Arts
Cincinnati Public Schools

In the past decade the cost of school building construction has continued to spiral. This factor alone demands that careful consideration be given to the needs of the community, space available, and selection and placing of equipment, as well as many other features. An equally important factor to the educational program is time and motion economy in the efficient use of the facilities.

Careful and thoughtful planning through the use of special or built-in features may eliminate confusion through proper traffic lane control, utilization of waste space, protection for the safety of the student, and accessibility of the installed equipment.

Careful planning must precede actual construction, since the facilities should meet present as well as future needs of the educational program. Objectives and their implementation must be of primary consideration. Since future requirements may demand adaptability of equipment and space, flexibility becomes a key feature for facilities in the industrial arts laboratory.

In long range planning it is wise to consider the basic or primary areas in a manner so that at some future time a conversion may be made to accommodate new developments in curricula, equipment, materials, and processes. A good example is the adequate distribution of electrical power in either floor or overhead channels. Accessibility of outdoor space, adjacent to the industrial arts laboratory, paved and protected with an extended roof overhang, is an example of needed space flexibility.

Studies in mass production techniques, automation, and new forms of power are predicted to change materially the general education programs in the future of which industrial arts is a part.

This chapter presents a number of industrial arts facilities with suggested means of utilizing space to the best advantage. Of course, the following pictorial suggestions can be applied in other types of industrial arts laboratories than those specifically shown.

Figure 56. Tool Cabinet

Tool Cabinet. (Figure 56). This is the first in a series showing arrangements and usage of the open type tool cabinet. When closed, it requires 24″ by 60″ floor space, or ten square feet. Since the average size tool room uses about 100 square feet of floor space, the tool and supply cabinet pictured can save considerable floor area.

This figure, however, shows a condition far from ideal, since opening the left door of the tool cabinet obstructs the use of the electrical panel.

Tool Cabinets, (Figure 57), can be planned to use only one half at a time, keeping the other half locked. This arrangement may be helpful if the laboratory is used for various grade levels during the day or if night classes may need separate tools. Note that 30″ are required on each side of the tool cabinet for opening the doors.

A tool cabinet of this design requires approximately 120″ wall space when both the doors are open.

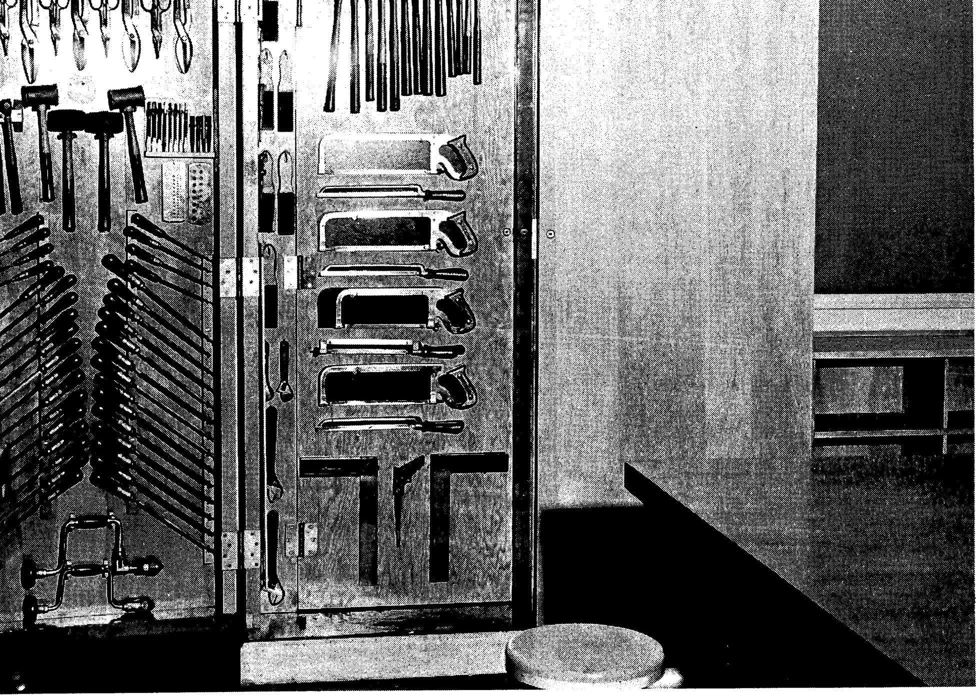
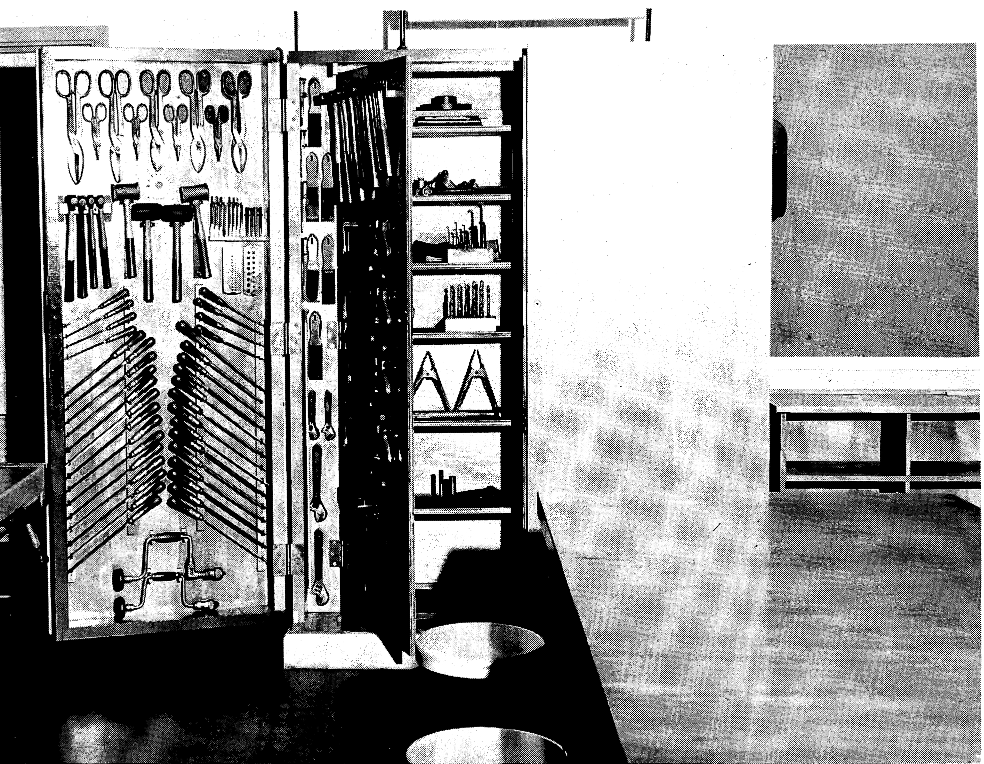


Figure 57. Tool Cabinet

Figure 58. Tool Cabinet



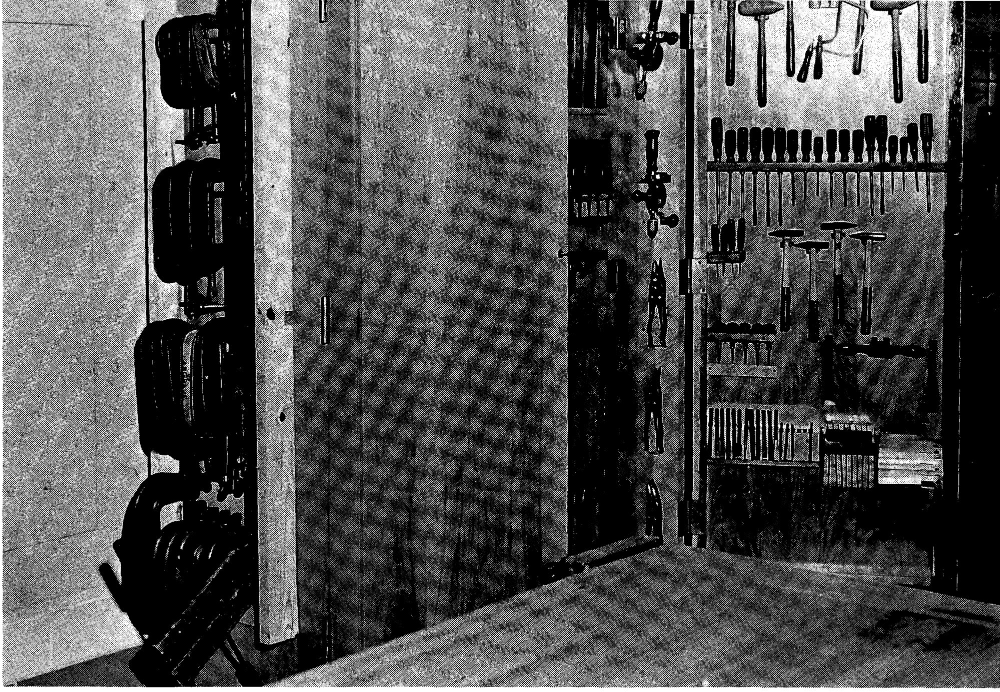


Figure 59. Clamp Rack

A Tool Cabinet (Figure 58) shows space for storing tools in more than one depth. The rear shelf space provides storage area for odd shaped tools, such as face plates, bending jigs, chucks or sets such as drill stands, and Allen wrenches. The interior swinging panel has tools mounted on one side only and when closed recesses into the frame of the cabinet. The storage shelves are 12″ deep, spaced about 12″ apart, and can be constructed so they are adjustable. Trays and drawers for small tools or accessories can be made in the laboratory or purchased. Glass jars with screw lids are also useful for small parts. The top of the cabinet serves as a possible location for needed supplies such as the paper dispenser shown.

Clamp Racks (Figure 59) can be installed on both ends of a tool or supply cabinet to hold various sizes of C-clamps, the parallel jaw wood clamps, and the 48″ bar clamps.

This location is not recommended as ideal, since the clamps shown become somewhat inaccessible when the doors are opened. However, solution to some problems of storage are a compromise between the ideal and the necessary, and a definite location for such items is preferable to creating a safety hazard or housekeeping problems.

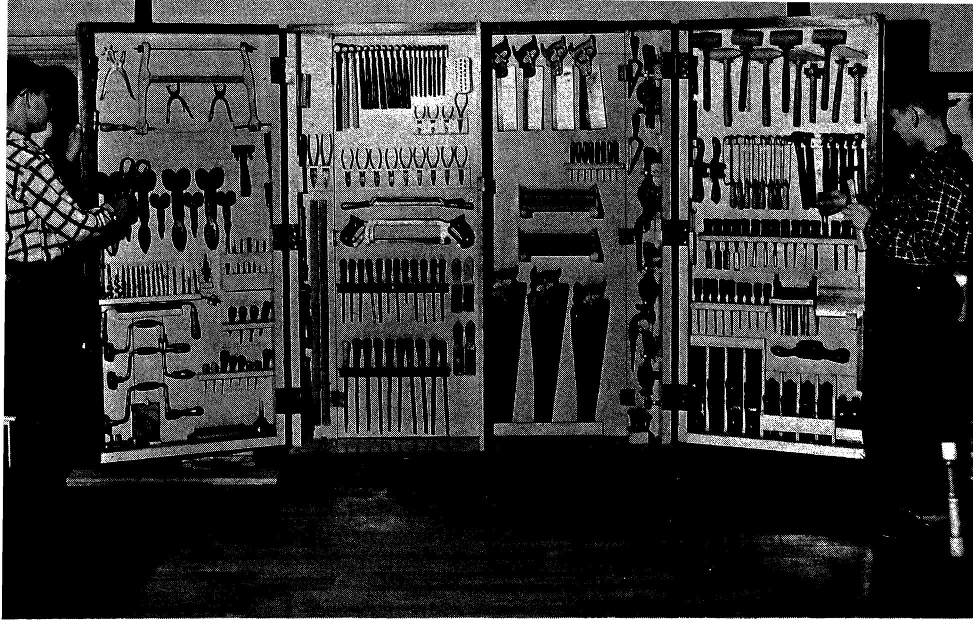


Figure 60. Tool and Supply Cabinet

Tool And Supply Cabinets (Figure 60) seem to be the easiest method of handling tools in the school laboratory. The tools must be carefully checked at the beginning and at the end of each class and locked when not in use.

Utmost care should be used in storing the key for the tool and supply cabinet.

All tools should have a definite place in the cabinet with a silhouette back or a special holder for each tool.

Since many of the students may not know the correct names of the tools, it is suggested that the name be placed on a label near each tool.

A cabinet 24″ deep by 60″ wide and 72″ high, with 12″ deep storage shelves back of the open tool mounting space, and with two 30″ swinging doors, is large enough for the tools needed for a class of twenty-four students.

Tool Cabinet For Special Power Tools and attachments (Figure 61). It is suggested that a special cabinet be used to house the special power tools and attachments.

Each tool and part should have a place in the cabinet for easy checking at the beginning and end of each class period. The correct names of the tools and parts should be placed in the label holder to help students learn the names of the various pieces of equipment.

Such a cabinet facilitates easy finding and returning of tools to their proper places. It is suggested that silhouettes behind the tools and parts be used to identify the tools housed in the cabinet.

Such tool cabinets should be locked when not in use.

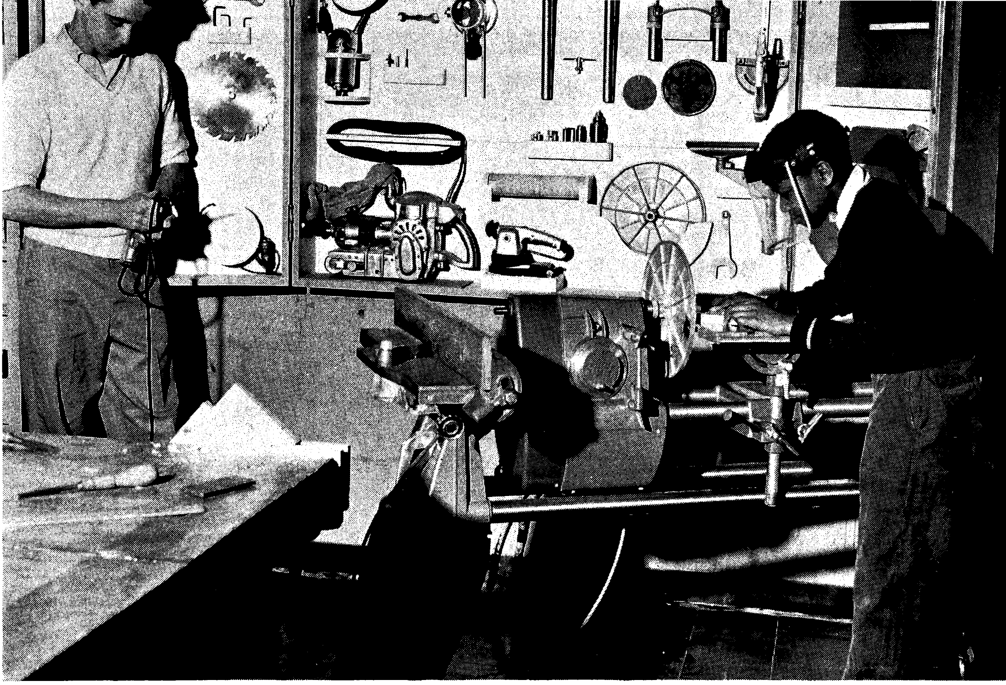


Figure 61. Tool Cabinet for Special Power Tools

Tool Panels (Figures 62 and 63). These two tool panels are identical in major construction, but show the variations possible in minor details, such as racks and storage drawers.

The tool panel is set at a slight slant from a vertical position to assist in keeping the tools on the racks provided.

In spite of the variety of sizes and shapes of the tools and accessories in the cabinets, a sense of harmony and order immediately impresses the observer. Particularly interesting is the storage of the hand power drill and router, often thrown in a drawer and not readily visible to the user.

A wide variety of drawer types and styles can be substituted for those shown to fit the needs of individual laboratory situations.

When the vertical sliding door is lowered to close the tool panel, space behind the two horizontal sliding doors over the top of the tool panel are available for bulk storage and extra tools. Below the tool panel are four hinged doors giving access to more bulk storage and additional space for machine accessories and other electrical tools.

Space is provided at the bottom so that the student reaching into the slanting tool panel is in a comfortable position.

Each panel shown is 16″ deep, 7′ wide, and 12′ high. The overhead storage space can be varied to accommodate ceiling height.

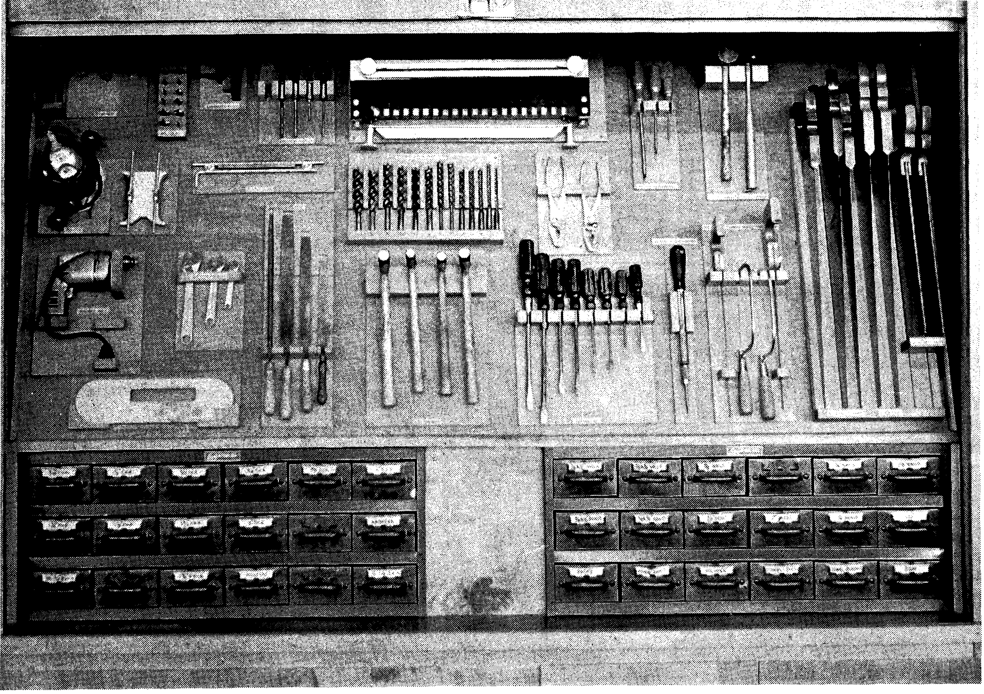
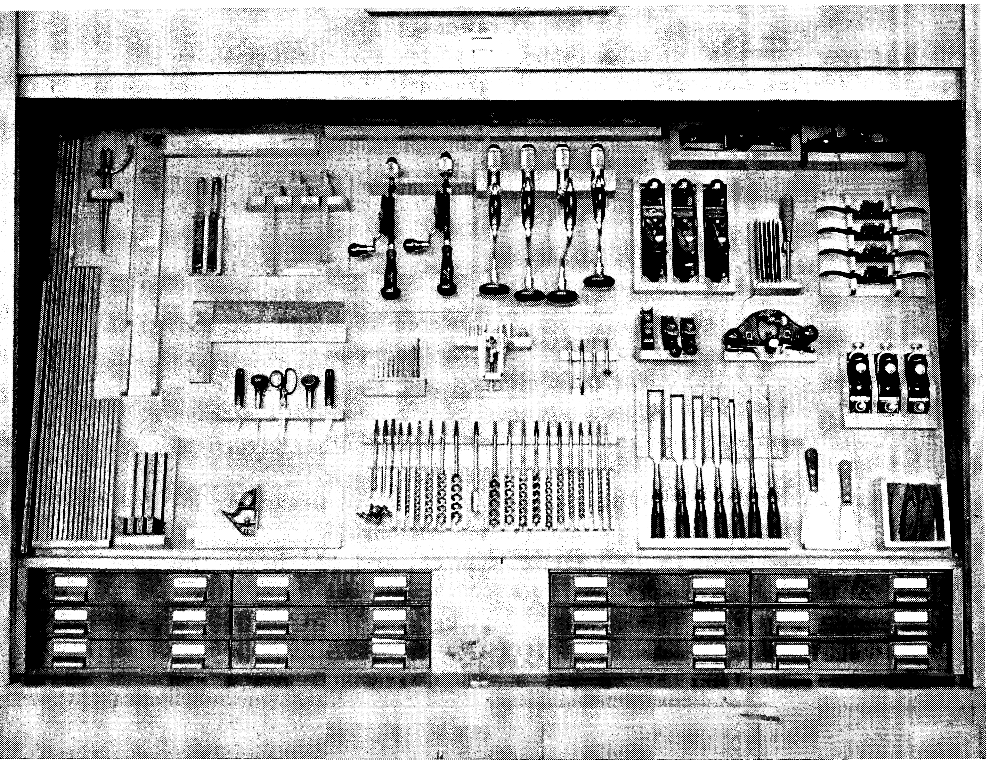


Figure 62. Tool Panels (Courtesy Willis H. Wagner)

Figure 63. Tool Panels (Courtesy Willis H. Wagner)



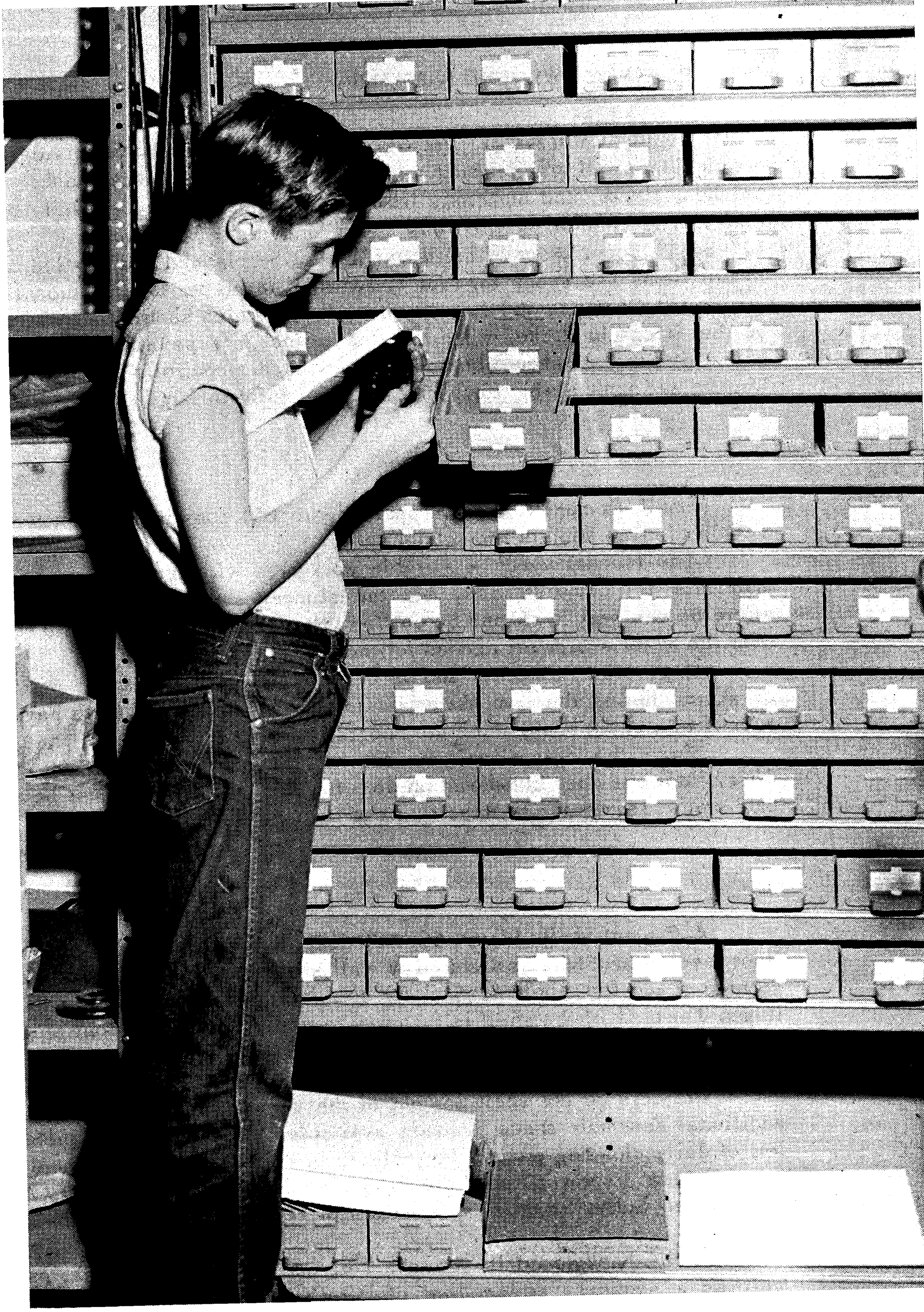


Figure 64. Supply Cabinet

Supply Cabinets (Figure 64) with drawers and drawer dividers are ideal for small supplies such as nails, brads, screws, bolts, washers, brushes, rivets, and numerous items in other areas as electricity or crafts. The cabinet pictured has ninety drawers approximately 4″ by 12″ by 3″ deep. Order of the drawers must be planned and labeled to locate items and check for replacements. With proper labels students can be taught to use and care for the cabinet, which should be located so that it can be locked when classes are not in session. The distribution of supplies should be under strict teacher control. Color cards, letters, and numerals have been used successfully to label the drawers.

Small Demonstration Groups (Figure 65) constitute a popular method of instruction in the school shop.

The teacher needs a suitable work area with proper tools and materials for demonstration, and the student should have a place where he can see, hear, and be comfortable. This work area should be near the major equipment needed for the instruction.

If possible, students should be provided with a place to write or sketch during the demonstration. Ideally the teacher should have access to a chalk board and a cork board.

Since the space available for the industrial arts program in most situations does not afford an area for such a center, it must be a part of other required work areas that can be used for several activities.

A Project Shelf (Figure 66) 24″ deep, approximately 84″ above floor level, and of lengths dictated by wall space available will provide storage space for supplies, partially completed projects, and finished items. The back of the shelf is fastened to the wall, and the front side is held by lengths of chain or long bolts spaced approximately 48″ apart.

Projects on the shelf are out of the way of other students and additional assembly space becomes available. The maintenance problem of daily cleaning around the projects is eliminated. Finished projects are on display without the danger of damage from handling. A sturdy step ladder or other safe means of reaching the shelf should be provided.

In the background is shown a horizontal type lumber rack, as well as a sequence arrangement of cut-off saw, circular saw, and jointer.

