American Council on Industrial Arts Teacher Education

24th YEARBOOK 1975

A Guide to the Planning of

INDUSTRIAL ARTS FACILITIES

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Donald E. Moon
Editor
Western Washington State College
Bellingham, Washington

24th YEARBOOK

American Council on Industrial Arts Teacher Education

A Division of the American Industrial Arts Association
and the National Education Association

Lithographed in U.S.A.

Yearbooks of the American Council on Industrial Arts Teacher Education are produced and distributed by the McKnight Publishing Company, Bloomington, Illinois 61701

Orders and requests for information about cost and availability of yearbooks should be addressed to the company.

Requests to quote portions of yearbooks should be addressed to the Secretary, American Council on Industrial Arts Teacher Education, in care of the publisher, for forwarding to the current Secretary.

Foreword

The past decade has brought considerable advancement in industrial arts in the area of instructional content and methodology. Accompanying this development has been an increased interest in facility planning due largely to the recognition that achievement of the goals and aspirations of curriculum and instruction rest heavily upon the adequacy of facilities.

Facility planning, therefore, has more and more permeated the entire spectrum of instructional content and methodology. This broader concept is the approach taken in the 24th Yearbook.

The ACIATE recognizes with grateful appreciation the work of the yearbook editor, Donald E. Moon, and the chapter authors. The quality of research and expertise which has gone into this publication makes it a particularly important addition to the professional literature.

The Council also recognizes with appreciation the valued contribution of the McKnight Publishing Company whose support over the years has made the ACIATE Yearbook series possible.

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President, ACIATE

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Yearbook Proposals

Each year, at the AIAA national convention, the ACIATE Yearbook Committee reviews the progress of yearbooks in preparation and evaluates proposals for additional yearbooks. Any member is welcome to submit a yearbook proposal. It should be written in sufficient detail for the committee to be able to understand the proposed substance and format, and sent to the committee chairman by February 1 of the year in which the convention is held. Below are the criteria employed by the committee in making yearbook selections.

ACIATE Yearbook Committee

Guidelines for ACIATE Yearbook Topic Selection

With reference to a specific yearbook topic:

1. It should make a direct contribution to the understanding and the improvement of industrial arts teacher education.
2. It should avoid duplication of the publications activities of other professional groups.
3. It should confine its content to professional education subject matter of a kind that does not infringe upon the area of textbook publication which treats a specific body of subject matter in a structured, formal way.
4. It should not be exploited as an opportunity to promote and publicize one man's or one institution's philosophy unless the volume includes other similar efforts that have enjoyed some degree of popularity and acceptance in the profession.
5. While it may encourage and extend what is generally accepted as good in existing theory and practice, it should also actively and constantly seek to upgrade and modernize professional action in the area of industrial arts teacher education.

6. It can raise controversial questions in an effort to get a national hearing and as a prelude to achieving something approaching a national consensus.
7. It may consider as available for discussion and criticism any ideas of individuals or organizations that have gained some degree of acceptance as a result of dissemination either through formal publication, through oral presentation, or both.
8. It can consider a variety of seemingly conflicting trends and statements emanating from a variety of sources and motives, analyze them, consolidate and thus seek out and delineate key problems to enable the profession to make a more concerted effort at finding a solution.

Approved, Yearbook Planning Committee
March 15, 1967, Philadelphia, Pa.

Previously Published Yearbooks

1. *Inventory-Analysis of Industrial Arts Teacher Education Facilities, Personnel and Programs,* 1952. Walter R. Williams, Jr. and Harvey Kessler Meyer, eds.
* 2. *Who's Who in Industrial Arts Teacher Education,* 1953. Walter R. Williams, Jr. and Roy F. Bergengren, Jr., eds.
* 3. *Some Components of Current Leadership.* Roy F. Bergengren, Jr. *Techniques of Selection and Guidance of Graduate Students.* George F. Henry. *An Analysis of Textbook Emphases.* Talmage B. Young. 1954, three studies.
* 4. *Superior Practices in Industrial Arts Teacher Education,* 1955. R. Lee Hornbake and Donald Maley, eds.
* 5. *Problems and Issues in Industrial Arts Teacher Education,* 1956. C. Robert Hutchcroft, ed.
* 6. *A Sourcebook of Readings in Education for Use in Industrial Arts and Industrial Arts Teacher Education,* 1957. Carl Gerbracht and Gordon O. Wilbur, eds.
* 7. *The Accreditation of Industrial Arts Teacher Education,* 1958. Verne C. Fryklund, ed., and H. L. Helton.
* 8. *Planning Industrial Arts Facilities,* 1959. Ralph K. Nair, ed.
* 9. *Research in Industrial Arts Education,* 1960. Raymond Van Tassel, ed.
10. *Graduate Study in Industrial Arts,* 1961. Ralph P. Norman and Ralph C. Bohn, eds.
*11. *Essentials of Preservice Preparation,* 1962. Donald G. Lux, ed.
*12. *Action and Thought in Industrial Arts Education,* 1963. E.A.T. Svendsen, ed.
*13. *Classroom Research in Industrial Arts,* 1964. Charles B. Porter, ed.
*14. *Approaches and Procedures in Industrial Arts,* 1965. G. S. Wall, ed.
15. *Status of Research in Industrial Arts,* 1966. John D. Rowlett, ed.
16. *Evaluation Guidelines for Contemporary Industrial Arts Programs,* 1967. Lloyd P. Nelson and William T. Sargent, eds.
17. *A Historical Perspective of Industry,* 1968. Joseph F. Leutkemeyer, Jr., ed.
18. *Industrial Technology Education,* 1969. C. Thomas Dean and N. A. Hauer, eds. *Who's Who in Industrial Arts Teacher Education,* 1969. John M. Pollock and Charles A. Bunten, eds.
19. *Industrial Arts for Disadvantaged Youth,* 1970. Ralph O. Gallington, ed.
20. *Components of Teacher Education,* 1971. W. E. Ray and Jerry Streichler, eds.
21. *Industrial Arts for the Early Adolescent,* 1972. Daniel L. Householder, Editor.
22. *Industrial Arts in Senior High Schools,* 1973. Rutherford E. Lockette, Editor.
23. *Industrial Arts for the Elementary School,* 1974. Robert G. Thrower and Robert D. Weber, eds.

*Out-of-print yearbooks can be obtained on microfilm and in Xerox copies. For information on price and delivery, write directly to University Microfilms Inc., 313 N. First Street, Ann Arbor, Michigan 48107.

Contents

Preface

The 8th Yearbook, *Planning Industrial Arts Facilities,* was published by the ACIATE in 1959. Of all the yearbooks published this one has been by far the most popular. Not only has it outsold all others but it has been the text most often used in Industrial Arts Facility Planning courses taught in the teacher training colleges and universities across the nation.

In 1969, ten years later, the Yearbook Committee decided that it was time to revise and update the 8th Yearbook. Sam R. Porter, then Chairman of the Equipment Standards Committee of the American Industrial Arts Association, was asked if he could form a committee to undertake the task. After considerable discussion with the faculty of the Department of Technology, Western Washington State College, volunteers decided to accept the challenge and responsibility for the preparation of the 24th Yearbook, *A Guide to the Planning of Industrial Arts Facilities.* The proposal to the Yearbook Committee and the ensuing outlines for the yearbook were prepared under the leadership of Sam Porter, then Editor of the proposed yearbook. As his role in the AIAA Conference (Seattle, 1974) became complex, the yearbook assignments were traded and I became the Editor. As the authors became involved in the development of their chapters, they decided to invite various authorities from around the country to become co-authors so as to have a broader representation.

The authors realized that new industrial arts facilities cannot, in a strict sense, be planned today for utilization tomorrow: that up to three years are required to plan and construct a new facility. Also, new developments in education, such as Career Education and Federal support for industrial arts, will undoubtedly have decided effects on the construction of facilities in the future. School construction reports indicate a decrease in the construction of new educational facilities due to the decrease in school populations. Therefore, it seemed appropriate to take into consideration the fact that additions to, and the remodeling of present facilities to accommodate the anticipated expansion of industrial arts programs, would become more and more common in the years ahead. The broad purpose of this new yearbook was enlarged to provide guidelines for the reorganization of established facilities as well as the construction of totally new ones.

Chapters have been prepared by four of my Western Washington State College colleagues: Richard J. Fowler, Claude E. Hill, Sam R. Porter, Michael R. Seal, and former WWSC faculty member Thomas A. Jasnosz. Assistance in the preparation of several of the chapters has been provided by our good friends and former associates: Ronald D. Bro, Robert D. Brown, H. A. Goltz, Alvin E. Rudisill, and Ralph V. Steeb. Special recognition is made to Fred A. Olsen of Western Washington State College, and Earl E. Smith of Oregon State University, who critiqued the yearbook copy and made valuable suggestions that have been incorporated into the yearbook. The Bureau for Faculty Research at Western Washington State College has been most generous in providing the artist and typists at various stages in the preparation of the manuscript.

It is hoped that this yearbook will prove to be as popular and contribute as much to the planning of industrial arts facilities as the 8th Yearbook has.

Donald E. Moon

CHAPTER I

Introduction

Donald E. Moon
Associate Professor of Technology
Western Washington State College
Bellingham, Washington

Industrial arts education is being influenced by a number of contemporary issues. The emphasis being placed on Career Education by the Department of Health, Education and Welfare; the Federal legislation which provides for the funding of certain industrial arts programs; ecological awareness which has been fostered by numerous ecological organizations; economic restraints on the use of certain raw materials that are either in short supply or are being exhausted completely; innovations in curricular development; and the promotion of new techniques in instructional technology, to mention only a few, are having and will continue to have a decided effect on the nature of industrial arts programs in the public schools as well as in the industrial arts teacher training colleges and universities. Industrial arts cannot afford to ignore these issues nor can it afford to be entirely influenced by any one of them. The nature of industrial arts programs is changing and will continue to change, for industrial arts is an integral part of the total educational system that reflects the society it serves.

The rapid changes in technology have had and will continue to have an overwhelming influence on education and society. A technological culture has been created with the development of practical applications, science principles, techniques of production, and ecological awareness. Industrial arts is that part of the educational program which concerns itself largely with preparing individuals to live in a technological culture. This is traditionally achieved through a study of industry by providing first-hand manufacturing and service-type experiences in the use of tools, materials and processes.

The task force that engaged in the writing of the publication *Guideline for Industrial Arts in Career Education* defines industrial arts in this manner:

> Industrial arts education is that field which provides opportunities for all students from elementary through higher education to develop an understanding about the technical, consumer, occupational, recreational, organizational, managerial, social, historical, and cultural aspects of industry and technology. Furthermore, it is a field wherein students acquire industrial-technical knowledge and competencies through creative and problem-solving learning experiences involving such activities as experimenting, planning, designing, constructing, evaluating, and using tools, machines, materials, and processes.

The task force goes on to state that: "Industrial arts provides unique experiences that further the discovery and development

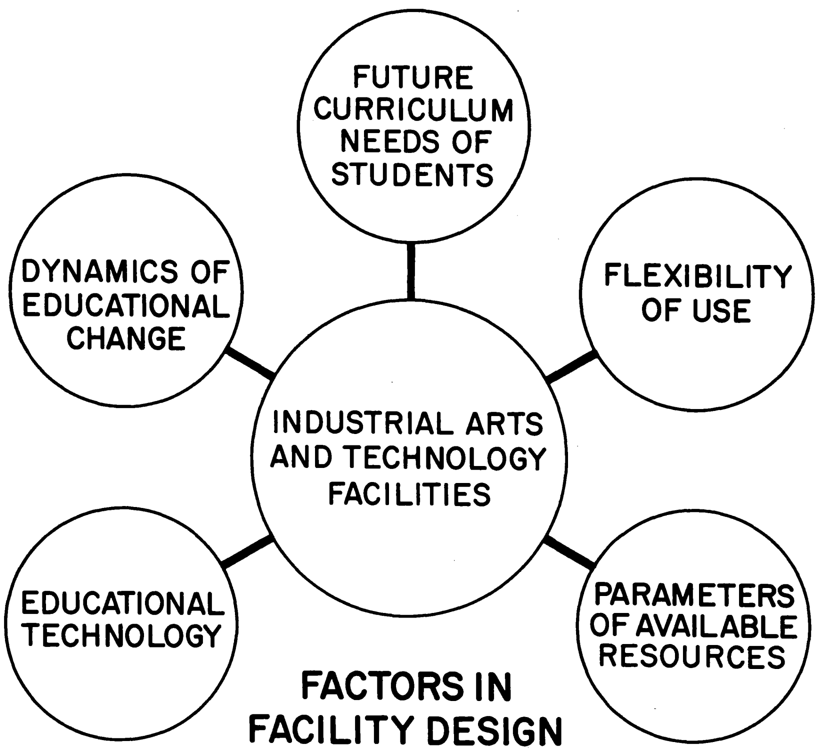


Fig. 1-1.
Copyright by AIAA, 1974. From Bro and Rudisill in *Industrial Arts and a Humane Technology for the Future*, p. 309.

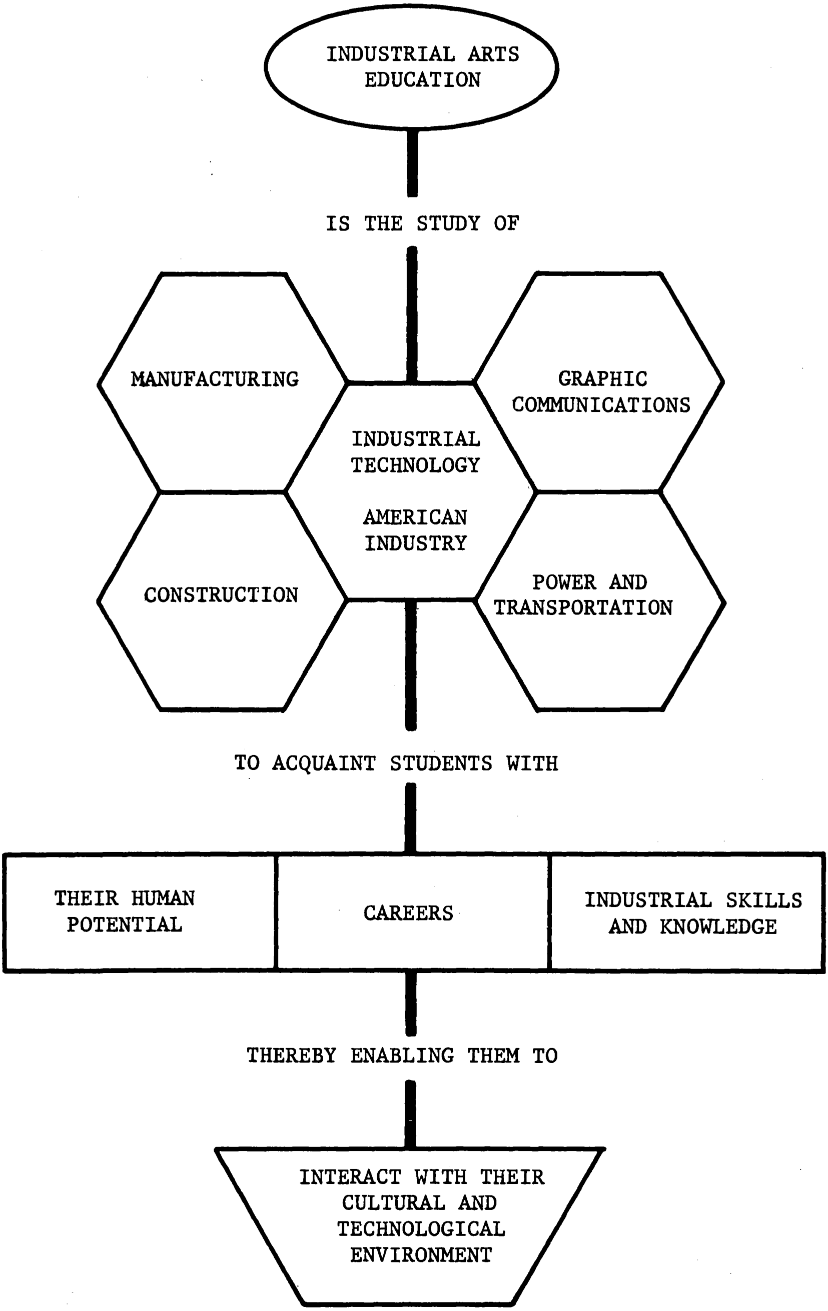


Fig. 1-2.
Copyright by ACIAS, 1974. From Ralph V. Steeb in *A Guide to Preparing Educational Specifications for Secondary Industrial Arts Facilities: Monogram I*, Washington: ACIAS, 1974, p. 8.

of each student's career potential, technical abilities, judgment, self-reliance, and resourcefulness to succeed as an effective producer and/or consumer in the industrial-technical society."

These above-mentioned concepts are graphically presented in Figure 1-2.

Industrial arts programs operate in laboratories equipped with the basic industrial materials, machines, and energies of industrial technology. A modern and up-to-date industrial arts program must have laboratory facilities that provide an environment representative of modern technology, yet with the capability of being flexible and readily adaptable to the changes reflected in the technological society.

Typically industrial arts facilities have been organized into the traditional material or area orientation with such designations being used as wood shop, metal shop, and drafting room. Many of the innovative industrial arts programs that have come about in the last decade make reference to conceptual teaching and the conceptualization of the subject matter found in industrial arts. This would suggest that the laboratory facilities for industrial arts should be designed to provide a learning environment in which the understandings and applications of the principal commonalities can be implemented with all materials, processes and energies of the technologies. A contemporary arrangement of the curriculum as has just been suggested would indicate that industrial arts laboratory facilities in the future may very well be referred to conceptually as: Material and Process Laboratory; Visual and/or Graphic Communications Laboratory; Power and Mechanical Laboratory; and Electrical Laboratory.

