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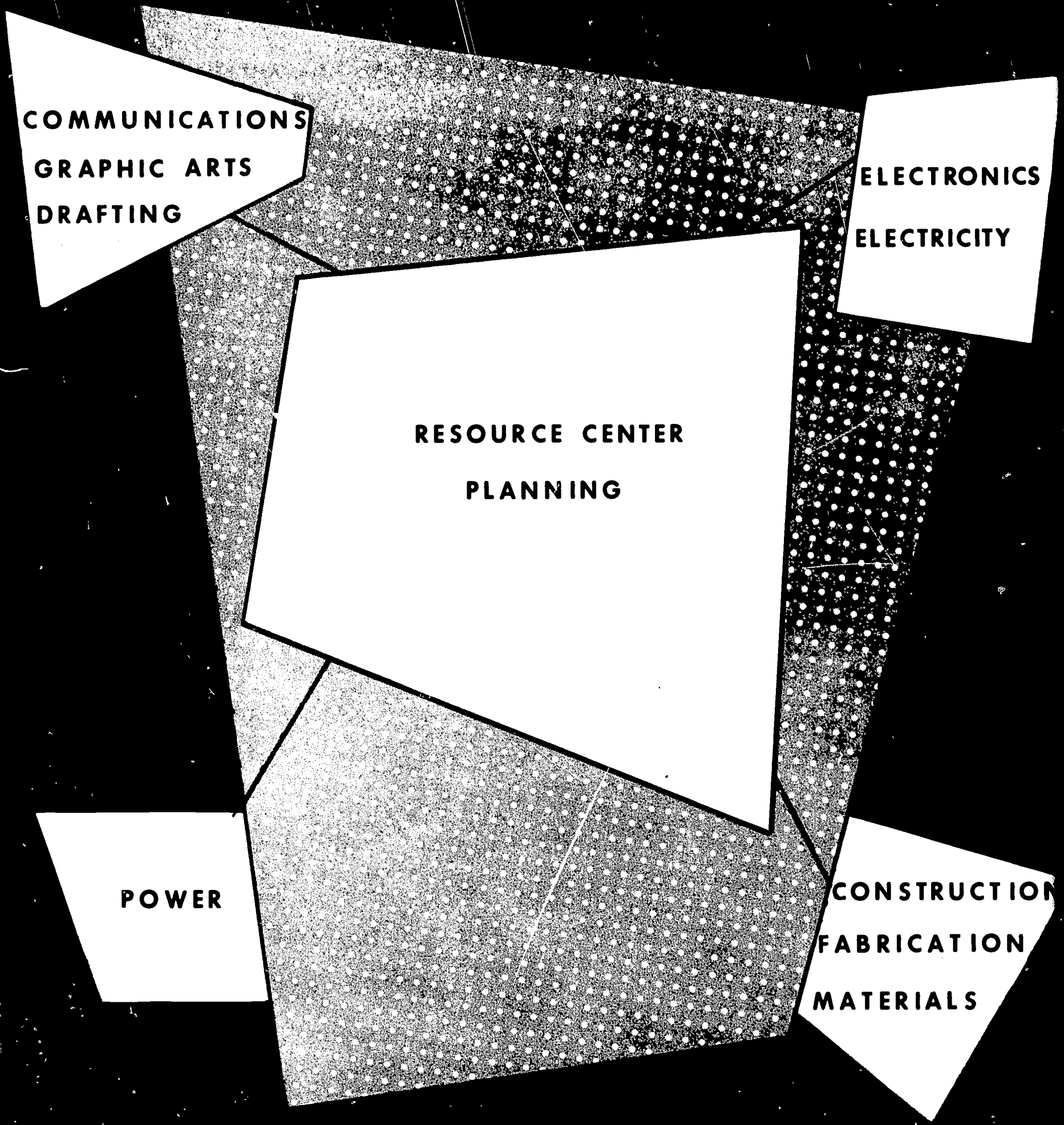
This guide was developed following a review of literature and a survey questionnaire which was completed by industrial arts consultants, teacher educators, teachers, and supervisors. The first draft was circulated to a state advisory committee for suggestions. Major sections are titled: (1) General Laboratory Specifications for Planning Industrial Arts Facilities, (2) Woodworking, Grades 7-12, (3) Metalworking, Grades 7-12, (4) Power Mechanics, Grades 7-12, (5) Electricity-Electronics, Grades 7-12, (6) Drafting, Grades 9-12, (7) Graphic Arts, Grades 9-12, and (8) Comprehensive General Shop, Grades 7-12. Included in each section are guidelines for room shape and use, floor space requirements, special features, and necessary utilities. (EM)

GUIDE FOR PLANNING INDUSTRIAL ARTS LABORATORY FACILITIES



Jesse V. Fasold, Superintendent of Public Instruction
Oregon State Department of Education
Division of Community Colleges and Vocational Education

GUIDE FOR PLANNING INDUSTRIAL ARTS LABORATORY FACILITIES

Prepared By

STATE DEPARTMENT OF EDUCATION
Division of Community Colleges
and Vocational Education
Salem, Oregon 97310

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F O R E W O R D

The increasing emphasis upon the restructuring of exploratory and occupational education programs has led to the need for improvement of existing and future facilities to house these programs.

Industrial Arts is an exploratory part of education which provides an insight into the nation's industrial society through laboratory-classroom experiences. The facilities in which industrial arts is taught should reflect industry's environment. The planning of appropriate facilities is the combined responsibility of all who are responsible for quality education in Oregon. The information in this publication will be useful to all who share this obligation.

The guidelines and specifications suggested in this publication reinforce and provide direction for these aims.

JESSE V. FASOLD
Superintendent of Public Instruction

P R E F A C E

There has been a long standing need for an instrument which would reflect existing and future needs for Industrial Arts facilities in Oregon. Teachers, administrators and architects have been requesting guidelines to provide a blueprint for direction in planning.

The preparation of the material in this Guide was developed from a survey questionnaire submitted to qualified personnel in the field of industrial arts education including consultants in industrial arts from state department of education, professors of teacher education universities, and teachers and supervisors who have demonstrated ability to design industrial arts facilities. A survey of contemporary literature was made to verify the field research.

A tabulation was developed from the survey questionnaire and circulated back to the respondents for corroboration. The first draft of the Guide was in turn submitted to the respondents for analysis and opinion. After revision, the Guide was circulated to the Industrial Arts Advisory Committee serving the Consultant in Industrial Arts Education, Division of Community Colleges and Vocational Education. The final draft is the result of all recommendations and proposals.