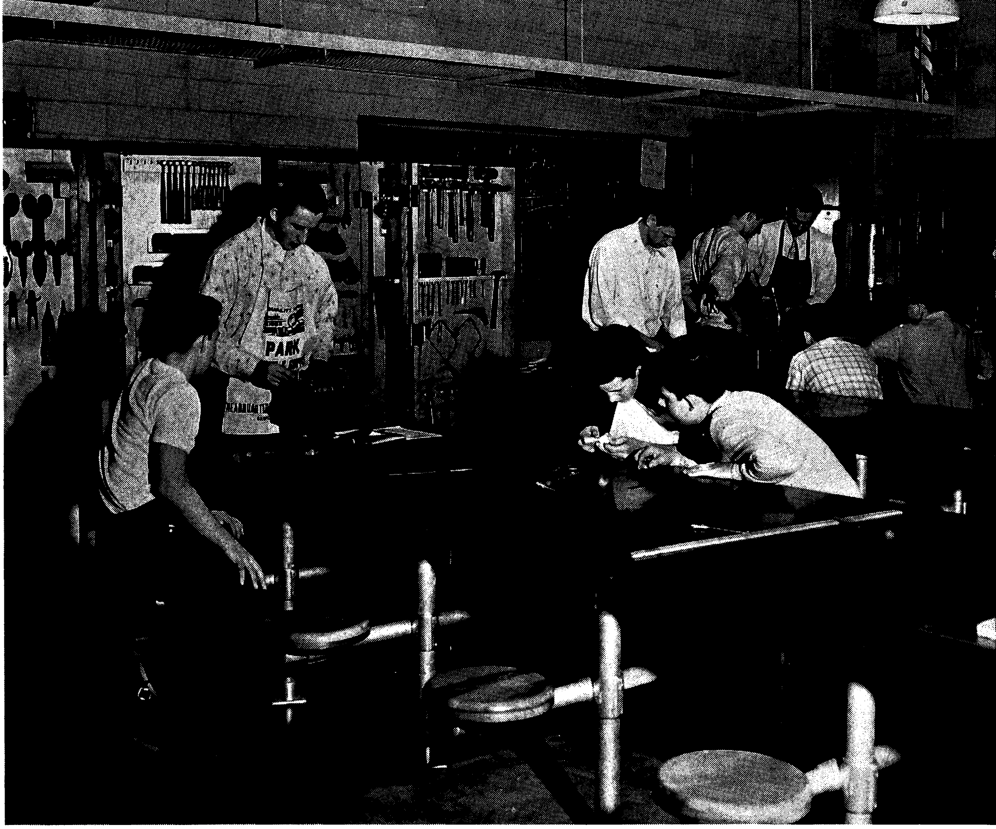
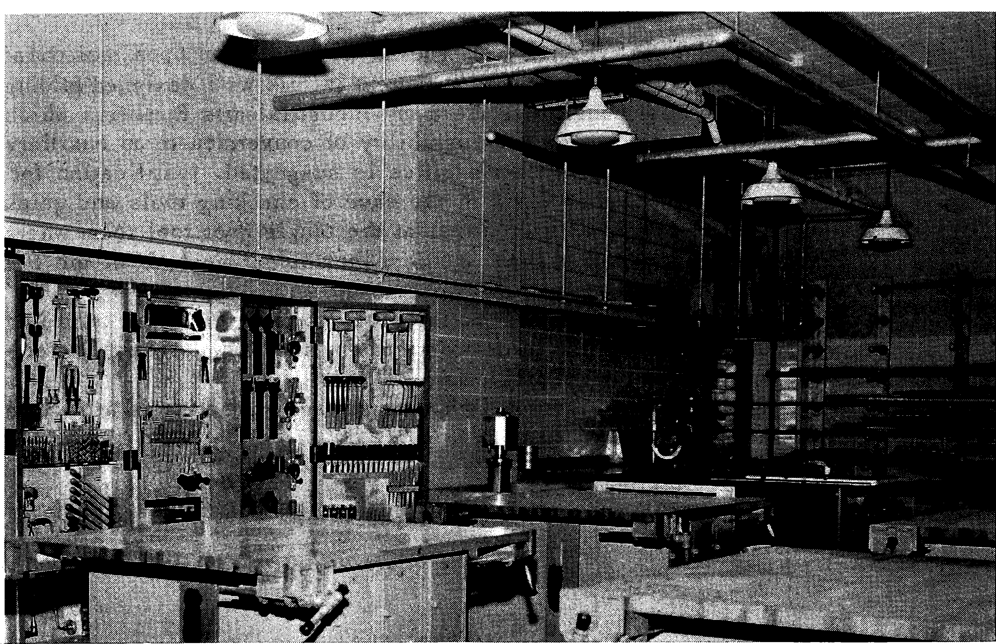


Figure 65. Small Demonstration Groups

Figure 66. Project Shelf



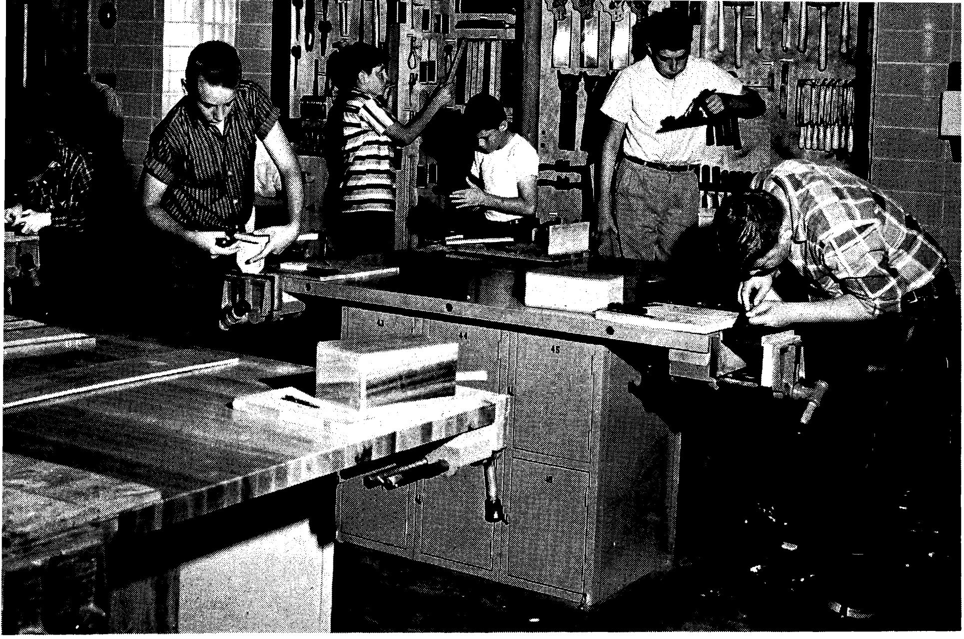


Figure 67. Work Benches

Work Benches (Figure 67) with four work stations, locker, space for twelve students, and four 7″ woodworking vises are usually standard equipment. These benches have 1½″ to 2″ hardwood tops and are 54″ by 60″ in size. The top is mounted on two standard locker units spaced 5¾″ apart, bringing the locker door near the front edge of the bench. These locker units can be secured with built-in combination locks or with a hasp for the regular key or combination lock. The benches should be fastened to the floor. Six of four stations are enough for a woodworking class. Benches for junior and senior high school laboratories should be 32″ high.

Tool Panel (Figure 68). The advantages of an open tool panel over the old type tool room are apparent in this well designed folding four-station tool panel. For the many industrial arts facilities which still contain tool rooms, the possibility of conversion to an auxiliary storage or combined teacher's office is suggested. Justification for the open tool panel is found in the ease of checking tools and quick accessibility. This is in contrast to the single door tool room where students must stand in line and lose valuable time both at the beginning and end of the period.

At the right rear is a portable blackboard which may be rolled around the room for use in demonstrations, sketching, figuring materials, and working design problems.

The bulls-eye system of locker storage numbering is attractive and easily visible.

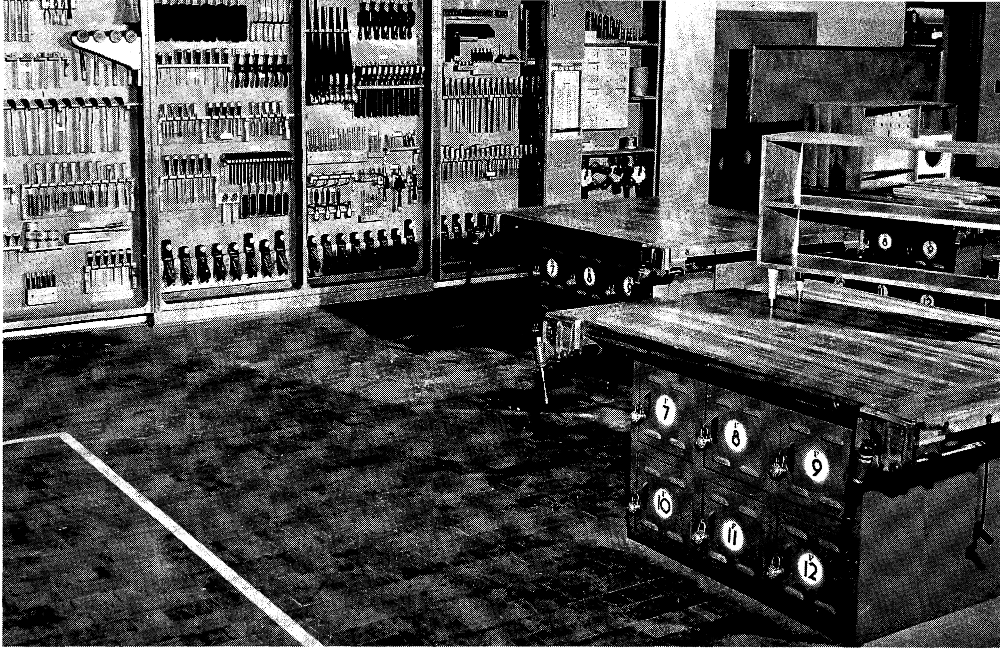
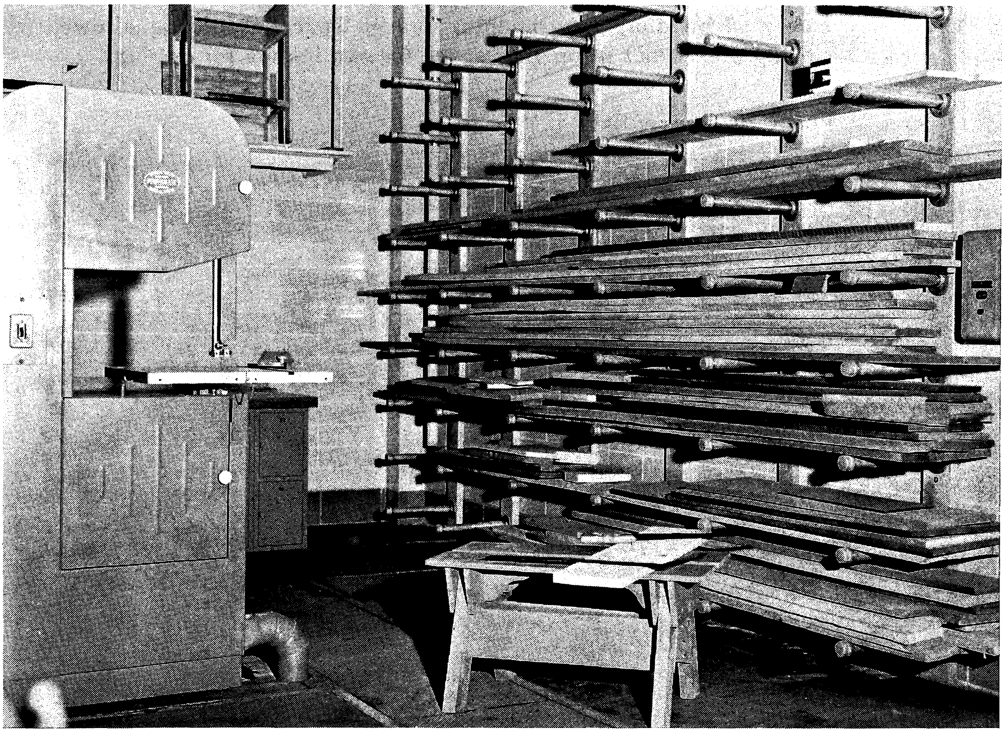


Figure 68. Tool Panel (Courtesy Los Angeles City Schools – Fred Baer)

Figure 69. Wall Pipe Arm Lumber Rack



Wall Pipe Arm Lumber Rack (Figure 69) will not hold as much lumber as the flat type rack providing sufficient space for sheet stock storage. The wall rack is ideal for small laboratories with space at a premium.

The upright pieces should be of 2″ material and fastened securely. The pipe arms of 1¼″ pipe spaced 12″ to 14″ apart are fastened to the upright by using floor flanges fastened to the 2″ by 6″ uprights with No. 14 two-inch flat head wood screws. This type of rack has also been used to store short pieces of lumber. By placing a pine shelving board on the arms, the shelf can be used for housing projects and other items. The end of the pipe arms should be capped. Pipe racks of this type are economical and can be constructed by the class or building maintenance personnel.

Lumber Racks (Figure 70) for the woodworking laboratory should be constructed to house the lumber in a horizontal and flat position, so it can be stacked for drying. The rack is long enough to hold 12′ to 14′ lumber, as well as store plywood sheets on the top section. On each side the arms can be extended 12″ to 18″ to store shorter pieces of lumber of varying sizes. Lumber racks can be constructed in a number of ways, but the one shown in the picture is made of 1½″ and 2″ galvanized pipe and adjustable Hollaender fittings secured from plumbing supply houses. They can be adjusted to house the type of lumber used.

The rack should be fastened to two walls for safety and security.

The lumber supply should be located near the cutting area for safety in handling long boards. Enough space should be allowed for moving the lumber to provide space for saw horses for cutting.

Figure 70. Lumber Rack

A Saw Horse (Figure 71) with a flat top is helpful in the wood area. The saw horse should be built sturdily with a top approximately 12″ wide, 30″ long, and 18″ high, with a 2″ slit through the center of the top board. By providing students with a saw horse, they can be taught the proper way to hold and use the cross-cut and rip saws.

Several saw horses should be available. Clamps can be used to hold small pieces of wood for cutting. The saw horse with a flat top can be used for many other activities.

A Vertical Storage Rack (Figure 72) for the storage of metal rod, bar, flat, and angle iron stock is a space saver and the best method of handling metal stock in the average school laboratory.

The dividers in the rack should not be over 3″ or 4″ apart; with this spacing the stock can be separated and is more easily located. For a metalworking laboratory two 36″ racks are sufficient. These vertical bar racks can be purchased from metal equipment companies, base size 24″ deep, 36″ wide, and 84″ high.

An ideal arrangement is to place the power hack saw between the two vertical storage racks. With the metal stock stored on end, the stock will be cleaner and easier for students and teacher to handle. The short pieces of stock may be stored in the front with the proper sizes of metal.

Vertical Sheet Metal Storage Racks (Figure 73) is the safest way to store large sheets of metal. Floor space 12″ to 18″ wide and 8′ long will house all the sheet metal needed to operate the average general metals laboratory. If this rack is 30″ to 36″ high, the top consisting of one or two hinged lids will serve as a work bench or a place to store books and planning materials. The only time the top lids need to be opened is when a short piece of metal has been moved too far back in the rack. In planning for the location of the rack, nine feet should be free or open to allow the removal of the full sheets of metal. The rack should be near a large flat table to place the sheet for layout and cutting. With the vertical rack there is less chance of the metal buckling while being handled by students.

Figure 71. Saw Horse

Figure 72. Vertical Storage Rack

Figure 73. Vertical Sheet Metal Storage Rack

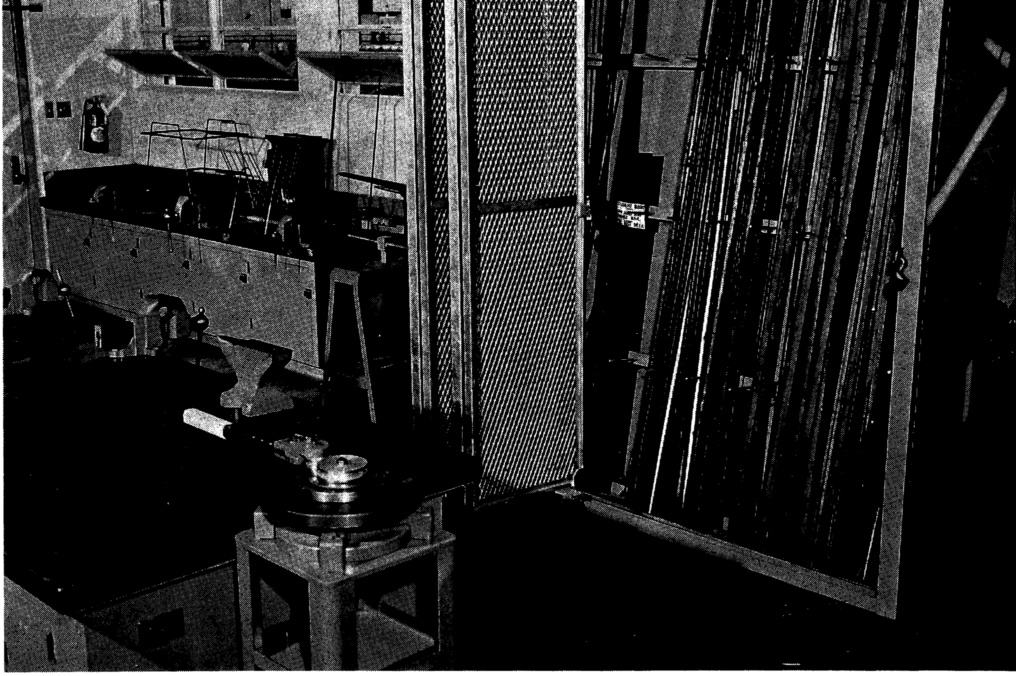


Figure 74. Metal Storage Rack (Los Angeles City Schools – Fred Baer)

Metal Storage Rack (Figure 74). A unique treatment of metal storage is shown in which the conventional vertical bar type rack is equipped with an enclosure and accordian-folding wire mesh doors. This provides for excellent control over rod, bar, and angle stock. In contrast to the horizontal type of rack with open ends, this arrangement affords a greater safety factor because there are no ends of projecting metal for students to run into.

The placement of the metal bending jig is well located for handling long stock, since pieces of this type may be supported by the work bench.

Awning type windows as shown provide up-draft ventilation, and if the panes are of obscure glass, they will give greater light diffusion throughout the room.

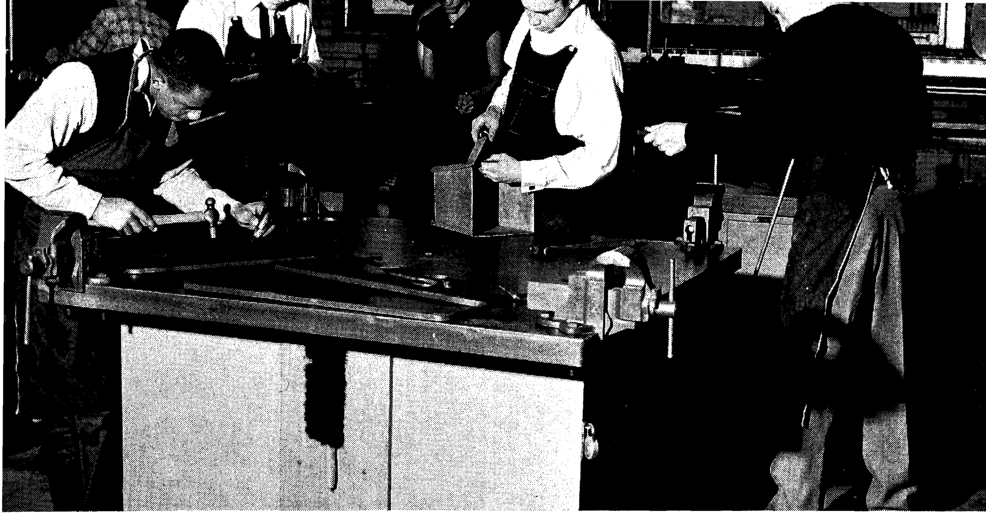


Figure 75. Metal Work Benches

Metalworking Work Benches (Figure 75) require a different construction from benches in woodworking. The top for the bench pictured has a 2″ wood base with 2″ angle iron ¼″ thick around all four sides, ¼″ masonite inside the angle iron area, and a sheet of ¼″ cold roll steel over the entire top. The edges can be tacked to the angle iron by welding or by heavy screws. Four 3½″ metal working vices are mounted so that they may swivel around the corners

This top can be mounted on the top of locker units or any other substantial frame. Heavy tops provide a work area for cutting, bending, riveting, and forming all types of metals. The open space between the locker units can be closed with an 8″ strip of wood and used to hang bench hooks and counter brushes. The type of top construction is suitable for the 24″ wall bench tops.

Six four station benches are sufficient to accommodate the average twenty-four student class.

Work Benches (Figures 76 and 77) with four swinging seats for four work stations are considered excellent for assembling small parts or close work where the student can do better work if he is seated.

When the seat is not needed, it can be swiveled under the table. The seats should be of chair height and approximately 12″ in diameter for the 30″ table height and 14″ for the 32″ table height. The table pictured has the standard hardwood top, approximately 2″ thick, and a 54″ by 60″ surface. The base is constructed of 1½″ galvanized pipe uprights, with cross members and seat arms of 1¼″ pipe. Hollaender fittings are used throughout and can be purchased at plumbing supply houses. This type of table or bench construction requires no pipe threading and can be constructed by the teacher and students, if necessary.

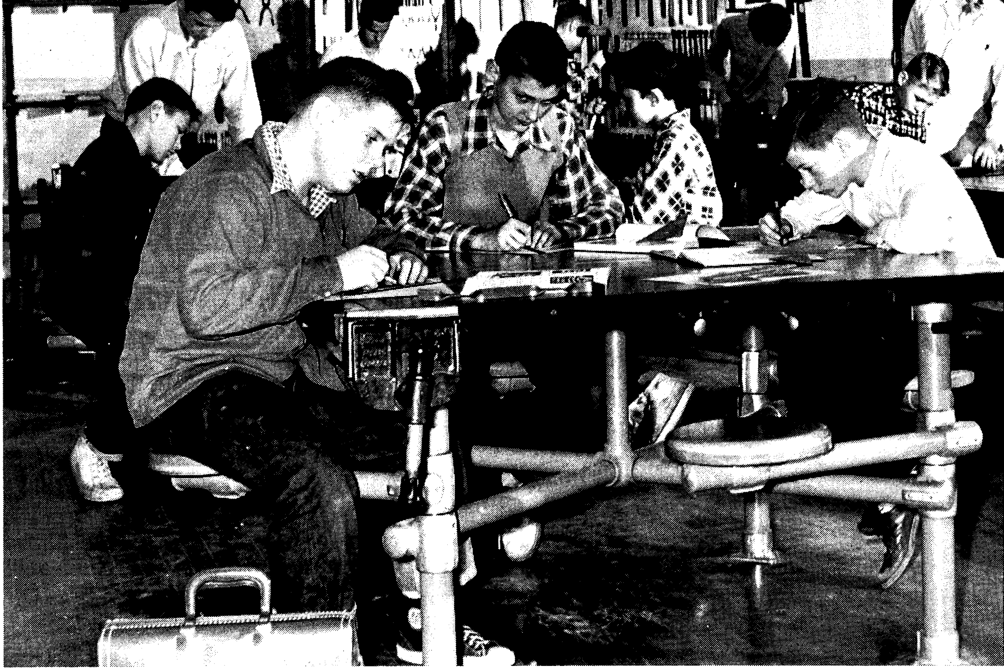


Figure 76. Work Benches

Figure 77. Work Benches

Metal Laboratory (Figure 78). Entrance to the metal laboratory is through the double doors in the left rear of photograph. These double doors provide ample access directly to an exterior court which permits delivery directly to the room. The wire glass doors insure a safe means of additional natural light.

Wall space along the rear of the room is converted to locked storage and may be utilized for supplies or partially completed projects.

The portable cut-off saw is placed where long stock may be easily handled. The brake in the foreground shows the use of operating and safety instructions attached to the machine for easy reference.

Over the furnace, the hood shown is brought down to a functional level for removing fumes. This area may also serve for using the portable welding unit stored against the back wall.

An excellent feature of this facility is the large wire glass safety panel between the buffer and grinder allowing the instructor clear visability of the entire laboratory, while at the same time giving adequate safety protection to student operators.

Figure 78. Metal Laboratory (Los Angeles City Schools — Fred Baer)

Metal Laboratory (Figure 79). This junior high school metal laboratory with smaller equipment shows an excellent use of safety lines to determine operator areas.

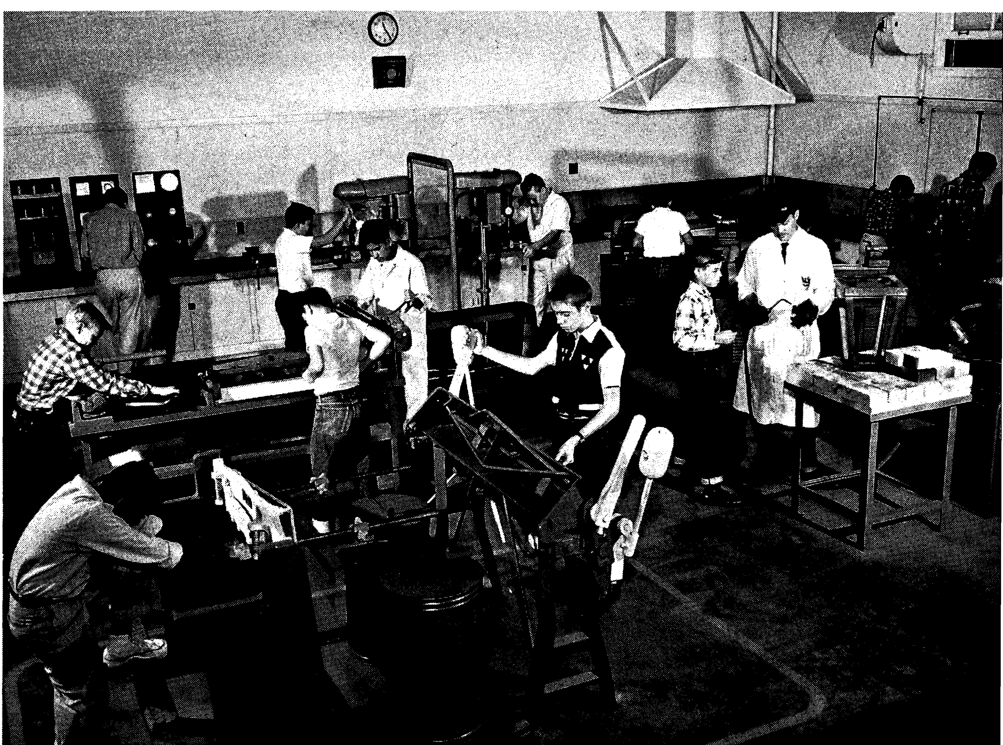
The student and teacher working at the welding table on the right demonstrate safe practices in using welding equipment. The instructor with shop coat and safety gloves is showing the student the proper method of lighting the torch. Safety goggles are ready for use in welding.

A cheap but functional welding table is featured. It is fireproof, easily constructed, and the firebricks can be rearranged to meet the needs of a variety of jobs.

Trash cans in the foreground are conveniently placed, but do not consume valuable floor space.

Attention is again called to the use of the wire glass safety shield between the drill presses.

Figure 79. Metal Laboratory (Los Angeles City Schools – Fred Baer)



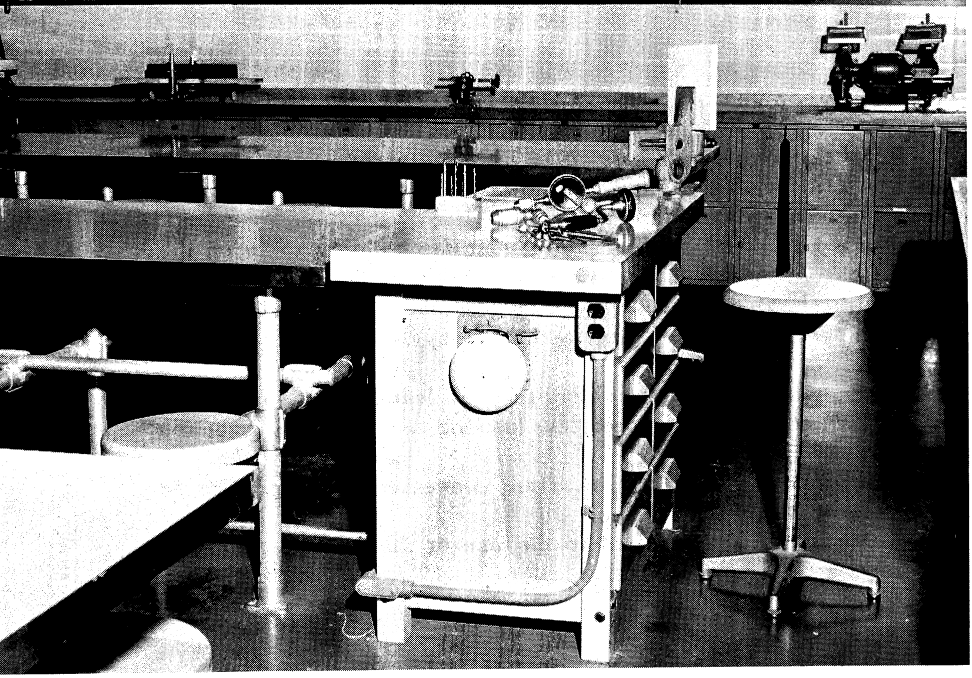
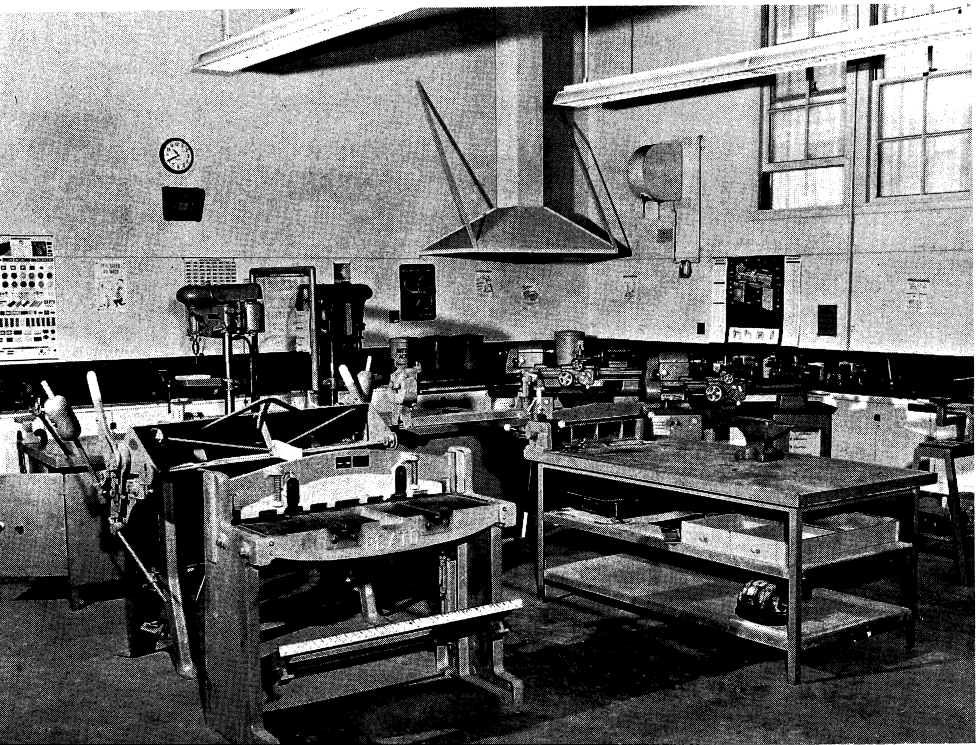


Figure 80. Teachers Demonstration Bench

Figure 81. Metal Laboratory (Los Angeles City Schools - Fred Baer)



Teacher's Demonstration Bench (Figure 80) 32″ high with a hardwood top and drawers with locks to house supplies and special tools. The bench should be equipped with both a woodworking and a metalworking vise. An electrical outlet with 110 volt current should be attached to the bench. Ideally the bench should be 30″ from a blackboard at the front of the demonstration tables. A hand operated bell or other device attached to the side of the demonstration table is useful for assembling students.