The design of industrial arts laboratories and buildings has too often been premised on present and past circumstances, with only a casual look to the future (Anderson, 1973). In an era of rapid curriculum change, such as is presently being experienced in industrial education, this procedure can result in facility obsolescence before construction is completed. Educators and architects need to work together to design facilities which will be functional in fulfilling the needs of students in the future. The design of today's facilities should be geared to emerging curricular programs and new instructional approaches in industrial education (Bro-Rudisill, 1974).

In the past, facility planning guides have reproduced floor plans that were fairly representative of typical industrial arts facilities, and presented equipment lists and specifications. In many cases planners duplicated these plans, equipment lists and specification; built the facility and then decided on the program that would go into the facility. Educational facility planners today advocate that: first, a study of the needs of the community be made; second, the specifications of the industrial arts program be written based on the results of the research; third, develop the plans for the facility with equipment being specified and purchased to implement the educational needs of the community. In addition, modern industrial arts facility planning must take into consideration the goals of the program. The following goal statements appear in *Guidelines for Industrial Arts in Career Education*:

1. Develop insights and understandings of industry and its place in our culture.
2. Discover and develop talents, attitudes, interests and individual potential related to the industrial-technical areas.
3. Develop abilities in the proper use of tools, machines, and processes.
4. Develop problem-solving and creative abilities involving materials, processes, and products of industry.
5. Interrelate the content of industrial arts with other school subjects in the curriculum.
6. Develop an understanding of a variety of careers and their requirements.

The purpose of this yearbook is to provide guidelines for the industrial arts facility planner. The yearbook provides a discussion of the terminology, status, and trends relevant to industrial arts education; a sequential development system for the planning of industrial arts facilities; the principles relative to the planning of facilities; the planning for effective organization and management of industrial arts facilities; and the facility needs to implement some of the innovative industrial education programs that have come about in the past two decades. In the Appendix, check list forms are provided to help the planner to determine the program requirements; to evaluate the facility; and to systematically analyze the safety conditions of the facilities.

It is hoped that this guide to the planning of industrial arts facilities will provide the profession with a document that will be useful in the planning of new and upgrading of existing industrial arts laboratories.

REFERENCES

A Guide to Preparing Educational Specifications for Secondary Industrial Arts Facilities, Monogram I, Washington: American Council of Industrial Arts Supervisors, 1974.

Anderson, Lowell D. "Trends in Laboratory Design for the Middle Schools," *Man/Society/Technology,* 32:239, March, 1973.

Bro, Ronald D. and Alvin E. Rudisill. "Designing Educational Facilities for the Future," in, *Industrial Arts and a Humane Technology for the Future,* Washington: American Industrial Arts Association, 1974.

Brown, Robert D. *Industrial Arts Laboratory Planning and Administration,* Milwaukee: Bruce Publishing Company, 1969.

Cochran, Leslie H. *Innovative Programs in Industrial Education,* Bloomington: McKnight Publishing Company, 1970.

Guide for Planning Educational Facilities, Columbus: Council of Educational Facility Planners, 1969.

Guidelines for Industrial Arts in Career Education, Washington: U.S. Office of Education.

Lindbeck, John L. *Practical Guide to Industrial Arts Education,* New York: The Center for Applied Research in Education, Inc., 1972.

Maley, Donald. *The Maryland Plan,* New York: Bruce Publishing Company, 1973.

Planning and Designing Functional Facilities for Industrial Arts Education, (U.S. Department of Health, Education, and Welfare), Washington: U.S. Government Printing Office, 1968.

Olson, Delmar W. *Industrial Arts and Technology,* Englewood Cliffs: Prentice Hall, Inc., 1963.

School Shop Development, Pittsburgh: Rockwell Manufacturing Company.

Wilbur, Gordon O., and Norman C. Pendered. *Industrial Arts in General Education,* 4th edition, New York: Intex Educational Publishers, 1973.

CHAPTER II

Terminology, Status and Trends

Richard J. Fowler
Associate Professor of Technology
Western Washington State College
Bellingham, Washington

TERMINOLOGY

The subject field of Industrial Arts, as a part of the total school curriculum, is a multi-faceted field with many categories and sub-categories. Because the field has such heterogeneous content and structural organization, some standard terminology is needed before meaningful discussion of the field can occur. For the sake of clarity, the remaining chapters of this yearbook will utilize the terminology defined and discussed below.

Content of Industrial Arts

The content of industrial arts can be categorized or divided into *Areas* and *Sub-areas*. There are several ways in which this division can be accomplished.

Sometimes the content of industrial arts is broken into *areas* on the basis of the materials involved; thus one can speak of the "woods area" or the "metals area" or the "plastics area." This has been the traditional breakdown of the subject matter of industrial arts.

More recently, other methods of categorizing or breaking down the subject matter of industrial arts have been utilized. These new approaches usually provide for much broader grouping and often cut across the traditional areas of industrial arts. For example, the content could be divided into such areas as "materials and processes," "power and transportation," and "communications." Under the new area of materials and processes would be included much of the subject matter which traditionally would fall under the areas of "wood," "metals," and "plastics." For example, the concepts of cutting, forming, molding/casting, assemblying, etc. could be taught as they apply to the materials mentioned above. Regardless of whether one uses the traditional categories or one of the new categories, the term "area" as used in the field of industrial arts refers to a grouping together of a large segment of the subject matter of industrial arts which has many common elements.

A *sub-area* is a further delineation of industrial arts content into smaller blocks that have more common elements than does all the subject matter included in one area. For example, the area of metal working can be divided into a number of sub-areas including art metal, sheet metal, foundry, and bench metal; or the area of drafting could be subdivided into the sub-areas of architectural drawing, machine drawing, mechanical drawing, etc.

Types of Laboratory Spaces

Industrial arts laboratory facilities contain two types of spaces: main laboratory spaces and auxiliary spaces.

The *main laboratory space* refers to that part of the laboratory where the major part of the manipulative activity takes place. In most areas of industrial arts, it contains the majority of the equipment, and would be the place where the student spends the majority of his time. It is generally the largest space in the facility, and is left as visually open (minimum partitions or dividers) as required safety factors will allow so that the instructor can provide continuous visual supervision of laboratory activities.

Auxiliary spaces are those spaces needed to supplement and support the activities carried on in the main laboratory space. Additionally, some auxiliary spaces are needed to carry on activities which for safety reasons cannot be conducted in the main laboratory space. Supporting auxiliary spaces would include supply storage, project storage, office, student resource and planning centers, and teacher resource and planning centers in larger departments where such activities as team teachers are utilized. Storage of flammable, toxic, and explosive materials may require special auxiliary spaces that meet federal, state and local safety requirements. (See Chapter IV.)

Types of Laboratory Organization

Three types of laboratory organization are used in the field of industrial arts: the *comprehensive general laboratory*, the *general unit laboratory*, and the *unit laboratory*.

The *comprehensive general laboratory* has two distinguishing characteristics: (1) it provides for instruction in two or more areas of industrial arts, and (2) it is organized so that the activities in the two or more areas occur simultaneously. Generally, this type of laboratory is found in the smaller schools which can support only one or two industrial arts laboratories. Most often only one instructor teaches in the comprehensive general laboratory; however, in some of the medium-sized schools two instructors may be teaching in the same comprehensive general laboratory facility. Although various other titles, including "multi-area," "multi-activity," "multi-field industrial," "laboratory of industries," and "general shop," are sometimes used to denote this type of laboratory organization, the term "comprehensive general" seems to be the most prominent and it will be used throughout this yearbook. A typical comprehensive general laboratory might offer simultaneous instruction and activities in the areas of woods, metals, drafting, and crafts.

This type of laboratory has several advantages over the other types. First, it allows the student in the small school with minimum industrial arts facilities to have exploratory experiences in a number of areas of industrial arts. Second, it allows for the integration of many different materials in student projects. This gives the student more freedom in the selection of his project or activity, and greatly enhances the probability of creative solutions of his design problems.

Some of the drawbacks to the comprehensive general laboratory are as follows:

1. It is difficult for the instructor to organize, manage, and keep abreast of the many areas of industrial arts.
2. It is difficult to start a new class of beginning students needing immediate instruction in several areas before they can safely undertake laboratory activities.
3. It is difficult to provide technical depth in any area for the advanced student.

The *general unit laboratory* – also known as an "area," "limited general," or "single-field industrial laboratory" – is a laboratory facility designed to provide instruction in a single area of industrial arts such as woods, plastics or metals. It provides for instruction in two or more sub-areas within a single area. As an example, a general unit laboratory in the metals area might provide for instruction in foundry, machining, sheet metal, and welding. The general unit laboratory is the most common type of facility in the public schools. It is used almost exclusively in those schools that maintain a series of industrial arts laboratories. The advantages and disadvantages of this type of laboratory are just the reverse of those listed for the comprehensive general laboratory. Some schools rotate beginning students through all the laboratories (usually six to nine weeks in each laboratory) in order to provide broad exploratory experiences in many areas of industrial arts.

The *unit laboratory* is a rather specialized facility; it is organized to provide instruction in a single sub-area such as sheet metal or foundry. Because of its specialized nature, it is seldom used in industrial arts. When used, it is most likely to be found in large schools with multi-shop programs that have a strong prevocational emphasis. The unit laboratory is also referred to as a "sub-area laboratory" or an "area-unit industrial laboratory."

A number of factors should be considered in deciding which type of laboratory (or what content in a comprehensive general laboratory) is appropriate in a given situation. Some of the factors would be:

1. Objectives and goals of the industrial arts program.
2. Nature of the learner to be served – age, previous industrial arts experience, etc.
3. Types of industry in the community and/or region.
4. Size of the school and the industrial arts program.
5. Amount and sources of funds available for constructing, equipping, and maintaining the industrial arts facility.

A full discussion of the relative importance of these, and other factors, and how they are incorporated into the planning process, is included in Chapter III.

STATUS

Because educational institutions and programs are usually in a slow, continual state of change, the current status of an educational field is practically impossible to determine. However, sudden and dramatic changes rarely occur, so "up-to-the-minute" statistics are hardly necessary for assessing the general status of industrial arts. According to a recent national survey, industrial arts teachers and teacher educators are quite reluctant to adopt new and/or radically different subject matter content or organization; any curricular reform will most likely evolve from the present structure and content of industrial arts (Carter, 1970).

Existing and Planned Facilities

A national survey, from which all national statistics for this section have been taken, has shown that more than 3.8 million boys and 84 thousand girls were enrolled in industrial arts classes in 1963 (Schmitt, 1966). Of the 25,526 junior high and senior high schools in the United States, 74% had an industrial arts program. As would be expected, approximately 96% of the larger (over 1000 enrollment) schools had programs while only 55% of the smaller (enrollment less than 400) offered industrial arts. In the schools that offered industrial arts, approximately 38% required industrial arts for 7th and 8th grade boys, 22% for 9th grade boys, and 9% required it for 10th, 11th and 12th grade boys; comparable percentages for the girls in these grades were 7%, 4%, and 4% respectively.

In general, the larger schools have more diverse industrial arts programs, more industrial arts laboratories, and more industrial arts teachers. The average school's industrial arts program has 2.2 teachers. Schools with less than 400 enrollment average 1.1 teacher, those with more than 1000 enrollment average 4.0, and those between 400 and 1000 average 1.9 teachers.

In 1963, over 202,000 industrial arts classes were taught in the U.S. in grades 7 through 12; approximately 27% of these classes were in "general industrial arts," 22% in general wood, 20% in drafting, 15% in general metals, 5% in graphic arts, 4% in electricity-electronics, 4% in crafts, and 3% in power mechanics. No national follow-up survey has been undertaken to determine what changes have occurred in the past 10 years. However, a 10-year follow-up study of industrial arts covering the period of 1961 through 1971 shows that some changes have occurred in the State of Washington (Olsen, 1972). Data from this study, shown in Table 1, indicates that proportionately fewer classes in woodworking and drafting and more classes in electricity-electronics, power mechanics and graphic arts are being offered. Since comparable follow-up data for other states is not available at this time, whether or not this is a general trend may be debatable.

Table 1

Changes in Percentage of all Courses Offered in Each of Eight Areas—Washington State 1961-71

Areas	Percentage of all Courses Offered 1961	1971
Woodworking	28.2	22.6
Drafting	26.0	20.8
Metalworking	16.3	16.2
Crafts	10.0	11.4
Comprehensive General Shop	7.8	7.6
Electricity-electronics	7.0	9.8
Power mechanics	3.5	8.3
Graphic arts	1.2	3.0

In 1963, over 17% of the 5823 junior high and senior high schools in the United States without industrial arts facilities were planning to construct such facilities within the next three years. The need for additional laboratory facilities for industrial arts is not likely to diminish. Although industrial arts facilities needs were not singled out, a 44-state report for 1969-70 indicated a need for nearly 22,000 laboratories in the fields of industrial and vocational education (Feirer, 1970). In the state of Washington, the percentage of the schools offering industrial arts which were planning new industrial arts facilities increased from 8.3% in 1961 to 13.0% in 1971 (Olsen, 1972).

One of the problems associated with both existing and future industrial arts facilities is equipping and maintaining them. In 1963 the average school spent $1,220 for supplies and $1,063 for equipment. This is about 15% more for supplies than for equipment. Schools with enrollments over 1000 tend to spend a greater percentage of their supply/equipment budget for supplies than do schools with enrollments under 1000 (62% vs. 48%).

Use of Facilities

The average class size for all industrial arts classes in grades 7 through 12 in the United States in 1963 was 19.3 students. As shown in Table 2, the area with the smallest class size was only .8 students below the mean, while the area with the largest class size was 1.6 students above the average. The stability of class size in industrial arts courses over a ten year period is indicated by the State of Washington study introduced previously. In this

Table 2

Average Class Size of Eight Areas of Industrial Arts — United States, 1963

Area of Industrial Arts	Average Number of Students per Class
All areas	19.3
General Industrial Arts	18.5
Woodworking	19.3
Drafting	20.8
Metalworking	18.6
Graphic Arts	18.6
Electricity-Electronics	19.3
Crafts	20.9
Power Mechanics	18.8

Table 3

Average Class Size of all Teachers' Smallest and Largest Classes — Washington State 1961 and 1971

Area of Industrial Arts	Average number of students in teachers' smallest class		Average number of students in teachers' largest class	
	1961	1971	1961	1971
Comprehensive General	17.0	19.9	26.7	25.5
Woodworking	17.0	18.8	25.4	25.5
Drafting	18.3	18.6	25.3	25.4
Metalworking	18.4	18.5	25.9	24.3
Graphic Arts	21.7	17.9	27.5	23.2
Electricity-electronics	20.1	18.0	25.5	23.9
Crafts	21.7	20.7	27.8	26.6
Power Mechanics	17.9	19.0	23.4	22.1

study, average class size was determined only for the teacher's smallest and largest classes. Thus, the average for all classes within a given area was not determined. Examination of Table 3 shows that the average size of both the largest and smallest classes changed most in graphic arts which had less than 3% of the total enrollment. In general, the trend is for the smallest classes to increase in size and the largest classes to decrease in size.

General industrial arts courses, usually taught in a comprehensive general laboratory, may include an almost infinite variety of combinations of areas of industrial arts. The instructional content of the average general industrial arts course in the United States in 1963 was divided between the following areas: woodworking 27%, metalworking 19%, drafting 16%, electricity-electronics 11%, leather 8%, plastics 7%, and "others" 12%. Woodworking, metalworking, and drafting dominate the instructional content of the general industrial arts course similar to the way in which they dominate the course offerings in the field of industrial arts.

For all but two of the traditional areas of industrial arts, approximately 70% of the instructional time is spent in laboratory activities and 30% in related classroom activities. The two exceptions to this lecture/laboratory ratio are electricity-electronics and power mechanics, both of which split the instructional time half and half. These ratios are applicable to both junior high school and senior high school programs.

TRENDS

During the last several decades, a number of changes have occurred in industrial arts which have implications for facilities planning. Some of these changes have been a direct result of the changing philosophies within the profession, while other changes have occurred in response to changes in the organizational structure of the schools at large. Regardless of the reason for the changes that have occurred or are occurring in industrial arts, they need to be examined in order to understand the trends in facilities planning.

Changing Laboratory Activities

One of the more obvious changes occurring in the profession has been a change in the types of laboratory activities in which the student is engaged. Traditionally, the student has been involved in the construction of some form of a take-home project. Whether the project was instructor-designed and assigned to the student, or one of the student's own choosing, by and large the activity was largely an individual effort and required little, if any, cooperation between students. This traditional type of laboratory activity is more and more being supplemented, and in some cases entirely replaced, by some form of activity requiring the cooperative efforts of a group of two or more students. For example, it is quite common today for industrial arts instructors to have groups or teams of students working on a common project or product. Indeed, many instructors are now including mass or line production units in their programs wherein all the class members are totally involved in the production of multiple copies of a single item. Planning for and carrying on this type of laboratory activity certainly requires a different facility and organizational structure than does the traditional industrial arts activity.

The experimentation-research approach to conducting industrial arts activities, which is becoming more and more common, also puts different demands on the laboratory facility than did the traditional approach. For this approach, a wide variety of materials, equipment and resource materials is needed. Flexibility in equipment arrangement, storage facility, and construction spaces is extremely desirable, if not essential, for effective use of the experimentation-research method of instruction.

Changing Content

Another trend that has implications for the planning of new industrial arts facilities is the changing content in industrial arts. Not only have numerous new processes been introduced into the traditional areas of industrial arts, but complete new subject areas, such as plastics, have been introduced in recent years; for example, new welding, forming and machining techniques in the metal area; printed circuit boards and integrated circuits in electricity-electronics; and fluid mechanics in the power mechanics area. All of these content changes have led to the need for new and different types of equipment and space. Often the new content incorporated into the industrial arts curriculum requires rather sophisticated equipment and materials. Future facilities must be designed with sufficient flexibility, especially in utilities, to accommodate the new content which our advancing technology will generate.

Although the study of industrial organization and the social implications of industrialization have historically been considered a part of the content of industrial arts, only recently has much emphasis been placed on this part of the total content of industrial arts. Development of this type of content often requires the extensive use of films, role playing, library research, resource persons, lectures, etc. Emphasizing these concepts in an industrial arts program certainly requires more and better auxiliary spaces than traditional industrial arts facilities have incorporated.