We would like to take this opportunity to acknowledge the counsel and advice of the following people who assisted in the development of this Guide: William Anderson, Arizona Department of Public Instruction; Robert L. Woodward, California Department of Education; Winifred Mayfield, Texas Education Agency; Joe Luke, Utah Department of Public Instruction; Herbert Bell, Washington Department of Education; Ronald Frye, Central Washington State College; Glen O. Fuglsby, Western Washington State College; C. L. Trautwein, Walla Walla College; William A. Bakamis, Washington State University; Sam Porter, Western Washington State College Ralph Bohn, Fresno State College; Louie Melo, San Jose State College; Pat Atteberry, Oregon State University; Earl Smith, Oregon University; LeRoy Wallis, Portland, Oregon; John Lavender, Seattle, Washington; Vern Voss, Medford, Oregon; James Grossnicklaus, Philomath, Oregon; Bruce Thompson , Salem, Oregon; Ted Gould, Eugene, Oregon; Robert Foster, Albany, Oregon; Wayne Close, Glendale, Oregon; Elmer Niska, Hillsboro, Oregon; Ivan Luman, Salem, Oregon.

The general development of the guide and the final editing of this manuscript have been the responsibility of William C. Oleson, Industrial Arts Consultant in the Division. It has been largely due to the interest and efforts of Mr. Oleson that this project was initiated and completed.

ROBERT O. HATTON
Assistant Superintendent
Public Instruction

WM. G. LOOMIS
State Director
Vocational Education

OREGON INDUSTRIAL ARTS ADVISORY COMMITTEE

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GUIDE FOR PLANNING INDUSTRIAL ARTS LABORATORY FACILITIES

Industrial Arts is an exploratory part of education which provides an insight into the nation's industrial society through laboratory-classroom experiences. The role of industry and technology is unfolded as students study the history, growth, and development of industrial organizations, materials, products, processes and related problems. Industrial Arts emphasizes problem-solving experiences which assists students in becoming alert contributors and consumers. Occupational interests and aptitudes are developed and reinforced.

Today's concept of industrial arts is of value to students of all levels of ability and aspiration. Programs such as "laboratories of industries", general shops and unit shops are utilized nationally as methods of organizing industrial arts programs. Advanced courses are especially useful for those who display special abilities and plan to use them in an occupation. Each industrial arts area presents many practical problems which serve to apply, reinforce, and extend pupil knowledges in mathematics, science, English, arts, etc.

The objectives of industrial arts education are presented as expected student behaviors; therefore, as a result of instruction in industrial arts education the student will:

1. Develop an insight and understanding of industry and its place in our society.
2. Discover and develop attitudes and skills in industrial-technical fields.

3. Develop problem-solving abilities related to the materials, processes and products of industry.

4. Develop skill in the safe and efficient operation of tools and equipment.

It is the purpose of this guide to present information that will be useful to administrators, teachers, architects and the public who are or will be involved in the development of facilities for industrial arts.

Generally, facilities planned for industrial arts in Oregon emphasize the basic industries of wood, metals, electricity, plastics, graphic arts, drafting, power mechanics and sometimes ceramics. Manipulative experiences in these areas play a major role in the day to day teaching. Effort should be made to achieve a better balance in interpreting industry to today's youth by organizing the instruction in an industrial arts environment. The study of industry should be represented by industry's general organization, distribution and sale of its products, processing and operational procedures, relations between labor and management, methods of financing, procurement of raw and semi-manufactured materials, analysis of products, and research and patent development. The facility for industrial arts should represent much more than the traditional manipulative aspect of industry.

"Industrial arts, today and tomorrow, emphasizes <u>how</u> industry uses tools, materials and ideas to solve problems; it challenges students to solve their own technical problems. It captivates their imagination through purposeful experiences

in research, mass production and various individual and teamwork design and problem-solving activities. Knowledge of the characteristics of materials is founded upon testing as well as manipulation. The study of processes and principles could include power metalurgy, die casting, electroforming, printed circuitry, feed-back systems, wood laminates, jet propulsion, the heat pump, injection molding, iron-tin alloys for engine blocks and many other devices, processes and developments."[1] Careful planning for facilities should include provision for these.

The planning of industrial arts facilities should also be represented by careful consideration of the needs of the immediate community as well as the total needs of the nation. Cooperation should be secured between the school board, administration, community and faculty in determining the educational blueprint for industrial arts.

The following specifications for planning are not generalized. They were determined by submitting a very comprehensive questionnaire to known experts in the field of industrial arts education including consultants in industrial arts from the eleven western state departments of education, professors of teacher education universities specializing in industrial arts education, and teachers and supervisors who have demonstrated talent in designing facilities for industrial arts.

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1. Robert E. Buxton, It's a Sign of the Times, The Journal of Industrial Arts Education, January-February 1968, page 10.

The tabulations from the research instrument were analyzed for agreement. Where discussion varied slightly as to what constituted agreement, an average was made to clarify a particular detail. In addition, a survey of existing literature was made to verify the findings from the field research. A bibliography is included in the handbook.

The planning details are divided into two categories: General Laboratory Details for Industrial Arts Facilities and Laboratory Details for Specific Subject Areas Within Industrial Arts. General Laboratory details will include recommendations that will encompass all areas of industrial arts. Details for specific areas will include recommendations which may not conveniently be included in the general details or should only be considered for a particular type of laboratory. An overview of what should be taught in these specific areas will introduce the recommendations.

GENERAL LABORATORY SPECIFICATIONS FOR PLANNING ALL INDUSTRIAL ARTS FACILITIES

Shape:

Rectangular with as close to a 2:3 proportion as possible.

Avoid "L" shape or "U" shape.

Partitions:

Flexible construction, nonbearing.

Reinforced glass between shop proper and auxiliary areas that require supervision (foundry, planning).

Contain minimum of built-in electrical conduit/outlets and plumbing.

Have low sound transfer-accoustically treated (place recitation areas back to back or on outside walls).

Be easily removed by custodians.

NOTE: Considerable attention is being given to the entire deletion of partitions between laboratories that have a commonality of processes. Example: metals and wood laboratories are involved in the study of processing materials (metal, wood, fibers (chemical and natural), plastics, ceramics, and finishes). Mass production units can involve broader use of equipment and materials without the restriction of permanent walls.

Laboratory Location:

Laboratories for Industrial Arts should be (whenever possible):

Centrally located in wing of main building.

Located on grade (heavy equipment on grade level--other laboratories, i.e., drafting, can be located on second floor).

Connected to main building by covered walks when separated from main building.

Located adjacent to a delivery drive.

Accessible to after-school use by adults.
Outside entrance necessary
Adjacent parking near outside door

Oriented to north and east exposure if windows are included that are not low transmission glass.

Accessible to science wing for relation of practical application to theory.

Storage:

Better housekeeping, class control, and inventory control results when most storage is located in one large central area.

Small areas within each laboratory should be provided for current supplies.

Much used supplies should have a storage facility in each laboratory, i.e., auxiliary storage for wood and plywood in woodworking laboratory.

Adult education storage provided separate from regular students for supplies, projects and personal articles.