Such a bench and instruction tables to seat twenty to twenty-four students make a good demonstration area, and the teacher has more success in presenting the many tools and how they should be used, as well as processes to be taught.

The demonstration bench drawers provide storage location for small supplies and tools available to students.

The bench also can be used for a student's work station if other facilities are crowded.

Metal Laboratory (Figure 81). This room shows a compact utilization of floor space maintaining adequate aisle widths without creating a safety hazard or complicating the problem of housekeeping.

Excellent storage space is provided around the walls, while gaining many bench type work stations necessary for most classes.

The acid area is hooded with adequate ceramic containers for pickling and cleaning acids.

The area above the workbench is used for teaching aids emphasizing safety and related information. To the right of the hood is a wall mounted, reel type, air hose.

The two drillpresses are separated by wire glass safety screen.

Metal Laboratory (Figure 82). This photograph shows a compact arrangement of the major equipment used in a junior high school electrical laboratory.

The use of the guards, instructional placards, angling of the equipment, and use of the safety lines on the floor contribute to the safety of this area.

If proper acoustical treatment of the laboratory is provided, the teaching conditions as shown in the photograph can exist. Specifically, it is feasible for the teacher to carry out individual or group instruction, while work in the laboratory is in progress. In addition, these conditions eliminate the need for multiple work-stations and duplication of equipment, since the student activity load is spread between instruction and equipment use.

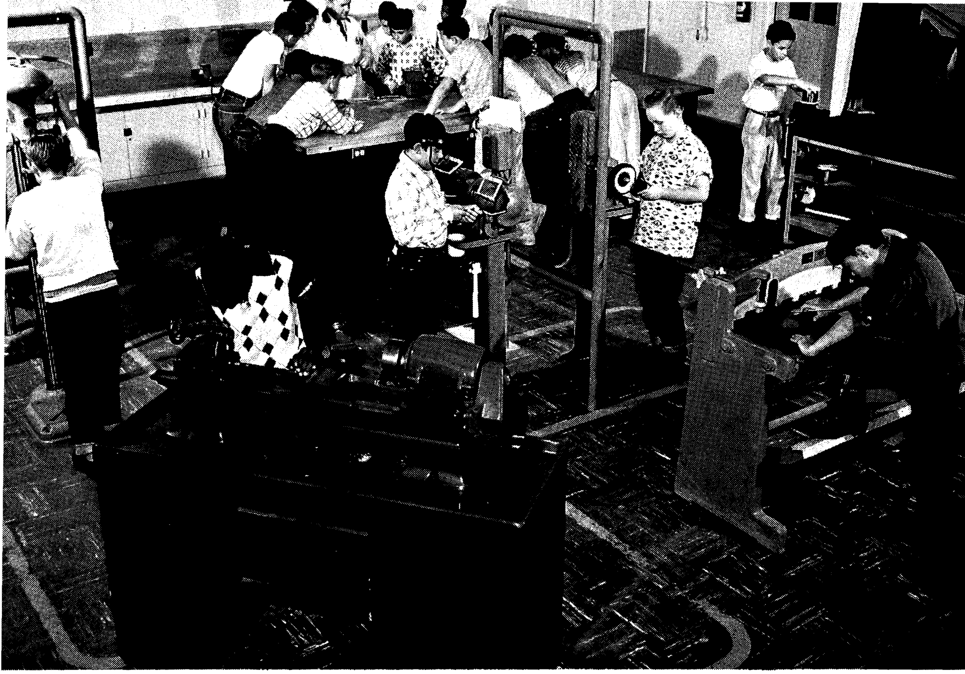


Figure 82. Metal Laboratory (Los Angeles City Schools – Fred Baer)

Figure 83. Graphic Arts Laboratory (Los Angeles City Schools – Fred Baer)

Graphic Arts Laboratory (Figure 83). A junior high school graphic arts class in action showing compositing work in progress, a student locking up a chase, and the instructor checking the alignment of a job on the press.

Along the back wall are students working on a variety of projects and using such equipment as the rubber stamp and Virkotype machine.

Above this area is shown the storage facility for a large roll of paper. Directly above this are the high windows which permit free use of wall area.

A locked storage space is provided in the rear corner with an adjoining built-in display case. The top of this case provides storage for a large teaching aid.

The double door is typical of most laboratories where movement of large equipment is necessary.

Type Storage Cabinets (Figure 84) with flat formica tops along the wall save valuable space in the graphic arts laboratory.

They are constructed to house the standard Hamilton California job case trays and other type case trays of the same dimensions.

The trays are removed and placed on top of the cabinets or taken to other tables in the laboratory for hand composing and distributing type.

The tops of the type cabinets can be used for other work in the graphic arts areas, such as book binding, silk-screen printing, and collating printed pages.

In the right foreground a bookbinder's vise is shown on the corner of the bench.

Figure 84. Type Storage Cabinets

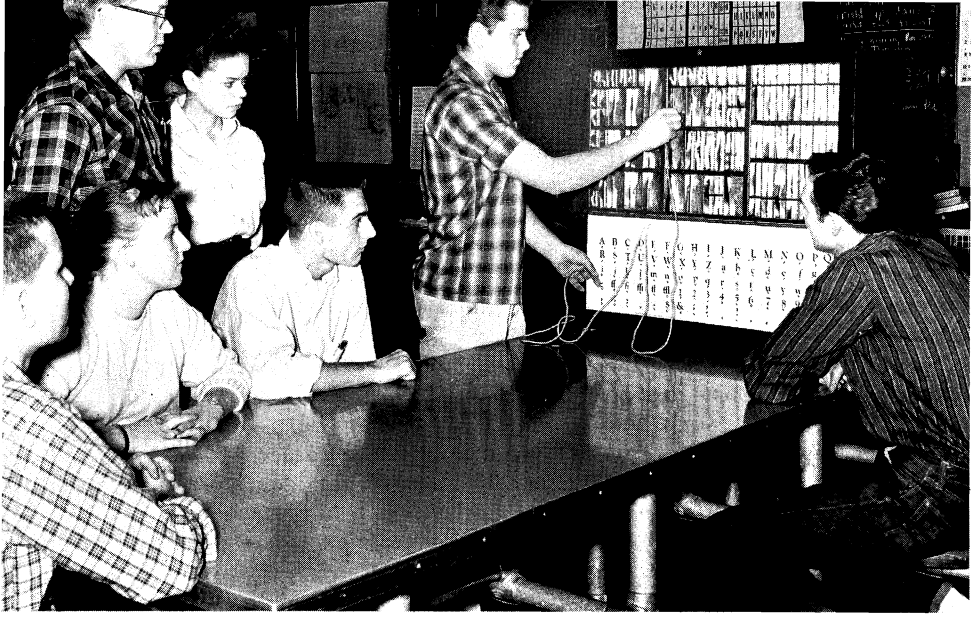


Figure 85. Teaching Aid

Teaching Aid (Figure 85) for students learning the layout of the type case. This device has been found useful for drill purposes and can be used to promote interest when used as a competitive or testing game.

This is a standard California job case with metal sheets in the bottom of each division connected to a copper wire on the back. A second copper wire is connected to the letters, numbers, and other characters. When the operator matches the letter with the space in the case, a light results.

The teaching aid shown in the picture is the cooperative results of students in electrical and graphic arts laboratories. Similar teaching aids electrically operated can be constructed for other areas.

Graphic Arts Laboratory (Figure 86). An example of a well planned graphic arts laboratory showing good correlation between type banks, imposing stone, and press area is shown.

Utilization of the fronts of storage cabinets as a display area, along with other wall displays behind the presses, makes the presentation of student work an interesting feature of the room.

Shown in the front left hand corner is the metal waste can, important for the storage of inflammable waste materials.

The location of the wash-up sink near the presses and away from the entrance door permits the press operators to keep hands clean, as well as preventing congestion around the entrance to the room.

Figure 86. Graphic Arts Laboratory (Los Angeles City Schools – Fred Baer)

Figure 87. Demonstration Alcove (Los Angeles City Schools – Fred Baer)

Demonstration Alcove (Figure 87). Illustrated here is a demonstration alcove, planning area, and teacher's office space. This also serves as a projection room with a pull-down screen mounted over the black board. Dark curtains to separate the instructional alcove from the laboratory and side enclosed venetion blinds provide for the darkened area. Projection is through a glassed aperture from the stock room behind the seating area, thus eliminating projection machine noises.

Riser type seats are shown at the right hand side of the alcove and a magazine rack in the center for graphic arts periodicals, along with a filing case and cabinet for reference materials.

A metal top demonstration table, with casters enclosing a storage space beneath for teaching aids, may be rolled into position when needed. When not used for group instruction, it furnishes additional mobile work space in other locations.

Using Power Machines (Figure 88) in the laboratory presents a safety problem. There are a number of methods to control the use of the various types of machines.

The teacher must give instruction to the class, later to groups, and then to individuals before students are allowed to operate the power equipment. After written and oral tests showing satisfactory understanding, the teacher gives each student permission to use the items of equipment in the order assigned.

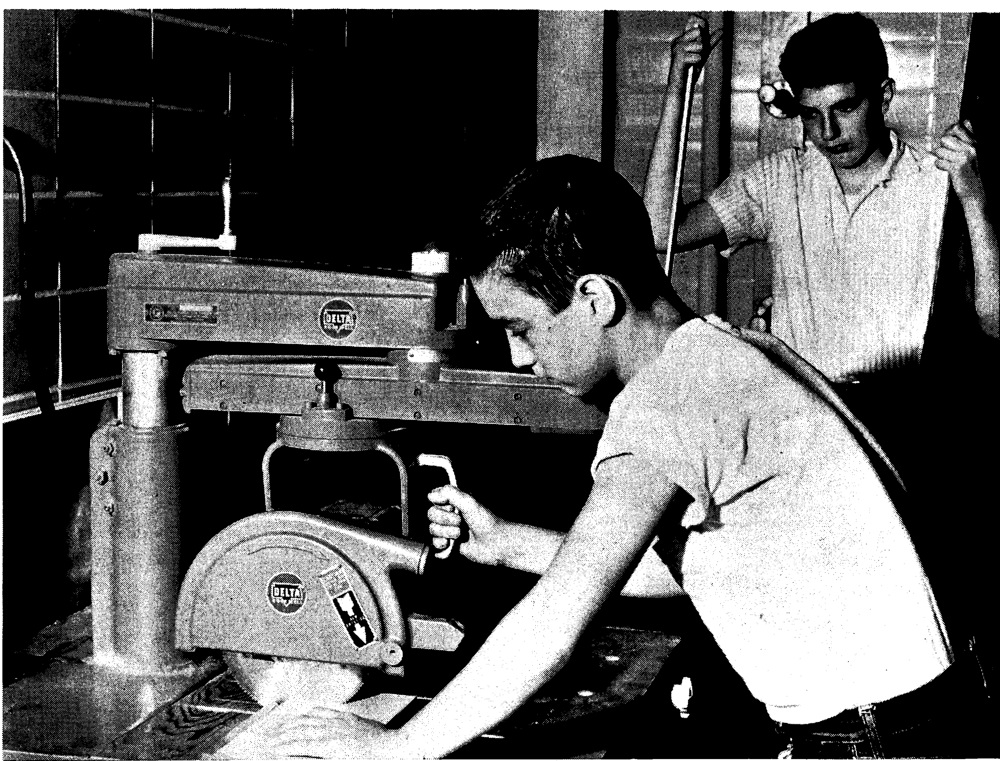
At the beginning of the period names of the students are placed on the board. The teacher checks the list and permits the use of the machine or gives the student the help he needs to operate it. This saves time for students, and the teacher has control as to the names that are to remain on the board.

Radial Arm Cutoff Saw (Figure 89) is one of the machines for cutting lumber and doing other woodworking operations. The 10″ saw seems to do most of the cutting required in industrial arts programs. When the proper guards and the magnetic switch are used, this machine tool is one of the safest. Teachers who have used the radial cutoff saw feel that it is as safe as a regular 10″ table saw, since the thrust is away from the operator.

For school use, it is suggested that ripping be done on a table saw and cross-cutting work on a radial arm saw. This saw can be converted for routing, shaping, and sanding by adding the proper accessories. The instructor should make certain the operator has had proper operating instructions and is capable of using the machine.

Figure 88. Organization for Machine Use

Figure 89. Radial Arm Cutoff Saw



In selecting the **Tool Grinder** (Figure 90) for edge hand tools, consideration should be given to the type of grinder, kind of wheels, and proper speeds. The grinder should be equipped with safety shields and have the tool rests adjusted to the proper position at all times.

Students should be taught how to use the grinder and to care for the grinding wheel surface. The safety glass shields should be cleaned regularly and replaced when pitted or broken. Only safety laminated glass should be used. A desirable feature is a built-in shield light in the grinder. When the type of job necessitates the removal of the safety shield, the use of safety goggles or helmet is mandatory. Grinding wheels should be regularly inspected for cracks and damage.

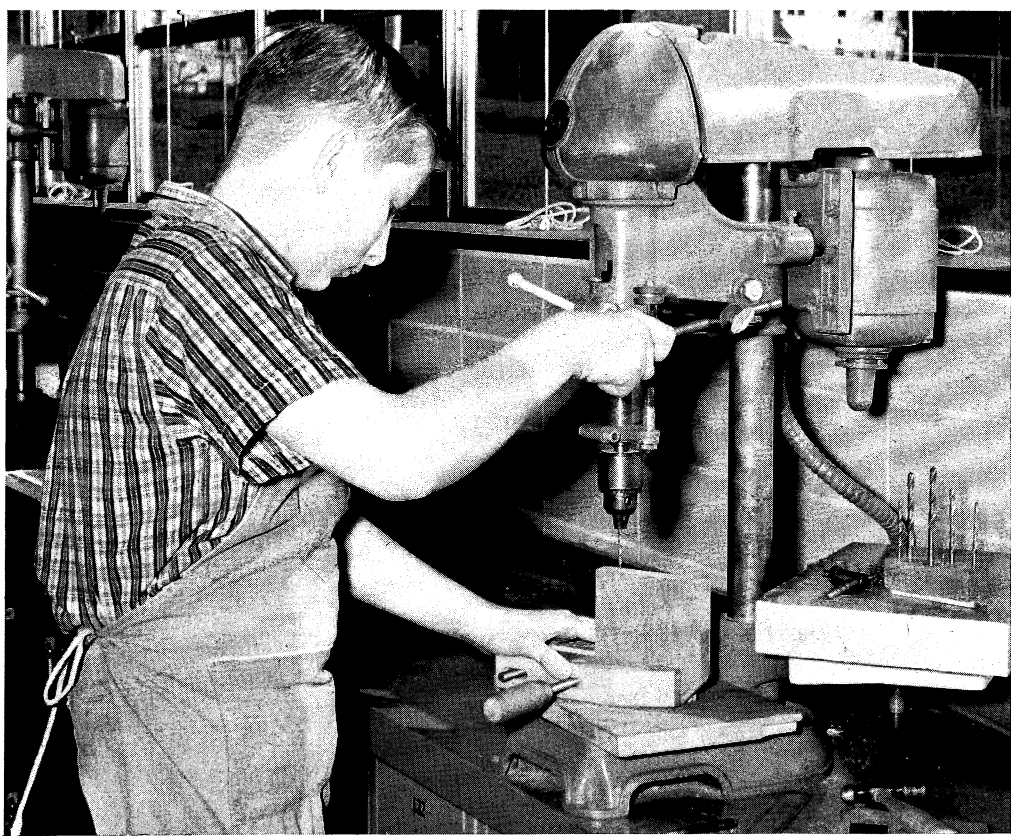
Wheels must be maintained, dressed, and trued with the wheel dresser shown on the bench to the left of the operator.

Figure 90. Tool Grinder

Drill Press (Figure 91) mounted on a wall workbench is well placed for safe working height and has good lighting. The work table must not be too high for the students who are to use the drill press. Small pieces of work to be drilled should be prick punched for centering drill and then held by a clamp rather than in the hands.

From the standpoint of safety, the operator is appropriately dressed. When operating machines revolving at high speeds, long sleeves, neckties, and loose garments should be avoided.

Figure 91. Drill Press



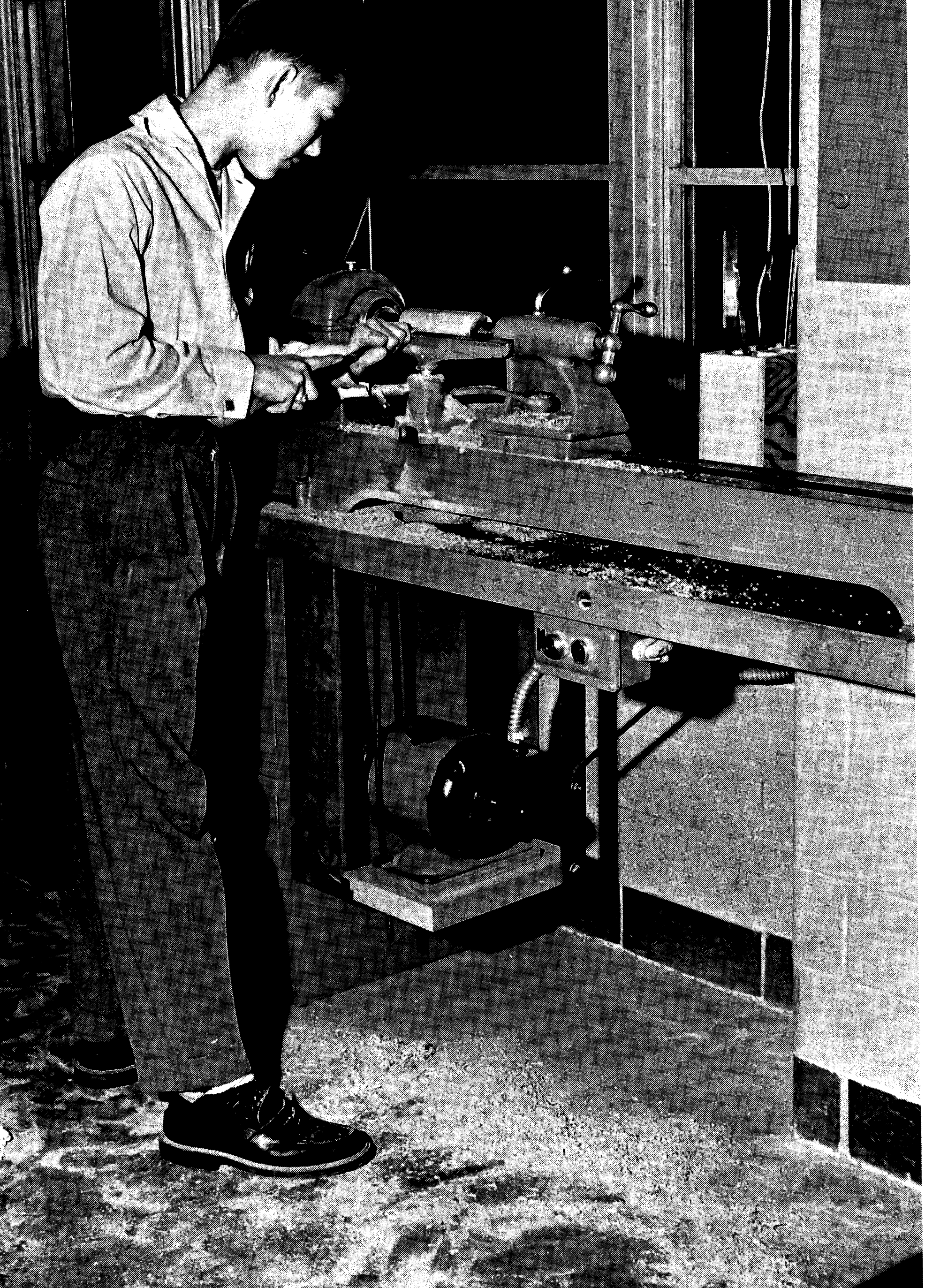


Figure 92. Wood Lathe

Woodworking Lathe Motor Mounting (Figure 92) shown in the picture places the motor so that it is free from dust and wood shavings. This type of mounting conceals the belt for safe use and provides a hinged door for entering to change the pulley speeds. The motor and the electrical wiring is out of the way and makes for easier cleaning. The lathe is mounted with the tail stock end in front of a wall pillar, thus using space otherwise wasted.

The motor is mounted on a heavy hardwood base hinged at the back, and an adjusting screw with lock nuts provides an adjustment to place the proper tension on the V-belt.

The hinged motor base makes it easier to change the V-belt for the lathe speeds. By mounting the lathe and motor as shown in the picture, considerable floor space is saved, and proper lighting is provided.

Woodworking Lathe Teaching Aid (Figure 93) for beginning spindle turning. This mock-up shows the placement and holding of tools for the cutting steps in woodturning.

Mock-up pictured is helpful to the beginner, in addition to the instruction given before a student is permitted to use the woodworking lathe. A glance from time to time assures the student he is following the proper procedures. Mock-up for special jobs can be a project for advanced woodturning students. Such aids are placed where the operator may easily refer to them.

On the wall below the teaching aid is the tool cabinet for the storage of all the woodturning tools. This at-point-of-use storage is gaining in popularity.

The facing of the machines is an additional safety factor, since material thrown from the lathe would not be in line with the opposite operator.

Figure 93. Woodworking Teaching Aid

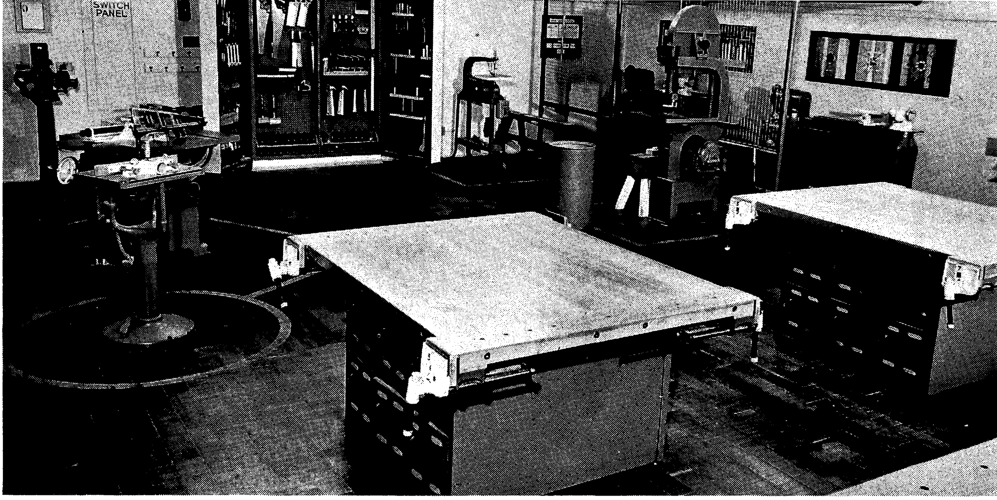


Figure 94. Woodworking Laboratory (Los Angeles City Schools – Fred Baer)

Woodworking Laboratory (Figure 94). Wire mesh safety panels between machines at the rear of the room provide a safety factor and become available as an overhead storage area.

It is considered good practice to identify clearly the electrical control panels in the laboratory.

A well arranged tool cabinet featuring the use of peg board and patented hooks is on the back wall.

An end-grain wood block floor is desirable from the standpoint of maintenance and comfort to the instructor and students, although it is not used extensively because of cost.

Safety areas around the items of equipment are well marked. Occasionally safety markings are allowed to become dull and worn. They should at all times be clearly visible.

Woodworking Laboratory (Figure 95). A high school wood laboratory, with a maximum floor space and adequate auxiliary areas for office, storage, and finishing, is shown.

This is an example of a high ceiling room which allows a balcony project storage area and permits the windows to be above eye level, providing valuable wall space. In this case the architect has located the fixtures to obtain more adequate light on the work bench and machines.

Because of ample floor space twelve two-station benches are used instead of the more common four-station benches.

The highly visible locker marking system calls attention to the fact that two-station work benches provide a greater number of lockers than the four-station arrangement.

The underfloor exhaust system is used to dispose of sawdust and chips. Safety lanes are indicated around major items of equipment and may be painted on the floor or applied with a specially prepared adhesive tape.

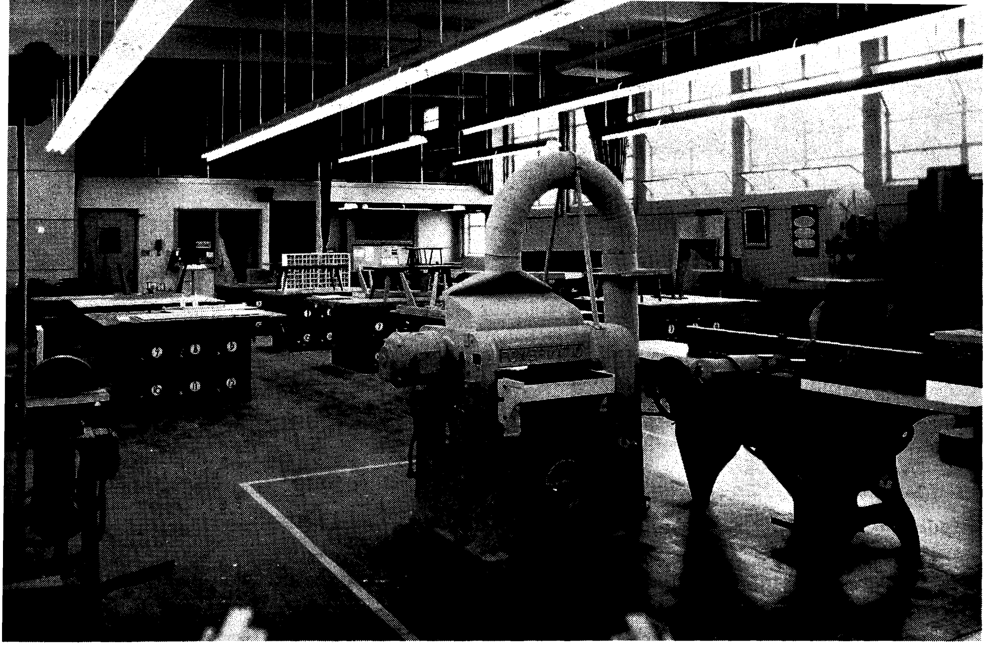


Figure 95. Woodworking Laboratory (Los Angeles City Schools – Fred Baer)

The Finishing Cabinet (Figure 96) must be constructed of metal and meet the regulations for local fire codes. The one pictured is a standard metal bench locker unit with six compartments and a metal covered top for a work surface. Each locker compartment can be made more accessible by using a low metal tray 2″ deep to fit into each compartment. This is an additional safety factor, since the trays catch liquids and prevent them from running on the floor. As a suggested use of the six compartments, the following arrangement is used in this cabinet:

No. 1 compartment for stains and fillers
No. 2 compartment for oils and turpentine
No. 3 compartment for enamels
No. 4 compartment for varnish
No. 5 compartment for lacquers
No. 6 compartment for wax and polishes

Used rags should be stored in a separate metal safety container with cover. This should be emptied daily. Having students cover the work area with newspapers will facilitate clean-up operations.