Changing Organizational Patterns and Methods

The organizational patterns of the schools also affect the industrial arts programs and the facilities needed to implement that program. For example, changing to a flexible time schedule or increasing the periods per day often changes the number of classes and students to be serviced by a facility; and of course the number of students serviced affects such things as the amount of storage needed in the industrial arts facility. Changing of the organizational structure of the school system from a 7, 8, 9 junior high or a 7, 8 junior high to a 6, 7, 8 middle school brings to the industrial arts laboratory the younger, less-mature, sixth-grade students whose needs and abilities are quite different from those of the eighth-ninth grader. The needs of the sixth grader may require different instructional techniques as well as different sizes and complexities of laboratory equipment.

Changes in instructional organization and methods have also brought about new demands on the industrial arts facilities. Industrial arts teachers are now involved in such approaches to education as team teaching, differentiated staffing, and interdisciplinary programs. To be effective, these new approaches require continual cooperative planning and evaluation. All teachers involved in the venture must also be involved in determining both long and short range goals, large-group lectures-demonstrations, small-group discussions, and laboratory activities; thus the need for clean, quiet conference and planning areas becomes most acute. Additionally, the facility must include areas appropriate for both large group lecture-demonstrations and small-group discussions.

New facilities must also provide for effective use of individual pacing and self-instructional techniques and materials now available. This may require learning carrels utilizing a wide range of educational media. Or, when wide-spread use is made of learning activity packages (LAP) a rather extensive filing, retrieval and management system may be needed.

In addition to the changing laboratory activities, content, and organizational structure discussed above, many other factors will have to be considered. The new innovative programs discussed in Chapter VI, new federal and state legislation such as those concerned with safety, and federal funding of industrial arts programs and related programs such as career education will all have some influence on the planning of new industrial arts facilities. Although it may be impossible to enumerate or to predict the specific influences of each of the above factors, the following general trends seem to be evident now and likely to continue in the future:

1. New facilities must provide flexibility of both spaces and utilities. As programs, content, and teaching methods change, the facility must be able to accommodate the changes.

2. More emphasis must be placed on the auxiliary spaces of the industrial arts facility. A greater percentage of the total space devoted to the industrial facility will be utilized in providing such things as teaching centers, resource centers, planning centers, and audio-visual facilities.

3. More emphasis must be given to the safety features of the facility. Recent safety legislation and court cases concerning teacher liability make this imperative.

REFERENCES

A Guide to Improving Instruction in Industrial Arts, 4th ed. revised. Washington, D.C.: American Vocational Association, Inc., 1968.

Carter, J. John. "An Investigation of Attitudes Held by Industrial Arts Educators Toward the Question of a Uniform Nationwide Curriculum for Industrial Arts," (unpublished Doctor's dissertation, University of Northern Colorado, Greeley, Colorado, 1970).

Feirer, John L. "Some Nagging Problems in Industrial Education," *Industrial Arts and Vocational Education,* 59:23, January, 1970.

Olsen, Fred A. *A Descriptive Survey of the Status of Industrial Arts in the State of Washington, 1961-1971* (unpublished), Bellingham, Washington, Western Washington State College, 1972.

Planning Industrial Arts Facilities, Eighth Yearbook of the American Council on Industrial Arts Teacher Education, Ralph K. Nair, Editor, Bloomington, Ill.: McKnight Publishing Company, 1959.

Schmitt, Marshall L. and James L. Taylor. *Industrial Arts Education — A Survey of Programs, Teachers, Students, and Curriculum,* (U.S. Department of Health, Education, and Welfare). Washington, D.C.: U.S. Government Printing Office, 1966.

———————. *Planning and Designing Functional Facilities for Industrial Arts Education,* (U.S. Department of Health, Education and Welfare). Washington, D.C.: U.S. Government Printing Office, 1968.

Planning Industrial Arts Facilities: The Process and the People

Sam R. Porter
Professor of Technology
Western Washington State College
Bellingham, Washington

Some Assumptions

This chapter presents information intended to assist those people engaged in the planning processes which lead to new or remodeled industrial arts facilities. It was written with three basic assumptions:

1. Industrial arts instructors should become involved in facility planning. Although many activities take place in the planning, developing and construction of facilities which are not within the purview of industrial arts instructors, they should nonetheless be knowledgeable about the process and be prepared to assume an active role if accorded this privilege. Practices vary, of course, but this chapter presents a generalized and idealized view of the planning process, with special attention given to the role of the industrial arts instructor.

2. The preparation and planning for facility development provides industrial arts instructors with the opportunity – even

the obligation — to engage in serious, soul-searching program development. Since facility planning is increasingly seen as a team effort, industrial arts teachers and students can become active agents on the team. This involvement can lead to the definition of new, exciting and changing programs in laboratories which are similarly characterized as new, exciting and changing.

3. No rules, standards or formulae which exist will provide all the answers. This chapter provides only the concept of curricular and facility planning as a *problem-solving process* rather than presenting neatly scheduled solutions. John Dewey's steps in problem solving have been written and rewritten for applications in engineering, architecture, education, and many other fields; they are equally useful when applied to industrial arts facility planning. Though the steps vary upon application, problem-solving consists of defining and clarifying a problem, gathering and examining various alternatives, choosing and testing an alternative, and evaluating the results. These steps form the foundation for the planning process described herewith; they can be applied to the smallest decision-making task (choosing a wall covering, for example) to the overall and total process itself (such as the systems approach to building design and construction.

THE PROCESS

Introduction

Critics from within and outside the schools frequently level the charge that American education does not keep pace with societal changes and that a fifty-year time-lag exists between change in society and change in education. Indeed, practices from the past do abound in education, and the evidence of tradition is often more obvious than evidence of change. However, those willing to look beyond these glittering generalities can observe that today's changing, technical society has spilled over into the schools. Listed here are a few notable examples of change:

1. Curricular content and available forms of curricular materials;
2. Team teaching; tutorial and individualized instruction;
3. Instructional technology; hardware and software assistance;
4. Self-instructional techniques; upgraded and nongraded classes;

5. Performance-based progress and grade placement;
6. Open and flexible scheduling; behavioral objectives;
7. Work experience; work-study; intern experiences;
8. Enrollment shifts to applied and technical subjects and methods;
9. Teaching assistants; para-professionals; differentiated staffing.

When one engages in the process of educational facility planning, it is obvious that even more variables and changes must be added to this list and carefully considered; changing demographic distribution; increasing costs and tax burdens; inflation; new construction and management techniques; and on and on.

Because of these variables, more questions than answers emerge. Can capital expenditures be cut without a corresponding cut in educational quality? Is it possible to provide "more for less?" With stable and sometimes downward enrollment trends, will the recycling and remodeling of space replace the new building boom of the 50's and 60's? Will industrial arts defy the enrollment trends of other disciplines and attract more students and space allocations? Given the right kind of planning processes, it can be assumed that industrial arts can be prepared to answer all of these questions. Evidence exists which would indicate most of the answers can be "yes": "Yes" we can provide more for less; "Yes" we can expect more remodeling than building; "Yes" industrial arts can expect good enrollments and space allocations; and "Yes" we can be ready for these or other eventualities. The planning process itself presents an opportunity – an opportunity for personal growth, program development, and constructive change.

A Chronology of Events

Steps to be taken in planning facilities are generalized and presented in sequence. Figure 1 provides a typical linear baseline or diagram of planning, programming, and building events with a delineation of responsibilities for architect and owner. This chart, used in a successful construction project, would indicate some divergence from other models regarding educational programming, but the major ingredients are present and the *modus operandi* differs only slightly from procedures used elsewhere. Figure 1 illustrates a concise graphic statement of events, with target dates to be supplied, which allows client and architect alike to detect the ultimate implications of early delays. In the

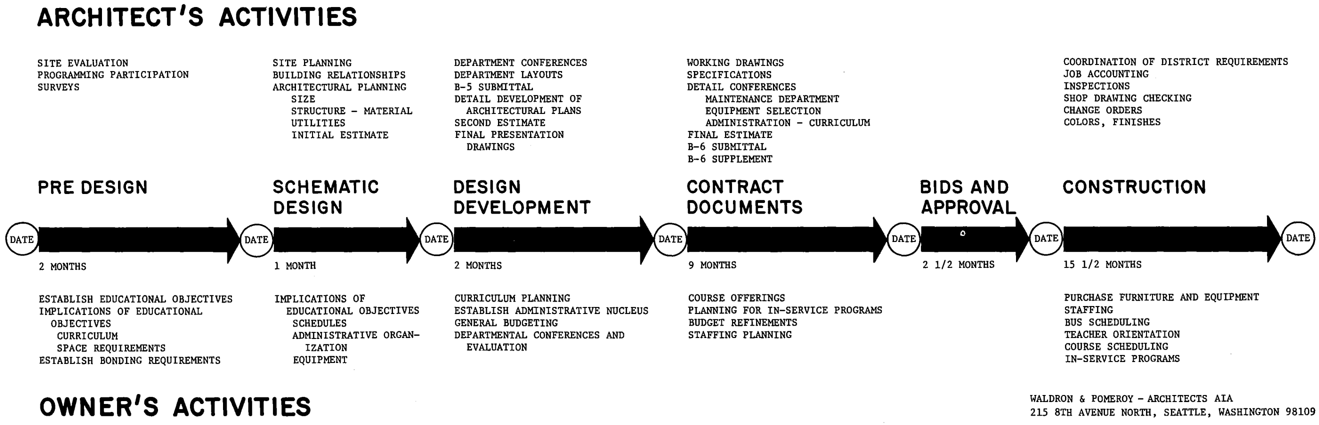

ARCHITECT'S ACTIVITIES
SITE EVALUATION
PROGRAMMING PARTICIPATION
SURVEYS
SITE PLANNING
BUILDING RELATIONSHIPS
ARCHITECTURAL PLANNING
SIZE
STRUCTURE - MATERIAL
UTILITIES
INITIAL ESTIMATE
DEPARTMENT CONFERENCES
DEPARTMENT LAYOUTS
B-5 SUBMITTAL
DETAIL DEVELOPMENT OF ARCHITECTURAL PLANS
SECOND ESTIMATE
FINAL PRESENTATION DRAWINGS
WORKING DRAWINGS
SPECIFICATIONS
DETAIL CONFERENCES
MAINTENANCE DEPARTMENT
EQUIPMENT SELECTION
ADMINISTRATION - CURRICULUM
FINAL ESTIMATE
B-6 SUBMITTAL
B-6 SUPPLEMENT
COORDINATION OF DISTRICT REQUIREMENTS
JOB ACCOUNTING
INSPECTIONS
SHOP DRAWING CHECKING
CHANGE ORDERS
COLORS, FINISHES
PRE DESIGN
SCHEMATIC DESIGN
DESIGN DEVELOPMENT
CONTRACT DOCUMENTS
BIDS AND APPROVAL
CONSTRUCTION
DATE
2 MONTHS
1 MONTH
2 MONTHS
9 MONTHS
2 1/2 MONTHS
15 1/2 MONTHS
ESTABLISH EDUCATIONAL OBJECTIVES
IMPLICATIONS OF EDUCATIONAL OBJECTIVES
CURRICULUM
SPACE REQUIREMENTS
ESTABLISH BONDING REQUIREMENTS
IMPLICATIONS OF EDUCATIONAL OBJECTIVES
SCHEDULES
ADMINISTRATIVE ORGAN- IZATION
EQUIPMENT
CURRICULUM PLANNING
ESTABLISH ADMINISTRATIVE NUCLEUS
GENERAL BUDGETING
DEPARTMENTAL CONFERENCES AND EVALUATION
COURSE OFFERINGS
PLANNING FOR IN-SERVICE PROGRAMS
BUDGET REFINEMENTS
STAFFING PLANNING
PURCHASE FURNITURE AND EQUIPMENT
STAFFING
BUS SCHEDULING
TEACHER ORIENTATION
COURSE SCHEDULING
IN-SERVICE PROGRAMS
OWNER'S ACTIVITIES
WALDRON & POMEROY - ARCHITECTS AIA
215 8TH AVENUE NORTH, SEATTLE, WASHINGTON 98109

Fig. 3-1.

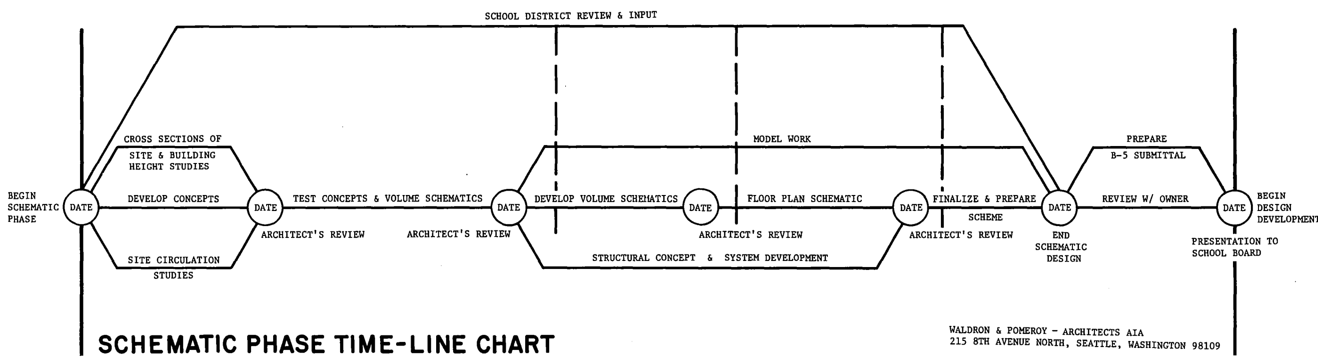

SCHOOL DISTRICT REVIEW & INPUT
CROSS SECTIONS OF SITE & BUILDING HEIGHT STUDIES
MODEL WORK
PREPARE B-5 SUBMITTAL
BEGIN SCHEMATIC PHASE
DATE
DEVELOP CONCEPTS
TEST CONCEPTS & VOLUME SCHEMATICS
DEVELOP VOLUME SCHEMATICS
FLOOR PLAN SCHEMATIC
FINALIZE & PREPARE SCHEME
REVIEW W/ OWNER
BEGIN DESIGN DEVELOPMENT
ARCHITECT'S REVIEW
END SCHEMATIC DESIGN
PRESENTATION TO SCHOOL BOARD
SITE CIRCULATION STUDIES
STRUCTURAL CONCEPT & SYSTEM DEVELOPMENT
SCHEMATIC PHASE TIME-LINE CHART
WALDRON & POMEROY - ARCHITECTS AIA
215 8TH AVENUE NORTH, SEATTLE, WASHINGTON 98109

Fig. 3-2.

pre-design and schematic-design states, planners are often lulled into costly delays, thinking that time is plentiful and not realizing the full impact of delays upon the subsequent construction and completion activities. It should be noted that Figure 3-1 illustrates one management illustration – the "critical path" which is to be followed. In actual practice, this chart and similar ones are backed by elaborate and carefully analyzed networks which present other planning and construction details (see Figure 3-2). Management techniques and other models for presenting tasks to be accomplished are discussed later in this chapter.

Pre-design Activities — Moving from Educational to Architectural Programming

If one examines the variety of definitions for the word "programming," it is apparent that it has different meaning for different people. From the many programming activities which lead up to school facility building, it is possible to perceive a *movement* or hierarchy of activities which start with the educational tasks of defining instructional program requirements and evolving almost imperceptibly into the ultimate architectural tasks of specifying structural details. Figure 3-3 indicates this movement in programming events. Generally speaking, all of these programming activities are considered pre-design activities because they take place before actual building design takes place. Educational programming can be seen in three steps:

1. *Community studies.* All of the kinds of data about a community should be known through some form of study. Today such data are often available through non-school sources: city planners, environmental agencies, and a whole host of city, state, and Federal agencies which gather information. For school planning purposes the data may have to be augmented, and a planning group, consisting of a carefully chosen cross-section of school and community representatives, might well learn to operate effectively as a team as they structure a study and gather, synthesize, and analyze facts about their community and its schools. The structure for the systematic study of the schools should emerge from these early, large, and important studies.

2. *Educational Master Plan.* As the data begin to focus more closely upon the schools and educational programs within the larger community context, such information should reveal facts important to the long-range goals and directions for the entire

COMMUNITY STUDIES

POPULATION STATUS; TRENDS
EDUCATIONAL ASPIRATIONS
ECONOMICS
LABOR DISTRIBUTION
THE ENVIRONMENT: PHYSICAL, SOCIAL, NATURAL
ENVIRONMENTAL IMPACT STATEMENT
ZONING, TRAFFIC PATTERNS
NON-SCHOOL EDUCATIONAL AND SERVICE AGENCIES

EDUCATIONAL MASTER PLAN

(FOR ENTIRE SCHOOL SYSTEM)

ENROLLMENT: STATUS AND PROJECTIONS
PHILOSOPHY, GOALS, OBJECTIVES
TAX BASE: SUPPORT, ATTITUDE, STRATEGY
LONG RANGE NEEDS ASSESSMENT
SCHOOL SITES, LOCATIONS
FACILITY EVALUATIONS
INSTRUCTIONAL MODES
PERSONNEL ORGANIZATION
COMMUNITY USE OF SCHOOLS
ADMINISTRATIVE ORGANIZATION

EDUCATIONAL SPECIFICATIONS

(FOR SPECIFIC CONSTRUCTION PROJECT)

GENERAL:
STATE EDUCATIONAL REQUIREMENTS HEALTH, SAFETY
PHILOSOPHY, GOALS, OBJECTIVES
COMMUNITY DATA RELATING TO PROJECT
JUSTIFICATION
CHARACTER OF SCHOOL, OVERALL DESIGN
NATURE OF CURRICULUM; PROGRAMS
ADMINISTRATIVE ORGANIZATION
PERSONNEL ORGANIZATION
ENROLLMENT TRENDS, POLICIES
MULTIPLE USE OF SCHOOL
FUNDS AVAILABLE, SOURCES
FUTURE EXPANSION PLANS
LEGAL ASPECTS
SPECIFIC:
DETAILS FOR EACH INSTRUCTIONAL SPACE
DETAILS FOR EACH SERVICE AREA
- OBJECTIVES; TRENDS
- ACTIVITIES AND LEARNING MODES
- LEARNERS; ENROLLMENTS BY AREA
- SCHEDULING
- SPACE REQUIREMENTS
- SPATIAL RELATIONSHIPS
- EQUIPMENT TO BE HOUSED
- LOCATION REQUIREMENTS
- STORAGE NEEDS
- ARCHITECTURAL LIMITATIONS
- SPECIAL ENVIRONMENTAL NEEDS (VENTILATION, TEMPERATURE, ETC.)
- SPECIAL UTILITY REQUIREMENTS

Fig. 3-3.

school system and be published in a Master Plan. Most important is the concept that the development and generation of a Master Plan is a *continuing process*, not an isolated event. Plans for a specific educational development are not difficult to anticipate or justify if they are a part of a larger Master Plan which has been carefully and continually researched and fully accepted by consensus. Industrial arts, for example, should be justified and carefully delineated and differentiated from vocational education and career education through statements in the Master Plan. Finally, a Master Plan should be scrutinized and approved by the Board of Education as a most useful document in priority setting and decision-making.