Balcony storage is not a desirable solution to storage problem--safety hazard.

Pupil personal storage (plans, clothes) should be designed into the laboratory.

Planning:

Space should be provided that:

Can be utilized for student planning.

Serve as a resource center.

Function as a classroom.

Serves two or more laboratories cooperatively.

Planning area should include:

Resource library--materials reserved from central school library.

Magazine File.

Books, charts, etc., rotated from library to complement units of instruction.

Tapes, film, slides, transparencies as needed for current instruction or refresher.

Development of gas, air, water, vents, etc., for future curriculum change.

Storage for Audio Visual equipment, etc.

NOTE:

Planning area should not be utilized for the express purpose of demonstration. Demonstrations have much greater impact when given at actual work stations in the laboratory.

Planning space should be reserved within the individual laboratories for immediate problem solving.

Demonstration - Visual Aids Facility:

Demonstration - Visual Aids facility should include:

Demonstration bench

Chalkboard

Electrical, gas, air, venting, water convenience

Window darkening device

Central control of lighting

Bulletin board

Accoustical treatment

Pull down projection screen

Audio-visual convenience - Television, overhead and projector

Study carrells for private viewing of 8mm single concept films, listen to tape recordings or individual study

Instructional Staff Planning Facility:

*Provide for joint office, centrally located for all departmental staff.

*Note: Joint office facility provides a built-in device for departmental and team planning.

Windows:

If walls include windows, windows should be:

Low transmission glass.

High enough from floor to provide bench/storage underneath.

Equipped with window darkening device.

Lighting:

Artificial lighting in the laboratories should be:

Florescent

Controlled fixture

Produce shadow and glare free illumination

Produce a non-flickering light

Designed to prevent stroboscopic effect whereby moving wheels and gears may appear to be stationary

Exhaust Systems:

Exhaust systems for dust, smoke, chips and fumes should:

Remove all air contaminates produced by machines (cutting and abrasive), welders, engines, and chemical fumes produced by Polymers or Etching.

Dust and chip exhaust system be installed in floor, on modular basis, in special ducts that are easily opened for maintenance.

Fume, smoke exhaust system installed from ceiling or in floor, hooded to a functional level.

Collection and exhaust units installed outside of building to decrease noise factor.

Have large enough capacity to allow for expansion and avoid clogging.

Air-Ventilation:

Air should be changed in principal work area every 15 minutes.

Air should be changed every 5 minutes in finish, plastics, or other areas where fumes are a hazard.

Electrical:

Installation of electrical system in laboratories housing heavy equipment should include:

115-130 and 220-440 volt installation, single and three phase or 115/230 and 208/220/440 volt, single and three phase.

Raceway installation on ceiling and perimeter service outlets.

Branch power circuits, one per machine protected by individual circuit breaker.

Magnetic remote control switch buttons installed for instructor control in emergencies (installation interval should relate to state/local code).

Power and light control panels with pilot light, located centrally to all of the laboratory with master control near instructor's teaching station.

Provision and design for future and flexibility.

Accoustics:

Walls and ceilings should be accoustically treated to lessen the intensity of noise vibrations in laboratories housing heavy equipment.

Sound absorption value of ceilings should be 50 percent to 70 percent.

Sound absorption value of walls should be 30 percent to 60 percent.

Machinery should be mounted on shock absorbers; felt, rubber, or cork.

Choice of Machinery:

Machines should be unit type (single purpose).

Safety features of machinery should be part of machine (not an accessory).

Machinery should be color, safety coded (National Safety Council).

Plumbing:

Lavatory facilities should be located centrally to all laboratories--general school use, in hall, plus one small toilet area per shop to serve boys and girls.

Each laboratory where dirt, dust, grease is a problem, should be provided with:

One wash station for each 10 students.

One work or slop sink with oversized grease trap.

Clean-outs readily accessible to each area where grease is a problem.

General:

Hazards in school shops should be indicated by symbolic colors, i.e., Standard color code, (National Safety Council).

Precautions should be taken to provide adequate working space and distinct aisles of traffic:

Five feet wide aisles between benches, machinery, and other equipment.

Operator's safety zones around machines should be designated on the floor. --Safety tread, pressure sensitive or painted on.

Cabinet Tops:

Cabinet tops should be covered with the noted materials when serving the following functions:

Finish room - metal
Sheetmetal - metal, wood, metal edged
Plastics - metal
Hotmetals - metal over asbestos, asbestos over metal
Wood benches - wood, transite
Machine area - metal
Adhesives, glueing - metal
Camera and Dark rooms - stainless steel, plastic (benolux)
Planning, testing - plastic laminate, masonite, wood
Graphic Arts - fiberglas, plastic laminate
Electrical - wood, plastic laminate, transite

LABORATORY DETAILS FOR SPECIFIC SUBJECT AREAS WITHIN INDUSTRIAL ARTS

Before specifying specific details for individual laboratories, some explanation should be offered concerning the organization of industrial arts programs.

Industrial arts courses are developed in terms of levels of activity and course purposes rather than by precise grade levels so that individual schools can adapt approved offerings to local needs and physical facilities. The indicated levels represent increasing complexity and progression in content with emphasis upon progress from broad to specific experiences, although many aspects of content are common to all courses offered at all levels. Occupational and technical information are integral parts of the course content at all levels.

Opportunities for educational activities related to industry range from the introductory, exploratory experiences of Level I junior high school courses through the advanced occupational experiences available in Levels III and IV senior high school courses.

Level 1. Introductory--Exploratory--Grades 7-8

In Level 1 courses, the organization and content provide opportunities for a wide range of introductory and exploratory experiences typical of major industrial fields.

The offerings should be presented in properly equipped multiple activity general shops. It is expected that the student will be encouraged to seek breadth of understanding rather than depth or specialization.

Level 2. Basic--Exploratory--Grades 9-12

Courses offered at Level 2 are elective and are based upon experiences provided at Level 1. In districts where Level 1 courses are not available, the content of Levels 1 and 2 should be combined. The primary purpose of Level 2 basic courses is to provide introductory experiences in a single industrial field. The emphasis is on basic concepts, processes, procedures, applications, and personal manipulative experiences in the industrial field.

The Level 2 courses should be taught in a properly equipped multiple activity, general shop. A properly equipped general shop will include equipment and materials suitable for student use at the experience level being taught. Not fewer than two instructional areas, such as power, wood-metal, graphic arts and electricity-electronics should be provided in a general shop. Drafting can be taught as an integrated part of these courses. A minimum of 150 square feet of floor space including principal and auxiliary working areas per student should be provided.

Level 3. Intermediate--Specialization--Grades 10-12

In Level 3 courses, it is expected that the student will acquire advanced knowledge and skills in a single industrial field. The individual student is provided an opportunity to select sub-areas within the field of emphasis. With the sub-area selection, the courses serve specialized educational needs and should also carry some prevocational values for the

student who has identified vocationally within the field being studied. For the student who seeks further general information about industry, Level 3 courses are an extension of his general education and also serve his special needs.