Figure 96. Finishing Cabinet

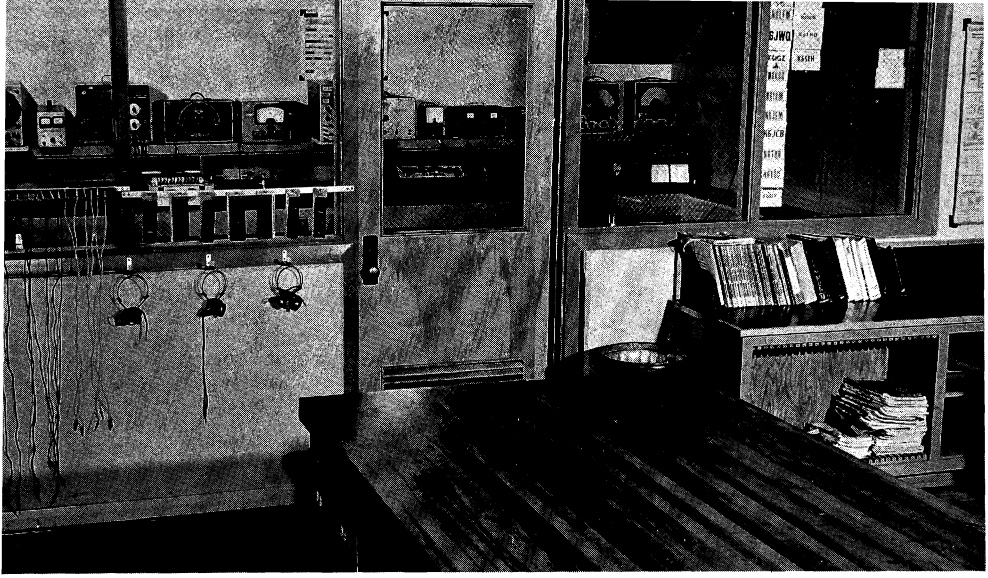


Figure 97. Electrical and Radio Laboratory (Los Angeles City Schools – Fred Baer)

Electrical And Radio Laboratory (Figure 97). In this senior high electrical and radio laboratory the enclosed radio room houses the "ham shack", testing, and tuning equipment. These activities require a quiet area separated from noise of the main laboratory.

An easily accessible storage rack for head phones and jacks is featured and is a desirable type of arrangement of this equipment.

On the right, the laboratory reference library promotes the use of current reading materials, manuals, and catalogues.

Special attention is called to the excellent visual control provided by the wire glass windows, as they permit the teacher to observe activity in this auxiliary room at all times.

Electrical And Radio Laboratory (Figure 98). There are times when little use is made of woodworking vises, and a rearrangement of bench equipment dictates a layout of such facilities in an unconventional manner. This arrangement eliminating most of the three foot aisle between benches in one direction gains considerable floor space, while still permitting the limited use of the vises when necessary.

Teachers should be encouraged to experiment with the location of laboratory equipment to facilitate greater use patterns to fit their individual needs, if there are no violations of recognized safety practices.

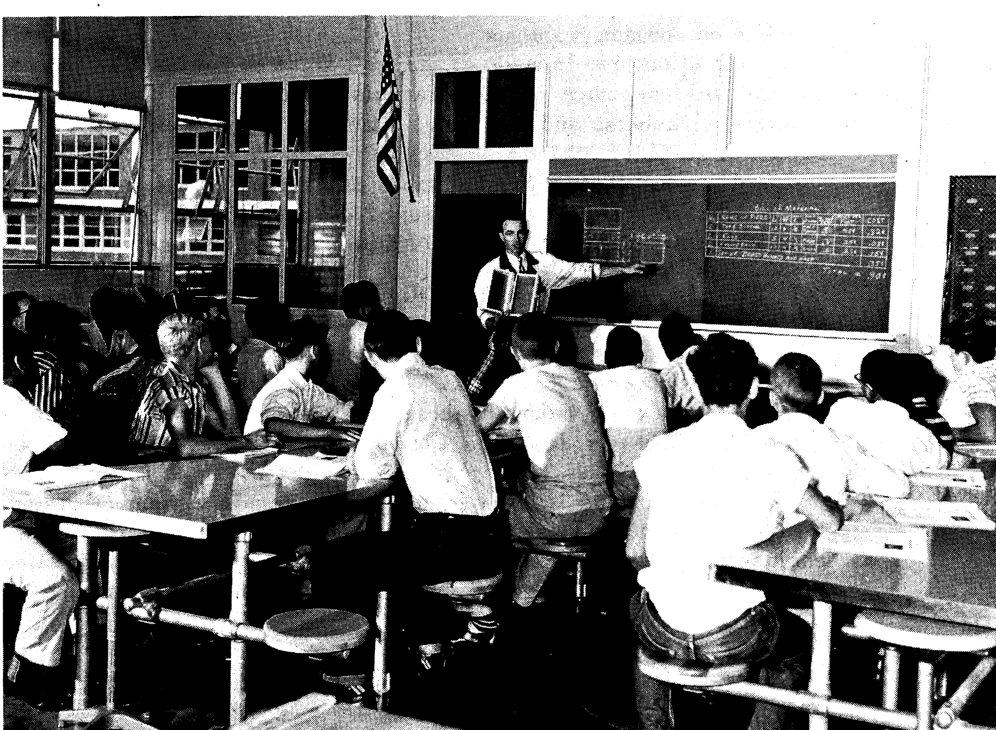
At the extreme left is a portable cart equipped with casters for moving heavier pieces of equipment around the laboratory as needed.

Good use is made here of the storage cabinet doors as a display area. To the right of the main door is an excellent student assignment board for laboratory service.

The visibility, portrayed to the teacher, of the student standing behind the grinder guart is well illustrated in this photograph.

Figure 98. Electrical and Radio Laboratory (Los Angeles City Schools – Fred Baer)

Figure 99. Student Instruction Table



Student Instruction Tables (Figure 99) with enough seats for a laboratory class are helpful and important in industrial arts instruction. They provide four important functions: starting and dismissing the class, a comfortable seating for group instruction, a place for tests and other written work, and a planning and layout center.

Three tables, 30″ high, 42″ wide, and 12′ long, with ten seats each making a total of up to thirty seats, seems practical for the average layout. Instruction table tops for the graphic arts, woodworking, and electrical laboratories are covered with some form of sheet plastic and bound with stainless steel edges. The base is made of galvanized pipe and Hollaender fittings available from plumbing supply houses. Tables in the metalworking area are covered with ⅛″ sheet steel fastened to 2″ angle iron edges.

The seats are 12″ in diameter and are of laminated hardwood with a natural finish. Tables with fixed seats are considered most desirable.

Drawing Laboratory (Figure 100). A drawing room with maximum utilization of floor space is achieved by facing the benches and using a common aisle of four foot width in place of two aisles of three feet. In making this kind of arrangement adequate artificial lighting is necessary so that students facing away from the windows are not working in their own shadows. A one inch gap between bench tops should be allowed. Some teachers object to this system because of possible conversation with the facing student, but if this is confined to the work at hand, it can be utilized to develop teamwork and assistance on common problems.

Excellent use is made of the wall areas to exhibit materials of student interest, such as the triangular scale teaching aid, sample lettering alphabets, and fractional dimension charts, as well as examples of student work.

A useful system of adjustable clips mounted along the top of the blackboard for the suspension of drawings or other illustrative material allows a dual utilization of this blackboard space.

Woodworking Laboratory (Figure 101). This wood laboratory shows the corridor entrance leading into the instructional area or alcove which contains the tiered seats for lecture and demonstration purposes. At the front of the room is the blackboard with a projection screen conveniently mounted above and cork board panels on each side. The teacher's desk and file are at the blackboard end of the alcove.

Draw curtains will close the alcove from the main laboratory area to show visual materials, which are projected through a glass enclosure from the stock room behind the seating area. This eliminates the noise from the projector and provides a permanent location for placing projection equipment.

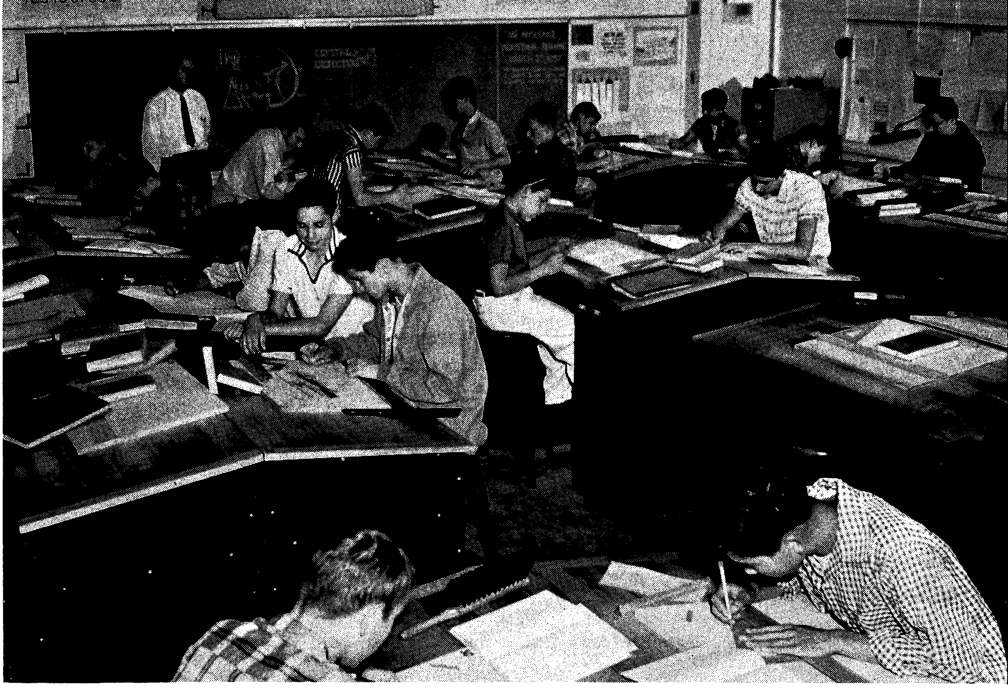


Figure 100. Drawing Laboratory (Los Angeles City Schools – Fred Baer)

Figure 101. Woodworking Laboratory (Los Angeles City Schools – Fred Baer)

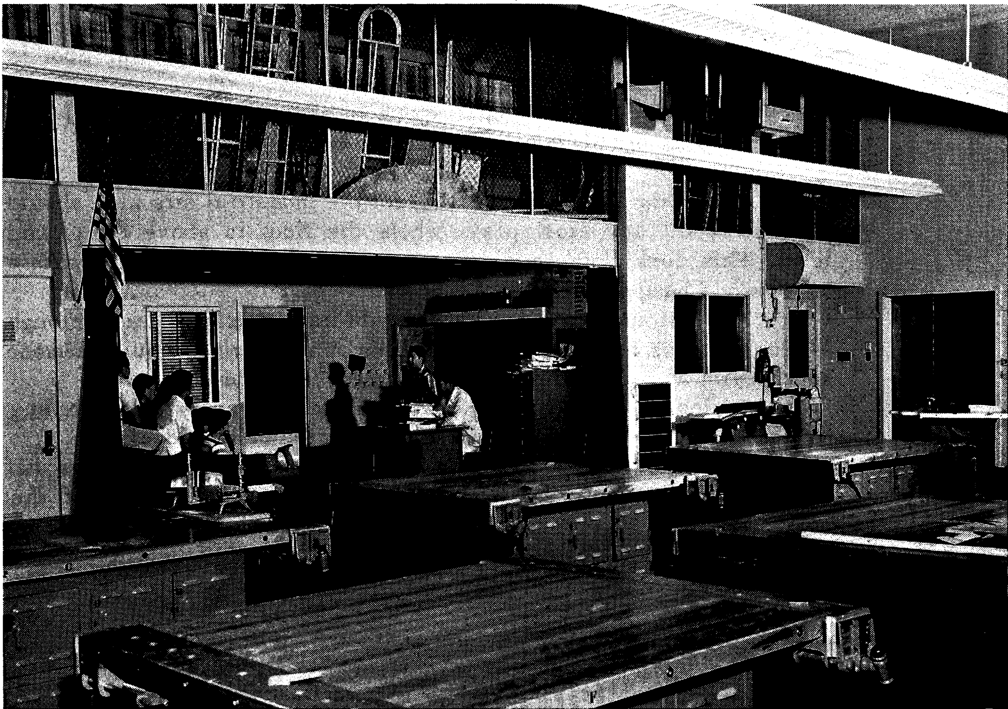


Figure 102. Graphic Arts Laboratory (Los Angeles City Schools – Fred Baer)

Graphic Arts Laboratory (Figure 102). A spacious graphic arts laboratory, which affords room for a permanent tablet arm chair seating area and student locker space immediately adjoining it, is shown.

This laboratory has a plastic type floor essential in graphic arts areas where type may be dropped. Safety areas are marked around the presses.

Portable stock racks and work tables are located near the press operators. A well arranged storage space on the sides of the type banks make for ease in checking the type sticks and pica rules.

The wash sink near the press area and away from the door is illustrated.

At the end of the counter space is shown the scale model constructed during the planning of the laboratory.

A Loading Dock (Figure 103) for the industrial arts area should be part of all laboratory plans where the floor is above the ground level. This dock floor should be at least 72″ wide and faced with a heavy wood bumper strip.

The entrance to the rooms should have openings large enough for easy access for the largest machines. The opening should be made secure with an overhead door with separate lock and key.

A loading dock and large door are necessary for handling materials and equipment, as well as other large bulky pieces.

The loading dock makes it safer to handle heavy machines and supplies and protects the halls, floors, doorways, and steps of the building.

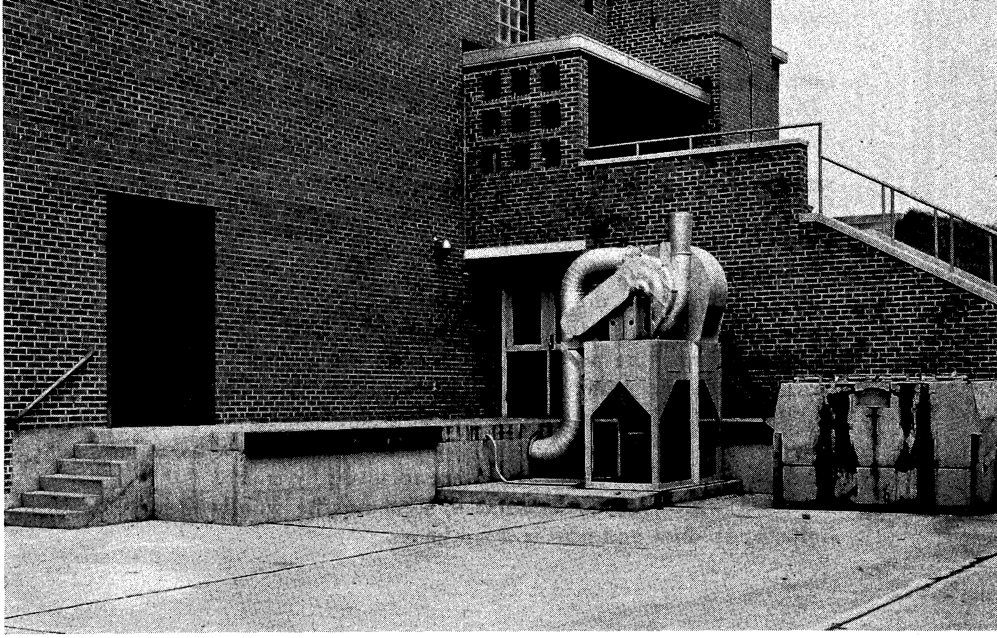
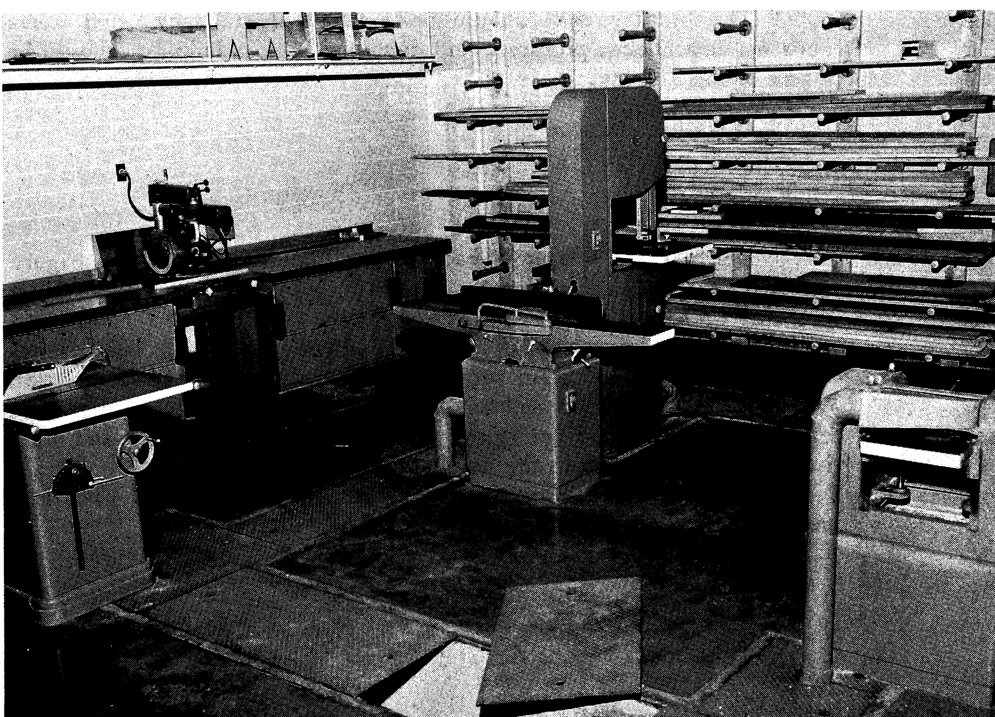


Figure 103. Loading Dock

Figure 104. Dust Collection System



A Dust Collection System (Figure 104) with all ducts from the woodworking machines running under the floor. The underfloor channel is covered with metal plates that can be lifted to provide easy access to the pipes and vent controls.

The channel is approximately 18″ wide by 20″ deep in size and is a part of the concrete floor. This under-floor opening also carries the conduits for the power line to the machines and other outlets in the machine area.

The main trunk line is connected to the power exhaust on the outside of the building where the sawdust and shavings are placed in large closed metal boxes approximately 72″ square and 48″ deep. When the boxes are filled, they are removed by truck.

A well-planned exhaust system for the woodworking laboratory helps keep dust and dirt at a minimum.

Display Cases (Figure 105) for industrial arts play an important part in the success of the industrial arts program.

Careful thought, planning, and selection of projects to be displayed is necessary, if high standards are to be maintained.

The display case should not be overcrowded. Each item should have full explanation, listing the name of student, class, name of project, material, and finishes used.

The display case should be changed often. Many other items such as new books, pictures, and developments in industry should be a part of the display.

Combination Display Shelf And Adjustable Peg-Board (Figure 106) is another way to display finished projects, models, and other teaching aids.

The shelf is made of ¼″ peg-board, fastened to a wood frame, and hinged to a wood strip secured to the wall 84″ above floor level. The shelf is 24″ wide and has 8′ sections. The angle of the shelf can be changed by adjusting the link in the chain. Projects and other items can be attached to the peg-board by hooks or screws.

Values derived from such a board come from careful planning, selection, and changing display objects.

Figure 105. Display Case

Figure 106. Combination Display Shelf

Figure 107. Project Display

Figure 108. Project Display

Project Displays of industrial arts work (Figure 107) offer a rewarding experience for students, teacher, and school. It encourages student craftsmanship, and students and parents are pleased when the work is selected for an award.

A public display is best when not crowded with too many projects, but should have each article placed so that it will be seen.

This can be accomplished by mats, elevations, or peg board mounting.

Each area should plan to enter something in the school, city, county, state, and national displays or contests each school year.

Project Display (Figure 108) of an exhibit winning special honors at the industrial arts statewide convention. On display in the Board of Education offices, this project attracted considerable attention. When teachers and students have prepared such a display, one should make as many uses of it as possible.

This picture was used in a daily newspaper article, furthering public relations and publicizing accomplishments in the industrial arts area.

APPENDIX "A"

Summary of Trends in Industrial Arts Shops Planning for the Past Half Century

by
Marshall L. Schmitt
U. S. Office of Education

TREND	PAST	PRESENT
1. SHOP LOCATIONS	Apart from or in Basement	In a Wing of Main Building Ground Floor Separate Building in Campus Style Architecture
2. PRE-BUILDING STAGE	Some	Based on Curriculum Teacher Participation Community Cooperation Planning Guides (Scientific & Objective) Check Sheets
3. SHOP SIZE	Square 1:1 Irregular 50 Sq. Ft. Per Pupil Ceiling 18 feet No Color, Drab	Rectangular 1:1½; 3:5 Average 100 Sq. Ft. Per Pupil Ceilings 11-15 feet Visibility Throughout

4. SHOP ORGANIZATION	Unit (One to Two Activities)	Comprehensive General Shop (Work in many areas)
		General Unit Shop
5. SHOP LAYOUT	Machine Area	Machine Area
	Work Bench	Assembly Area
		Work Stations
		Area Tools
		Auxiliary Rooms
		Teacher Office
		Finishing
		Storage
		Planning & Library
		Project Storage
6. UTILITY OUTLETS	Gas	Gas
	Electricity	Electricity
	Water	Water
		Radio and TV Outlets
		Compressed Air
		Clock
		Class Bell System
		Fire Alarms
		Inter-communication
7. SHOP EQUIPMENT	Heavy Industrial (Overhead Belt)	Light Weight
		Multiple Purpose
		Single Purpose
		Safer
		Portable
		"V" Belts
		Motor-in-head
		Simple Design

8. PLANNING AREA	None	Drawing Facilities Shop Library Reference and Planning Materials Projector Facilities Demonstration Facilities Instructor's Desk & Materials Glass Enclosed
9. DISPLAY	None or Improvised	Located in Planning Area Main Corridors Recessed in Walls In Each Activity Area
10. LIGHTING	5 to 30 foot Candles at Bench Height	50 Ft. Minimum Candles at Bench Height Individual Machine Illumination Florescent Lights Venetian Blinds Windows (20% floor area, minimum) Glass Blocks
11. FLOORS	Wood Concrete	Concrete (General, Hot Metals, Automotive) Resilient Tile (Office, Planning, Drawing, Graphic Arts) Asphalt Tile Cork Mastic Rubber Wood End Grain Parquet Tongue and Groove

12. HEALTH & SAFETY	Lack of Adequate Guarding	Guards Lines Painted Around Danger Zones Grounding of Machines Portable Equipment Fire Extinguishers Hoods – Exhausts Non-Slip Floor Surfaces Booths for Welding Dust Collection Systems Automatic Sprinkler System Air Conditioning Separate Finishing Rooms Color Treatment Noise Control
13. TOOL PROCEDURES	Tool Crib	Area Tool Panels at Point of Use. Wall Cabinets
14. PLUMBING	School Lavatory	Drinking Fountain Washing Facilities Toilet Nearby

APPENDIX "B"

Planning an Industrial Arts Program

By: Robert L. Woodward
Consultant in Industrial Arts
California State Department of Education

In planning an industrial arts program for a particular school, consideration should be given to the potential enrollment of the school. The number and types of laboratories selected should provide for present needs and future expansion. Attention should be given to the total anticipated enrollment in industrial arts, the enrollment in each phase of the program, and to the needs and abilities of the students that will be enrolled in each area.*

Plans for the organization of industrial arts programs according to grade levels and school enrollments with recommended number and types of laboratories and the instruction that may be provided follow. The first organizational plan is for grades seven and eight of elementary schools and for grades seven, eight, and nine of junior high schools. The second plan is for four year and senior high schools. Each organizational plan is arranged in three columns and each column has an appropriate heading.

The enrollment figures used in column one and the number of laboratories recommended in column two are based on statewide average enrollments in industrial arts courses and departments in the public schools of California derived from the reports of secondary school principles. The types of laboratories and the instruction that may be provided in these facilities are consistent with the findings of surveys of present practices and standards appearing in *Guide for Industrial Arts Education in California, Revised Edition, Suggested Courses of Instruction in Industrial Arts for the Junior High School Level, Suggested Courses of Instruction in Industrial Arts for the Senior High School Level, and Guide for Planning and Equipping Industrial Arts Shops in California Schools.*

The "Number and Types of Laboratories" listed in column two takes into consideration the long term purpose of each facility and the limitations caused by multiple use of a facility. The third column, "Areas of Instruction," lists courses and elements of courses (activities) that may be offered in the facilities proposed in column two.

*Editor's Note: (The reader may assume the proper curricular determinations will be made before inaugurating an organizational plan based upon the total enrollment of the school.)

PLANS OF ORGANIZATION

RECOMMENDED NUMBER AND TYPES OF INDUSTRIAL ARTS LABORATORIES AND INSTRUCTION THAT MAY BE PROVIDED FOR JUNIOR HIGH SCHOOLS AND GRADES SEVEN AND EIGHT OF ELEMENTARY SCHOOLS ACCORDING TO SCHOOL ENROLLMENT

Total School Enrollment	Number and Types of Laboratories	Areas of Instruction
To 250	ONE UNIT 1 - *Comprehensive general*	Activities or courses: *Industrial drawing, electricity, general metal,* and *general wood.*
250-500	TWO UNITS 1 - *Metal* 2 - *Wood*	Courses: *General metal* and *general wood.* (Note: Activities or courses in *industrial drawing* would be provided in the wood laboratory and activities or courses in *electricity* would be provided in the metal laboratory. *Handicraft* activities may be introduced in appropriate courses.)
500-750	THREE UNITS 1 - *Metal* 2 - *Wood* 3 - *Industrial Drawing*	Courses: *Industrial Drawing, general metal,* and *general wood.* (Note: Activities or courses in *electricity* would be provided in the *metal* laboratory. Appropriate *graphic arts* activities may be introduced in the industrial drawing courses. *Handicraft* activities may be introduced in appropriate courses.)
750-1000	FOUR UNITS 1 - *Metal* 2 - *Wood* 3 - *Industrial Drawing* 4 - *Electricity*	Courses: *Industrial drawing, electricity, general metal* and *general wood.* (Note: Appropriate *graphic arts* activities may be introduced in the industrial drawing courses. *Handicraft* activities may be introduced in appropriate courses.

1000-1250	FIVE UNITS 1 - *Metal* 2 - *Wood* 3 - *Industrial Drawing* 4 - *Electricity* 5 - *Graphic arts* or *Handicrafts*	Courses: *Industrial drawing, electricity, graphic arts* or *handicrafts, general metal,* and *general wood.* (Note: If courses are provided in graphic arts, *handicraft* activities may be introduced in appropriate courses. If courses are provided in handicrafts, appropriate *graphic arts* activities may be introduced in the industrial drawing courses.)
1250-1500	SIX UNITS 1 - *Metal* 2 - *Wood* 3 - *Industrial Drawing* 4 - *Electricity* 5 - *Graphic Arts* 6 - *Handicraft*	Courses: *Industrial drawing, electricity, graphic arts, handicrafts, general metal,* and *general wood.*

RECOMMENDED NUMBER AND TYPES OF INDUSTRIAL ARTS LABORATORIES AND INSTRUCTION THAT MAY BE PROVIDED FOR FOUR-YEAR AND SENIOR HIGH SCHOOLS ACCORDING TO SCHOOL ENROLLMENT

Total School Enrollment	Number and Types of Laboratories	Areas of Instruction
to 250	ONE UNIT 1 - *Comprehensive General*	Activities or courses: *Drafting, electricity-radio (electronics), general metal,* and *general wood.*
250-500	TWO UNITS 1 - *Metal* 2 - *Wood*	Courses: *Drafting, general metal,* and *general wood.* (Note: *Drafting* courses would be provided in a laboratory classroom, a multipurpose classroom, or the wood laboratory. Activities or courses in *electricity-radio (electronics)* may be provided in the metal laboratory.)