Moreover, it should be noted that, because of the enormity of the task, Master Planning is frequently shortchanged or neglected. At the same time, poor planning at this stage is the obvious cause of most blunders in school facility planning. School planners and architects will agree that the most difficult part of constructing a new building is the extraction of the necessary details about the educational program to be housed. Architects and engineers can provide almost any kind of educational environment;

the big question is not "what is the architectural answer?" but "what is the educational requirement?" Industrial arts teachers, at least for themselves, must ask the right questions and seek the answers if their goals are to be widely known, carefully researched, and cooperatively determined and included in the Master Plan of the school district.

3. *Educational specifications.* In regard to a specific building or remodeling project, educational specifications must be generated which are terse, concise, and useful in making the transition from educational to architectural considerations. As the major communication link between client (school) and architect, they must describe the performance requirements of the facility. Because they focus on specific project details, they must bear all information necessary for the correct interpretation of educational intent; inclusions frequently listed for educational specifications are listed in Figure 3-3. Because of the special requirements of industrial arts facilities (power, ventilation, etc.) and because architects frequently lack experience in designing facilities for the new programs, educational specifications for industrial arts must be more detailed than most, yet must avoid the dictation of architectural features which would inhibit the variety of choices an architect might creatively use. Without full input from industrial arts personnel, architects and planners frequently derive their models from very traditional school shops or from the industrial requirements of tools and machines rather than the educational requirements of learners. For these reasons, the architect is generally included – at least as a consultant and participant – in the generation of educational specifications.

The client (school board) ultimately approves educational specifications, but client, architect, and educational planners alike must proceed on a trial and error basis, guessing at the ultimate desires and solutions and frequently setting back the project completion date. If he cannot be paid for extra planning effort, an architect's time is expended in areas outside his field of expertise instead of at architectural tasks.

None of the inclusions typical to educational specifications has been discussed in detail; adequate resources are available through school planners, architects, and school districts who have experienced building projects. Chapter 5 of the *Guide for Planning Educational Facilities* by the Council of Educational Facility Planners, International is descriptive and helpful in this regard.

Schematic Design

As the educational specifications are being developed, relationships between spaces or within spaces and between parts are analyzed through the use of "bubble" and "arrow" diagrams. The architect is able to make preliminary drawings to be used for discussions and negotiations from these assorted charts. A carefully prepared diagram which shows spaces to scale and indicates required physical proximity to other spaces will allow planning participants to manipulate spaces easily, explore contingencies and adjust size, shape, and location. From such discussions and the resulting supporting documents, the architect can move to schematics which, though still easily adjusted and changed, begin to approximate the final design solution. Further, given initial cost limitations, sizes and space inclusions can be adjusted to be in line with available funds. The industrial arts teacher is frequently asked to contribute to the discussion of schematics because he can, at this stage, visualize final solution possibilities. Prior to approval of the schematics by the Board of Education, and if not already utilized in the educational programming, a professional educational facility planner should be consulted for recommendations.

Design Development

During the preparation of final drawings, the planning process becomes increasingly irreversible and far more difficult to alter. During design development, specifications are begun, working drawings are started, materials are chosen, costs analyzed, and regulatory bodies consulted.

Contract Documents

Given the authority to proceed, the architect and his engineers next complete working drawings and all specifications. Educational detailing, too, is taking place during this time. Staff is designated and prepared for the new facility. Some would dispute this late designation of teaching staff. However, others – and especially districts large enough to use their own teachers as consultants and in advisory roles – fear "pet project" planning if the teaching staff is chosen too early in the process. A team of industrial arts teachers, for example, can do the planning to this point and provide needed information which is consistent with Master Plan and industrial arts philosophy. If district-wide policies, goals, and programs are to be implemented, disputes about the details over change orders can be settled by a district-wide team more prudently than by each individual teacher assigned to the new space.

Bidding and Approval

The procedures for bidding and approval are established by law. It is incumbent upon all parties to follow legal practices, answer questions, evaluate bids, and finally to award contracts which are legally correct yet beneficial to the client. New methods (fast-track) and new kinds of personnel (construction managers) are being engaged to represent the best interests of the client, speed up the bidding process, and conduct the construction activities more efficiently. These methods are discussed in a later portion of this chapter.

Construction

Industrial arts teachers are usually interested in the construction phases of a project, and rightfully so if they purport to "interpret industrial practices" through the courses they teach. The construction of a new facility presents an instructor with an opportunity to get a close look at the construction industry, to study plans and specifications, to observe installation of components, and to watch skilled tradesmen at work. Teachers must, of course, gain permission for such activities and not interfere with the work at hand.

Students, too, are interested in construction details, and one teacher recently painted "working drawings" of the drafting room on the ceiling so that drafting students could check details with physical realities.

MANAGEMENT AND CONTROL TECHNIQUES

Contemporary industrial practices – i.e., scheduling, management, and mass-production techniques – have come only recently to the construction industry and have to this day made only a few inroads into school construction. Three special practices are mentioned here: (1) management and scheduling techniques (CPM, PERT); (2) construction management; and (3) system building techniques (SCSD).

Management and Scheduling Techniques

Evolving from the early simple flow charts which graphically analyzed tasks to be performed in order, architects and school planners are now utilizing Critical Path Methods (CPM) for scheduling and streamlining large, complex project activities. One of several scheduling techniques, and developed for those projects frequently analyzed by computers, CPM seeks to chart a "best" path through an array of tasks which will yield the desired results in the shortest time. A similar management technique, Program Evaluation and Review Technique (PERT), analyzes and reviews "milestone" events to discover where small operations not conducted on time or in sequence might hold up the major operations and target dates. Both PERT and CPM are based upon a careful analysis of component activities which are arranged in sequence in respect to others. When time durations are assigned to each component, the total project time can be calculated and events scheduled. Both techniques can be used "by hand" or with computers. These two management techniques are useful in accomplishing the following:

1. *Project planning.* A network diagram shows graphically each activity in sequence. An example of such an arrow diagram as applied to school construction is given by Richard Meckley and is followed by a "bar" diagram or chart which is still used by those not familiar with CPM and PERT (Meckley, 1970).

2. *Time estimation.* Cumulative time estimates for each component are usually more accurate than estimations of larger increments.

3. *Scheduling.* Since earliest starting and latest completion dates are given for each component, scheduling assignments are possible and delay implications revealed.

4. *Time-cost trade-offs.* If scheduled time is satisfactory, project planning and scheduling may proceed. Also possible, however, is an analysis of the cost of reducing total project time.

5. *Resource allocation.*

6. *Project control.* The final network plan and schedule can be used in the field to check off events as they happen and to reveal to client, builder and architect alike the ongoing progress of the project.

Construction Management

The relationship between client, architect, and contractor, each with his own set of goals, parameters and problems, is often strained and marked by misunderstandings. Architects are accused of designing "castles" because their work is on a percentage basis of total cost and by running the costs high their fee rises correspondingly. Builders, on the other hand, want to cut costs because their profit is the difference between the cost and the bid (subcontractors complicate this problem even more). The owner – in this case, the school – is interested in quality workmanship and materials (which cost more) and the actual move-in date. In order to intervene with a protective agent who is knowledgeable in construction techniques, conditions and costs, a *construction manager* is sometimes retained. This manager and the architect form a team with the owner (Figure 3-4). Relationships described

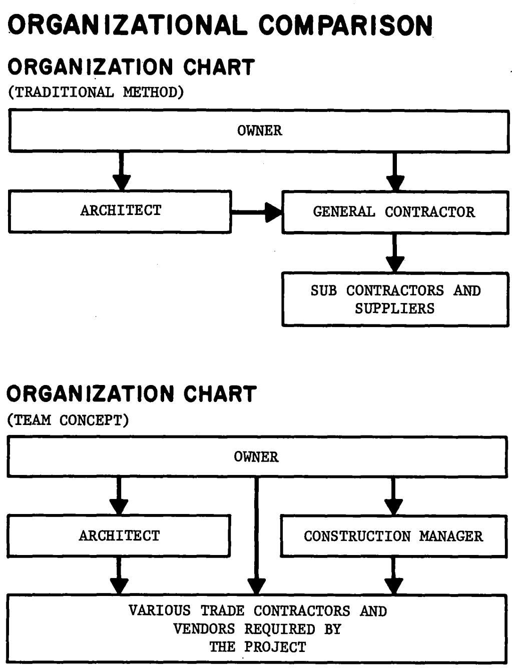


Fig. 3-4.
Relationship Comparison – Traditional vs. Team Concept Methods of Construction Management. (Tropl, CEFP Journal, Vol. X, No. 5, pp. 4, 6.)

above among client, architect and contractor are greatly altered because the construction manager is hired at a predetermined fee or hourly rate and the architect, hired similarly, contributes only architectural – not construction – techniques and knowledge.

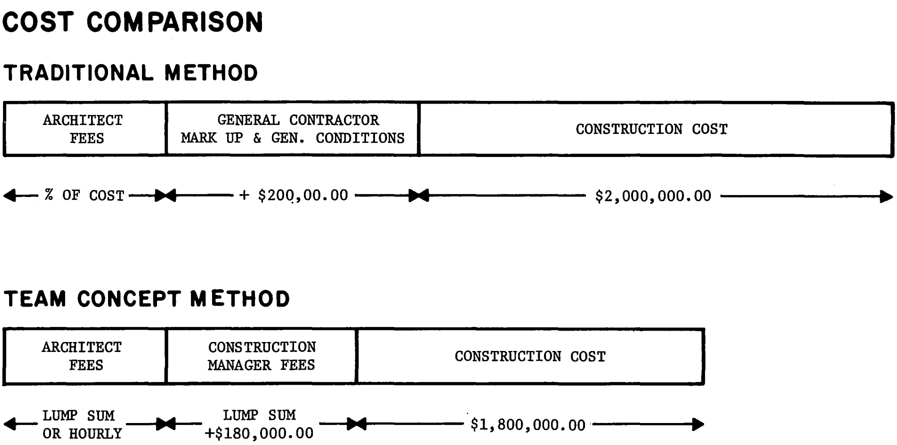


Fig. 3-5.
Cost Comparison – Traditional vs. Team Concept Methods of Construction Management.
(Tropl, CEFP Journal, Vol. X, No. 5, p. 6.)

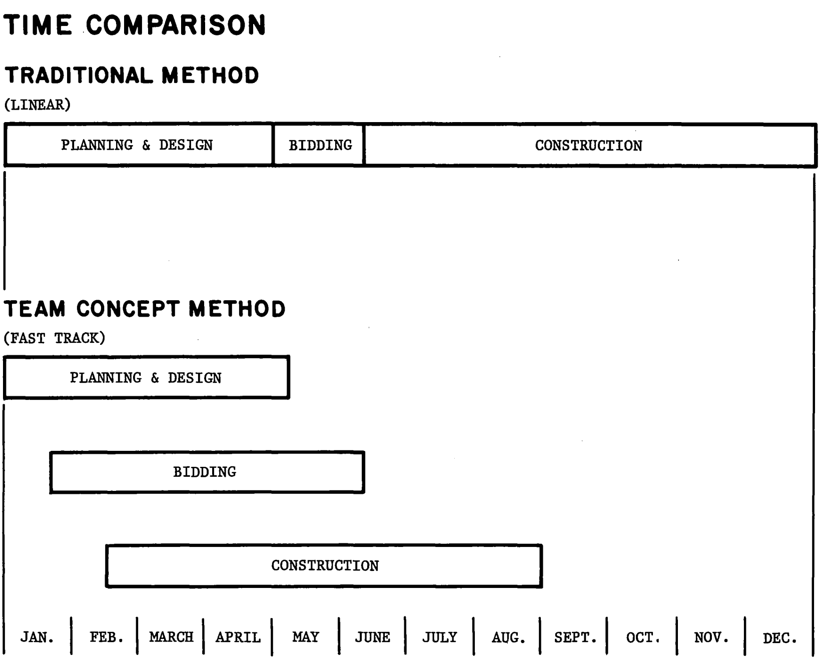


Fig. 3-6.
Time Comparison – Traditional vs. Team Concept Methods of Construction Management.
(Tropl, CEFP Journal, Vol. X, No. 5, p. 7)

Throughout all of planning and construction stages the construction manager is available with expert cost analyses, materials selections, and field supervision. As the owner's agent, the construction manager is likely to achieve savings in time and money. Figures 3-5 and 3-6 (Tropl, 1972) illustrate the savings claimed for construction management.

Systems Building Techniques

Only recently have systems approaches been applied on a massive scale to the building industry. C. W. Griffin defines a systems approach as simply a means by which

> a problem will be solved in an orderly process that will define the goals, analyze the means of achieving them, and then carefully organize the actual achievement (Griffin, 1971).

Applied to the construction industry, he states

> the system approach necessitates an improvement in building technology and it demands a revolution in management techniques (Griffin, 1971).

With early roots in England and Canada and large experiments in California (called the School Construction Systems Development (SCSD), the systems approach to construction is purported to bring modern management and mass-production technique advantages to the school construction field.

The term "systems approach" has various meanings and interpretations. Robert Hastings points out that to the architect and owner as programmer,

> the term systems construction suggests the basic functions to be performed in the building, orderly relationships between these functions, the processing equipment and methods required to carry out these functions, and the total purpose to be served by the building (Hastings, 1964).

He further states:

> To the architect and his fellow professional designers, the term (systems construction) suggests basic building components (floor, wall, ceiling, heat, lighting, etc.) that must be designed and assembled into an integrated structure that meets the program requirements of his client in an efficient, technically correct and aesthetically satisfying manner. It also suggests ways of assembling and evaluating design data required to establish basic functional relationships, basic building components, and other design decisions (Hastings, 1964).

> To the product manufacturer and building constructor as producers, the term suggests efficient assembly-line methods of producing and assembling complete buildings (Hastings, 1964).

Alan M. Baas has reviewed for ERIC the articles which have been written on the systems approach to buildings and has compiled a useful synthesis on systems building techniques (Baas, 1972).

The evaluation of systems building approaches has been cautious. Although construction *can* be cheaper, it has not always proven to be so. There must be a sufficiently large demand in the market to stimulate and justify modular and mass-production construction of components; today's shrinking enrollments do not promise such a mass market. Moreover, the traditional and tested relationships between contractors, manufacturers, client, and architects have been realigned under systems building approaches, and many legal implications have not been clarified. For these reasons, the systems approach to *planning* seems to remain viable but the mass-production approach to large *construction* components will probably be restricted to industrial and similar growth markets and not attain widespread utilization in school construction.

THE PLANNING PEOPLE

It is difficult to describe an articulated and succinctly stated role for each of the participants in a facility planning project. For example, large school districts might have specialized administrative personnel for planning while the same function in a small district might be accomplished by the appointment of a school principal as project planner on an *ad hoc* basis. Moreover, in specific projects, the team of planners tends to set its own boundaries of activity and authority. Design teams which defy rules and generalizations nonetheless often accomplish creative school planning. Finally, the separation of role descriptions is especially difficult because, increasingly, the task is seen as a team effort and the planning is not confined to a few key individuals with well defined functions.

Involvement on the Increase

One notable phenomena in American education during the past decade has been the increasing and vocal demand for involvement. Various sub-groups in society are no longer willing to be manipulated by the decision-makers; they seek a measure of control over their destiny. So it is with the schools, as taxpayers and various citizens' groups are no longer content to approve and pay for schools but not be involved in planning them. Facility planning, therefore, must proceed with all of the inconvenience of involvement and delay in striving for consensus. There have been notable instances where the citizens have rejected elaborate school plans because they were not consulted and involved. Successful projects, then, require the participation of many individuals with varying perspectives. Some are trained, competent, and articulate; others may wish simply to state their wishes, concerns, priorities and feelings – and have a right to do so. The authors of *To Plan a School*, published by the California State Department of Education, state it this way:

> The success of school planning depends heavily on human relations. Ultimately it depends upon the skill of planners in involving the right persons and the proper time in the planning process.

Organizing for Team Planning

Earlier literature on the subject frequently restricted recommendations for the design team to the superintendent, the architect, and an educational consultant. Stuart Smith has called for broader participation and designates a planning organization as follows:

1. *The superintendent*, as the chief administrative officer of the district, should be the final clearinghouse for specifications and directions.
2. *An administrative assistant* should directly supervise all planning activities.
3. *A steering committee* should consist of the administrative assistant, the educational consultant teams and the administrator responsible for finance, and administrators responsible for appropriate curriculum; i.e., secondary, elementary, or special education.
4. *Staff committees*
   a. *Curriculum committees* should include teachers in all areas of instruction; if a larger district, this committee would be comprised of a specified number of teachers from each subject area.
   b. *Grade level committees* should be representative of teachers at every grade level; if the building is to be an elementary school in a large district, several teachers should represent each grade level.

c. *Special service committees* should include representatives of pupil personnel, health, library, transportation and maintenance.