It is expected that the work of Level 3 courses will be founded on Levels 1 and 2 experiences and that such experiences are necessary for admission to the courses.

Level 4. Advanced--Specialization--Grades 11-12

Level 4 courses offer an opportunity for special advanced work in a single industrial field. The courses are based on Level 3 work in the same field. Students can concentrate their study in one or more sub-areas of a field. This opportunity for development of advanced, specialized industrial skills and knowledge serves to meet prevocational needs of those students who have become identified with a vocational field.

Level 5. Industrial Occupations

Courses listed as "Industrial Occupations" are intended to serve vocational needs in those schools where reimbursed vocational courses are not offered. Industrial arts courses as they are identified can be grouped in broad designations such as Construction and Fabrication, Electronics, Communications, and Power. Construction and Fabrications includes the areas of Woodworking and Metalworking; Electronics includes Electricity and Electronics; Communications includes Mechanical Drawing, Architectural Drafting, Engineering Drafting, Photography, Design and Graphic Arts; Power will include Power Mechanics and Auto Mechanics. Comprehensive General Shop, as

it is used in this handbook, will be considered as a laboratory that may include all or part of the above subject areas. These groupings should not be confused with the occupational cluster concept which classifies occupations into logically related groups. The grouping of subjects is a simple device to combine subjects either in one laboratory or shop or by materials, operations and processes.

CONSTRUCTION AND FABRICATION

Woodworking, grades 7-12:

Level 1 Hand tools and related processes

Level 2 Introduction to power tools and related processes

Level 3 Advanced tool applications and related processes

Level 4 Specialized application in single fields

Room use: Wood and Related Materials

Approximate shape including auxiliary areas: Rectangular with a proportion as near 2:3 as possible.

Number of students to be accommodated at one time: 24

Square feet per student in the principal work area:

Grades 7 thru 9: 100-125 sq. ft. per pupil

Grades 9 thru 12: 125 sq. ft. per pupil

Vocational: up to 200 sq. ft. per pupil

Courses to be taught in laboratory:

Introduction to Woodworking, Levels 1 and 2.

Advanced Woodworking, Levels 2-4. Instruction includes cabinetmaking, patternmaking, bending and lamination, finishing, mass production, introduction to carpentry, experimentation with plastics and resins, materials testing.

Building trades and/or evening apprenticeship instruction.

Adult education.

Floor level preference: On grade because of heavy equipment requirements.

Special room requirements: Auxiliary work area,

Grades 7 thru 9: 35 sq. ft. per pupil

Grades 9 thru 12: 60-80 sq. ft. per pupil

Recommended inclusions within auxiliary areas:

Finishing
Industrial Plastics
Supplies, special tools
Solid lumber and plywood storage
Planning
Materials testing
Project storage

Auxiliary areas are in addition to the principal working area of wood's laboratory.

Special room features:

Type of flooring:

Bench area - wood
Finishing, industrial plastics, storage - concrete
Planning area - tile, linoleum

Type of lighting:

Florescent
Controlled fixture
Non-flickering

Light engineer should be consulted to determine candle-power at working surface for:

Bench area
Machine area
Finish room and spray booth
Lumber room
Supply storage
Planning
Materials testing
Project storage

General lighting of the laboratory should be supplemented by local lighting on individual machines when deemed necessary for better instruction/safety.

Storage:

Project storage requirement/student:

Grades 7 thru 9: 16 sq. ft. per pupil

Grades 9 thru 12: 20 sq. ft. per pupil

Tool panels adjacent to work areas (general use tools in open panels, specialized equipment requiring security stored in tool room).

Lockers provided for regular students work and street clothes.

Bench (under), open shelving, perimeter wall storage (open or with door security are alternatives for storage).

Project storage conveniently provided for near bench area.

Lumber stored horizontally on safe pipe racks.

Plywood and plastic laminates stored flat on racks (pipe or wood).

Finishing:

Separate space should be provided for finishing. This can be a joint use facility with separate specialized equipment suitable for woodworking, metal, etc. Should be equipped with spray booth.

Spray Booth:

Walk-in type. Located adjacent to outside wall whenever possible; provision should be made for outside exit, must be vented. Air exhausted from spray booth should be 125 c.f.m. per square foot of booth floor area; 1000 c.f.m. per booth or whichever is greater; or 800 c.f.m. drawn from within 16 inches of each spray nozzle. Air should be drawn from above the work location. Equip with vapor proof lighting and sprinkler system.

Finish Room: 130 to 200 sq. ft. in area

Should include bench area for other methods of finish application, i.e., dipping, brushing, wiping.

Should include metal storage cabinets for storage of current supplies.

Should include sink with clean-out trap.

Drying Area:

Should be designed into the total finishing area complex:

Protected from spray room.

Provision made for drying large objects (40 sq. ft. of area).

Slatted type shelving increases air circulation.

Ceilings:

Be 14 feet from floor to provide for air volume.

Be accoustically treated.

Cabinet Tops:

Finishing - sheetmetal

Industrial plastics - sheetmetal

Wood benches - hardwood, transite

Adhesives, gluing - sheetmetal

Planning and testing - masonite, wood, plastic laminate

Services and Utilities

Electrical:

115-130 and 220-440 volt installation, single and three phase or 115/230 and 208/220/440 volt, single and three phase.

Power circuit system should include raceway installation (exposed installation on ceiling) and perimeter service outlets.

Branch power circuits should be one per machine protected by individual circuit breakers.

Magnetic remote control switch buttons should be installed for instructor control in emergencies (installation interval should relate to local/state code).

Power and light control panels should be located centrally to all of the laboratory with master control near instructor's bench.

Mechanical:

Dust and fume collection - suitable to provide removal of all air contaminate produced by machine and hand tool operations and fumes developed by bonding of adhesives or fiberglas and plastics experimentation. Installation in floor or from ceiling, on modular basis, with special ducts that are easily opened for maintenance.

Dust collection unit installed outside of laboratory facility to decrease noise factor.

Floor-sweeping ducts provided at convenient intervals.

Air-changed every 5 minutes in finish and plastics area. Air-changed in principal work area every 15 minutes.

Heating system - large enough to replace heat exhausted by dust and fume collection system.

Accoustics control - sound absorption value of ceiling should be 50 percent to 70 percent; sound absorption value of walls should be 30 percent to 60 percent.

Plumbing:

Lavatory facilities should be located centrally to all laboratories (general school use (in hall) plus one very small toilet area per shop).

Washing and drinking facility provided within:

One wash station for each 10 students.
On work or slop sink with oversized grease trap in principal work area and in finishing room.

Clean-outs readily accessible to each area where grease is a problem.