500-750	THREE UNITS 1 - *Metal* 2 - *Wood* 3 - *Auto*	Courses: *Auto, drafting, general metal,* and *general wood.* (Note: *Drafting* courses would be provided in a laboratory classroom, a multipurpose classroom, or the wood laboratory. Activities or courses in *electricity-radio (electronics)* may be provided in the metal laboratory.
750-1000	FOUR UNITS 1 - *Metal* 2 - *Wood* 3 - *Auto* 4 - *Drafting*	Courses: *Auto, drafting, general metal,* and *general wood.* (Note: Activities or courses in *electricity-radio (electronics)* may be provided in the metal laboratory. Activities or courses in *graphic arts* may be provided in the drafting room.)
1000-1250	FIVE UNITS 1 - *Metal* 2 - *Wood* 3 - *Auto* 4 - *Drafting* 5 - *Electricity-radio*	Courses: *Auto, drafting, electricity-radio (electronics), general metal,* and *general wood.* (Note: Activities or courses in *graphic arts* may be provided in drafting room.)
1250 - 1500	SIX UNITS 1 - *Metal* 2 - *Wood* 3 - *Auto* 4 - *Drafting* 5 - *Electricity-radio* 6 - *Graphic arts*	Courses: *Auto, drafting, electricity-radio (electronics), graphic arts, general metal,* and *general wood.* (Note: Activities or courses in *photography* may be provided in the graphic arts laboratory.)
1500-1750	SEVEN UNITS 1 - *Metal* 2 - *Wood* 3 - *Auto* 4 - *Drafting* 5 - *Electricity-radio* 6 - *Graphic Arts* 7 - *Handicraft*	Courses: *Auto, drafting, electricity-radio (electronics), graphic arts, handicrafts, general metal,* and *general wood.* (Note: Activities or courses in *photography* may be provided in the graphic arts laboratory.

1750 - 2000	EIGHT UNITS 1 - *Metal* 2 - *Wood* 3 - *Auto* 4 - *Drafting* 5 - *Electricity-radio* 6 - *Graphic arts* 7 - *Handicraft* 8 - *Photography* or a duplication of one of the other laboratories.	Courses: *Auto, drafting, electricity-radio (electronics), graphic arts, handicrafts, general metal, photography,* and *general wood.* (Note: If *photography* is provided for elsewhere in the curriculum, additional courses may be provided in any of the above areas.

If the enrollment for a school exceeds the largest total enrollment appearing in column one of either preceding organizational plan a duplication of laboratories could be made according to student demand. At the high school level basic and advanced laboratories could be provided in areas of industrial arts where the need exists.

APPENDIX "C"

Plans and Layouts

Compiled by: Paul L. Scherer
University of California, Santa Barbara

Editor's Note: Figures 109 through 104 are architectural renderings and laboratory layouts of actual facilities either under construction or completed. The first seven figures in this initial group are examples of recent construction at the college and university level. Figures 116 through 122 are architectural renderings of recently constructed junior high schools in the Los Angeles school system. Figures 123 and 124 are two high school laboratories shown as examples of actual construction and appeared in the California Guide for Planning.

Beginning with Figure 125 and continuing through the remaining portion of the appendix are *suggested* plans for industrial arts facilities. These plans appeared in the *Guide for Planning and Equipping Industrial Arts Shops in California Schools (1956).* Although the responsibility for this publication was in the hands of a state-wide committee of fourteen secondary teachers, supervisors, and teacher educators, many other sub-committees and individuals throughout the state participated in the actual preparation and final suggested plans. Two preceeding California State Department of Education publications were used as basic references for these suggested facility layouts. They were *Suggested Courses of Instruction in Industrial Arts for the Junior High School Level (1953),* and *Suggested Courses of Instruction in Industrial Arts for the Senior High School Level (1955).*

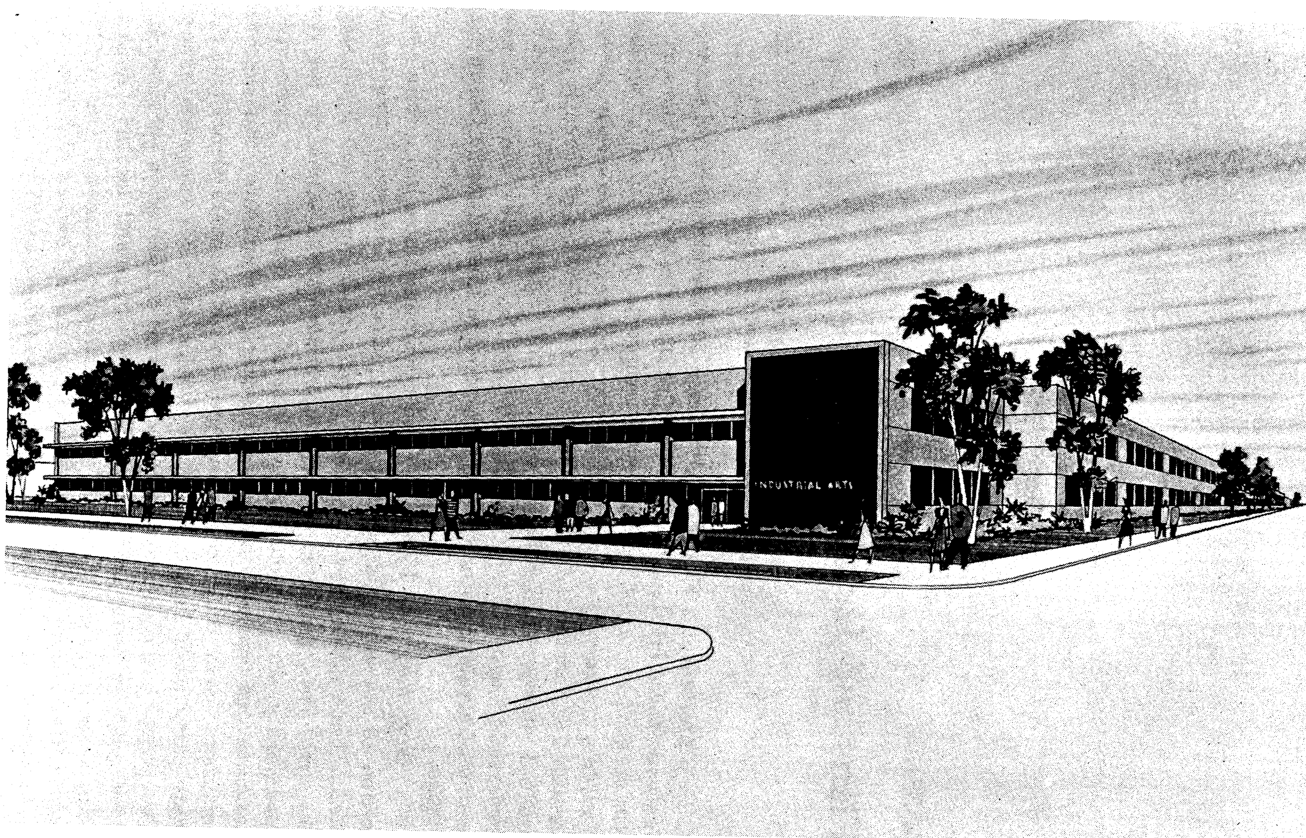
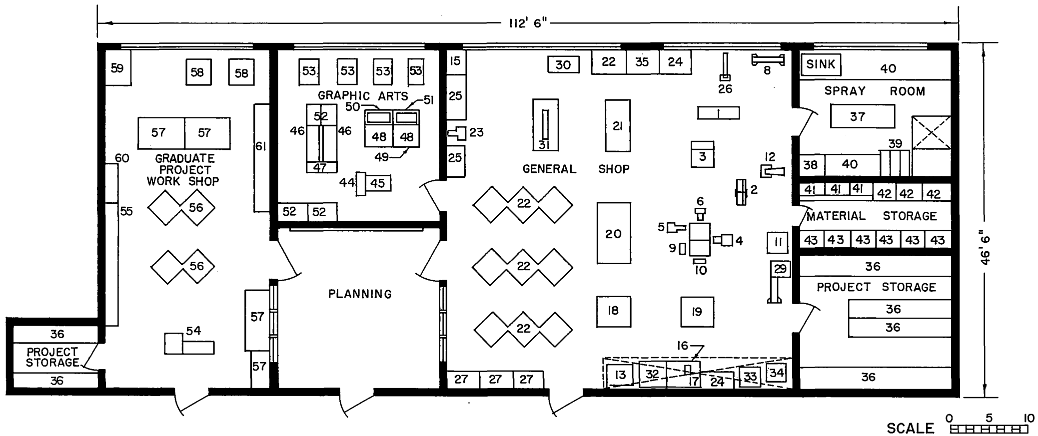


Figure 109. Industrial Arts Building, San Jose State College, California (Courtesy Heber A. Sotzin, Chairman)

GENERAL SHOP



GENERAL SHOP
1. SHOP SMITH
2. JOINTER
3. TILTING ARBOR SAW
4. BAND SAW
5. BELT SANDER
6. DISC SANDER
7. DUST COLLECTOR
8. LATHE
9. BUFFER
10. GRINDER
11. ELECTRIC WELDER
12. DRILL PRESS
13. ENAMELING KILN
14. ANVIL 90 LBS
15. PLASTICS OVEN
16. SOLDERING BENCH
17. SOLDERING FURNACE
18. FORMING TOOLS
19. COMBINATION TOOLS
20. SHEET METAL BENCH
21. GLUE BENCH
22. WORK BENCH
23. WET SANDER
24. DRAWER UNIT
25. PLASTICS BENCH
26. JIG SAW
27. TOOL CABINETS
28. MOLDING BENCH
29. METAL LATHE
30. SEWING MACHINE
31. ELECTRICITY TEST BENCH
32. WELDING BENCH
33. FORGE
34. CRUCIBLE FURNACE
35. SHOP DESK

PROJECT STORAGE ROOM
36. PROJECT LOCKERS

SPRAY ROOM
37. METAL BENCH
38. WORK CENTER
39. SOLVENT HIGHBOYS
40. DRYING SHELVES

MATERIAL STORAGE ROOM
41. MATERIAL RACKS
42. CABINETS
43. SHELVING UNITS

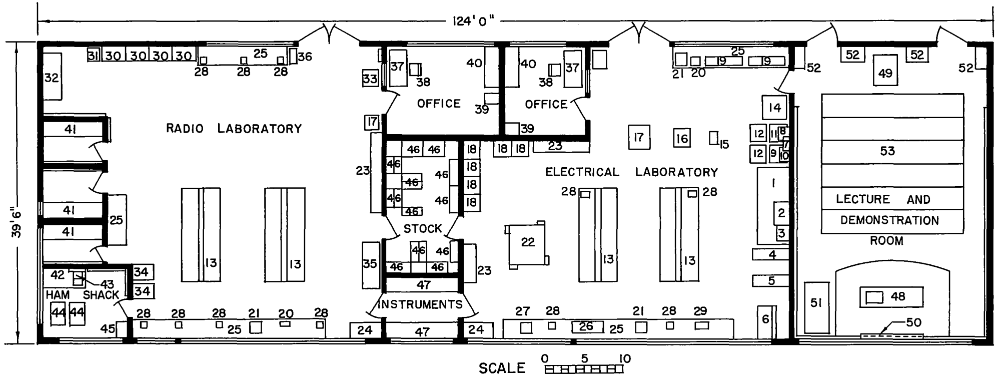
GRAPHIC ARTS ROOM
44. PILOT PRESS
45. PROOF PRESS
46. TYPE CABINETS
47. SLUG RACK
48. CABINETS WITH IMPOSING STONE
49. GALLEY RACK
50. CHASE RACKS AND FURNITURE STORAGE
51. REGLET RACK
52. STORAGE CABINETS
53. DRAWING BENCHES

GRADUATE PROJECT WORK SHOP
54. SHOP SMITH
55. ACCESSORY RACK
56. WORK BENCH
57. TABLES
58. DRAWING BENCHES
59. PLAN FILE
60. STORAGE CABINETS
61. TOOL STORAGE CABINET

Figure 110. General Shop, San Jose State College, California (Courtesy Heber A. Sotzin, Chairman)

Figure 111. Arts Building, University of California, Santa Barbara (Courtesy Kermit A. Seefeld, Chairman)

RADIO & ELECTRICITY LABORATORY



RADIO & ELECTRICITY LABORATORY
1. MAIN DISTRIBUTION BOARD
2. BATTERY & RECTIFIER ASSEMBLY
3. RECTIFIER UNIT
4. MOTOR GENERATOR SET
5. EXPERIMENTAL GENERATOR
6. TRANSFORMER BANK
7. A.C. STARTING PANEL
8. D.C. STARTING PANEL
9. PORTABLE A.C. STARTER
10. SYNCHRONOUS MOTOR CONTROL
11. PORTABLE STARTER RACK
12. LOADING UNITS, A.C., D.C.
13. LABORATORY BENCHES WITH RAISED CENTER SECTION FOR POWER DISTRIBUTION
14. LOADING UNIT, 3 PHASE
15. ANVIL
16. TABLE SAW
17. SHEAR
18. PORTABLE TABLES
19. MACHINE LATHES
20. BENCH GRINDER
21. DRILL PRESSES
22. WOODWORKING BENCH
23. TOOL STORAGE CABINETS
24. VISUAL AIDS STORAGE
25. BENCH W/ DRAWERS & CABINETS
26. SINK
27. BENCH FURNACE
28. VISES
29. BUFFER
30. STORAGE CABINETS
31. ELECTRONIC DISARMING MACHINE
32. CODE INSTRUCTION UNIT
33. FINGERBREAK
34. PHILCO DEMONSTRATION RACK
35. PHILCO ELECTRONIC DEMONSTRATOR
36. SPOT WELDER

RADIO & ELECTRICITY OFFICES
37. DESK
38. SWIVEL CHAIR
39. FILE CABINETS
40. BOOKCASES

TUNING ROOMS
41. TUNING BENCHES

HAM SHACK
42. OPERATING TABLE
43. HALLICRAFTERS RECEIVER & SPEAKER
44. RADIO TRANSMITTER
45. JENSON SPEAKER CABINETS

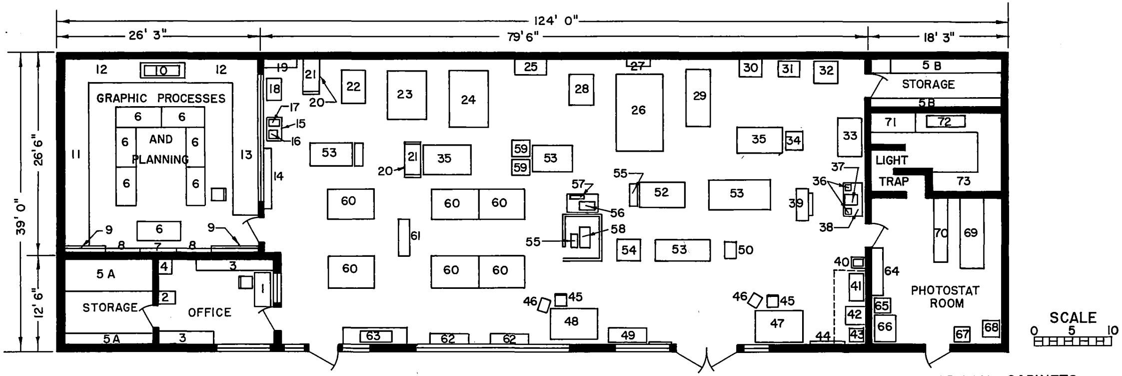
STOCK ROOM
46. SHELF ASSEMBLIES W/ DRAWER UNITS TO FIT

INSTRUMENT STORAGE
47. SLOPING INSTRUMENT STORAGE WITH SHELVES

LECTURE & DEMONSTRATION ROOM
48. DEMONSTRATION TABLE
49. PROJECTION EQUIPMENT
50. PROJECTION SCREEN
51. PORTABLE DEMONSTRATION TABLE
52. STORAGE CABINETS
53. TABLET ARM CHAIRS

Figure 112. Radio and Electricity Laboratory, University of California, Santa Barbara (Courtesy Kermit A. Seefeld, Chairman)

GRAPHIC ARTS LABORATORY



OFFICE
1. DESK & CHAIR
2. FILE CABINETS
3. BOOKCASES
4. CLOSET

STORAGE
5. SHELF STORAGE
A. TEACHING AIDS
B. PAPER & SUPPLIES

GRAPHIC PROCESS ROOM
6. PLANNING & WORK TABLES
7. BEADED SCREEN
8. BLACKBOARDS
9. CORKBOARDS
10. ACID PROOF SINK
11. SILK SCREEN AREA
12. ETCHING & BLOCK PRINTING
13. BOOKBINDING AREA

MAIN LABORATORY
14. COMPOSING ROOM TOOL RACK
15. ELECTROTYPE STORAGE
16. RUBBER STAMP MACHINE
17. GOLD STAMP MACHINE
18. INK & ROLLER CABINET
19. SOLVENT STORAGE CABINET
20. PILOT PRESS STORAGE CAB.
21. PILOT PRESSES
22. PLATEN PRESS 8" X 12"
23. PLATEN PRESS 10" X 15"
24. PLATEN PRESS 12" X 18"
25. PRESS SUPPLY CABINET
26. MIEHLE CYLINDER PRESS
27. ROLLER RACK
28. MIEHLE VERTICAL
29. WASHINGTON HAND PRESS
30. ADJUSTABLE HOLE PUNCH
31. PAPER DRILL AND CABINET
32. STITCHER
33. POWER PAPER CUTTER
34. HAND PAPER CUTTER
35. DRYING RACK & STOCK TABLE
36. PADDING PRESSES
37. WIRE STAPLER
38. PADDING STORAGE TABLE
39. MULTILITH
40. STEEL DUMP TRUCK
41. STEREOTYPE CASTING BOX
42. INGOT MOLD
43. REMELT FURNACE
44. STEREOTYPE TOOL PANEL
45. SWIVEL CHAIR
46. WORK AND COPY TABLE
47. INTERTYPE
48. LINOTYPE
49. LINOTYPE WORKBENCH
50. GALLEY PROOF PRESS
51. BAUM FOLDER
52. WORK BENCH W/ GALLEY STORAGE
53. IMPOSING TABLES
54. MAGAZINE STORAGE
55. STIP MATERIAL CABINETS
56. ROUSE MITER
57. SLUG CUTTER
58. GLASS ENCLOSED SOFT METAL SAW
59. OILY WASTE CANS
60. 4 STATION COMPOSING BANKS
61. PROOF PRESS
62. STUDENT STORAGE
63. WASH-UP SINK

PHOTOSTAT & CAMERA ROOM
64. STORAGE CABINET
65. CARD CUTTER
66. LAYOUT TABLE
67. VACUUM FRAME
68. ARC LIGHT
69. ROBERTSON CAMERA
70. PHOTOSTAT MACHINE
71. ROCKER WASHER
72. DARKROOM SINK
73. STORAGE

Figure 113. Graphic Arts Laboratory, University of California, Santa Barbara
(Courtesy Kermit A. Seefeld, Chairman)

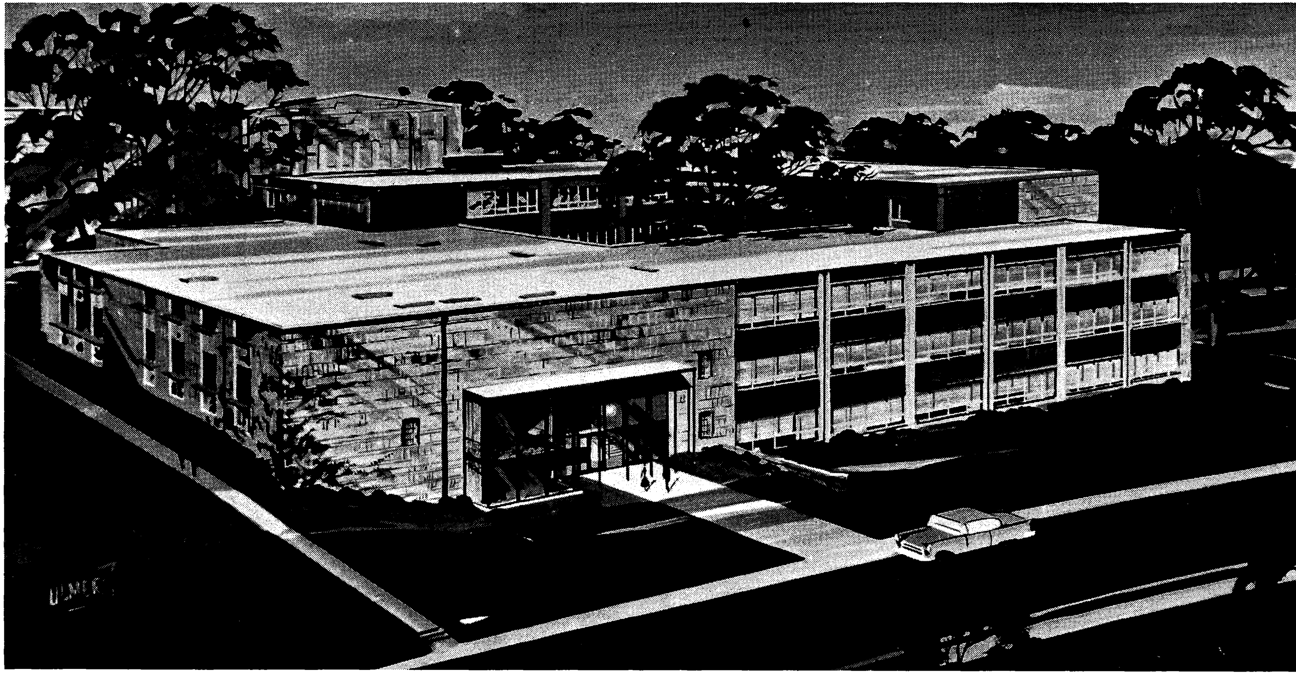
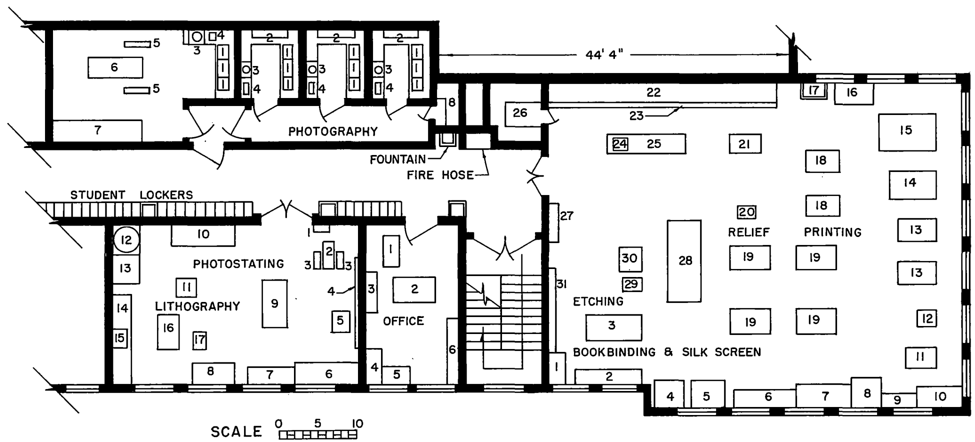


Figure 114. Industrial Arts Building, Central Missouri State College, Warrensburg (Courtesy Noel B. Grinstead, Chairman)

GRAPHIC ARTS LABORATORY



MAIN LABORATORY
1. DUPLICATOR
2. BENCH
3. LAYOUT & EDITING
4. PAPER DRILL
5. STITCHER
6. TOOL CABINET
7. BENCH
8. TYPE CABINET
9. WORK SPACE
10. BENCH
11. TYPE CABINET
12. HAND PRESS
13. PLATEN PRESSES
14. PLATEN PRESS
15. LITTLE GIANT PRESS
16. STEREOTYPE BOX
17. SINK
18. IMPOSING TABLES
19. TYPE BANKS
20. PROOF PRESS
21. PAPER CUTTER
22. WALL CABINETS
23. BENCH & PAPER STORAGE
24. HAND PAPER CUTTER
25. WORK BENCH
26. STOCK ROOM
27. INK CABINET
28. WORK BENCH
29. BACKING PRESS
30. ETCHING PRESS
31. BLACKBOARD

PHOTOGRAPHY
1. SINK
2. DRYER
3. ENLARGER
4. CONTACT PRINTER
5. LIGHTS
6. COPY CAMERA
7. PHOTO BENCH
8. CHEMICAL STOCK ROOM

PHOTOSTAT & LITHOGRAPHY
1. DRYER
2. PHOTOSTAT
3. LIGHTS
4. BLACKBOARD
5. VARITYPER
6. BENCH
7. DUPLICATOR
8. TOUCH UP TABLE
9. TABLE
10. BENCH
11. PAPER CUTTER
12. PLATE WHIRLER
13. PLATE PRINTER
14. WORK BENCH
15. SINK
16. OFFSET PRESS
17. OFFSET DUPLICATOR

OFFICE
1. TABLE
2. INSTRUCTOR'S DESK
3. CABINET
4. FILE
5. DESK
6. BOOK CASE

Figure 115. Graphic Arts Laboratory, Miami University, Oxford, Ohio (Courtesy John A. Whitesel, Chairman)

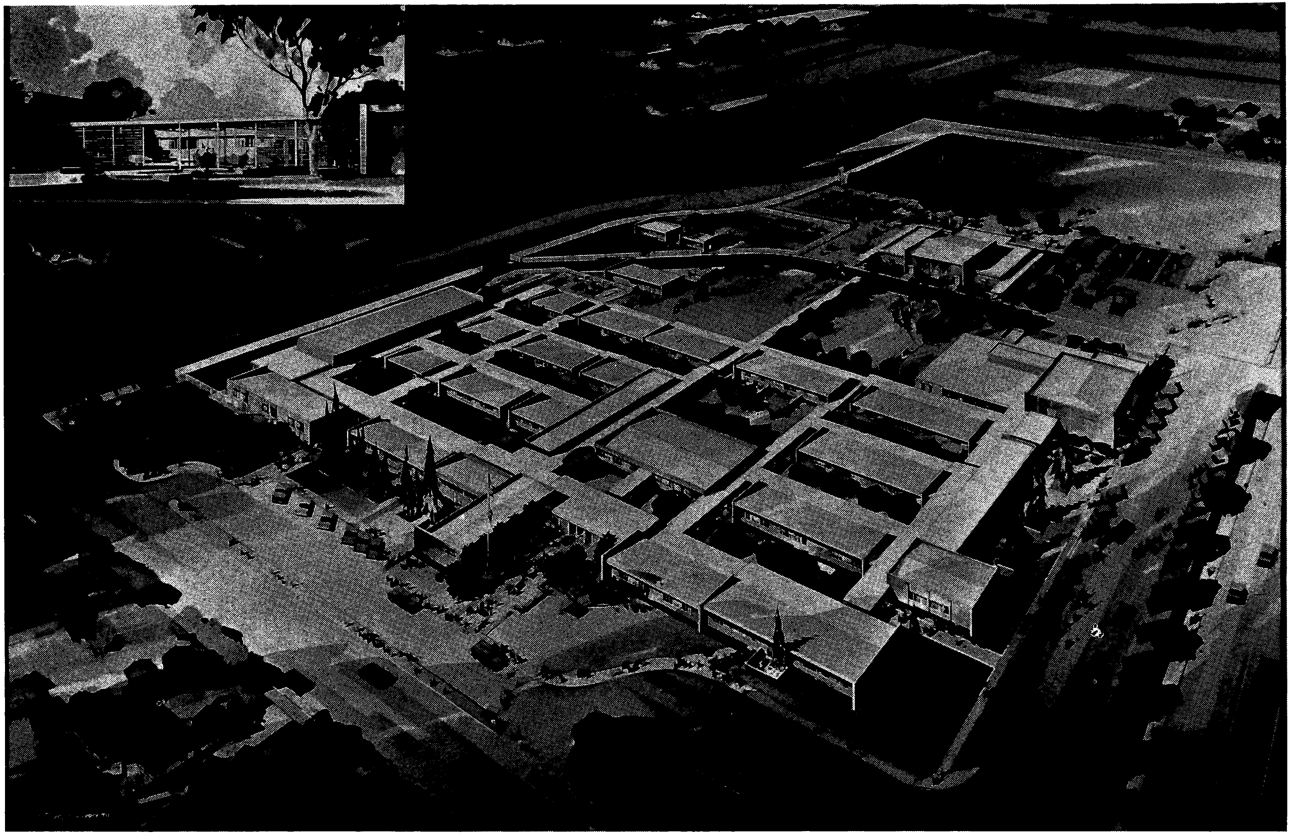


Figure 116. Francisco Sepulveda Junior High School, Los Angeles, California City Schools (Courtesy Fred Baer, Supervisor)