5. *A citizen committee* should be organized because it is particularly important that the public be informed when many changes from existing programs and facilities are to be made.

6. *An educational consultant team* should be available to draw on for expertise in determining state and national trends in facility plannings, in assessing available media approaches, in accommodating the building to instructional needs, and in providing data on curriculum, maintenance and operation, construction and architecture (Smith, 1972).

This involvement structure obviously uses educators in their field of expertise and keeps the public fully informed and involved. Involvement means, of course, more than token approval of school actions. Each group must accept responsibility, assign work, organize for action, identify needs, prepare written reports, and report through proper channels. Such authentic activity will provide "ownership" of the plan by the group.

Role for Individuals

1. *The industrial arts instructor.* Award-winning schools are frequently attributed to ideas submitted by classroom teachers who have described the teaching environment they preferred, leaving the architect and engineer to create that environment. "Describing the environment" is an oversimplification, of course. Industrial arts teachers, usually more familiar with facility planning and construction than are teachers from other disciplines, can make a substantial contribution to design and programming efforts. First, of course, they must have their own program clearly in mind and be able to support its viability in an exemplary fashion. To accomplish this, they and their colleagues must conduct on-going development of philosophy, goals, content, and methodology and be able to defend these developments through notably good teaching practices and well thought out statements. Secondly, industrial arts teachers must be prepared to assume an active role in facility planning – either on short-term or long-term notice. His role is described in *Planning and Equipping Industrial Arts Facilities*, a publication of the California State Department of Education, this way:

> Industrial arts teachers should participate in planning new industrial arts facilities and remodeling of existing facilities. The planning group thus has the services of specialists who know shop/laboratory requirements and the planning group has assurance that as planning moves ahead, the facilities included will be those needed in conducting a well-rounded industrial arts program. These teachers can also make available for planning groups sketches, drawings, prints, and building scale models in which equipment is properly placed so as to give a realistic view of proper facilities and requirements.

2. *The school board, the superintendent, and the professional staff.* The *school board,* as a legal body, establishes the framework for all facility planning and procedures. Their work, however, is not routine. They must establish policy, order priorities, check on progress, supervise the legal implications of all planning and construction activities, and develop a "climate" which allows creative planning to take place through intellectually honest study. The school board can, of course, choose the narrow view and opt for inferior processes and products on cost-only criteria or, to the contrary, they can set high expectations and use available tax dollars efficiently and ingeniously.

The *superintendent* has a role which is frequently difficult to assess. His leadership role cannot be clearly described nor established with concise standards and boundaries. Not only does the superintendent set in motion the planning processes by designating the various administrative staff and their contribution to the planning procedure, but also he influences the entire planning procedure through the type of human relations he maintains with citizens, teachers and colleagues.

Either directly or through delegated authority, the superintendent has many legal and functional tasks. His influence over the choice of engineers, architects, consultants, and planners gives him a primary responsibility for success.

> Of all those directly involved in the planning of educational facilities – the board of education, the planner, the staff, the architect, the consultants, and other resources – it is the superintendent or his designated planner who plays one of the most vital roles in constructing successful education facilities (*Guide for Planning Educational Facilities,* 1969).

The administrative and *professional staff member(s)* designated as facility planners(s) for a specific project will be charged with much of the detail work in educational programming. Lay advisory committee members and classroom teachers cannot be expected to assemble the vast quantity of data about the community, the Master Plan, and the educational specifications. In smaller districts it is not uncommon for an outstanding teacher or principal to be chosen as the administrator in charge of facility planning on a specific project. Larger districts may designate a part-time or full-time administrative person as a facility planner; this person may or may not have experience in this arena. Administrative staff serving in a planning role will, of course, need adequate secretarial support in order to compile all of the necessary data.

3. *The architect.* There is no way to overemphasize the influence of an architect upon a project, since he is the one person involved from the very early planning to final construction completion. No one has more comprehensive knowledge of the project than the architect. Architectural services are needed throughout all facility planning and construction even for relatively small projects. Some districts employ "in-house" school system architects who have certain designated functions; in these districts, outside private architectural services are retained only for projects of large magnitude or complexity. Smaller districts use administrative staff members for in-house planning and hire architectural services for each project.

The precise role of the architect is somewhat difficult to describe – especially as this role changes from job to job. The most frequent variable in his role is related to educational, not architectural, work. In some cases the architect must fill in planning gaps for educators if needed data has not been provided. The architect provides this service to insure the success of the project, although frequently he has not been retained and reimbursed as an educational planner. His success is in direct proportion to the extent to which his talents and services are focused on his field of competency in architecture and his energies are directed to this end. This is not to say that the architect can ever confine his activity to his own office; he must be effective in the human relations aspects of group planning.

The selection of an architect is based upon his experience, state laws, registrations in AIA, reputation among previous clients and other architects, experience in similar projects, his support staff, facilities, and his interest in the project at hand. Since the industrial arts teacher has no part in choosing an architect it can only be hoped that an industrial arts planning project will be assigned to an architect who has had previous experience in this type of work but, more importantly, is willing to listen to groups of teachers who are contributing to the educational specifications.

A *local* architectural firm has a certain advantage, when the architect can quickly meet with administrators and easily visit the construction site, there will be an opportunity to resolve crises directly.

Figure 3-1 illustrated the typical architect's role in a school project. He is, of course, a participant in all stages of a construction project including pre-design, schematic design, design development, contract document development, bid and approval processes, and construction. In addition to these obvious functions, other services which may be performed by an architect are listed by the Council of Educational Facility Planners in the *Guide for Planning Educational Facilities*:

1. Making measured drawings of existing construction when required for planning additions or alterations.
2. Revising previously approved drawings, specifications, or other documents to accomplish changes not originally initiated by the architect.
3. Preparing change orders and supporting data when the change in basic fee is not comensurate with services required.
4. Preparing documents for alternate bids requested by the client.
5. Providing detailed estimates of construction costs.
6. Providing consultation and professional services concerning replacement of work damaged by fire or other causes during construction.
7. Providing interior design work or other services required in connection with selection of furniture and furnishings.
8. Provide services as an expert court witness.

4. *Educational facility planners.* Because of the complexity of the planning process – especially at the educational programming stages – it is usually desirable to appoint an experienced educational facility planner. Some school districts appoint such a person from within their own ranks and that person acquires training and experience through engagement in planning projects. Other districts hire an in-house facility planner who is trained in the various facets of the work. Educational facility planners are also available as private consultants and they are hired by school districts for specific kinds of planning services. On occasion, when architects feel they are asked to conduct educational programming beyond their fields of knowledge or the time available, they hire an educational facility planner to assist in the non-architectural

phases of their work. Because of the sporadic nature of building projects – especially in districts too small to keep continual and on-going programming underway, the use of private educational facility planners is often advantageous. Upon the completion of the project, in this case, planning staff can be released.

Facility planners should be competent educators who are trained and experienced in their field. As indicated earlier, the newer systems approach, management techniques, and computer assistance have created a rapid modification of planning techniques, and an experienced facility planner must keep abreast of these developments in order to direct, coordinate, and utilize these sophisticated services.

A professional organization of facility planners, The Council of Educational Facility Planners, has as its goal "the maintenance of action-oriented programs and activities that will give authoritative information to all individuals, groups and agencies involved in planning and maintaining the physical aspects of the teaching/learning environment" (*Options For Involvement*, 1972). The address of this organization is noted in the References.

5. *Lay citizens; students.* As previously mentioned, there is a demand for greater involvement by citizens and students in school planning. While this extra input may prove bothersome for the traditional facility planning groups, it does appear necessary if valid information from the users of school facilities is to be included in the final design. The greatest difficulty in groups of this sort is that there is the temptation to use them in unimportant roles and on problems which have already been solved. It is interesting to note that the amazing state-of-the-art in management we have utilized for cultivating the talents of executives has never been extended to other groups now included in management schemes; staff, citizens, and students are all full partners in school management today and they should not be asked to rubber-stamp decisions. When these new groups of participants realize that they are a necessary and influential part of the planning process, it is to be expected that they will participate effectively and willingly.

6. *Others who have a role. Contractors* must obviously abide by the terms of the specifications in their construction work. The prime contractor coordinates the work of the subcontractors, secures the necessary permits, orders, stores and safeguards materials, and schedules the work in progress. While this role is very legalistic in nature, the contractor can prove to be extremely help-

ful in making suggestions and decisions regarding substitutions and in selecting equipment, materials, and methods. *Suppliers and manufacturers* too are limited to the legal terms of prepared specifications; when such specifications, often prepared by industrial arts teachers, are incomplete or carelessly written trouble can arise. The continuing participation of many commercial exhibitors, publishers, and suppliers at the professional meetings of the American Industrial Arts Association and the state associations is evidence that these vendors are indeed interested in maintaining good relationships with their school customers and in supplying the product needs of the industrial arts profession.

REFERENCES

A Primer for Planners, Washington: American Association of Junior Colleges, 1967.

Baas, Alan M., *Systems Building Techniques,* EROC Clearinghouse on Educational Management, Eugene, Oregon, 1972.

Boice, John R., *A History and Evaluation of the School Construction Systems Development Project;* 1961-1967, Educational Facilities Laboratories, Inc., 1970.

Boles, Harold W., *Step by Step to Better School Facilities,* New York: Holt, Rinehart and Wilson, 1965.

Buhl, Harold R., *Creative Engineering Design,* Ames: Iowa State University Press, 1960.

Candoli, I. Carl, "Student-Community Involvement in School Facility Planning, "*Journal of the Council of Educational Facility Planners.* November/December, 1971.

Castaldi, Basil, *Creative Planning of Educational Facilities,* Chicago: Rand McNally & Company, 1969.

Council of Educational Facility Planners (CEFP), 29 West Woodruff Avenue, Columbus, Ohio 43210.

Davis, Edward W. and Lindsay White, "How to Avoid Construction Headaches," *Harvard Business Review,* March-April, 1973.

Davis, J. Clark, *Principal's Guide to Educational Facility Design, Utilization, and Management,* Columbus: Charles E. Merrill, 1972.

Educational Planning, North Carolina Department of Public Instruction, July, 1964.

Foxhall, William B., "Professional Construction Management and Project Administration," *Architectural Record and the American Institute of Architects,* 1972.

Griffin, C. W., Jr., *Systems – An Approach to School Construction,* New York: Educational Facilities Laboratories, Inc., 1971.

Guide for Planning Educational Facilities, Columbus: Council of Educational Facility Planners International, 1969.

Guidelines for School Planning and Construction: A Handbook for School Business Officials, Research Bulletin #8. Research Corporation of the Association of School Business Officials, 1968.

Hastings, Robert F., "What Systems Construction Means to the Architect," *Technical Bulletin,* #107, March, 1964.

Kosro, Jerry M., "Construction Management Works at Federal Hospital," *Civil Engineering – American Society of Civil Engineers,* January, 1974.

Martino, R. L., *Applied Operational Planning,* American Management Association, New York, 1964.

Meckley, Richard F., Ovan Valentine, and Zane McCoy, *A Guide to Systematic Planning for Vocational and Technical Schools,* Research and Development Series 15, CVTE, Columbus, Ohio, 1970.

———, *Planning Facilities for Occupational Education Programs,* Columbus: Charles E. Merrill Publishing Company, 1972.

Nerden, Joseph T., *Vocational-technical Facilities for Secondary Schools,* Columbus: Council of Educational Facilities Planners, 1971.

O'Brien, James J., *CPM in Construction Management,* New York: McGraw-Hill Book Company, 1965.

Options for Involvement, Columbus: Council of Educational Facility Planners International, 1972.

Parker, Floyd G., and Max S. Smith (editors), *Planning Community Junior College Facilities,* East Lansing: Michigan State University, 1967.

Planning and Equipping Industrial Arts Facilities, Second Edition, Sacramento: California State Department of Education, 1971.

Planning Industrial Arts Facilities, Eighth Yearbook of the American Council on Industrial Arts Teacher Education, Ralph K. Nair, Editor, Bloomington, Ill.: McKnight Publishing Company, 1959.

Propst, Robert, *High School: The Process and the Place,* Educational Facilities Laboratories, Inc., 1972.

Schneider, Raymond C., "Instructional Technology and the Teaching-Learning Environment," *Educational Horizons,* Vol. 49, No. 3, Spring 1971.

Smith, Stuart, *What Went Wrong?,* SKS Educational Facilities Consultants, Edmonds, Washington, Mimeographed, 1972.

Theodores, James L., *Crisis in Planning,* Columbus: Council of Educational Facility Planners, 1968.

To Plan a School, Sacramento: California State Department of Education, 1971.

Tropl, Carl F., "Construction Management Through Team Approach," *Council of Educational Facility Planners International Journal,* 1972.

Weddell, Dorothy, "Computer Speeds Construction," *Detroit Free Press,* Sunday, November 11, 1973.

CHAPTER IV

Planning Principles

Michael R. Seal
Associate Professor of Technology
Western Washington State College
Bellingham, Washington

H. A. Goltz, Director
College Planning Office
Western Washington State College
Bellingham, Washington

INTRODUCTION

When a laboratory project is proposed within a school system, it is a common practice to involve the local faculty in drafting a project program. Whether that program is for a new facility or for remodeling an existing facility, the process is much the same. A project program is the statement of the problem – it is *not* the solution to the problem. That responsibility is given to the design consultant, usually an architect, who prepares floor plans, specifications and cost estimates for the review of the faculty and school authorities.

The program statement should spell out the needs of the department as precisely as possible. But it should also be flexible enough to allow the designer to raise questions and propose alternative solutions. The program should describe the following elements:

1. The purpose and function of each proposed space or change in programmatic terms. What is the space going to be used for?

2. The methodology to be employed in using the space. How many persons are involved and how are they going to be taught?

3. The necessary equipment to be used. What pieces of equipment are to be utilized and what are the mechanical and electrical requirements?

4. What are other requirements or desires in a priority listing?

PRINCIPLES OF SPACE ANALYSIS

As the student population has stabilized for the next decade the emphasis of laboratory planning will center on remodeling facilities to adjust to changing industrial arts programs in addition to the building of entirely new facilities. More than ever, program decisions should precede facilities design. Care must be taken, however, to ensure that long term use of flexible laboratories be provided for, based on broad educational objectives obtainable by a number of teachers rather than on the likes and dislikes of a particular teacher who may not remain in the laboratory throughout its useful life.

Gross Space Recommendations

Once the areas of emphasis have been decided the necessary gross space requirements must be established. Assuming twenty-four students in each class the recommendations given in Table 4 have been found to be useful in design of laboratory facilities. The space allotments given should in no case be cut by more than 25%. If possible 25% should be added to the base figure.

If at all possible it is highly desirable to provide each laboratory with a separate faculty office. In addition it is useful to have nearby classrooms available for lecture-demonstration sessions. If night school classes are anticipated separate lock up storage must be planned for these groups. Telephones are necessary in faculty offices.

Location Recommended

In general, auxiliary rooms (Table 4) must be contiguous with their corresponding open laboratory space to facilitate supervision. Certain areas require ground floor access. Power mechanics and auto-mechanics laboratories require access for vehicles while metals, plastics, and woods need easy access to street level for heavy materials delivery. In addition, certain laboratory areas complement each other if they are located adjacently. For example, power mechanics and metals team taught require close

Table 4

Adequate Laboratory Gross Space

Laboratory	Square Feet
Senior High Automechanics	3400
Clean room	250
Storage room	225
Dynomometer room	250
Junior High Power Mechanics	2400
Storage room	210
Senior High Electronics	2400
3 soundproof test booths	150
Storage room	210
Junior High Electricity	1800
1 soundproof test booth	125
Storage room	70
Senior High Graphic Arts	2000
Photo lab.	250
Storage room	250
Junior High Graphic Arts	1800
Photo lab.	225
Storage room	225
Visual Communications Education	1800
Process camera room	200
T.V. room	400
Press room	600
Storage room	225
Senior High Drafting	2400
Print room	150
Storage room	175
Junior High Drafting	1800
Storage room	135
Senior High General Woods	2400
Finish room	150
Storage room	300
Junior High General Woods	1800
Finish room	125
Storage room	275

Table 4 (cont'd)

Laboratory	Square Feet
Senior High General Metals	2400
Foundry	400
Finish room	150
Storage room	300
Junior High General Metals	1800
Finish room	125
Storage room	225
Senior High Plastics	2400
Fiberglass layup room	600
Storage room	600
Comprehensive General Laboratory (Junior High)	2000
Finishing room	125
Storage room	300
Comprehensive General Laboratory (Senior High)	3000
Finish room	300
Storage room	300
Industrial Crafts (Senior High)	2400
Glaze and/or Finishing Room	150
Storage Room	250
Industrial Crafts (Junior High)	1800
Glaze and/or Finishing Room	125
Storage Room	250

proximity if design and fabrication of power oriented projects is undertaken. Visual communications, communications, graphic arts, and photography realize a synergistic benefit if they can be situated adjacently. If design drafting is to result in student constructed hardware, easy access to the metals, plastics, and woods, or comprehensive general laboratories should be provided. Nothing dampens enthusiasm for project construction quite like soggy blueprints carried through the rain from the drafting room to the metals laboratory.

CONTROLLING THE ENVIRONMENT

Pollution Control

In the past, industrial arts laboratories have been among the most serious pollution offenders in a typical school situation. For example, noxious liquids have been allowed to foul storm drain systems. Used oil from power mechanics and automechanics laboratories should be placed in collection barrels mounted outside the laboratory on a concrete slab with provision for keeping rain out of the oil so that it can be returned for recycling. Acetone, paint thinners, and other non-recycled liquids from plastics, metals, woods and power mechanics laboratories should be collected and stored in a fireproof area until it can be removed from the premises. Used non-flammable photochemicals and blanket wash from the graphics area can be stored inside the building prior to pick-up.

It should be noted that it is often cost effective to install a silver recovery system to treat photochemicals. Sinks in all aforementioned laboratories should be fitted with easily cleaned sump type traps as it is inevitable that some liquid pollutant will find its way down the sink.