Compressed Air:

Compressor located: centrally to all laboratories, far enough from use for air to cool and moisture to condense; outside shop proper to eliminate noise factor, where air intake is warm dry air, high enough for easy drain of tank.

Compressed air outlets provided in finish, plastics, materials testing and principal shop area.

Combustible Storage:

Finishing supplies not required for immediate use stored in closed fireproof vault (refer to local fire codes).

METALWORKING, grades 7-12

Level 1 Introduction to General Metals.

Level 2 Basic exploration of General Metals.

Level 3 Intermediate specialization of General Metals in natural groups.

Level 4 Specialized applications in a single field of metals (sheetmetal, machine shop).

Room use: Metalworking activities and related instruction.

Approximate shape including auxiliary areas: Rectangular with a proportion as near 2:3 as possible.

Number of students to be accommodated at one time: 24

Square feet per student in the principal work area:

Grades 7 thru 9: 125 sq. ft. per pupil

Grades 9 thru 12: 125 sq. ft. per pupil

Vocational: up to 200 sq. ft. per pupil

Courses to be taught in the laboratory:

Exploration of metalworking (for students with little or no previous metalworking instruction).

Advanced general metalworking including: Forging and Heat Treating, Machining, Welding, Sheetmetal, Foundry practices, Welding--Oxy-Acetylene, Arc, and Inert gas, Plating and Related Processes and an introduction to Production line techniques.

Trade and vocational instruction.

Adult education.

Floor level preference: On grade because of heavy equipment requirements.

Special room requirements: Auxiliary work area,

Grades 7 thru 9: 25-30 sq. ft. per pupil

Grades 9 thru 12: 40 sq. ft. per pupil

Recommended inclusions within auxiliary areas:

Metal finishing and plating
Special tool and material storage
Planning
Project storage
Lockers

Auxiliary areas are in addition to the principal working area of the metal's laboratory.

Special room features:

Type of flooring:

Principal and auxiliary areas, except planning, concrete
Planning - tile, linoleum
Machine area - sealed to prevent oil saturation
Hot metals area - steel over concrete to prevent hot metal contacting damp or wet concrete to avoid explosion/corrosion.

Type of lighting:

Florescent
Controlled fixture
Non-flickering

Lighting engineer should be consulted to determine candlepower at working surface for:

Sheetmetal area
Machining area
Hot metalworking area (foundry, welding, heat treating).
Wrought metalwork area
Finish room and storage rooms
Bench area
Planning

General lighting of the laboratory should be supplemented by local lighting on individual machines when deemed necessary for better instruction/safety.

Storage:

Project storage requirements/student:

Grades 7 thru 9: 8 sq. ft. per pupil

Grades 9 thru 12: 10 sq. ft. per pupil

Same principles concerning Woodworking for tool panels, lockers, bench storage, and project storage should apply.

Finishing:

Separate space should be provided for finishing. This can be a joint use facility with separate specialized equipment suitable for woodworking, metal, etc. Should be equipped with a spray booth.

Spray Booth:

May be joint use facility with woodworking. Does not have to be walk-in type if it is provided for in metal-working laboratory. Must be vented and equipped with adequate, vapor proof lighting.

Finish room:

May be joint use facility with woodworking. Include bench area for other methods of finish application, i.e., dipping, brushing, wiping.

Provision should be made to include exploratory facility for baking on finishes (oven) and cleaning metals.

Drying Area:

Should be designed into the total finishing area complex:

Protected from spray room.

Provision made for drying by hanging or on slatted shelving (increased air circulation).

Ceilings:

Be 14 feet from floor to provide for air volume.

Be accoustically treated.

Cabinet Tops:

Finishing - sheetmetal

Sheetmetal - sheetmetal, steel

Hotmetals - metal over asbestos

Machine area - sheetmetal, steel

Planning - testing-plastic laminate

Services and Utilities

Electrical:

115-130 and 220-440 volt installation, single and three phase or 115/230 and 208/220/440 volt, single and three phase.

Power circuit system should include raceway installation (exposed installation on ceiling) and perimeter service outlets.

Branch power circuits should be one per machine protected by individual circuit breakers.

Magnetic remote control switch buttons should be installed for instructor control in emergencies (installation interval should relate to local/state code).

Power and light control panels should be located centrally to all of the laboratory with master control near instructor's bench.

Mechanical:

Smoke, fume and dust exhaust--suitable to provide removal of all air contaminate produced by machine, hand tool, hot metals, welding operations and chemical milling. Installation from ceiling, hooded to a functional level over all areas that project fumes or smoke. Air exhausted from each welding booth should be 100 c.f.m. per square foot of booth floor area or 1000 c.f.m. per booth, whichever is greater; or 600 c.f.m. drawn from within 12 inches of each welding arc. Air should be drawn from above work location. Floor installation on modular basis to remove dust.

Collection - exhaust unit installed outside of laboratory facility to decrease noise factor.

Floor sweeping ducts provided at convenient interval; screened to prevent pickup of metal fragments.

Air changes in principal work area every 15 minutes. Air changes in plating and cleaning (acid) area every 5 minutes.

Heating system - large enough to replace heat exhausted by dust collection - exhaust system.

Accoustics - sound absorption of ceiling should be 50 to 70 percent; sound absorption of walls should be 30 to 60 percent.

Plumbing:

Lavatory facilities should be located centrally to all laboratories (general school use (in hall) plus one very small toilet area per shop).

Washing and drinking facility provided within the laboratory.

One wash station for each 10 students

One work or slop sink with oversized grease trap.

Clean-outs readily accessible wherever grease is a problem

Water plumbed to welding area for TIG welder.

Water plumbed to sheetmetal area for water-cooled spot welder.

Compressed Air:

Compressor located: centrally to all laboratories, far enough from use for air to cool and moisture to condense; outside shop proper to eliminate noise factor, where intake is warm, dry air, high enough for easy drain of tank.

Compressed air outlets provided in finishing area, soldering bench, metal testing area, hot metals area (foundry and heat treating).

Combustible Storage:

Gas for welding stored outside of building in closed vault (refer to local fire code).

POWER MECHANICS, grades 7-12

Level 1 Introduction to Power, exploratory

Level 2 Basic exploration of Power sources

Level 3 Specialization in Power sources

Level 4 Specialized application in a single field of Power, i.e. automechanics

Room use: The study of power and its related forms.

Approximate shape including auxiliary areas: Rectangular with a proportion as near 2:3 as possible.

Number of students to be accommodated at one time:

Power Mechanics, grades 7 thru 12: 24 students

Auto Mechanics, grades 10 thru 12: 22 students

Square feet per student in the principal work area:

Power Mechanics, grades 7 thru 9: 100 sq. ft. per pupil

Auto Mechanics, grades 10 thru 12: 125 to 140 sq. ft. per pupil

Vocational: up to 200 sq. ft. per pupil

Courses to be taught in laboratory:

Introduction to Power Mechanics (students that have not received exploration in comprehensive general shop in intermediate (junior high) school).