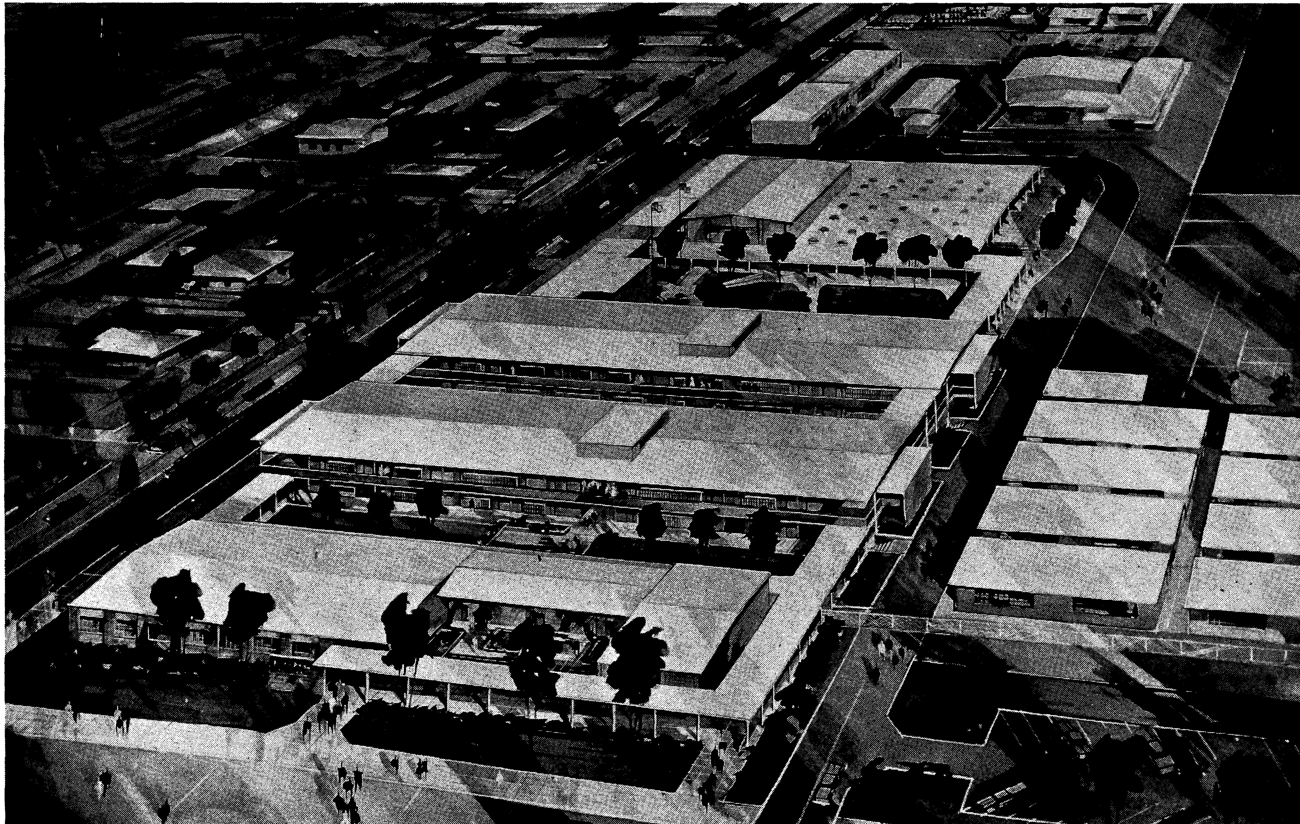


Figure 117. Patrick Henry Junior High School, Los Angeles, California City Schools (Courtesy Fred Baer, Supervisor)

Figure 118. Richard E. Byrd Junior High School, Los Angeles, California City Schools (Courtesy Fred Baer, Supervisor)

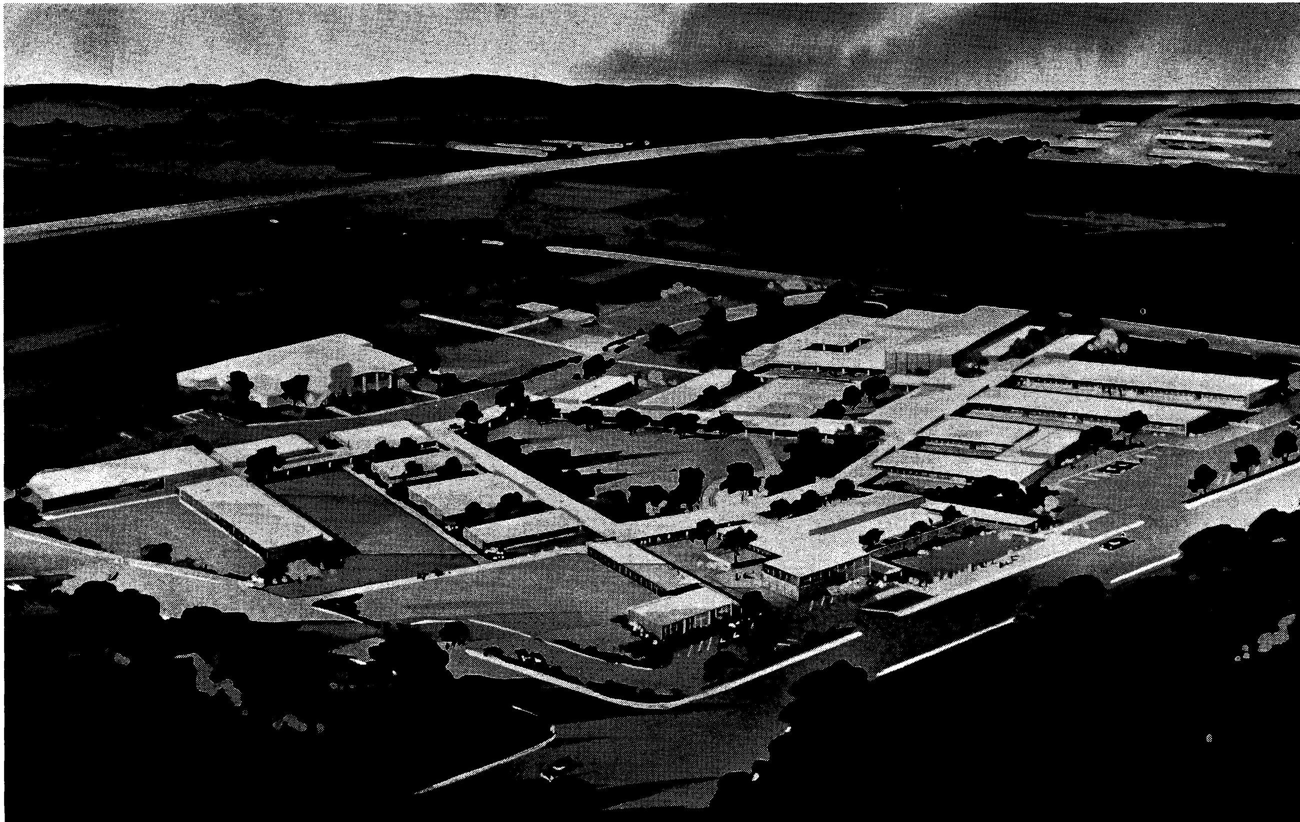


Figure 119. Marina del Rey Junior High School, Los Angeles, California City Schools (Courtesy Fred Baer, Supervisor)

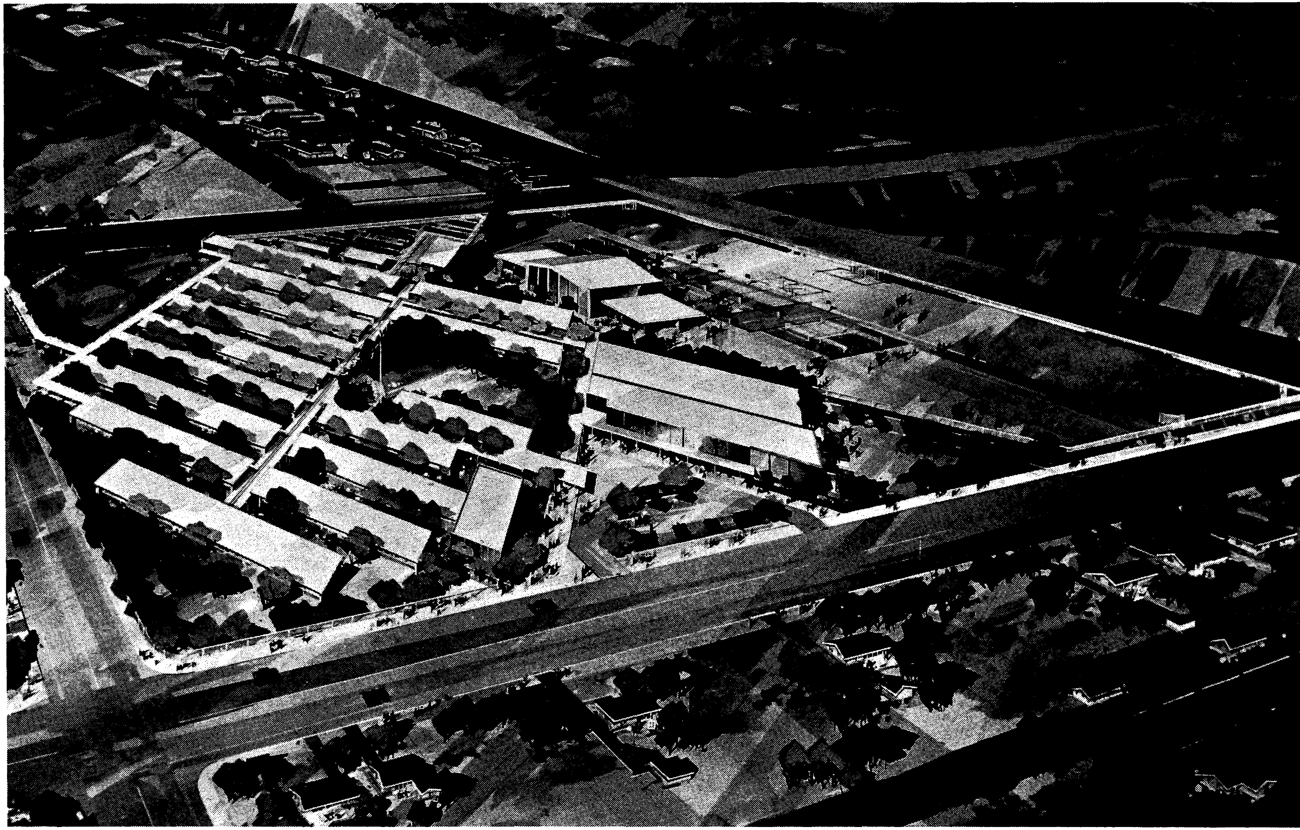


Figure 120. Charles Maclay Junior High School, Los Angeles, California City Schools (Courtesy Fred Baer, Supervisor)

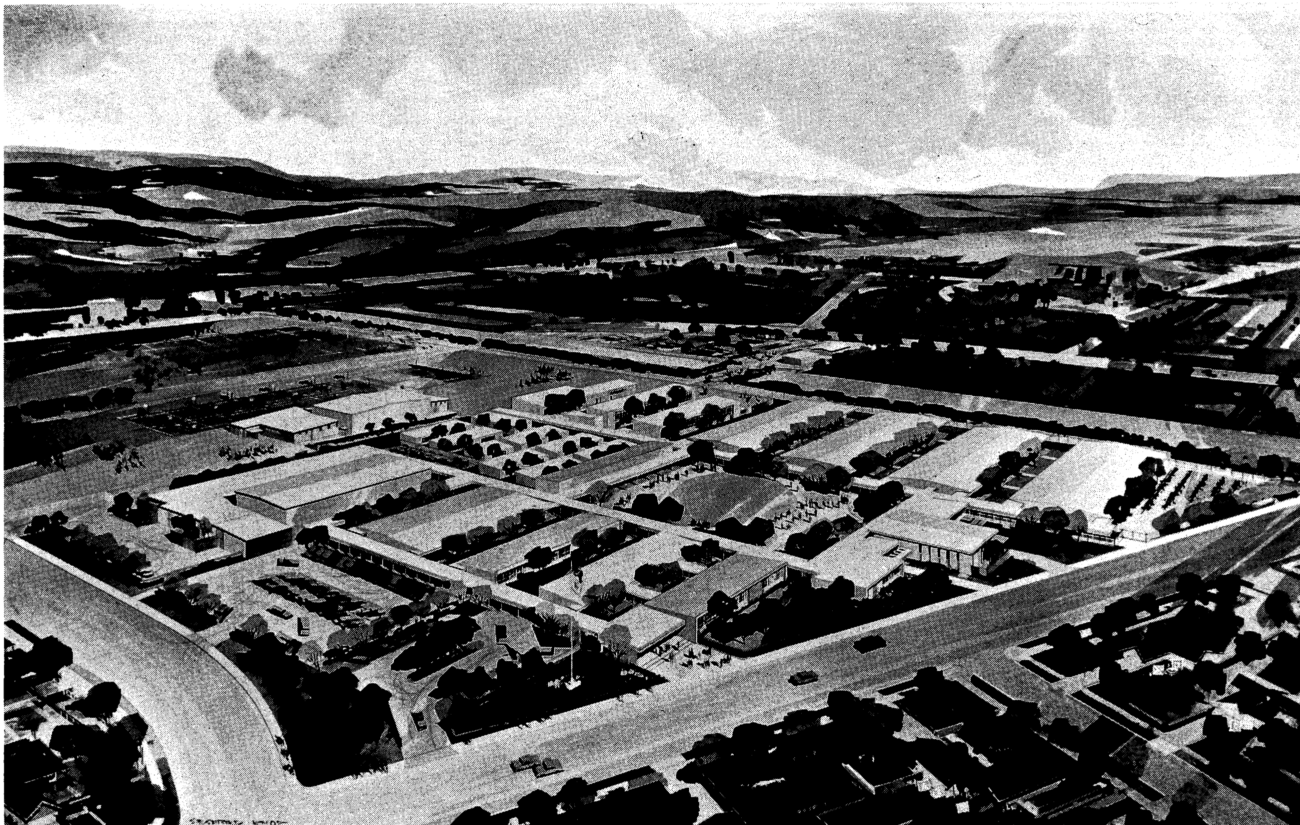


Figure 121. Gaspar De Portola Junior High School, Los Angeles, California City Schools (Courtesy Fred Baer, Supervisor)

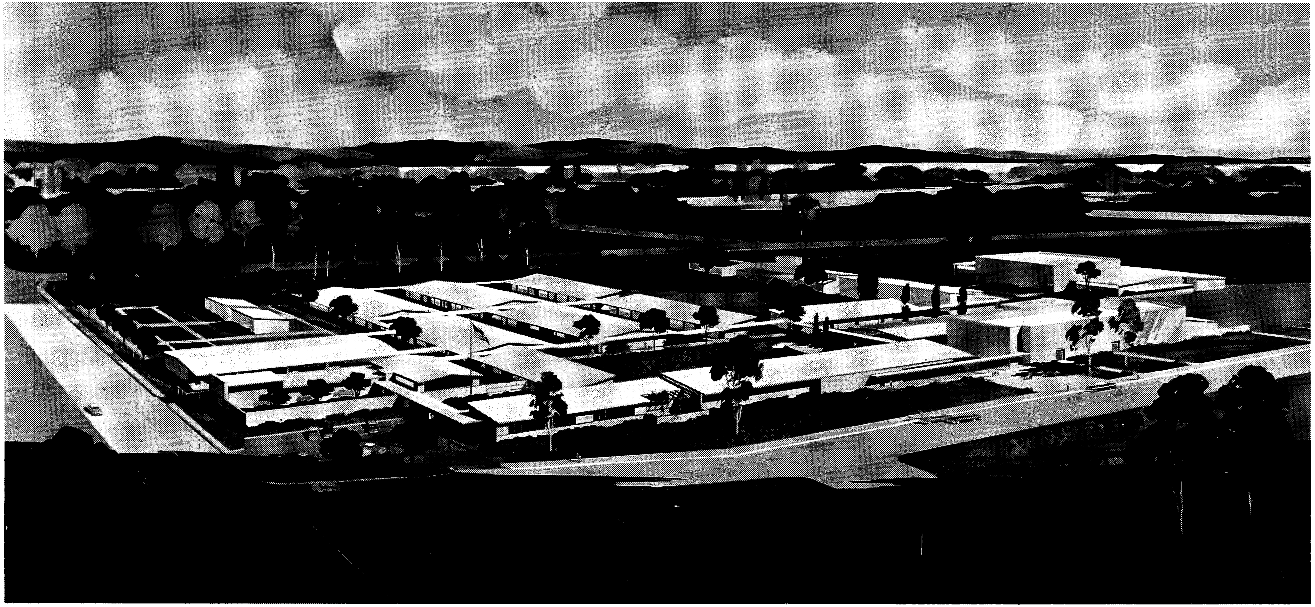


Figure 122. El Camino Junior High School, Los Angeles, California City Schools (Courtesy Fred Baer, Supervisor)

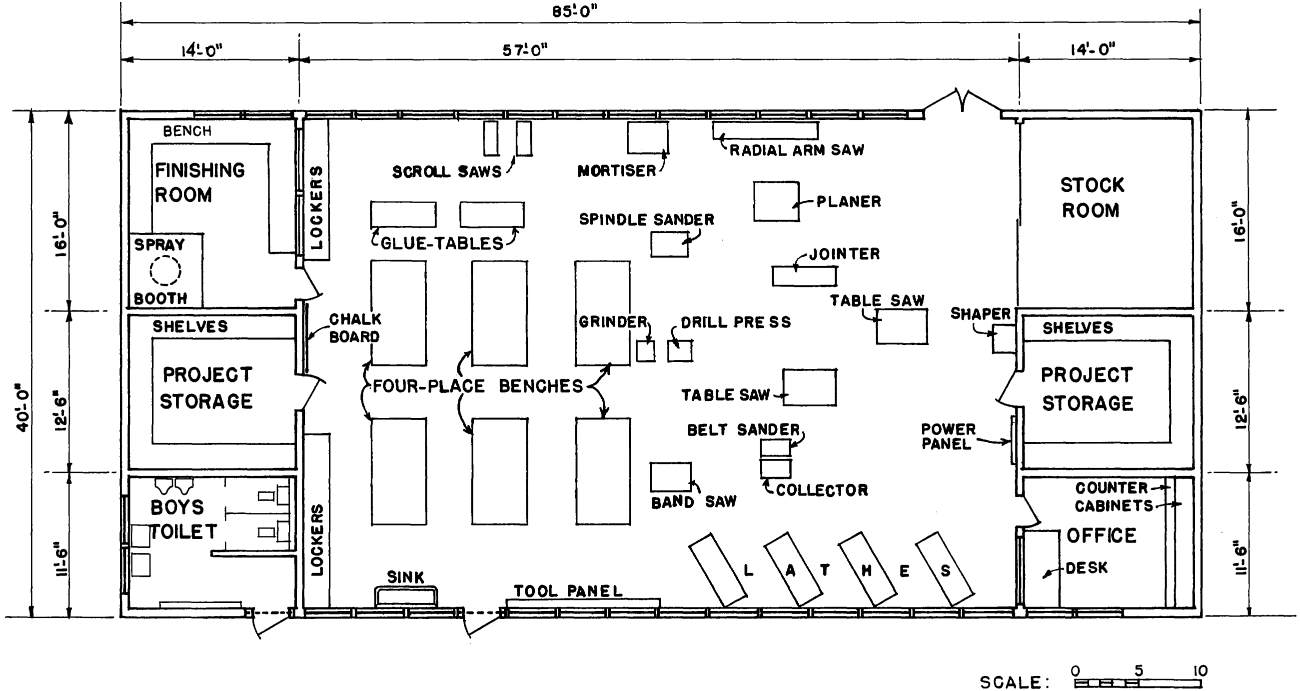


Figure 123. Wood Laboratory, Camden High School, San Jose, California
(Courtesy California State Department of Education)

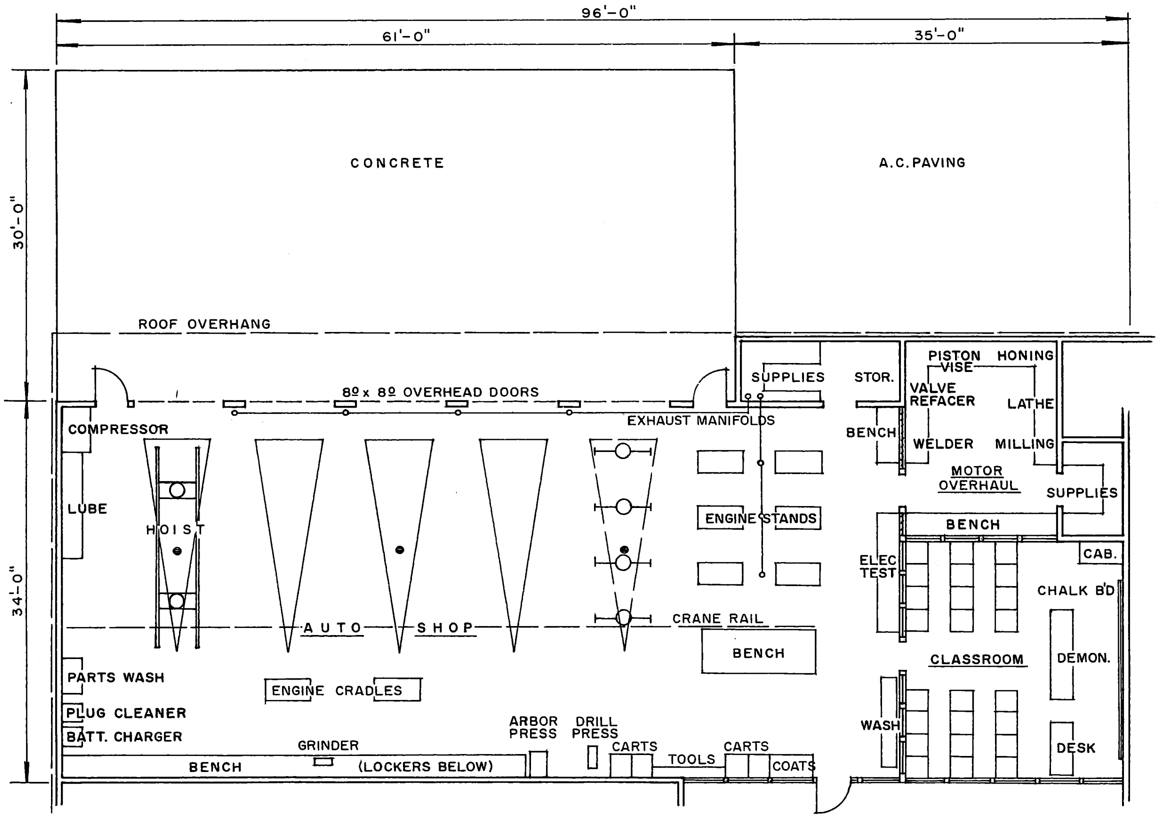
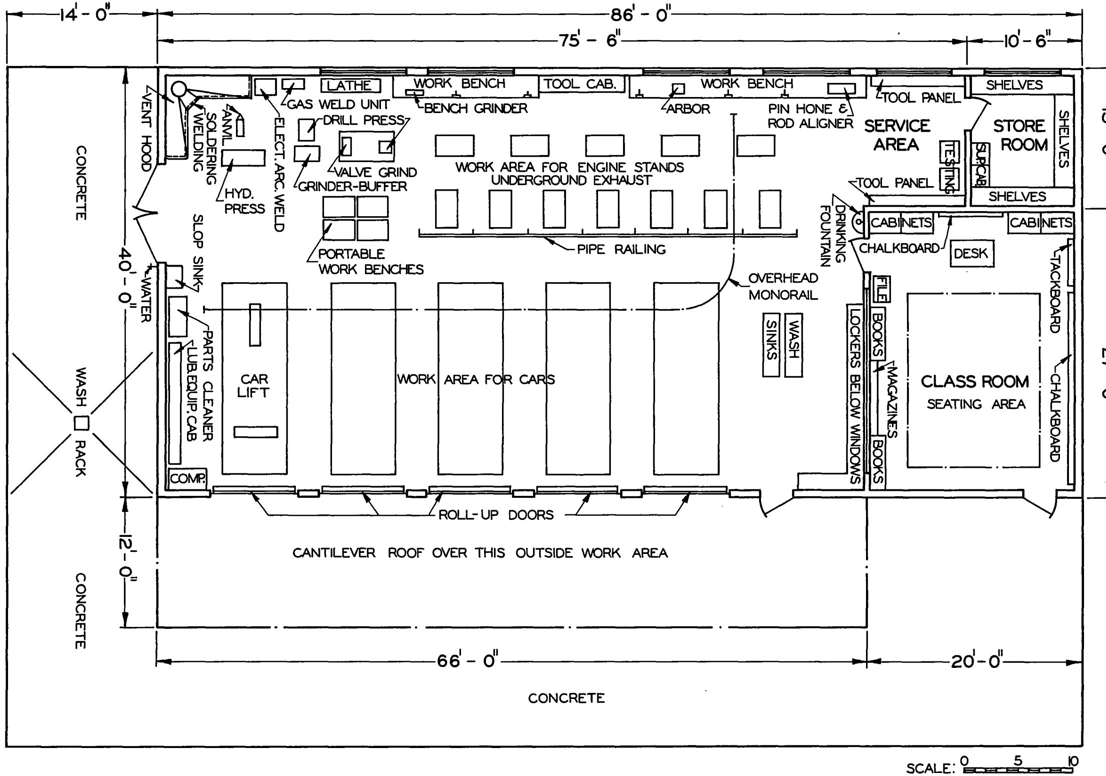
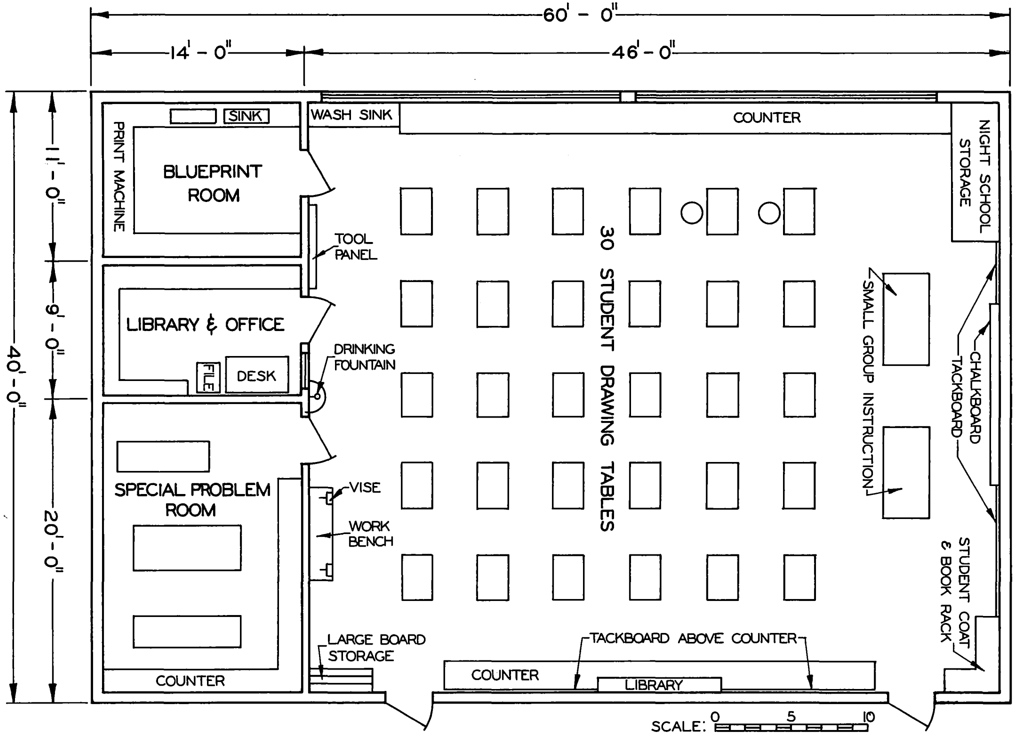


Figure 124. Auto Laboratory, Arroyo Grande High School, Arroyo Grande, California (Courtesy California State Department of Education)