Fumes and poisonous gases cause problems in certain areas. Welding booth and foundry areas must have fume hoods. Fiberglass lay-up, acid etching, plating, anodizing, and spray paint booths must have explosion-proof lights, switches and provision for evacuation of fumes. Power mechanics and automechanics laboratories need provision for engine exhaust removal, as these gases tend to be heavier than air. Underfloor systems work well and require no pumping for short runs. When pumps are required they must be fitted with explosion-proof motors. Woods laboratories require dust removal systems. Easy access to the cyclone should be provided. Both overhead and in-floor systems have disadvantages. In-floor systems make movement of machines virtually impossible, while overhead systems tend to foul the work space on or around the machine.

Noise is a problem in most industrial arts laboratories. Engines running on dynomometers create a great deal of noise which mandates a special cooled muffler system. Woodworking equipment such as routers, thickness planers and circular saws create noise that is almost impossible to muffle. Machinery manufacturers have struggled with this problem for years and are beginning to make progress by applying design principles and new technology toward the creation of machinery that will be much quieter and help to eliminate the problem. Suitable ceiling treatment can do much to stop reverberations. Suppression of noise transmission must use different techniques however. Therefore a decision must be made at an early design stage to determine whether sound can be absorbed or whether transmission of sound is to be suppressed. Thick concrete walls provide good noise transmission suppression, but do nothing to absorb reverberations. Acoustical engineers must be consulted.

Heating, Ventilation and Air Conditioning

Though most industrial arts rooms have conventional temperature control requirements, certain areas have unusual requirements. Areas with large overhead door access lose a lot of heat when the door is opened. Faster recovery heaters will need to be located near these doors. Typically foundry and welding areas will require cooling rather heating. As gas furnaces use large quantities of air when operating, outside air access should be provided to help eliminate a build-up of carbon monoxide around the furnaces. Tighter temperature control than normal will be required in visual communications, graphic arts, photography, plastics and finishing laboratories due to the specialized equipment generally associated with these laboratories.

Lighting

In the interest of building efficiency and architectural design many industrial arts facilities will be built without windows. However, in areas requiring close work, like drafting, it is desirable to provide for outside light. Even though outside windows may not provide enough light to the center of large rooms, skylights and clear story window schemes may be utilized to provide the necessary light. Areas of the country with heavy air conditioning loads will probably need to rely upon artificial light for energy conservation, while insulated windows will minimize heat transfer. Light colored walls and ceiling will provide good light levels without the excessive loss of power.

It is important that the highest brightness in the field of view not exceed ten times the brightness of the visual task area. Drafting rooms require broad source, indirect or luminous ceilings to make sure that shadows along scales and triangles will not make lines invisible.

Utilities Planning

If a common air compressor is used, it should be as centrally located as possible to reduce line losses, among but not in any of the laboratories requiring air. Adequate provision for water condensers must be provided. The automechanics shop will have need the greatest air supply as a hoist needs a large volume of high pressure air. Both automechanics and power mechanics laboratories require air pressure for distributor testers and spark plug cleaning machines. Spray paint equipment will of course require clean, dry compressed air. Air powered drills, portable saws, grinders and sanders are especially desirable as they are rugged, shock proof and not likely to be stolen. Air lines used for blowing dust off clothes and machines must be equipped with OSHA approved low velocity nozzles.

Wash-up sinks must be provided for each laboratory area. Additional water outlets must be provided for MIG and TIG welders, photography sinks, steam cleaners, engine dynomometers, and finishing room water walls. Water flow requirements of anticipated equipment for the present and for the future, must be provided for in the initial design of the facilities. Adequate sumps must be provided on all drains to catch waste products that would be harmful to a sewer system.

Casting and heat treatment furnaces need gas plumbing brought to them in such a manner that people will not trip over them. All gas shut off valves should be located in such a place that they can be closed at a spot removed from the source of trouble. If, for example, a furnace has caught fire, the shut off valve should not be so near to the trouble that it cannot be closed. Solonoid controlled valves must be used so that flow of gas cannot resume after accidental loss of gas service.

Adequate wiring must be provided not only for the machine tools that will be provided immediately but also for expected additions as it is much cheaper to provide this capability during the original project. Convenience outlets should be provided every six feet around the walls and on each pillar. In addition, drop cords from the ceiling are extremely useful for plugging in power hand tools. If machine tool wiring comes from an overhead bus bar system, later changes and additions to the equipment can be easily handled. Care must be taken that correct phase, voltage, and current capabilities be provided for expected equipment.

Principles of Security

Generally speaking, tool loss can be kept to a minimum if the rooms are designed in such a manner that the teacher can see all parts of the laboratory from one vantage point. Open tool panels allow the instructor to check all tools rapidly at the close of each work period. Materials storage should be in a secure location easily monitored by the instructor from his classroom.

PRINCIPLES OF PLANNING FOR SAFETY

Where it was once considered adequate to design new or remodeled laboratory spaces so there would be no obvious safety hazards, it is now required that all facilities meet state safety standards modeled after those formulated under the Occupational Safety and Health Administration. Under the meaning of the act protection must be provided for employees only. However, an industrial arts laboratory that is safe for the instructor will presumably be safe for students working in it. Not only do built-in health and safety standards protect the teacher and the students in the laboratory, they also contribute positively to the learning of sound health and safety practices. Although the complete federal standards are contained in the code of Federal Regulations Number 29, Part 1910 Occupational Safety and Health Standards, a brief list of points to consider when designing industrial arts facilities follows.

Electrical

1. Individual off and on controls or disconnect plugs are installed at or near all machines as well as in the room control box.
2. A master control switch is readily available in each laboratory to control power.
3. Each shop laboratory has its own power panel located in its shop area.
4. Proper grounds are installed on all machines and power outlets.
5. Magnetic switches should be installed on all machines.

Gas

1. The main cut-off valve is identified, readily accessible, and located out of the heat zone in case of fire.
2. A positive shut-off valve is located in each laboratory.
3. An outside air source is available in the foundry and forge areas to counterbalance the air used in the operation of this equipment.
4. Gas equipment is provided with a safety system (example: spark ignition, gas pressure regulator, and safety gas check valve).

5. Gas appliances are installed with protective insulation materials adjacent to flammable surfaces.

Welding

1. Must be absolutely free of combustible materials.
2. Provision must be made to store oxygen and acetylene cylinders upright in separate locations, clear of passageways, and in ventilated areas.
3. The gas and arc welding areas must be located in such a manner that an arc cannot be struck on a gas cylinder or on gas lines or water lines.
4. Reflective screens are provided to protect others from arc flashes and burns.
5. Arc welding area must be dry.
6. An insulated hanger must be provided for the electrode holder in order to eliminate possible arcs to ground.

Storage

1. Students and teacher are protected from protruding materials and sharp edges.
2. Acids, caustics and other poisonous chemicals must be stored in approved containers.
3. Fire resistant storage cabinets must be provided for all flammable materials.
4. Bulk storage of flammable materials should be in an outbuilding of suitable construction and location to meet local fire codes. (Editor's Note: A Laboratory Safety Evaluation Form is provided in Appendix C.)

PRINCIPLES OF SANITATION

One sanitary drinking fountain and a washing station with hot water and suitable soap should be provided for every five students in plastics, woods, metals, power, automechanics and graphic arts laboratories. Other areas may need sinks if ready access to general lavatories is not available. Shower rooms for boys and girls should be provided close to the industrial arts complex. An approved eyeglass sanitizer should be provided for the safety glasses and welding goggles.

PRINCIPLES OF PLANNING STORAGE

Industrial Arts laboratories require two basic kinds of storage.

Live storage is for equipment and supplies used almost every day, while dead storage is for items used infrequently. Live storage should be contiguous with the laboratory it is serving if at all possible. Dead storage, on the other hand, can be in much less desirable space. Various laboratories require different storage space (see Table 4). In addition, a general use dead storage area with a minimum of 150 sq. ft. per laboratory served should be provided.

Materials storage spaces should be located in such a position in the building that the unloading of 20 ft. long pieces of steel and wood, and 50 gal. barrels of solvent and resins will be facilitated. Once stored it must be possible to take the material to the part of the laboratory in which it will be used.

(Editor's Note: An example of a Project-Program Requirements Check List is provided in Appendix A to assist the facilities planner.)

REFERENCES

Brown, Robert D., *Industrial Arts Laboratory Planning and Administration,* Milwaukee: The Bruce Publishing Company, 1969.

Federal Regulations Number 29, Part 1910 – Occupational Safety and Health Standards, Washington, U.S. Government Printing Office.

Guide for Planning Educational Facilities, Columbus: Council of Educational Facilities Planners, 1969.

Industrial Arts Safety Instruction, Sacramento: California State Department of Education, 1966.

Laboratory Safety Evaluation Form on Human Safety; Materials, Storage and Handling; Physical Facilities; and Machines and Tools, Manassas, Virginia: Department of Industrial Arts, Trade and Industrial Education, 1974.

Planning Industrial Arts Facilities, Eighth Yearbook of the American Council on Industrial Arts Teacher Education, Ralph K. Nair, Editor, Bloomington, Ill.: McKnight Publishing Company, 1959.

Safety Manual for Industrial Education, Los Angeles: Division of Instructional Services, Los Angeles City Schools, 1964.

Schmitt, Marshall L. and James L. Taylor, *Planning and Designing Functional Facilities for Industrial Arts Education,* (U.S. Department of Health, Education and Welfare), Washington: U.S. Government Printing Office, 1968.

Vocational-Technical Facilities for Secondary Schools: A Planning Guide, Columbus: Council of Educational Facilities Planners.

Woodward, Robert L. and Norman L. Myers, *Planning and Equipping Industrial Arts Facilities* (Second Edition), Sacramento: California State Department of Education, 1971.

CHAPTER V

Planning for Effective Organization and Management

Claude E. Hill
Associate Professor of Technology
Western Washington State College
Bellingham, Washington

and

Robert D. Brown
Professor of Industry and Technology
Northern Illinois University
DeKalb, Illinois

PERSONNEL MANAGEMENT

Every industrial arts teacher needs substantial expertise in facilities planning so that he can solve problems of organization and management that are an integral part of his professional life. The extent to which he is successful in his planning activities will, in large measure, determine the value of the industrial arts program in his community. His skill as a designer will have a direct effect on the educational benefits and enjoyment that students derive from work in the laboratory, and it will have much to do with the efficient utilization of tax monies. It is possible to spend a large sum of money on the creation or redesign of a laboratory only to find that the community has obtained a facility that is neither as safe nor as useful as it should be. On the other hand, a superb laboratory may result, and the difference often lies mainly in the quality of the planning that is done.

A facilities planner must keep reminding himself that, as any industrial arts course progresses, there will be a constant movement of people and materials in the laboratory. This will help him to keep efficient people-materials flow in proper perspective as a key element in his design.

It is true in a specific situation that a number of factors unrelated to laboratory design – among them, the course outline, school policies on discipline, and the personality and capabilities of the teacher – are likely to play a part in determining the effectiveness of any system of class control and of the supervisory practices employed. However, subsequent discussion will explore chiefly the role of physical plant organization, including equipment layouts, traffic flow, materials handling and storage systems in achieving satisfactory class management and laboratory operation.

Physical Plant Design: Its Effect on Supervision

An industrial arts facility includes two fundamental parts. They are the main work area and the complex of auxiliary areas.

The main work area must encompass as many square feet of floor space as are needed to permit an efficient flow of traffic, and the areas must be shaped so that such a flow is possible. The most functional shape for a main work area is the rectangle. If a good pattern of lateral and longitudinal traffic lanes is to be established, a main work area should be no less than thirty-five feet wide. Ideally, it will be forty-five feet in width. The length (and, therefore, the proportion) is determined by the number of square feet of floor space required. For example, a woods laboratory having a main work area that is forty feet wide and fifty feet long provides 2000 square feet of floor space – an adequate size for a class of twenty students.

Appropriate types, sizes, and locations of auxiliary areas contribute to good class management and traffic flow; and they add needed capacity to an industrial arts facility. Certain auxiliary areas should be constructed as rooms, while others are best designed as *areas* adjacent to, or actually in, main work areas. A few can be planned as either rooms or areas, depending on the needs and practical considerations of situations.

Table 5
Auxiliary Areas

Area	Size/Capacity	Location	Remarks
classroom	40 sq. ft./student	adjacent to main work area	provide for visual supervision
office	140-200 sq. ft.	central	provide for visual supervision
design center	25% of class; 50 sq. ft./student	adjacent to main work area	provide for visual supervision
library and media resource centers	25% of class; 40 sq. ft./student	adjacent to main work area	provide for visual supervision
demonstration area	entire class sitting or standing	in main work area	portable seating recommended
locker area	2 cu. ft./students; 120+ lockers	in two or more groups adjacent to main work area	steel storage units recommended
project storage room	storage for 120 or more projects	adjacent to main work area, finishing room	provide for visual supervision; floor space and shelf space needed
materials storage room	varies with lab; 1½ year supply	adjacent to "rough" production area	vertical and horizontal storage
project assembly area	150-200 sq. ft. floor space	adjacent to bench area	for final assembly of large projects
laboratory restroom(s)	1-person capacity	near, or in, lab	separate male/female facilities
wash area	2-6 student capacity	adjacent to bench area	provide hot and cold water/soap/towels

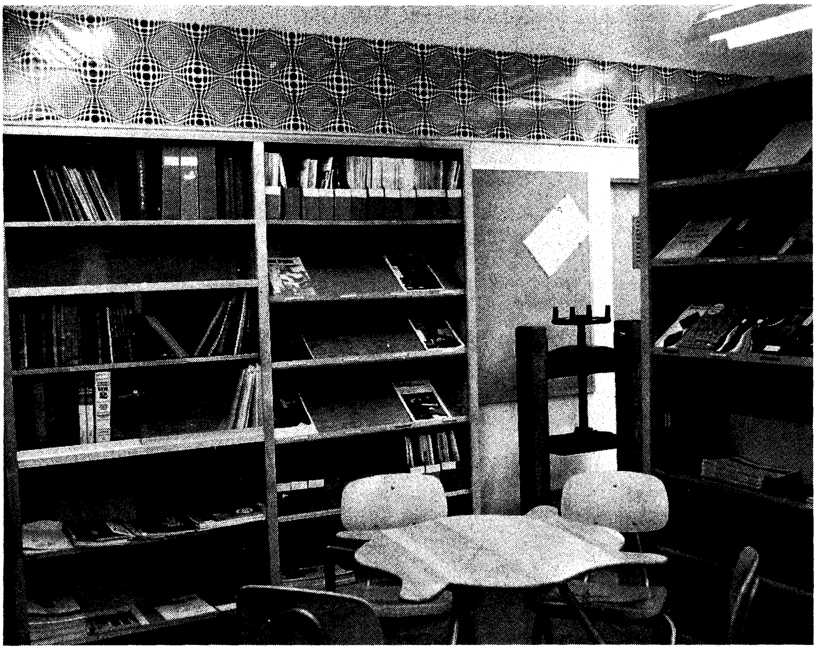
Important auxiliary areas include classrooms (or class areas), teachers' offices, design centers, libraries and media resource centers, demonstration areas, student locker areas, project storage rooms, materials storage rooms, project assembly areas, restrooms, and wash areas. The major characteristics of these areas, as they relate to student control and supervision, can be set off as in Table 5. If auxiliary areas are properly sized, located, and constructed, in the manner indicated in Figure 5-1, student travel will be minimized and made more efficient. In addition, opportunities for visual supervision by the teacher will be greatly enhanced in all parts of the laboratory.

Fig. 5-1.
Resource Center Strategically located in the Laboratory. Photograph by Dury Fox, Bainbridge Island, Washington

Designing for Effective Visual Supervision

A teacher cannot be everywhere at once; yet, he must be in constant supervisory touch with every student in his class. The question is, how is this best accomplished?

One of the answers is supplied by the design of the laboratory. If the main work area is rectangular, the teacher will be able to see everyone who is working in it. Areas with blind corners or isolated rooms invariably contribute to supervisory problems. Auxiliary rooms which are enclosed by transparent partitions



Library Resource Center. Photograph by Thomas A. Jasnosz, San Jose, California

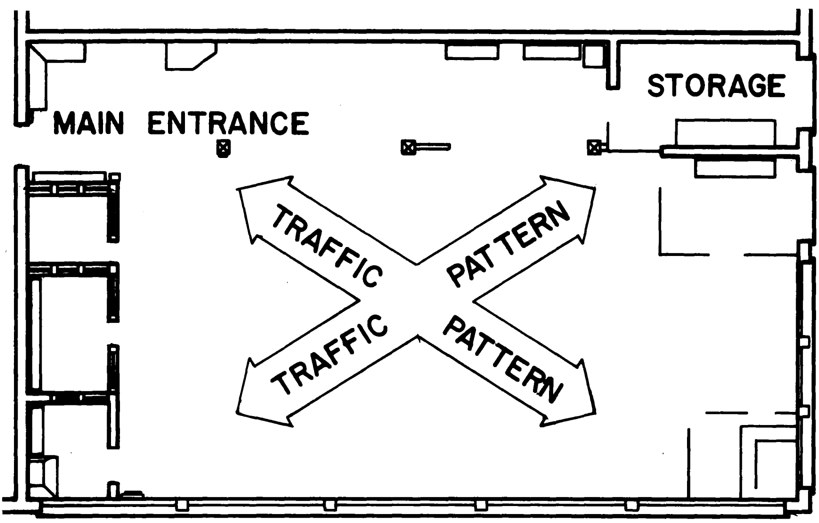


Fig. 5-2.
A Diagonal Orientation for a More Controlled Traffic Pattern. Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

Fig. 5-3.
Balcony Used as Instructor's Office and/or Classroom Area. Photograph by Robert D. Brown, Northern Illinois University

make it possible to keep students in sight at all times. The most satisfactory way of providing auxiliary room visibility is to construct the partitions of transparent material from the 3′-6″ level to the ceiling. Solid material should be used below the 3′-6″ level, because this is where most wall damage accumulates. Partition surfaces below the glass must be especially durable.