Power Mechanics, including study of internal and external combustion converters, electrical power, fluid power, and other forms of power used in American industry and transportation:

Auto mechanics

Evening trade and technical instruction

Floor level preference: On grade

Special room requirements: Auxiliary work area,

Power Mechanics, grades 7 thru 9: 60 sq. ft. per pupil

Auto Mechanics, grades 10 thru 12: 70 sq. ft. per pupil

Recommended inclusions within auxiliary areas:

Supplies, special tools

Materials and engine testing

Planning - classroom

Auxiliary areas are in addition to principal working area of the power laboratory.

Special room features:

Type of flooring:

Concrete throughout laboratory except planning - classroom which should be provided with tile or linoleum covering. Concrete sealed to prevent penetration of grease.

Principal working area and testing areas should be provided with pump drains.

Type of lighting:

Florescent
Controlled fixture
Non-flickering

Lighting engineer should be consulted to determine candlepower at working surface for:

Bench areas
Machine area
Planning - classroom
Testing - service area
Supply - special tool storage
Lubrication - car area

General lighting of the laboratory should be supplemented by local lighting on individual machines when deemed necessary for better instruction/safety.

Storage:

Storage requirements per student (personal):

Power Mechanics, grades 7 thru 12: 8 sq. ft. per pupil

Auto Mechanics, grades 10 thru 12: 8 sq. ft. per pupil

Tool panels adjacent to work areas (general use tools in open panels, specialized equipment requiring security stored in tool room).

Benches equipped with trays to hold tools used for assembly - disassembly.

Lockers provided for students' work and street clothes.

Open shelving, perimeter wall storage.

Spare parts, hardware storage provided convenient to testing and assembly - disassembly area.

Finishing:

Cooperate with joint-use facility in Metalworking - Woodworking laboratories.

Ceilings:

Be 12 to 14 feet from floor to provide for air volume.

Be accoustically treated.

Equip when possible with overhead monorail to mount overhead hoist.

Cabinet Tops:

Laboratory, storage areas - metal covered.

Electrical - transite, benolux, wood.

Services and Utilities

Electrical:

115-130 and 220-440 volt installation, single and three phase or 115/230 and 208/220/440 volt, single and three phase.

Power circuit system should include raceway installation (exposed installation on ceiling) and perimeter service outlets.

Branch power circuits should be one per machine protected by individual circuit breakers.

Power and light control panels should be located centrally to all of the laboratory with master controls near instructor's bench.

Mechanical:

Fume and smoke exhaust - suitable to provide removal of all air contaminate produced by machine, engine, or welding operations. Installation in floor on modular basis.

Exhaust unit installed outside of laboratory to decrease noise factor.

Air changed in principal work area every 15 minutes.

Heating system - large enough to replace heat exhausted by exhaust system.

Accoustics control - sound absorption value of ceiling should be 50 to 70 percent; sound absorption value of walls should be 30 to 60 percent.

One single post hydraulic hoist should be included if automobiles mechanics is explored.

Plumbing:

Lavatory facilities should be located centrally to all laboratories (general school use (in hall) plus one very small toilet area in the laboratory).

Washing and drinking facility provided within:

One wash station for each 10 students.

One work or slop sink with oversized grease traps.

Sewer systems provided with grease and sand traps (floor sump drains).

Clean-outs readily accessible wherever grease is a problem.

Compressed air:

Compressor located: centrally to all laboratories, far enough from use for air to cool and moisture to condense; outside shop proper to eliminate noise factor, where air intake is warm dry air, high enough for easy drain of tank.

Air outlets provided at work stations and mounted over head.

Air outlets provided at 60-150 lbs. pressure per square inch.

Combustible Storage:

Gasoline stored in underground tank outside building (refer to local building and fire codes).

Gas for welding stored outside of building in closed vault (refer to local fire codes).

Storage of automobiles:

It is recommended that some consideration be given to storage of automobiles and availability to servicing automobiles outside of the laboratory itself. Where possible the following should be considered:

Fenced in patio with concrete or asphalt paving.

Cantilivered roof, up to 12 feet overhang, over outside work area, extending above entrance doors of the laboratory. Paved apron either concrete or asphalt.

Service Doors:

Overhead or hinged double door with removable center mullion.

ELECTRONICS:

Electricity-Electronics, grades 7-12

Level 1 Applied Electricity - a general understanding about electricity and its related tools.

Level 2 Basic Electricity - a terminal course; introduction to Electronics, general understanding of the use and application of test equipment.

Level 3 An extension in the use of test equipment, with greater depth and the application of basic theory.

Level 4 Electronics - application of electronics to industrial arts uses.

Room use: Electricity and Electronics

Approximate shape including auxiliary areas: Rectangular with a proportion as near 2:3 as possible.

Number of students to be accommodated at one time: 24

Square feet per student in the principal work area:

Electricity-Electronics, grades 7 thru 9: 75 sq. ft. per pupil.

Electronics, grades 9 thru 12: 75 to 100 sq. ft. per pupil.

Vocational: The area may be increased in proportion to the amount of service training that will be planned.

Courses to be taught in the laboratory:

Basic Electricity (source, magnetic effect, circuit analysis, AC-DC theory, power and projects).

Basic Electronics (radio and television component functioning, basic and advanced communication, sound effects, testing, servicing and projects).

Trades and/or evening adult or apprenticeship instruction.

Floor level preference:

On grade or above those laboratories that require grade level entry.

Special room requirements: Auxiliary work area,

Electricity-Electronics, grades 7 thru 9: 20-25 sq. ft. per pupil

Electronics, grades 9 thru 12: 25 sq. ft. per pupil

Recommended inclusions with auxiliary areas:

Special tools and supplies
Planning
Sound proof room (when possible)
Student storage for personal equipment

Auxiliary areas are in addition to the principal working area of the electricity-electronics laboratory.

Special room features:

Type of flooring:

All areas, principal and auxiliary - tile, linoleum

Type of lighting:

Florescent
Controlled fixture
Non-flickering

Lighting engineer should be consulted to determine candle-power at working surface for:

Bench and testing area
Planning
Storage
Fabrication and service area

General lighting of the laboratory should be supplemented by local lighting at stations which require close tolerance work.

Storage:

Storage requirements per student:

Electricity-Electronics, grades 7 thru 9: 6 sq. ft. per pupil

Electronics, grades 9 thru 12: 6 sq. ft. per pupil

Trade - vocational: increase proportionately; depending on projected use

Tool panels adjacent to work areas. Tools needed for general use can be stored in test benches. Specialized tools and equipment requiring security stored in tool room.

Test equipment generally conceded necessary to daily instruction should be stored at test benches.

Ceilings:

Be 10 feet from floor. Standard classroom height.