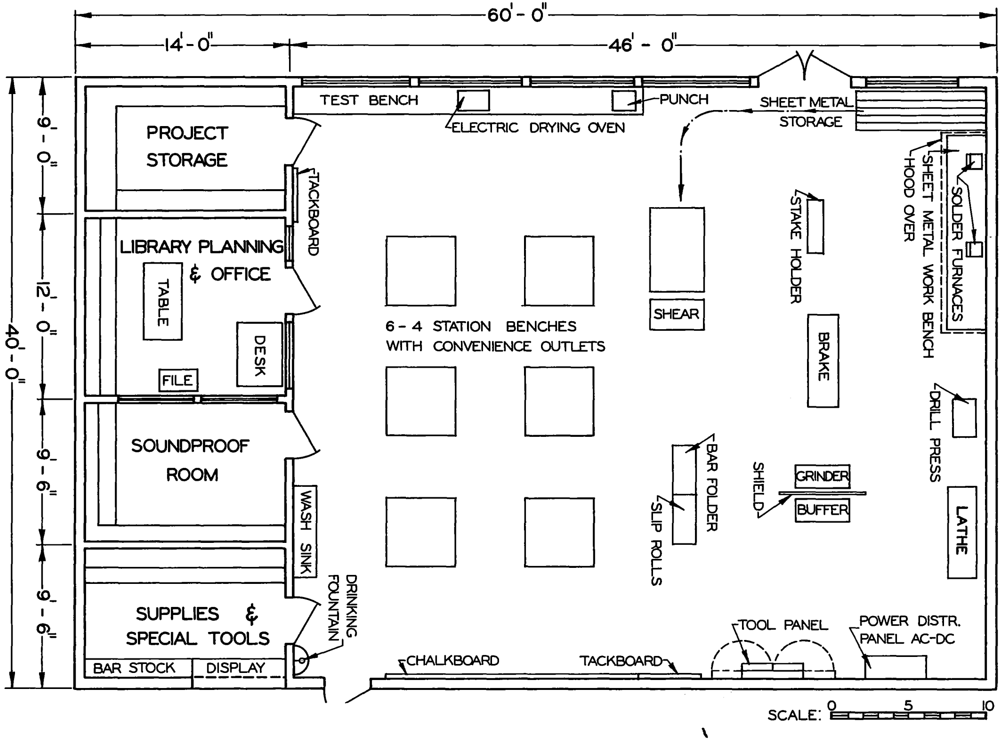
Facilities for Auto Essentials and Auto Mechanics Courses for Four-year and Senior High Schools

Figure 125. Auto Laboratory (Courtesy California State Department of Education)



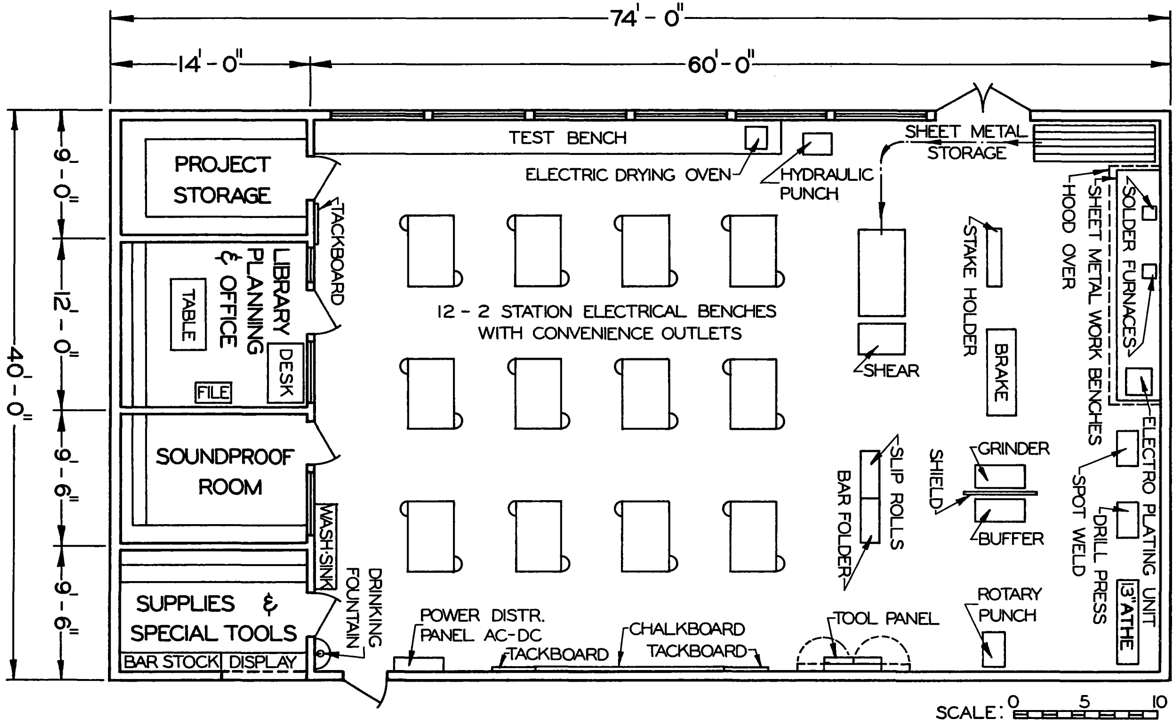
Facilities for Planning and Drawing and Industrial Drawing Courses for Junior High Schools and Grades 7 and 8 of Elementary Schools; Drafting Courses for Four-year and Senior High Schools

Figure 126. Drawing Laboratory (Courtesy California State Department of Education)



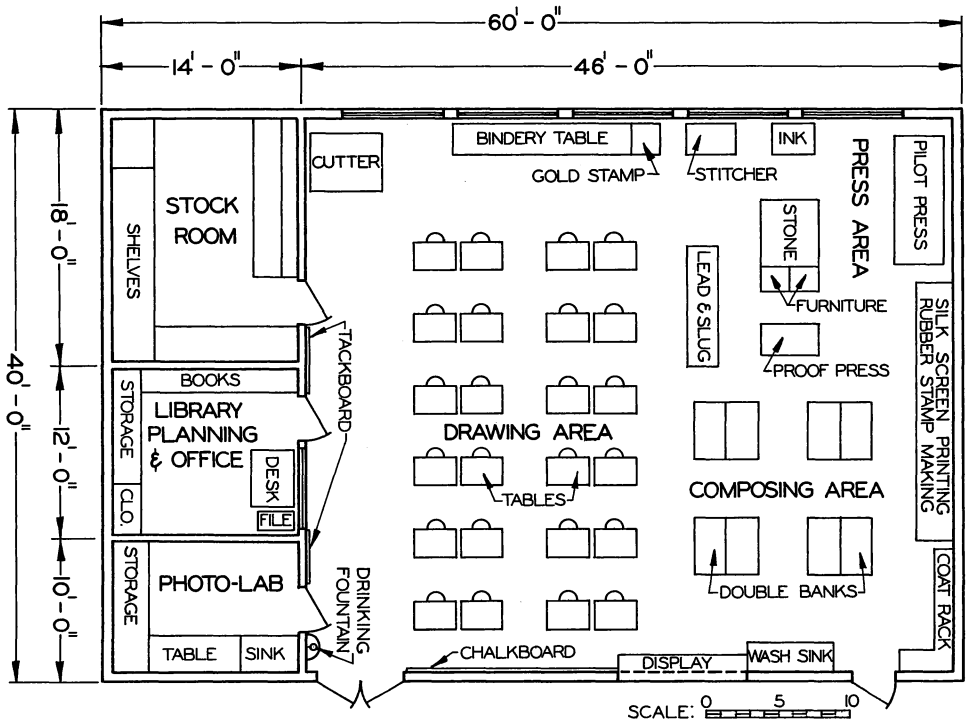
Facilities for Electricity Courses for Junior High Schools and Grades 7 and 8 of Elementary Schools

Figure 127. Electrical Laboratory (Courtesy California State Department of Education)



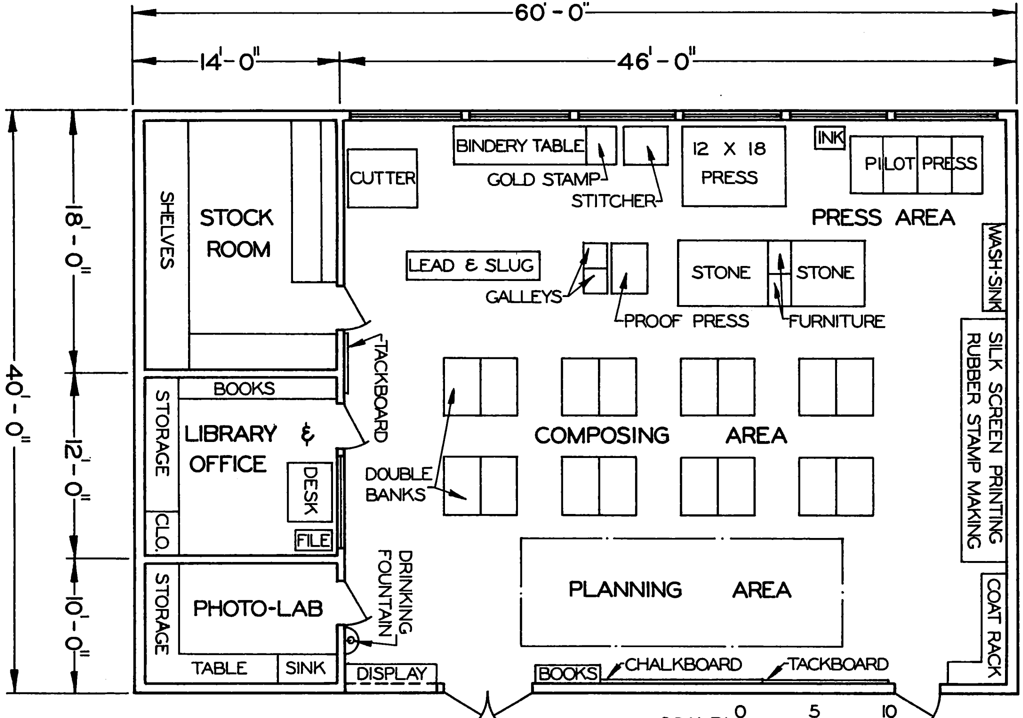
Facilities for Electricity-Radio (Electronics) Courses for Four-year and Senior High Schools

Figure 128. Electric-Radio Laboratory (Courtesy California State Department of Education)



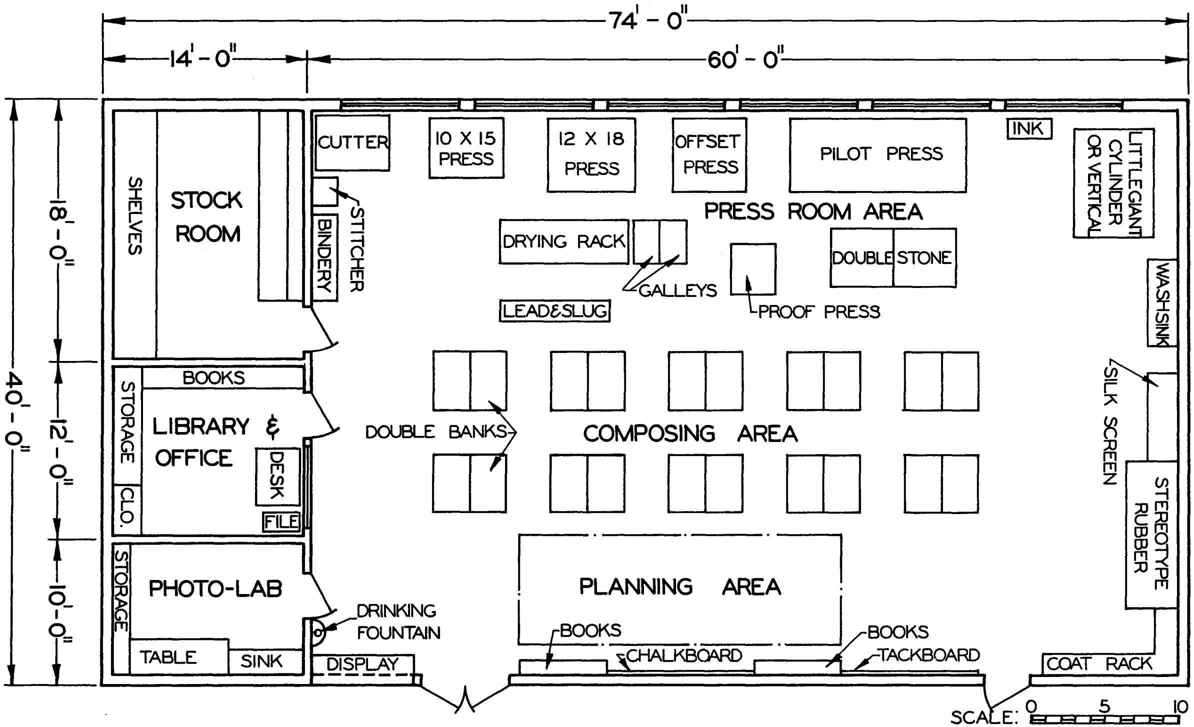
Facilities for Graphic Arts Courses Introduced with Industrial Drawing Courses for Grades 8 and 9 of Junior High Schools and Grade 8 of Elementary Schools; Graphic Arts Courses Introduced with Drafting Courses for Four-year or Senior High Schools

Figure 129. Graphic Arts Laboratory (Courtesy California State Department of



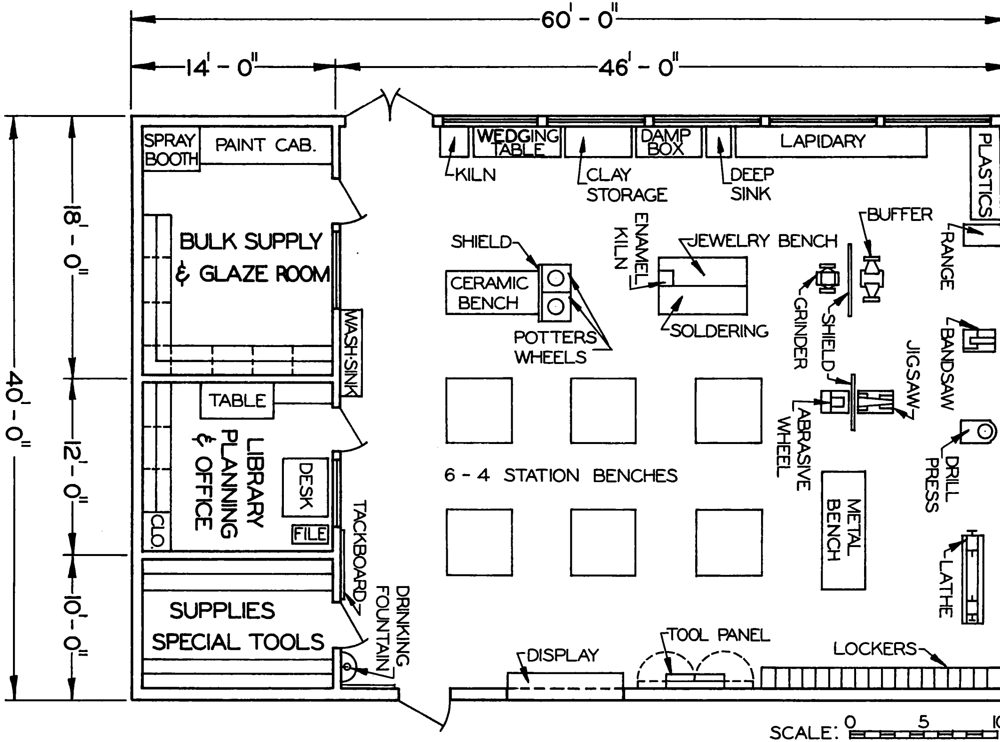
Facilities for Graphic Arts Courses for Junior High Schools and Grades 7 and 8 of Elementary Schools

Figure 130. Graphic Arts Laboratory (Courtesy California State Department of Education)



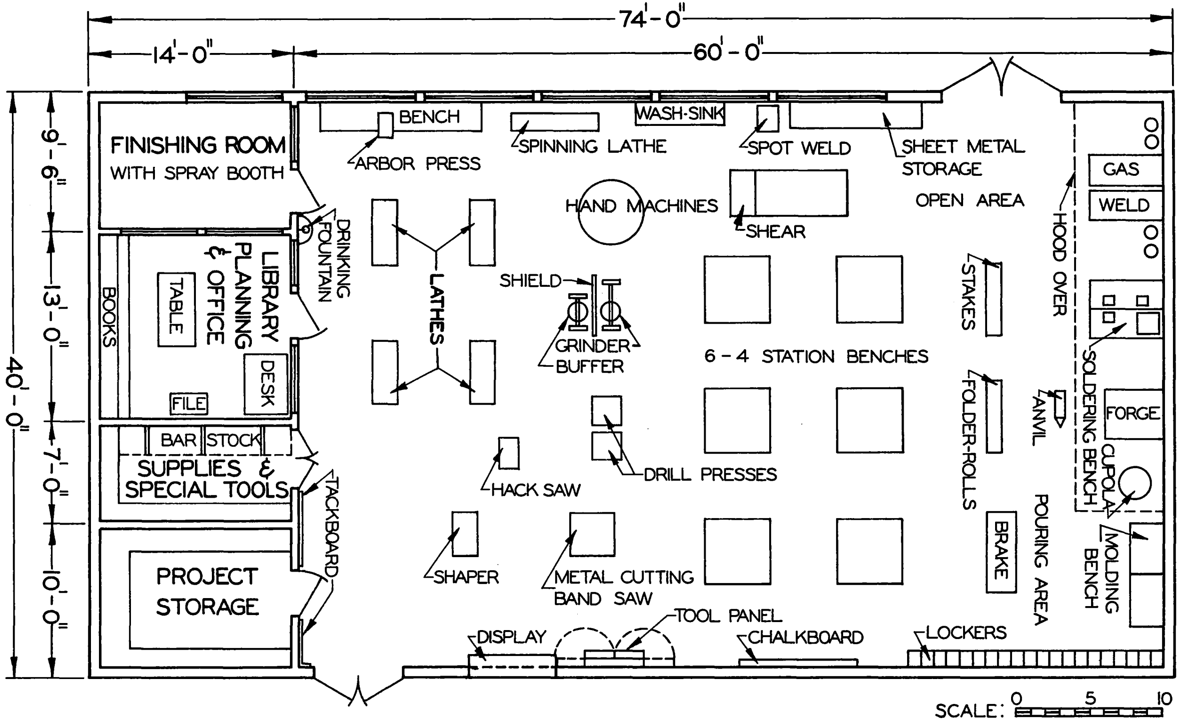
Facilities for Graphic Arts Courses for Four-year and Senior High Schools

Figure 131. Graphic Arts Laboratory (Courtesy California State Department of Education)



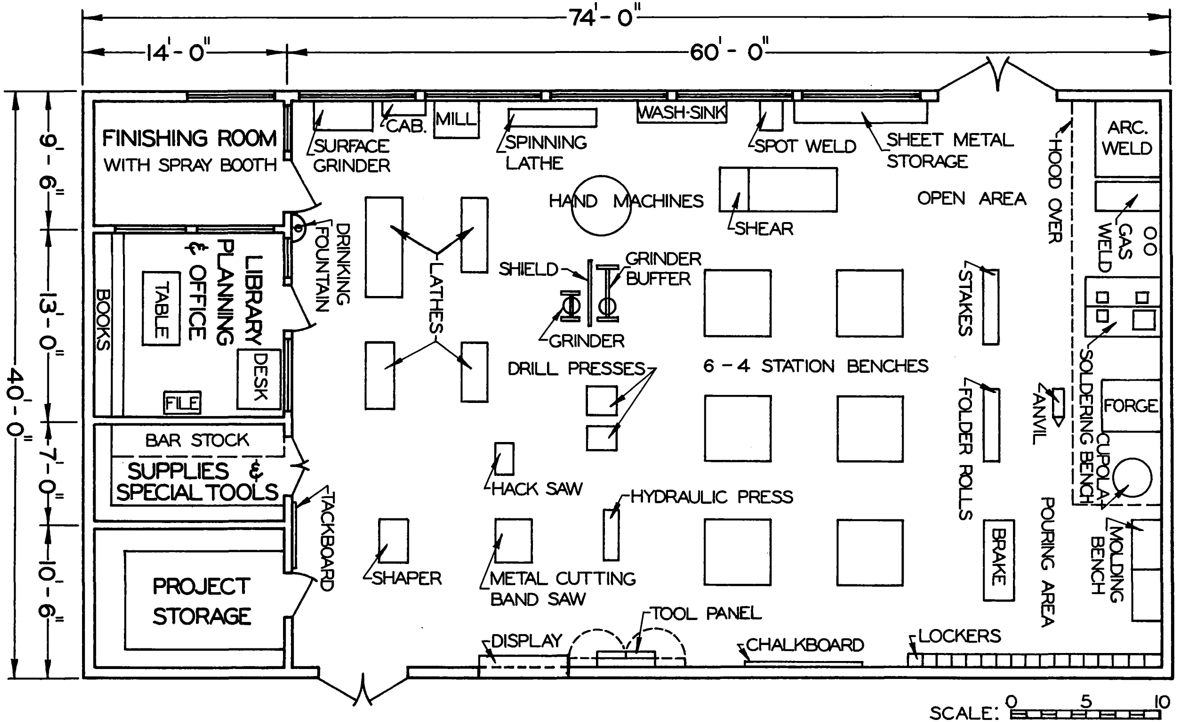
Facilities for Handicrafts Courses for Junior High Schools, Grades 7 and 8 of Elementary Schools, and Four-year and Senior High Schools

Figure 132. Handicraft Laboratory (Courtesy California State Department of Education)



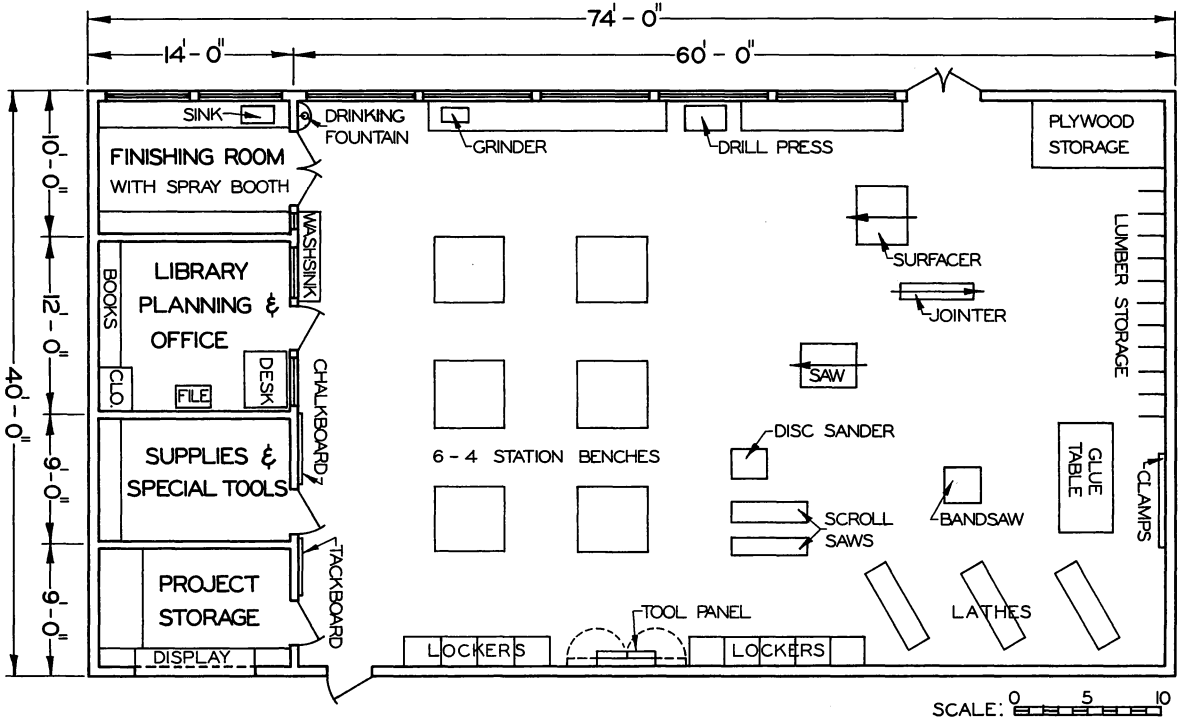
Facilities for General Metal Courses for Junior High Schools and Grades 7 and 8 of Elementary Schools

Figure 133. General Metal Laboratory (Courtesy California State Department of Education)



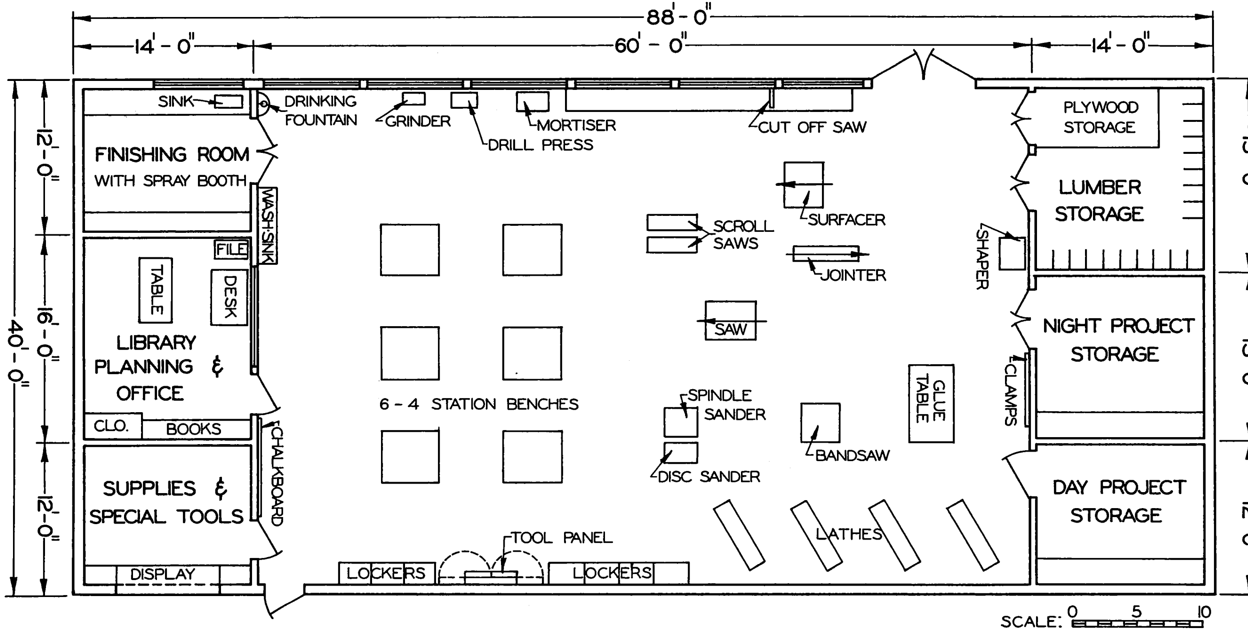
Facilities for General Metal Courses for Four-year and Senior High Schools

Figure 134. General Metal Laboratory (Courtesy California State Department of Education)



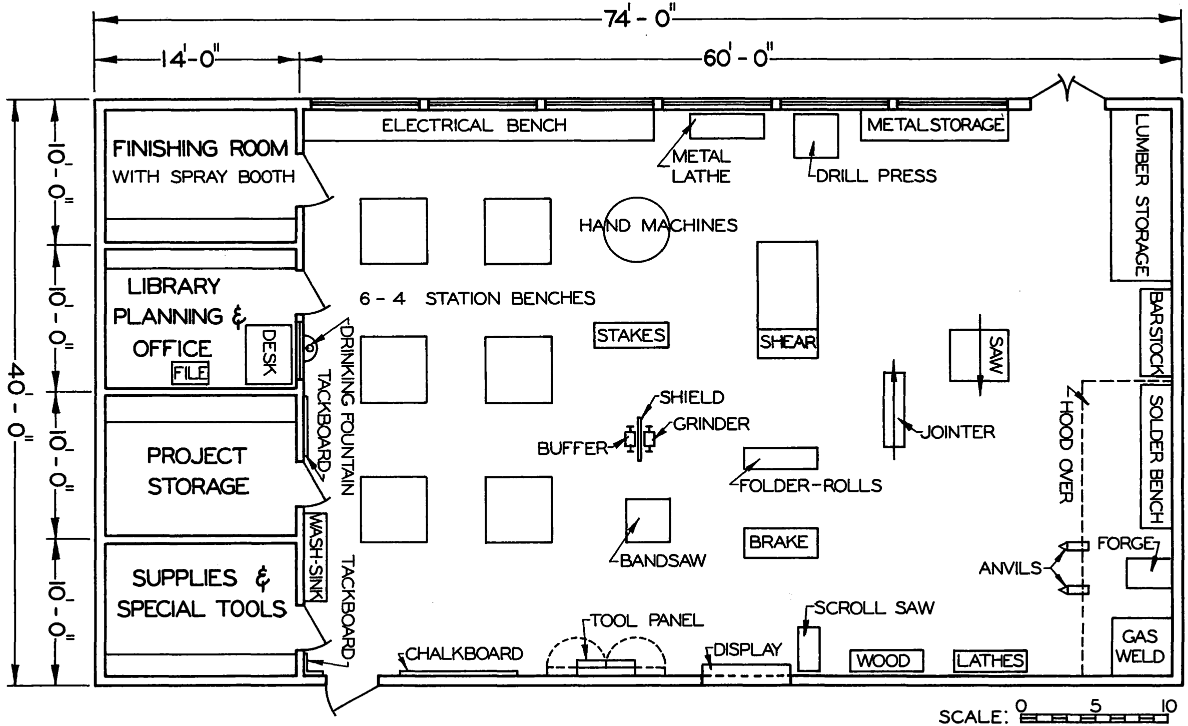
Facilities for General Wood Courses for Junior High Schools and Grades 7 and 8 of Elementary Schools