Divisions in transparent sections must be thin and strong. Aluminum extrusions which are anodized work well for this purpose. The transparent material can be either safety glass, acrylic, or polycarbonate plastic. Glass must conform to existing safety standards; therefore, it is usually necessary to use laminated safety plate glass, tempered glass, or wired glass. The clear sheet plastics (acrylic or polycarbonate) are available in a variety of grades, depending on the impact strength and degree of scratch resistance required. Coatings are also available to eliminate static electricity which often causes dust particles to adhere to the plastic surfaces.

Cabinets and pieces of equipment should not obstruct visibility through the transparent partitions.

Balconies for storage and/or student activities are a space-saving possibility, but can lead to supervisory and safety problems in a laboratory.

In addition to the potential hazards involved in the vertical movements of students and materials, balconies require the teacher to supervise on two levels – a difficult, usually impossible, task to perform adequately.

A teacher's office, in or near the laboratory, should also afford maximum control and visual supervision of student activities. Additional faculty work space, with more privacy than available in a laboratory office, can be provided in an area with combined faculty conference – library, lounge, and restroom facilities.

Traffic Flow

Movement of people must be considered in its entirety when new or remodeled facilities for industrial arts are designed. The movement must be adequate in the complex (i.e., the area, wing, or building) that houses the various laboratories, and it must be efficient within each laboratory in the complex.

Good laboratory complex design necessitates a corridor system that will enable large numbers of students to pass easily from one laboratory to another, as well as move between the auxiliary areas of the complex. Corridors should be 10-12 feet in width, and laboratory doors should be staggered to prevent congestion. Specifically, main entry doors to laboratories should not be placed next to each other or directly across the corridor from each other.

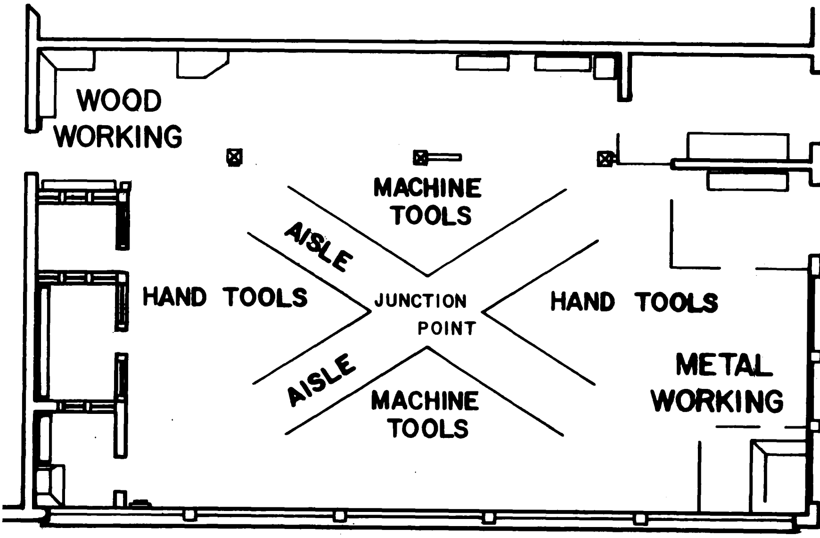


Fig. 5-4.
Aisles Used to Block Out the Laboratory Into Learning Activity Areas. Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

Spatial relationships among laboratories in a complex should be as favorable as possible, particularly between those laboratories which are functionally related to each other. For example, automotive and general metals laboratories might well be placed adjacent to each other. Connecting doors or movable walls between such areas may allow for program versatility and interrelatedness, but this could also increase the difficulty of maintaining control of specific classes.

Within each laboratory, size is a critical factor in achieving a good supervisory situation and an efficient flow of traffic. Facilities that are too small, especially in the main work area, and/or deficient in auxiliary areas, are invariably congested. If sufficient space is available, all things are possible; if not, many problems cannot be satisfactorily solved.

Students should be able to enter a laboratory and move to all parts of it without having to detour around pieces of equipment that are not well located. Distinct traffic lanes, formed by the organization of equipment, and storage facilities, must connect places used frequently, such as tool panels, machine areas, project storage areas, and the finishing room. It may even be desirable in certain situations to denote traffic lanes with taped or painted lines on the floor.

Two main types of traffic lanes are found in most laboratories. They are longitudinal lanes and lateral lanes. Auxiliary (feeder) lanes may also be used to connect areas of more-or-less infrequent use. Longitudinal and lateral lanes should be no less than four feet in width, except in drawing rooms, where they may be three feet and two feet wide, respectively. Auxiliary lanes as narrow as three feet may be used. Somewhat greater widths may sometimes be desirable in all types of traffic lanes, but too much width is no advantage. Worse, it is a waste of space.

High level windows increase the efficiency of student movements by freeing wall space for the most advantageous placement of tool panels, bulletin boards, chalkboards, and equipment. Windows installed in the upper part of a wall should begin at the eight foot level and extend toward the ceiling, which is assumed to be approximately fifteen feet above floor level. Class control is also improved by this kind of window design; the sun's glare is reduced and outside distractions are removed from the view of students.

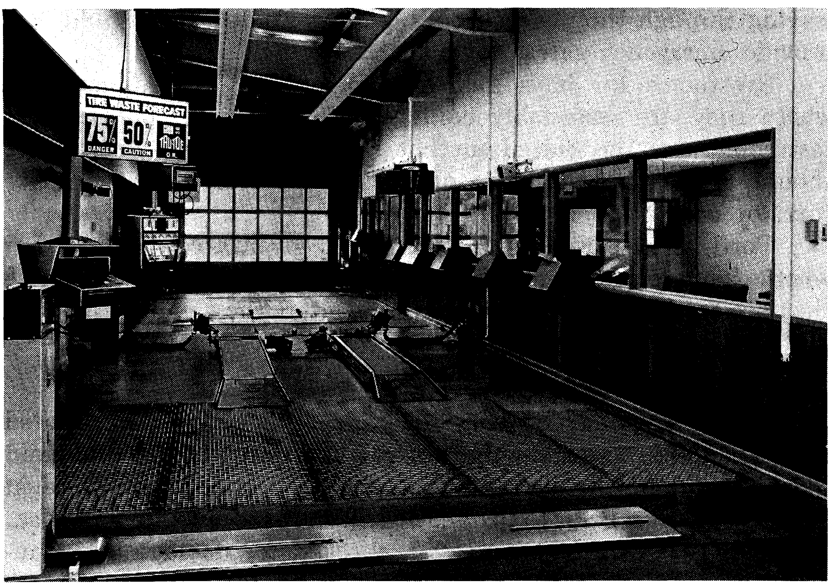


Fig. 5-5.
A Diagnostic Lane is Supervised Through Well Placed Windows. Photograph by Robert D. Brown, Northern Illinois University

Equipment and stock being processed must never be allowed to project into traffic lanes; therefore, a generous amount of space should be provided on the infeed and outfeed sides of machines. One of the best ways to analyze traffic flow is to place a sheet of vellum over the preliminary draft of a floor plan and outline all traffic lanes on the vellum. Then, if traffic movements at the beginning of a class period, during the period, at the end of the period, and in emergencies, are visualized, the general picture should emerge. If there are problems, improvements should be made.

In case of fire, or other emergencies, a good traffic flow requires (1) more than one exit, (2) doors that are 36″-42″ in width, and (3) doors that open *out* of student work areas *into* corridors or to the out-of-doors. An overhead door used to handle incoming supplies and equipment will serve well as an emergency exit. Such an exit must never be blocked by equipment, projects, or stacks of materials.

Several exits to the outdoors should be provided in an industrial arts complex in order to avoid the necessity of entering and leaving through the main school building. These exits should also provide emergency egress for all laboratories.

Restrooms for boys and girls should be located centrally where they are reasonably equidistant from each laboratory. If restrooms must be placed so that they are adjoining, the doors should be on opposite sides of the rooms in order to minimize corridor congestion.

Corridor display facilities should be given a central location where they are conveniently available to all laboratories and where they are readily visible to anyone who enters the complex.

TOOLS AND EQUIPMENT

Equipment must be selected, requisitioned, bid, and ordered early enough in the planning procedure so that it will be on hand – installed and fully operational – well before classes are to begin in a new facility. Prior to installation, each piece must be unloaded, set in place, uncrated, degreased, checked for damage and completeness, and serviced, as necessary. This is a task that requires considerable expertise, and it is time-consuming because of the large number of items involved.

When a teacher prepares a requisition, he does so on the basis of his search for the best combination of important design features, absence of uncorrectable design faults, and high overall quality. In his search, he must evaluate the possibilities for modification, because some design defects are more significant than others, and not all can be corrected. To illustrate, local lighting can be added, if necessary, but a left-handed option may be unavailable.

Acquisition of inadequate or inappropriate equipment will inevitably result in a limited program and a laboratory which will be far from satisfying as a place in which to teach and learn.

Specifications

Anyone who selects equipment for an industrial arts program finds himself faced with two important responsibilities. The first is that of selecting *types* of equipment. The only valid basis for selecting types is the program, since equipment is placed in a laboratory so that certain objectives can be met.

Teacher bias will, of course, affect what is purchased. This is unavoidable, but it must be minimized. Money also plays a part in the selection process but, in theory at least, is relatively unimportant. Most schools can acquire whatever they are convinced is important.

Pieces of equipment that enrich industrial arts programs, such as wood laminating presses and ammonia print machines, make special – even unusual – activities possible and thereby expand the horizons of courses. They also add laboratory capacity (work stations), thus helping to avoid supervisory and traffic problems related to a scarcity of equipment.

Once the types of equipment to be purchased have been determined, the search for the most suitable *brands* must begin. Brands differ widely with respect to quality and design features even within the same general price range; therefore, it is essential to examine specifications carefully.

Some purchasing systems do not permit listing brand names on requisitions or bid requests. Others allow this but make it necessary to add the phrase "or equivalent" after each brand name specified. Even so, a teacher must determine the best brand available for each item to be purchased and make every effort to see that it is obtained.

There are three major bases for selecting brands of equipment. They are *function, manufacturer's services,* and *appearance;* and this is the order of their importance. Any selection practice

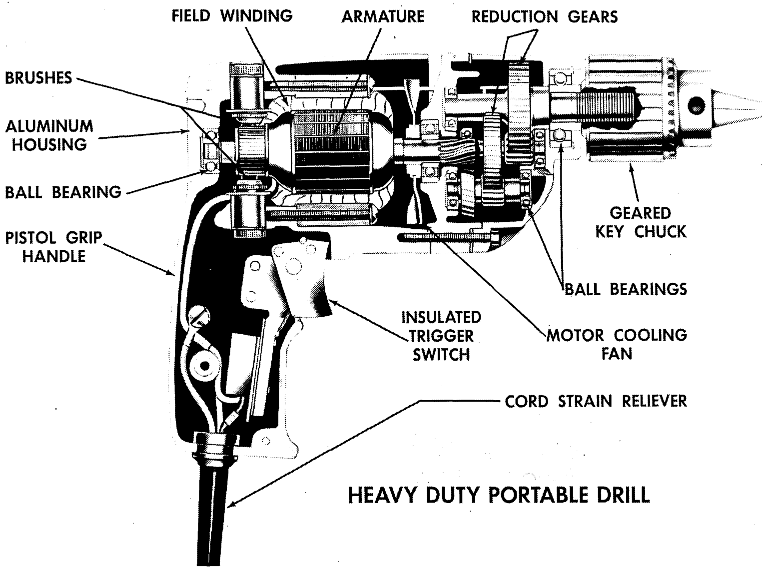


Fig. 5-6.
Typical Specifications (Below) for Machine Pictured Above. Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

3/8" Heavy Duty Portable Drill:
To have 3.5 amp, 110V., A.C. heavy duty motor; 1000 RPM idle speed; heavy duty trigger switch, mounted in pistol grip handle, to be full 16.0 amp rated, double pole type and fully insulated from housing; 3-conductor heavy duty cord, 6′ min. length, with strain reliever firmly locked to drill handle; 3-prong grounding plug molded to cord; sealed precision ball bearings; machined reduction gears; integral motor cooling fan; housing to be polished, die-cast aluminum; to have heavy duty, 3-jaw, industrial geared key chuck with 3/8" max. diameter capacity; chuck key included; net weight of drill not to exceed 4½ lbs. Machine and accessories to comply with all current OSHA safety standards and requirements; to be shipped with complete instructions, parts manuals and warranty; manufacturer to have complete line of repair parts and accessories available for this machine. Specific model desired:__________ __________or equivalent.

not related to one of these three – for example, ordering only "name" brands, restricting orders to one major supplier, tradition, personal bias, desire for brand uniformity, or desire for brand diversity – represents an incompetent procedure. It will not usually result in acquisition of the best equipment, and it is likely to waste taxpayers' money in one way or another.

The following considerations are significant when the *functional* qualities of a piece of laboratory equipment are assessed:

1. potentialities for student learning and development;
2. ability to do the job it is designed to do;
3. interface with students' physical and mental capabilities;
4. ease and safety of operation;
5. quality of electrical design and construction;
6. quality of manufacture; and
7. simplicity of design and structure.

A piece of laboratory equipment is a production unit; but at the same time, it is a teaching medium. Consequently, it must assist in the teaching-learning process as much as possible. In short, it must help the teacher to teach operating and scientific principles, work techniques, craftsmanship, operating procedures, and equipment maintenance. The extent to which equipment is instrumental in doing this is a true indication of its worth in an industrial arts program.

If a piece of equipment is to be of maximum value to a teacher and his students, it must be capable of doing *well* what it is designed to do. It should be accurate enough to produce a high quality of work and fully adjustable so that there will be little, if any, decline in precision in the latter stages of its service life.

Equipment must also be matched to the physical needs of students. Since students vary greatly with respect to size, strength, and coordination, smaller sizes of equipment and left-handed options should be made available by manufacturers. (Reductions in the size of equipment should not be accompanied by reductions in quality.) The operation of a piece of equipment should be well within the strength and coordination capabilities of students. This implies that easily read dials; large, well-placed electrical switches; smoothly working controls; color coding to meet existing safety standards, and other provisions for successful operation will be important selection criteria.

Ease and safety of operations are other important considerations. Handles and operating levers must be large, slip-proof, shaped to fit the hand (or foot), and properly located. Surfaces that will be grasped by hands should be painted, plated, or made of a corrosion-proof material. Manufacturing tolerances should be such that smooth operation is assured. Work surfaces must be sufficiently large, and machine bases should be rigid enough to eliminate vibration and shaped so as not to hamper the movements of operators.

The piece of equipment which is convenient and safe to operate is adequate in terms of speed range and power. In addition, it is well guarded, exhibits good electrical design and construction, and has been skillfully manufactured.

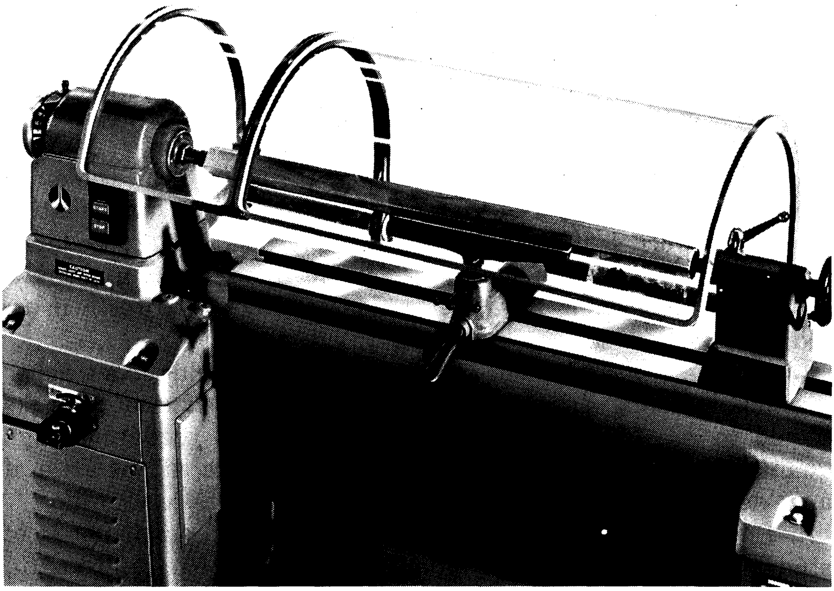


Fig. 5-7.
A Well Guarded Wood Lathe. Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

Guards on new equipment may, or may not, provide proper protection. In some cases, it is difficult to find a machine which is well guarded; but after purchase, modifications can solve the problem. The goal is to secure guards that are simple, durable, effective, easily activated, automatic in operation, and which do not hamper production.

Evidence of good equipment manufacture is something that a teacher must learn to recognize. This includes: proper finishing (no burrs, sharp edges, sharp corners, rough holes, splintery wood, protruding set screws, or blowholes in castings); adequate lubrication and provisions for adjustments (sealed bearings, self-lubricating materials, large lubricant reservoirs, screw-thread adjustments, and self-adjusting devices); careful preparation for immediate operation; and complete assembly. The presence of lubricant leakage and other defects frequently give indication that the manufacturer was not all that it should have been.