Cabinet Tops:

Test benches - wood, plastic (benolux), plastic laminate.

Services and Utilities

Electrical:

115-130 volt installation single phase.

Power circuit system installed to each test bench and perimeter service outlets.

Branch power circuits should be one per machine protected by individual circuit breakers.

Power and light control panels should be located centrally to all of the laboratory with master control near instructor's bench.

Ground potential and capacitive mass materials should be reduced to a minimum.

Adequate safety control and equipment protection should be provided through the use of fuses, switches, isolation transformers, and relays.

General:

Non conducting type fire extinguishers should be installed in the classroom.

Mechanical:

Air changed in principal work area every 15 minutes.

Accoustics control - sound absorption value of ceiling should be 50 to 70 percent; sound absorption value of walls should be 30 to 60 percent.

Plumbing:

Lavatory facilities located centrally to the laboratory-general school use.

COMMUNICATIONS:

Drafting, grades 9-12

Level 1 Exploratory - application and introduction to the various subject areas studied within industrial arts offering, metal, electricity, power, wood, etc.

Level 2 Basic exploration of the place of drafting in today's industrial society.

Level 3 Intermediate specialization and continued exploration in broad areas of drafting, engineering (graphics), architectural, industrial drafting, etc.

Level 4 Specialization in a selected sub-area in drafting.

Room use: Drafting and related graphic communications.

Approximate shape including auxiliary areas: Rectangular with a proportion as near 2:3 as possible.

Number of students to be accommodated at one time: 26

Square feet per student in the principal drafting area:

Grades 9 thru 12: 75 sq. ft. per pupil

Courses to be taught in laboratory:

Mechanical drawing (introduction to drafting)

Architectural drafting

Engineering drafting - graphics

Industrial drafting - print reading

Technical illustration

Adult education

Floor level preference: On grade or above those laboratories that require grade level entry.

Special room requirements: Auxiliary work area,

Grade 9 thru 12: 10 sq. ft. per pupil

Recommended inclusions within auxiliary areas:

Reproduction of drawings - printmaking

Model and supply storage

Special problems room (large planning tables)

Auxiliary areas are in addition to the principal working area of the drafting area.

Special room features:

Type of flooring:

All areas - tile or linoleum

Type of lighting:

Florescent
Controlled fixture
Non-flickering and non-glare

Lighting engineer should be consulted to determine candle-power at working surface for:

Bench area
Auxiliary rooms

Storage:

Storage requirements per student: 4 to 6 sq. ft. per student.

Storage cabinets, adjacent to drafting area to store student drawings, paper stock and models.

Shelving to display resource materials and models.

Specialized equipment (surveying instruments and drafting instruments) requiring security may be stored in special cabinets.

Student benches provided with storage for materials and equipment used in daily instruction.

Finishing:

Work requiring air brush treatment may be explored in reproduction room (if properly vented) or in joint use finishing facility of the woodworking laboratory.

Ceilings:

Be 10 feet from floor

Cabinet Tops:

Reproduction room and storage - plastic laminate if individual drawing boards are used (tops) should be completely non-glare or covered with non-glare paper or mat).

Services and Utilities

Electrical:

115-130 volt installation, single phase.

Power circuit system should include perimeter service outlets in principal and auxiliary areas.

Power and light control panel should be located centrally to all of laboratory.

Mechanical:

Fume exhaust provided in reproduction room.

Air changed in principal and auxiliary work areas every 15 minutes.

Accoustic Control - sound absorption value of ceiling should be 50 to 70 percent; sound absorption value of walls should be 30 to 60 percent.

Color contrast of walls should be very low.

Plumbing:

Lavatory facility located centrally to the laboratory-general school use.

One wash sink in both the reproduction room and the principal work area for cleaning of drafting equipment.

GRAPHIC ARTS, grades 9-12

Level 1 Exploratory (general graphic arts: silk screen, letterpress, block printing, rubber stamp, book-binding, direct copy offset).

Level 2 Basic exploratory (advanced processes from Level 1, photo-offset, photography).

Level 3 Specialization (photo-offset, lithography, relief printing, photography).

Level 4 Specialized application in a single field.

Room use: printing and photography

Approximate shape including auxiliary areas: Rectangular with a proportion as near 2:3 as possible.

Number of students to be accommodated at one time: 24

Square feet per student in the principal work area:

Grades 9 thru 12: 100 sq. ft. per pupil

Vocational: 150 sq. ft. per pupil

Courses to be taught in laboratory:

General printing and photography - introduction to graphic medias

Advanced graphic arts - including specialized photography and commercial printing (offset lithography).

Practical application of graphic medias - trade or pre-vocational.

Adult education - avocational.

Floor level preference: On grade or above those laboratories that require grade level entry.

Special room requirements: Auxiliary work area,

Grades 9 thru 12: 25 sq. ft. per pupil

Darkroom (print processing area)
Darkroom (negative processing area)
Offset camera room
Wash area
Storage
Planning

Auxiliary areas in addition to the principal working area of the graphic arts laboratory.

Special room features:

Type of flooring:

All areas, principal and auxiliary - tile or linoleum

Type of lighting:

Work area (machine, planning)
Worktables - Florescent
Controlled fixture
Non-flickering
Darkroom area - Incandescent
Fixed/portable dark light

Lighting engineer should be consulted to determine candlepower at all stations. Because of specialized, close work, candlepower should be rated same as drafting.

Storage:

Project storage requirements/student:

Grade 9 thru 12: 6 sq. ft. per pupil

Tool panels adjacent to work areas.

Specialized equipment (cameras) requiring security stored in cabinets with locks.

Materials subject to spoilage by light, heat, spontaneous combustion and dampness stored in area that will prevent waste.

Open shelving for paper stock.

Special storage for type, bindry and offset supplies.

Perimeter, wall storage.

Ceilings:

Be 10 feet from floor

Cabinet Tops:

Camera and dark rooms - stainless steel or fiberglas

Graphic Arts laboratory area - plastic laminate

Services and Utilities

Electrical:

115-130 volt installation, single phase.

Power circuit system should include wireway installation in floor (modular) and walls (perimeter plug strips).

Bench power circuits should be one per machine protected by individual circuit breakers.

Power and light control panels should be located centrally to all of the laboratory with master control near instructor's bench.

Mechanical:

Fume collection - suitable to provide removal of all air contaminate produced by machine and photographic processing, silk screening, and cleaning of equipment.

Air change in principal work areas every 15 minutes.

Heating system - large enough to replace heat exhausted by fume control. Avoid direct currents of air on materials and work in process.

Accoustics Control:

Sound absorption value of ceiling should be 50 to 70 percent; sound absorption value of walls should be 30 to 60 percent.

Plumbing:

Lavatory facility located centrally to the laboratory - general school use.

Wash sink in the principal wash area of the laboratory.