Figure 135. General Wood Laboratory (Courtesy California State Department of Education)



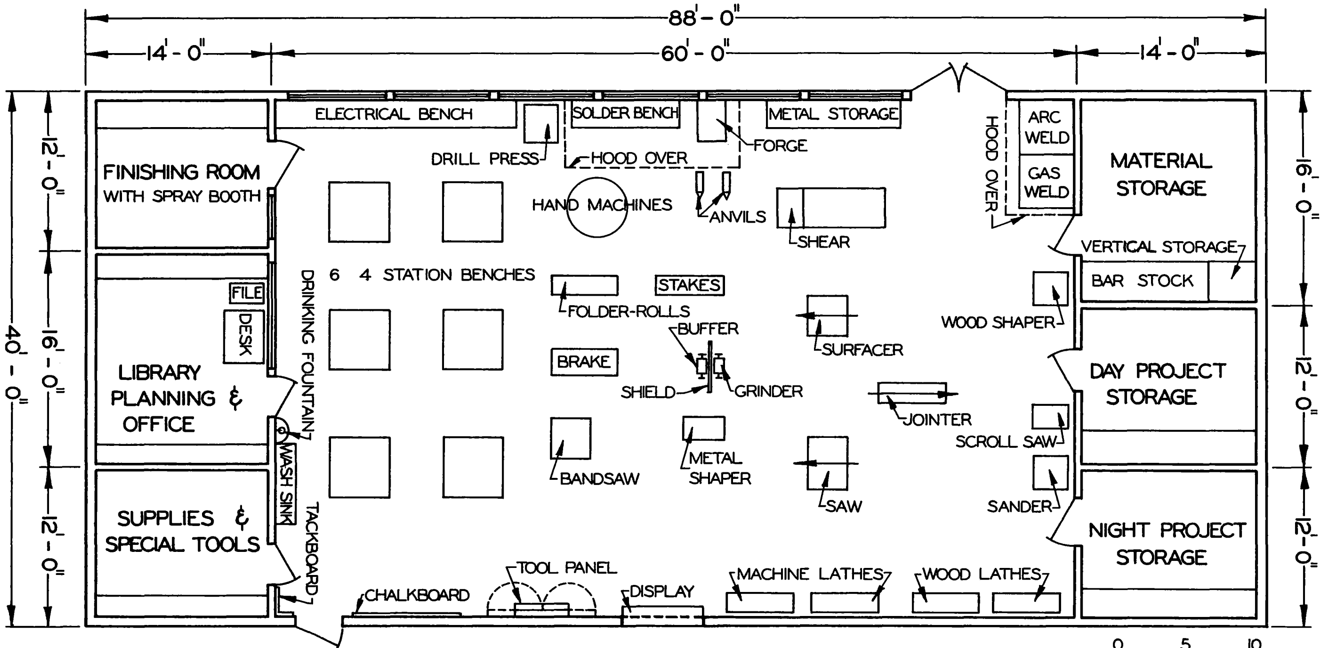
Facilities for General Wood Courses for Four-year and Senior High Schools

Figure 136. General Wood Laboratory (Courtesy California State Department of Education)



Facilities for Comprehensive General Courses for Junior High Schools and Grades 7 and 8 of Elementary Schools

Figure 137. Comprehensive General Laboratory (Courtesy California State Department of Education)



Facilities for Comprehensive General Courses for Four-year and Senior High Schools

Figure 138. Comprehensive General Laboratory (Courtesy California State Department of Education)

APPENDIX "D"

Equipment and Non-Consumable Tools and Supplies

By: Paul L. Scherer
University of California, Santa Barbara

This appendix is organized to serve as a guide and checklist. Curricular needs should be the first consideration in selecting equipment and tools. Available funds allocated for initial complements in setting up new facilities or yearly budgets in remodeling older facilities must also be taken into consideration.

In this list, multiple possibilities are listed and the instructor or supervisor will be expected to discriminate as to his needs. For example, where a single machine is needed, both bench and floor types are listed. The extent of equipment in a single laboratory will also be determined by the number of sequence courses to be taught. For example, a laboratory devoted entirely to Metals I and II would need less extensive equipment than one in which Metals I, II, III, and IV were to be taught.

Those persons who are planning comprehensive general laboratories should select the basic equipment and tools for the curricular areas to be offered, keeping in mind that each area explored will be of limited duration.

SUGGESTED BASIC HAND TOOLS FOR PRIMARY AND INTERMEDIATE GRADES

Primary

Clamps
 "C" - 4" and 6"
 carriage 4"
Dispensers, glue, plastic
Drill, hand
Drills, twist, assorted
Hammer, claw 7 oz.

Pliers, side cutting, 6"
Rasp, wood, w/handle
Saws
 coping
 crosscut, 16", 11 pt.
Screwdriver, 4", plastic handle

Intermediate

In addition to the primary set add the following:

Awl, scratch
Bench Rules, 12" and 24"
Bits
  auger, assorted, ¼" to 1"
  expansion
Brace, ratchet bit, 8"
Chisels, paring, ¼", ½", ¾"
Cornering Tool
Countersink, rose
Dividers, 6" solid nut
Drill, yankee
Files, metal, assorted
Hammer, claw, 10 oz.
Marking Gauge
Nail Set
Planes
  block
  junior jack
  smooth
Pliers, combination
Saws
  back
  compass or keyhole
  rip
Snips, tinners 8"
Square
  combination
  try, 6"
Vice, clamp-on

SUGGESTED EQUIPMENT AND NON-CONSUMABLE TOOLS AND SUPPLIES FOR SECONDARY SCHOOLS

AUTOMOTIVE LABORATORY

Equipment

Aligner
  rod
  wheel
Anvil
Balancer, wheel
Benches
  electrical test
  work, w/machinist vises
Blowtorch, 1 qt.
Boring Bar, cylinder
Chain Hoist
Charger, battery, 6-12 v.
Cleaner
  parts
  spark plug and adaptors
Compass, magnetic
Crane, portable
Creepers, car
Drill press
  bench
  floor
Dynamometer
  chassis
  engine
Furnace, soldering
Grinder
  bench, 2 wheel, carborundum
  valve refacer
  valve seat
Gauges
  compression meter
  cylinder
Guns
  chassis, grease and can
  spray
Hone
  cylinder
  pin
Hose, air, w/trigger nozzle, 25'
Jacks
  hydraulic
    floor, roller
    hand, stationary
  manual

Lathe, engine
Lift, hydraulic
Meters
 ammeter, 30 amp.
 AVR, 75 amp.D.C. 6, 12, & 24 volt
  scales
 hydrometer
 voltmeter, 10 v. rating
Monorail, overhead
Motor Analyzer
Press, arbor
Pump, gear lubrication
Regulator, air
Reliner, brake
Sander, portable, electric
Scales
 spring tension
  brush & points 0-48 oz.
  steering gear 0-4 lbs.
Stands
 car
 engine
 rear axle
Testers
 coil
 condenser
 distributor
 generator
 headlight
 motor
 thermometer
Torch, gas, preheating
Vise
 bench, machinists
 drill press
 piston pin
Welder
 arc
 gas

Non-consumable Tools & Supplies

Bolt cutter
Calipers
 inside
 outside
Cans
 oil, flexible spout
 oil, trigger pressure
 oily waste
 safety
Chisels
 cape
 cold
 diamond point
Clamps
 "C"
 handscrew
Compressor, piston ring
Cords, extension, 25'
Cotter Pin Extractor
Dies, tap and die set
Dividers, spring, needle point
Dresser, emery wheel
Drills
 breast
 electric, portable
 hand
File Card
Files
 flat, bastard
 half round, bastard
 half round, lead float
 hand, smooth
 ignition point
 mill, smooth
 round, bastard
 square
 warding
Flaring Tool
Gasket Punches, set
Gauges
 airppressure
 center
 depth
 screw pitch
 shoe and drum
 spark plug
 thickness
 thread
 vacuum
Glass Cutter
Goggles, safety
Groover, piston ring
Hack Saw
Hammers
 ball peen
 claw
 machinists
 sledge
 soft faced
Knife, putty

Lifter, valve
"c"-type
universal
Magnet, bar
Micrometers
inside
outside
Oil Stone, carborundum
Pans, small parts
Piston Ring Inserter, set
Pliers
battery
combination
diagonal
flat nose
pump
round nose
tapered flat nose
vise grip
Pullers
bearing
gear
wheel
Punches
center
blacksmith
drive pin
taper pin
Reamer
cylinder ridge
piston pin
taper
Rivet Set
Rule, steel
machinists, 12"
push-pull
Scrapers
bearing
carbon
Screwdrivers
clutch head
offset
phillips
regular
Scriber
Snips
curved
regular
Soldering
coppers
iron, electric
Spring Spreaders
Square, combination
Stamps, steel
figures, 0-9 inc. 3/16"
letters, 28 in set, 3/16"
Timing Light, neon
Wrenches
adjustable
Allen, set
box
cresent
electrical
extension
monkey
open end
pipe
ratchet
rim socket
socket
spanner
spark plug socket
tap
tappet adjusting
tension handle
universal joint

DRAFTING LABORATORY

Equipment

Boards, drawing
16" × 21" to
24" × 36"
Cabinets
for drawing boards
for filing drawings
for instruments and tools
for storing models
Cutter, paper, 24" × 36"
Instruments, drawing, sets
Lettering Sets
speedball
template types
Level or transit

Leveling Rod
Machines
  blueprint
  drafting
  ozalid
Marking pins
Stools, adjustable
Tables
  drafting, adjustable
  layout
  tracing, lighted

Non-consumable Tools and Supplies

Blackboard
  compass
  dividers
  protractor
  t-square
  triangles
Calipers
  inside
  outside
Compass
  beam
  drop bow, spring
Curves
  adjustable, spline
  irregular, sets
Dispensers
  drafting tape
  scotch tape
Dividers, proportional, 6" and 12"
Dusting Brushes
Ellipsograph
Gauges
  depth
  thread
  wire
Hammer, claw
Magnifier, reading lens,
  4" diameter
Micrometer, 2"
Oil Stone, Arkansas, hard
Pantograph
Parallel Rules
Pen, contour
Protractor, 6" transparent
Punch
  eyelet
  three hole adjustable
Reducing glass, 4" diameter
Rule
  pocket, 6"
  push-pull
  steel, 100'
Scales, flat and triangular
  architects
  engineers
Scissors, 4", 6", 10"
Screw Driver
  instrument
  Phillips
  regular
Sharpener, pencil
  draughtsmans
  regular point
Shields, erasing
Slide Rule
Square, steel, combination
  w/bevel protractor and center head
Stamps, steel
  figures, 0-9 inc. 1/8" & 1/4"
  letters, 28 in. set, 1/8" & 1/4"
Stapling Machine, hand
Templets, sets, various
  architects
  circle
  electrical symbols
  ellipse
  isometric
  nut and bolt
  valves
Triangles
  adjustable
  30-60 degree
  45 degree
  lettering
T-Squares, transparent edge,
  24", 36", 42"
  adjustable head
  fixed head
Yardsticks

ELECTRICITY AND RADIO LABORATORY

Equipment

Antennas
 broadcast
 short wave
Automatic Code Sending Machine
Benches
 4 station w/vises
 electrical benches
 electrical test benches
Blowtorch
Brake, box and pan
Buffer
 bench
 pedestal
Charger, 6-12 volt, battery
Drill, electric portable
Drill Press
 bench
 pedestal
Furnace, soldering
Generator
 audio frequency
 radio frequency
Grinder
 bench
 combination buffer
 pedestal
Ground
 clamps
 rods
Lathe, engine, bench
Meters and Test Instruments
 ammeters
 battery hydrometer
 bridge, L.C.R.
 calibrated air condenser (precision)
 capacitator analyzers
 crystal calibrator
 decode box
 frequency modulator
 galvanometer
 micro ammeters
 multimeters
 power level indicators
 q-meters
 signal tracers
 thermo galvanometers
 thermometers
 voltmeters
 watt-hour meter
 wattmeters
Microphones
 carbon
 crystal
 velocity
Motors
 compound, 1 h.p. 110 v.D.C.
 series, 1 h.p. 110 v.D.C.
 shunt, 1 h.p. 110 v.D.C.
 split phase induction fractional h.p. 110 v. 60 cycles
 split phase, 110 v. single phase A.C.
 three phase, 1 h.p. 200 v. A.C.
 three phase, 2 h.p. 200 v. A.C.
 universal, fractional h.p. 110 v.
 universal, variable speed, ½ h.p.
Oscilliscope
Oven, electric drying
Pipe Bender and Dies
Photo-Electric Cell Unit
Power Distribution Panel
Pulley and Gear Puller
Punch Press
Radio Receivers, various types
Shear, squaring
Storage Battery 6, 12 v.
Telephone Magneto
Television sets, various types
Testers
 appliance
 tube
Transmitter-receiver, communication

Non-consumable Tools & Supplies

Attachment plugs, various types
Bits, various sizes
 auger
 expansion
Blocks, drill and clamps
Boxes
 outlet
 starting

- compound motors
- shunt wound w/overload release
- shunt wound w/no voltage release

Brush, bench, dusting
Buzzer
- 2 coil
- high frequency

Calipers
- inside, 6" solid nut
- outside, 6" solid nut

Cans
- oil
- safety
- waste

Chisels, various sizes
- cold
- socket firmer

Clamps, various sizes
- "C"
- spring

Compass
- bow, 8"
- magnetic

Copper, soldering
Dividers, 8" solid nut
Doorbells
Dresser, emery wheel
Drills
- breast
- hand
- rose
- star

Files
- flat
- half round
- square
- rat tail

Gauges
- tap and drill
- test 1"
- wire

Hammers
- ball peen
- claw
- rivet

Headsets, double
Indicator, speed
Knives
- electricians
- sloyd

Ladle, melting
Magnets
- bar
- horseshoe

Micrometer
Oil Stone, combination
Planes
- block
- smooth

Pliers
- combination
- diagonal
- linesmans
- long nose
- needle nose
- side cutting

Pot, melting
Potentiometer
Punches
- center
- pin
- radio chassis, various

Reamers
- expension
- pipe burring
- taper

Rheostats
- compression
- field

Rivet set and anvil
Rules
- steel
- zig-zag

Saws
- compass or keyhole
- coping
- hack
- hole, for drill press
- panel, cross cut

Screw Drivers
- Phillips, various sizes
- regular, various sizes

Snips
- aircraft, right and left hand
- tinners

Stamps
- figures, steel, 0-9 inc. 1/8"
- letters, 28 in set, steel, 1/8"

Stocks and Dies, various
- for pipe threads

Switches
- flush, push button
- knife, various
- safety, 2 and 3 pole
- surface, snap

Telegraph sets including sounders, keys, and relays
Transformers
- door bell
- radio

Vises
- drill press
- machinists
- pipe

Wire Strippers
Wrenches
- Allen, set
- cresent
- box
- open end
- pipe
- socket
- spintite

GRAPHIC ARTS LABORATORY

Equipment

Banks, double, school type
Bindery Table
Cabinets
- cut storage
- galley
- ink
- lead, slug, space, and strip
- matrix
- roller
- type, California

Chase Rack
Cutters
- guillotine
- hand lever
- slug and lead

Densitometer
Drill, paper
Folding Machine
Hot Stamping Machine
Imposing Stone
Job Backer, 29" jaw
Mitering Machine
Numbering Machine
Offset
- camera
- arc lamp
- developing unit
- layout table
- press
- printing frame

Perferator
Photo Composing Unit, hand
Plastic Binding Unit
Presses
- bookbinders
- cylinder
- padding
- pilot
- power platen
- proof
- rubberstamp

Punch, hole
Racks
- drying
- lead and slug
- reglets
- wooden furniture

Saw Trimmer
Silk Screen Unit
Slug Casting Machine
Smelter, lead
Stapler, wire
Stereotype Unit
Stitcher
Virkotype Machine

Non-consumable Tools and Supplies

Bellows
- electric
- hand

Bones, folding
Brayers, ink
Cans
- oil, copperized oiler
- oily waste
- safety

Cases
- blank, full size to accommodate ¼ size cases
- border, ¼ size for ornamental borders
- lead and slug
- metal furniture
- rule, ¼ size for brass rule

Chases, various sizes
Composing Sticks, various
Furniture
- metal
- wood

Galleys, steel, various
Gauge Pins, spring tongue
Glue Pot, electric
Hammers
- backing
- claw
- rounding

Ink Fountains
Knives
- ink
- overlay, for makeready
- stencil

Leaders
Lettering Pallet, 6" jaw
Line Gauges
Make-up Rule
Mallets
- rawhide
- rubber
- wood

Magnifying Glass
Micrometer
Ornaments, various, assorted
Planer
- proof
- type

Pressboards
Punch, hand, adjustable
Quoins and Keys
Rule
- brass
- plain

Spacing Material
- leads
- slugs
- reglets

Stapler, hand
Tools
- bookbinding, set
- etching, set
- linoleum block, sets

Tweezers
Type, fonts, various
Type-high Gauges
Wrenches
- cresent
- open end

HANDICRAFT LABORATORY

Equipment

Anvil
Benches, 4 station w/vises
Buffer, w/spindles for cotton felt and wire buffs
Damp Box, ceramics
Drill, electric, portable
Drill Press
- bench
- pedestal

Furnace, soldering
Grinder, 2 wheel, carborundum
Guns
- flock
- spray

Jointer, bench
Kilns
- ceramic
- enameling

Lapidary Unit
Lathes
- spinning
- wood

Loom, 4 harness
Mitre Box
Mitre, frame clamps
Oven, plastic heating and forming
Paper Cutter
Plastic Molding Press
- pressure
- vacuum

Plating Tank, w/rectifier
Potters Wheel

Sand Blast Unit
Sanders
- belt, small
- disc
- portable

Saws
- band, wood and metal
- circular
- jig

Sewing Machine
Spray Booth, ceramic
Tools
- carving and grinding, electric portable, flexible shaft
- sheet metal forming, small set

Torches, soldering unit
- acetylene
- propane
- natural gas

Non-consumable Tools and Supplies

Awl, scratch
Bits
- auger, various
- dowel, set
- expansion

Brace, ratchet, 8" sweep
Brayer, ink
Brush, bench, dusting
Cans
- oil, copperized oiler
- oily waste
- safety

Can Opener, wall mounted
Chisels, various
Clamps
- bar, adjustable
- "C", various sizes
- handscrew
- spring

Copper, soldering, electric
Cord, extension, 25'
Countersink, rose
Dividers, solid nut, 8"
Doweling Jig
Dresser, emery wheel
Drills
- breast
- hand
- yankee

Eyelet Setter
Files
- die sinkers riffle files
- jewelers, set
- metal files, assorted

Gauges
- draw, 4" slide
- outside bevel, ½" and ¾"

Glass Cutter
Goggles, safety
Hammers
- ball peen
- chasing
- claw
- embossing
- planishing
- raising
- silversmiths

Jars, stoneware, various sizes
Knives
- saddler's swivel
- skiving
- sloyd
- stencil

Mallets
- plastic
- rawhide
- rubber
- wood

Mandrel, ring
Nippers, end cutting
Oil Stones, various
Pans, for acids
- pyrex, various
- white enamel, various

Planes
- block
- smooth

Pliers
- chain
- combination
- diagonal
- flat nose
- needle nose
- round nose
- side cutting

Punches
- drive, set
- lacing
- revolving

Rasps, wood, various
Rules, steel, 12" and 24"

Saws
- back
- compass or keyhole
- coping
- crosscut
- dovetail
- hack
- jewelers
- rip

Screwdrivers
- Phillips
- regular, various sizes

Scissors, various sizes
Slip stones, Arkansas, various grits
Snap Setter
Snips
- aircraft, right and left hand
- jewelers
- tinners

Squares
- framing
- mitre
- try

Stake-Plate, mounted
Stakes, set
Tongs, enameling
Tools
- chasing, set
- clay modeling, set
- engraving, set
- leather, set
- linoleum, set
- spinning, set
- stippling, set
- wood carving, set

Torch, mouth blow
Tweezers
Vises
- bench
- clamp-on
- machinists
- pipe

Wheel, marking
Wrenches
- cresent
- box
- monkey
- pipe

METAL LABORATORY

Equipment

Anvil
Arbor Press
- bench
- pedestal

Benches
- 4 station w/vises, storage below
- molding
- soldering
- welding

Bender, metal and pipe
Blowtorch, 1 qt.
Bolt Clipper
Boring Bar
Boring Mill
- horizontal
- vertical

Brake
- box and pan
- cornice
- press

Buffer, 2 wheel
Centering Machine
Core Oven
Drill, electric, portable
Drill Press
- bench
- pedestal

Flasks
Folder, bar
Forge, gas fired
Furnace, gas
- annealing
- brass and soft metal
- case hardening
- cyanide
- heat treating
- melting
- pot and crucible
- soldering

Grinder
- bench
- face
- precision
- surface
- tool

Gun, spray

Hardness Tester
Kiln, electric
- annealing
- enameling
- heat treating

Lathe
- engine
- metal spinning
- turret
- wood (pattern makers)

Metal Forming Set
- bending
- burring
- crimping and swaging
- elbow edging
- hand turning
- setting down
- wiring

Milling Machine
- plain
- universal

Nibbler
Planer
Press
- hydraulic
- punch, metal

Pyrometer
Rod Parter
Rolls, slip forming
Sandblaster, with cabinet
Saws
- band, metal cutting
- grob
- hack, power

Spring Winder
Shaper, metal
Shear
- notching
- ring and circle
- squaring

Stake Plate, mounted
Stakes, set
Surface Plates
Tongs
- crucible
- enameling

Torches
- cutting
- welding

Vises
- drill press
- machinists
- pipe
- planer
- shaper

Welding
- arc
- gas
- inert gas, electric welder
- spot

Non-consumable Tools and Supplies

Arbors
- drill chuck
- reamer
- shell tool
- straight shank
- taper shank

Awl, scratch
Bar, wrecking
Bellows, molders, hand
Bench Pin and Holder
Bits, auger, various
Blocks, drill and clamp
Brace, ratchet, 10" swing
Brush, bench, dusting
Burnisher, $4\frac{1}{2}$" blade
Calipers
- hermaphrodite
- inside
- outside
- vernier

Cans
- oil, coppered oiler
- oil, trigger pressure
- oily waste
- safety

Chisels
- cape
- cold
- diamond point
- round nose

Clamps
- "C"-various sizes
- machinists
- spring
- strap

Coppers, soldering
Counterbore
Countersink
Cutters
- hole, various
- pipe
- taper sprue

Dial Indicator
Dividers
- solid nut, 8"
- wing, 12"

Dresser, emery wheel
Drill
- breast
- hand
- star

Engraver's Marker, 7"
Extractor, screw
Files
- die sinkers
- flat, bastard
- half round
- hand, smooth
- mill, smooth
- needle
- round, bastard
- square, bastard
- swiss, various
- triangular
- warding, double cut

Gauges
- center, U.S. Std. 60°
- depth
- drill, 1/16" to 1/2" by 64ths
- drill and tap 1–60
- height
- screw pitch, 4 to 42
- sheet
- surface
- telescoping
- thickness
- wire, 0-36 Am. Std.

Goggles, safety
Groover, hand, various sizes
Hammers
- babbit
- ball peen
- bumping
- chasing
- claw
- embossing
- raising
- riveting
- setting
- silversmiths
- sledge

Head, anvil, various shapes
Jar, stoneware, various sizes
Knurling Tool, with assorted knurls
Ladle
- bull
- hand bowl
- molding

Leggings, fireproof duck
Mallets
- rawhide
- rubber
- wood

Mandrel
- core, hollow
- ring

Micrometers, various sizes
- inside
- outside

Molding Boards
Nail Set
Nippers, end cutting
Oil Stone, carborundum, various grits
Pad, hand, thumb-type, open back for pouring molten metal
Pattern Letters and Figures
- various sizes, sets

Planes
- block
- smooth

Pliers
- chain
- combination
- diagonal
- flat nose
- gas burner
- linesman's
- long nose
- round nose
- side cutting
- vise grip

Punch
- center
- drive pin
- hand lever
- hollow
- long taper
- pin
- prick
- solid set

Pusher, for stone setting
Rammer, molders bench, hardwood
Reamer
- hand, spiral flutes
- machine

Riddle, foundry, various sizes
Rivet Sets, various sizes
Rules
- circumference, plain, 36"

shrink, set
steel, various sizes
Saws
coping
crosscut, 9 pt.
hack
jewelers
keyhole
Scissors, various
Scraper, steel
Screwdrivers
offset
Phillips
regular
Scribers
Seamer, handy, $3\frac{1}{2}'' \times 7''$ blade
Shears
bench
hand cutting, right and left hand
Shields, face
Shovel, square point, D.handle
Slick, molders
Spoon, gate cutters
Snips
aircraft, right and left hand
compound lever
curved
hawks-bill
regular
trojan, pocket
scroll pivot
Sprue Picks
Squares
steel, body $24'' \times 2''$, tongue $16'' \times 1\frac{1}{2}''$
steel, combination without center-head
steel, combination w/bevel protractor and center head
try, 6"
Stamps, steel
figures, 0-9 inc. various sizes
letters, 28 per set, various sizes
Swabs
Tachometer
Taps and Dies, various
Tools
chasing, set
dapping die and punches
engravers, set
spinning, set
turning, set
Torch, mouth blow
Trammel, points and bar
Tray, etching
enamel
glass
Trowel, margin
Tweezers
Vises
clamp-on
pin
swivel base
Wrenches
Allen, set
box
cresent, single end
end
adjustable
open
monkey
pipe
socket

WOOD LABORATORY

Equipment

Benches
1, 2, or 4 station, w/vises
glue
Drill, electric portable
Drill Press
bench
floor
Grinder, 2 wheel
bench
pedestal
Gun, spray
Jointer
Lathes, wood
Miter Box and Saw
Miter Cutter
Mortiser
Planer
Router-Shaper

Sander
- belt
- disc
- portable
- spindle

Saws
- band
- circular
- radial
- scroll or jig

Vise
- bench, quick acting

Non-consumable Tools and Supplies

Awl, scratch
Bar, wrecking
Bits
- auger, various
- dowel
- expansion
- screwdriver

Braces, ratchet bit
Brush, bench, dusting
Burnisher, 4" blade
Calipers
- inside
- outside

Cans
- oil, flexible spout
- oil, trigger pressure
- oily waste
- safety

Carving Tools, sets
Chisels, various
Clamps
- bar
- "C"
- handscrew

Cold Chisel
Compass, pencil
Countersink, rose
Cutter, plug
Divider, wing
Dowel Sharpener
Dresser, emery wheel
Drill
- breast
- hand
- star

Files
- auger bit
- flat
- mill
- pillar
- tapered
- triangular
- rat tail

File Cleaner or Card
Hammers
- claw, 10, 16, 20 oz.
- tack

Gauges
- auger bit
- marking

Glass Cutter
Goggles, safety
Gouges, bevel
- inside
- outside

Jig, doweling
Knives
- draw
- putty
- sloyd

Level
Mallets
- rubber
- wood

Nail Sets, assorted
Nippers, end cutting
Oil Stones
- flat
- gouge, slip stones

Planes
- block
- jack
- jointer

Planes
- rabbet
- router
- smoothing

Pliers
- combination
- diagonal
- needle nose
- side cutting

Plumb Bob
Rasps, wood
- bastard cut
- smooth cut

Rules
- bench

- push-pull
- shrink
- zig-zag

Saws
- back
- compass
- coping
- crosscut
- dado
- dovetail
- hack
- rip

Saw Clamp
Saw Set
Scrapers
- box
- cabinet
- hand

Screwdrivers
- bit brace
- Phillips
- regular, various blade sizes
- spiral ratchet

Snips, regular
Spoke Shave, adjustable
Square
- bevel-T
- combination
- framing
- try

Tape, steel, 50'
Tools, wood turning
- chisels
- gouges
- parting
- points
  - round
  - spear
  - square
- skews

Trammel, points and bar
Wrenches
- adjustable
- box
- end, sets