Sinks (designed for processing film, continuous, metered flow) in the photographic dark room.

Compressed air:

Compressed air outlet provided for air brush exploration in the principal shop area.

General:

Presses should be mounted on vibration absorption blocks.

Darkroom should have light lock (trap) door between principal work area and darkroom. Revolving door is possible solution.

COMPREHENSIVE GENERAL SHOP, grades 7-12

See explanation of General Shop in description of Level 1 and Level II pages 11 and 12.

Room use:

Should include equipment and materials for at least two subject areas of industrial arts. Any combination of the following that fits the needs of the students as planned within a given community:

Electricity
Graphic Arts
Woodworking
Metalworking
Power Mechanics
Drafting related to the above

Approximate shape including auxiliary areas: Rectangular with a proportion as near 2:3 as possible.

Number of students to be accommodated at one time: 24

Square feet per student in the principal work area:

Grades 7 thru 9: 100 sq. ft. per pupil

Grades 9 thru 12: 100 sq. ft. per pupil

Courses to be taught in laboratory:

Grades 7 thru 9: Level I Introductory, Exploratory

Grades 9 thru 12: Level II Basic, Exploratory (see page 12 for explanation of levels of activity).

Floor level preference: On grade because of some heavy equipment requirements.

Special room requirements: Auxiliary work area,

Grades 7 thru 9: 40 sq. ft. per pupil

Grades 9 thru 12: 50 sq. ft. per pupil

Recommended inclusions within auxiliary areas:

Finishing
Planning - Conference - Drawing
Supplies, special tools
Materials testing
Darkroom
Lumber - metal storage
Seating area, away from principal work area

Auxiliary areas are in addition to the principal working area of the Comprehensive General Shop.

Special room features:

Type of flooring:

Concrete - all activities that will create a fire hazard or involve oil, water, hot metals, or mechanics. Examples - Power Mechanics, Metal-working, Finishing. Steel over concrete in foundry area to prevent hot metal contacting damp concrete.

Wood, tile, linoleum - planning, woodworking, graphic arts, electricity.

Type of Lighting: Principal and auxiliary areas.

Florescent
Controlled fixture
Non-flickering
Darkroom - incandescent
fixed/portable dark light

Lighting engineer should be consulted to determine candle-power at working surface for:

Bench areas
Machine areas
Finish room and spray booth
Lumber and metals storage
Supply and special tool storage
Planning - demonstration areas
Materials testing
Project storage
Photo-darkroom

General lighting of the laboratory should be supplemented by local lighting on individual machines when deemed necessary for better instruction/safety.

Storage:

Project storage requirements per student:

Grades 7 thru 9: 8 sq. ft. per pupil

Grades 9 thru 12: 10 sq. ft. per pupil

Project storage should be designed into the laboratory facility, if possible, and adjacent to the bench or finishing facility.

Tool panels adjacent to work areas (general use tools in open panels, specialized equipment requiring security storage in tool room).

Lumber stored horizontally on safe pipe racks.

Plywood stored flat on racks (pipe or wood).

Metal stored vertically or horizontally on safe pipe or solid metal racks.

Open wall shelving or closed storage provided by perimeter placement or under benches.

Lockers provided for regular students' work and street clothes.

Supplies subject to spoilage from dust and dirt, dampness, light exposure, heat and fumes should have appropriate storage facility convenient to use.

Finishing:

Separate space should be provided for finishing. Spray booth equipment should be provided.

Spray Booth:

Walk in type: located adjacent to outside wall whenever possible; provision should be made for outside exit, must be vented. Equip with vapor proof lighting and sprinkler system.

Finish Room:

130 to 200 sq. ft. in area.

Should include bench area for other methods of finish application, i.e. dipping, brushing, wiping.

Should include metal storage cabinets for storing of finishes that are currently being used.

Drying Area:

Should be designed into the total finishing area complex; protected from spray booth; provision made for drying large objects (40 sq. ft. of area).

Slatted type shelving for increased air circulation.

Ceilings:

Be 12 to 14 feet from floor to provide for air volume.

Be accoustically treated.

Cabinet Tops:

Finish room - sheetmetal

Plastics - metal

Wood benches - wood

Adhesives, gluing - metal

Planning, testing - plastic laminate, masonite, wood

Electrical - wood, plastic (benolux), plastic laminate

Sheetmetal - metal

Hotmetals - metal over asbestos, asbestos over metal

Machine area - metal

Power - metal

Camera and darkrooms - stainless steel, fiberglas, plastic (benolux)

Graphic Arts area - plastic laminate

Services and Utilities

Electrical:

115-130 and 220-440 volt installation, single and three phase or 115/230 and 208/220/440 volt, single and three phase.

Power circuit system should include raceway installation (exposed installation on ceiling) and perimeter service outlets.

Branch power circuits should be one per machine protected by individual circuit breakers.

Magnetic remote control switch buttons should be installed for instructor control in emergencies (installation interval should relate to local/state code).

Power and light control panels should be located centrally to all of the laboratory with master control near instructor's bench.

Explosion proof fixtures should be installed whenever combustible materials or fumes will be a hazard.

Mechanical:

Dust, fume collection - suitable to provide removal of all air contaminate produced by machine, hand tool, materials processing (including bonding of adhesives, fiberglas and plastics experimentation, and chemical milling) or finishing. Dust and chip collection installation in floor, on modular basis, in special ducts that are easily opened for maintenance. Fume, smoke, spray exhaust installed overhead in appropriate areas.

Collection unit installed outside of laboratory facility to decrease noise factor.

Floor sweeping ducts provided at convenient intervals.

Air changed in principal work area every 15 minutes.

Air changed every 5 minutes in finish and plastics area.

Heating system - large enough to replace heat exhausted by dust collection system.

Accoustic Control:

Sound absorption value of ceiling should be 50 to 70 percent.

Sound absorption value of wall should be 30 to 60 percent.

Plumbing:

Lavatory facilities should be located centrally to all laboratories (general school use (in hall) plus one very small toilet area per shop).

Washing and drinking facility provided within:

One wash station for each 10 students.

One work or slop sink with oversized grease trap.

Sinks (designed for processing film, continuous, metered flow) in the photographic darkroom.

Sewer system provided with grease and sand traps (floor sump drain)in power mechanics area.

Clean-outs readily accessible wherever grease is a problem.

Compressed Air:

Compressor located far enough from use for air to cool and moisture to condense; outside shop proper to eliminate noise factor, where air intake is warm dry air, high enough for easy drain of tank.

Compressed air outlets should be provided in finish, power, materials testing, graphic arts, metalworking (hot metals) and woodworking.

Combustible Storage:

Gasoline stored in underground tank outside building (refer to local building and fire codes).

Gas for welding stored outside of building in closed vault (refer to local fire code).

Extra finishing and cleaning materials (combustible) stored in closed vault outside of laboratory (refer to local fire code).

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