A well designed piece of equipment is planned so that maintenance and cleanup will be relatively easy. Disassembly should be simple, and frequently undertaken adjustments and service operations should not require major strip down. Leveling devices, where necessary, should be built-in. The base, if it supports a machine, should be enclosed to the floor to facilitate cleanup, yet

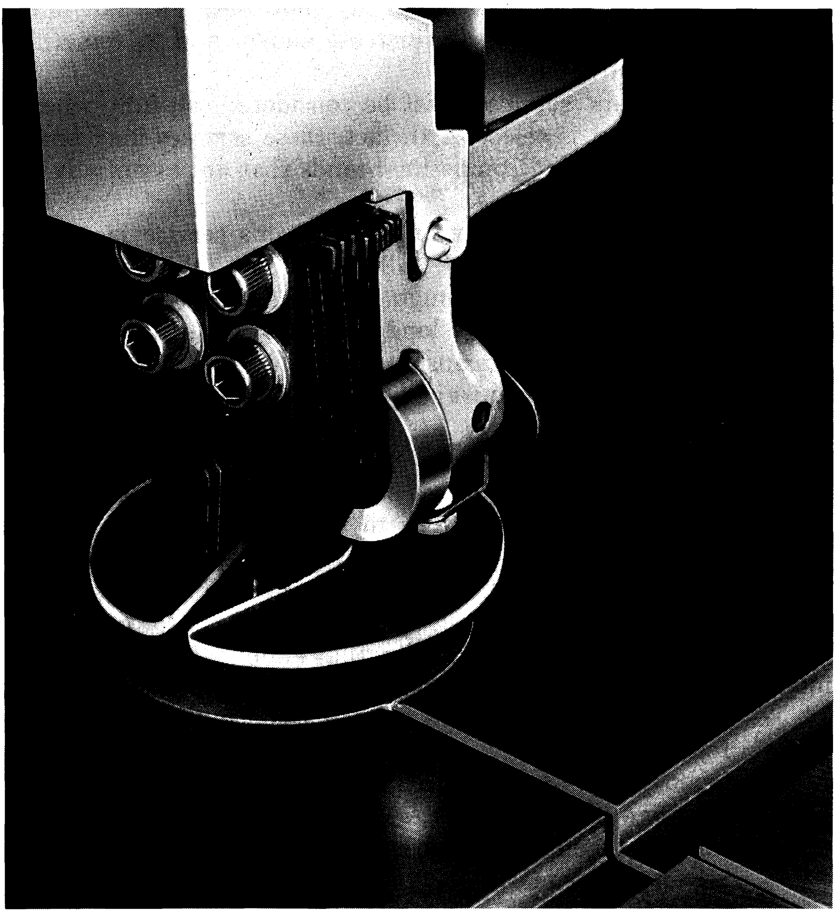


Fig. 5-8.
A Guard Designed for Maximum Protection on the Band Saw.
Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

it must provide ready access to the motor and drive system for service. Machines that produce debris should be designed so that they can be connected to dust collection systems.

Good function is, in many instances, related to simplicity of purpose. It is seldom wise to make elaborate provision for performing operations which almost never need to be done. Interestingly, most multipurpose machines have not been commercially successful. Teachers, by-and-large, have preferred unit machines, because they offer superior function. Simplicity, however, does not imply lack of essential features which increase and/or add to versatility or convenience of operation.

Manufacturers' services must be considered carefully when a piece of equipment is selected. In fact, these services may be the chief difference between competing brands that are essentially the same in functional qualities.

Perhaps the most important manufacturer's service is a satisfactory warranty, coupled with willingness and ability to back it up. It should be inclusive enough to provide needed protection, and it should remain in effect long enough to cover all defects in materials, design, and workmanship. Such a warranty should never equivocate; moreover, it must indicate exactly how claims are to be handled.

A manufacturer's ability to provide good warranty service results from the establishment of effective service centers, as well as the maintenance of an adequate stock of reasonably priced repair parts. Further, repair parts must be made available throughout the expected service life of every piece of equipment.

Other manufacturer's services which are helpful to the teacher and may, therefore, be considered important selection criteria, include the following:

1. adequate directions for installation, maintenance, and repair;
2. technical assistance with installation, if necessary;
3. complete and well illustrated operating literature;
4. training sessions designed to acquaint teachers with the use of equipment;
5. the policy of designing modifications so that they can be incorporated in earlier models; and
6. instructional aids of various types that will be of help in explaining the use of equipment.

All of these services should be provided, free-of-charge, to purchasers. Moreover, manufacturers must acquaint teachers with the fact that they are available.

Appearance is a significant factor in the design of a piece of laboratory equipment. Although it is less important than function and manufacturer's services, there is no reason why equipment cannot be attractive. Every teacher wants his laboratory to exhibit good aesthetic design, and the appearance of the equipment is a substantial part of the total effect.

Many equipment manufacturers have, in recent years, made vigorous efforts to improve the visual design of their products. It

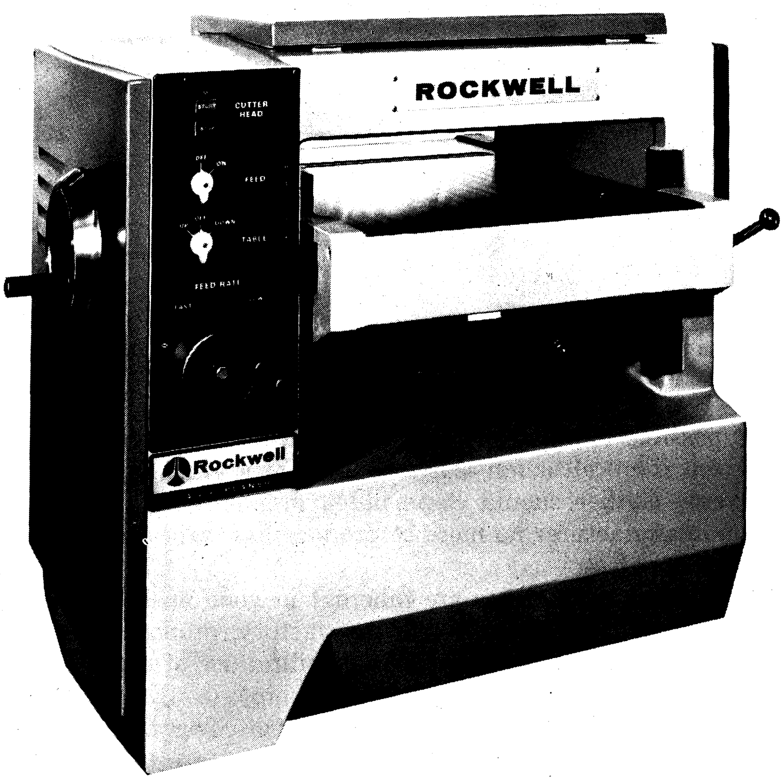


Fig. 5-9.
A Planer of Functional Design and Appropriate use of Materials and Labeling. Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

Fig. 5-10.
An Illustration of Functional Design and Pleasing Appearance.
Courtesy Sun Electric Company, Chicago, IL

is now possible to obtain *both* good appearance and good function in a given item, although this may require a vigorous search. In any event, neither should command a premium price. It should cost the manufacturer no more to produce first-rate design, and it may even cost less.

A number of qualities are inherent in good aesthetic design. These include interesting form, satisfactory proportion, proper balance, appropriate use of materials, skillful use of color (including accents and texture), good workmanship, strong expression of function, and simplicity. If a teacher can discover these features in a piece of equipment, he can be reasonably sure that it has an attractive appearance.

Procurement

The process of procuring equipment can be simple or complex. The degree of complexity depends on the amount of specifications required by a school's business procedures.

In general, procurement takes place in three steps. They are: (1) *requisition* (purchase request by the teacher, (2) *request for bids* (if necessary) by the purchasing office, and (3) *purchase order* by the purchasing office. The purchase order, which goes to the successful bidder, usually contains a date by which the equipment is to be delivered, and it represents a contract between buyer and vendor. Deviations from specifications, delivery date, or price should require the *written* approval of both the buyer and the vendor.

When a teacher submits a requisition, he may be permitted to stipulate the brand name and the vendor's current catalog number for each piece of equipment requested. If so, the task of preparing the requisition is greatly simplified. All that is necessary is to record the general specifications and inclusions listed under the number. Even this is not essential, as long as the number includes everything that is wanted. It is wise to add a statement prohibiting deviations, since catalogs often indicate that specifications and prices may be changed without notice.

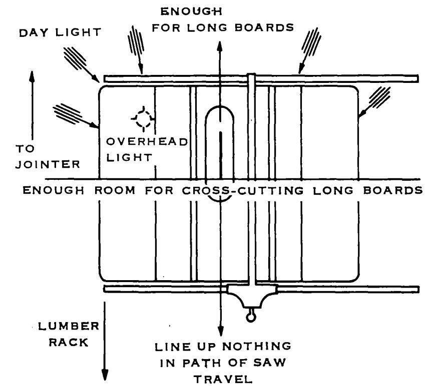
If it is not possible to list brand names or catalog numbers, or if this is permitted only where the phrase "or equivalent" follows each brand name, specifications must be written so exactly that only the desired brand and model meets them. Obviously, this is a time-consuming task, but in such a situation loose specifications often lead to substitutions or omissions which can be disappointing.

Quite often, manufacturers and vendors put together "packages" of equipment, each of which contains many items grouped under one catalog number. For example, a single catalog number may identify a tool cabinet and a large number of tools offered at a specified package price. Listing packages speeds up the process of preparing requisitions, but it tends to be unduly expensive and frequently ineffective. The purchaser may well be obliged to acquire a number of tools he doesn't really need, as well as excessive quantities of certain other tools. At the same time, he is likely to find that the package does not provide some of the highly specialized items that are essential. In fact, the package serves as a tool salesman, more than anything else; and the teacher should be aware that a package deal will seldom be entirely to his advantage.

In many cases, a requisition includes suggested vendors' names and addresses, the desired date of delivery, and other items

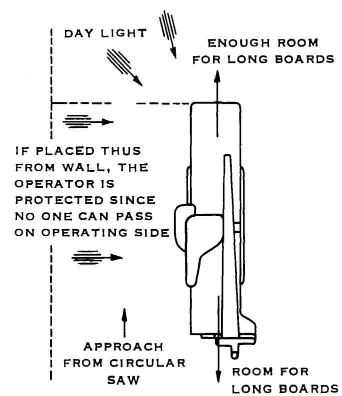
THE CIRCULAR SAW

The circular saw should have natural light coming from the left-hand side and the rear. Artificial light should be from the back of the blade and to the left. Allow enough room for ripping long boards and enough room on each side for cross-cutting. The amount of room necessary will depend upon the type of projects. Generally, projects for the senior high school are larger than those in the elementary and junior high schools and, therefore, more room should be allowed. It is well not to line up another machine or a bench in direct line of the saw travel; a careless student may allow a piece of stock to kick back. Provide a wide aisle to the back or front of the saw to prevent traffic interfering with projecting lumber.



THE JOINTER

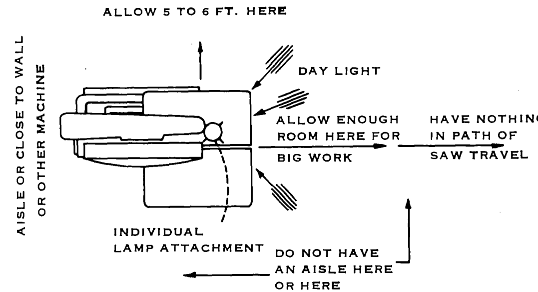
The jointer should be placed to the left and behind or ahead of the circular saw. Jointer operations generally follow work on the saw. Light on the jointer should come from the left and back as shown. Enough room should be allowed in front and back of the jointer for running the size of boards generally used. The widest aisle should be on the left side of the machine so that passing students do not bump into the operator.



THE BAND SAW

The band saw should have its light coming from the right-hand side. Since most modern machines, however, can be equipped with an individual light attachment, this is not absolutely vital.

The band saw may be placed so that there is an aisle to the operator's left or to the back of the machine. A wide aisle should be to the right or in front of the machine to eliminate possible interference with the operator. Locate the machine so that the path of saw travel is not in line with other operators or people at their benches.



THE LATHE

A very fine arrangement of lathes is shown here. They are set at an angle of about 45° from the window wall so that the light coming in will flood the entire lathe bed and headstock. In this way a sufficient amount of light is thrown upon the work whether straight spindle turning or face plate turning is being done. If an overhead light is installed, it should be in back of the lathe.

The diagonal position recommended also insures that work turning in one lathe will not be in line with other operators. With adequate shop lighting, the position of the lathe and the operator become less dependent upon natural light. High windows create less glare and student distraction, permitting the operator to face the wall or windows. This allows the head stock to be "in the shop," not against the wall, saving space and providing safer outboard turning.

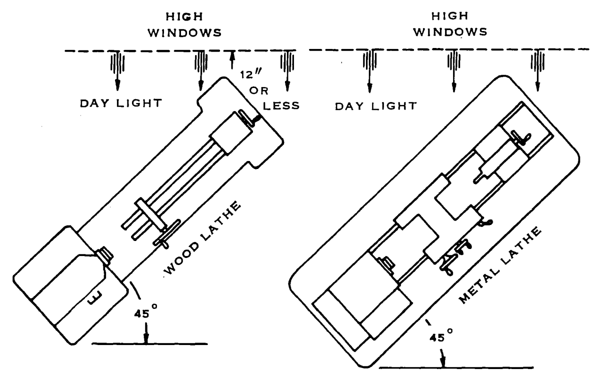
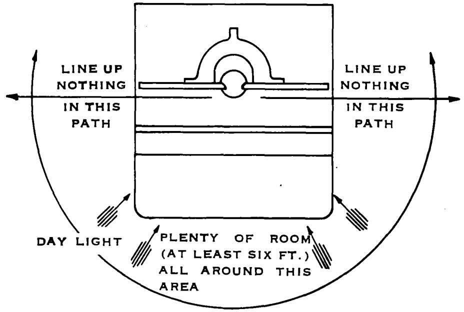


Fig. 5-11.
Principles of Machine Arrangement.
Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

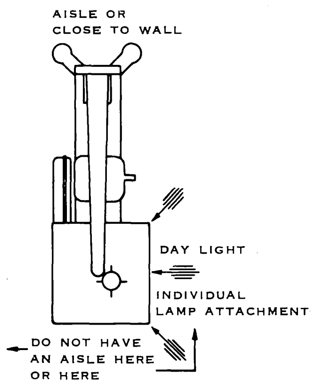


THE SHAPER

One of the woodworking machines that must be carefully operated is the shaper. It should be placed so there will be absolutely no interference from passing students and the work can be observed by the instructor at all times. Often it is placed in an area by itself. Light should come to the shaper from the front and both sides and at least 6 feet should be allowed in front and on both sides for the operator.

If possible, nothing should be lined up with the shaper on either side.

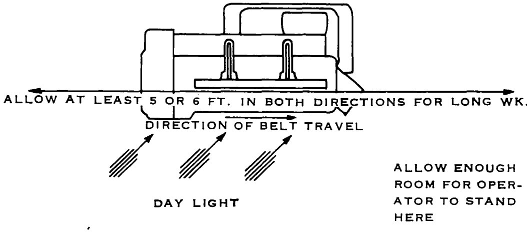
If projects call for the manufacture of long pieces of moulding, then the shaper can be placed along one of the walls.



THE SCROLL SAW

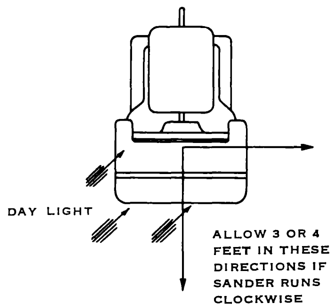
The scroll saw is used in more schools than any one other power-driven machine. It should be centrally located so that all students can have easy access to it. Since much of the work on this machine is fine in nature, an individual light is usually supplied with it. Consequently outside light is not so important.

In placing this machine be sure to allow enough room, at least 5 to 6 feet to the front and sides of the machine, so that the operator will have freedom. It is also well to place the machine so that the back faces the aisle.



THE BELT SANDER

The illustration shows a belt sander in a horizontal position. The fence accessory has been substituted in the drawing for the cast iron table usually supplied with this sander. Daylight should come to the machine from the front as shown. The widest aisle should be on the operator's side of the machine.



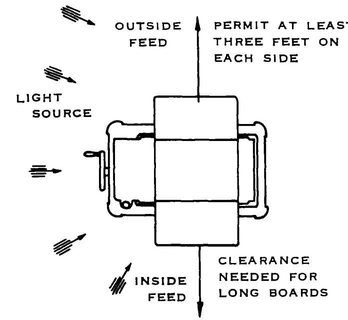
THE DISK SANDER

Three or four feet of room in the front and to the right of the machine is generally enough for operation on a disk sander. Daylight should come from the left-hand side and onto the disk. No other precautions are especially emphasized.

Fig. 5-12.
Principles of Machine Arrangement.
Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

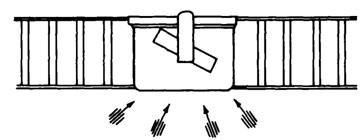
THE PLANER

The planer should be placed so that it is immediately accessible to the lumber rack and lumber storage. Obviously, ample clearance must be provided on both the infeed and outfeed sides to permit the planing of long boards. The light source should be such that the dimensional gauges and operating levers can be observed and safely handled.



THE RADIAL SAW

This power tool is most serviceable when placed against a wall adjacent to the lumber rack. At least 12 feet of bench space on either side should be allowed so that long and heavy boards may be cut with ease and safety. A wide aisle should be provided in front of the machine to prevent interference with the operator.



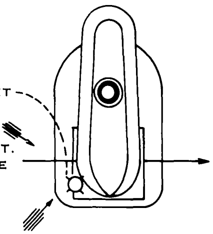
PLACING OF BENCHES

In most schools the most satisfactory arrangement of placing benches in the woodworking shop is to allow at least 30 inches between the vise of one bench and the back of another bench. The distance between benches from end to end should not be less than 24 inches. These dimensions should be the *minimum* amount of space allowed for the pupil. Here again, common sense must be used.

THE DRILL PRESS

In the woodworking area, the drill press should be located against a wall with enough space allowed on either side for mortising work on all sizes of stock.

In a metalworking area the drill press can be placed in close quarters because the work generally is small in size. For accurate results on a drill press it is quite essential that an individual light attachment be provided. For this reason, it is not important to place the machine with reference to natural outside light. The back of the machine can be placed very close to the wall with a wide aisle in front of the machine.



THE GRINDER

The grinder should be placed fairly close to the drill press or the lathe. It is most often used to sharpen the tools of these two machines. It can be placed fairly close to a wall or to machines. Since most of the work done on the grinder is small, an aisle may be permitted on the operator side.

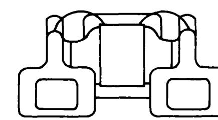
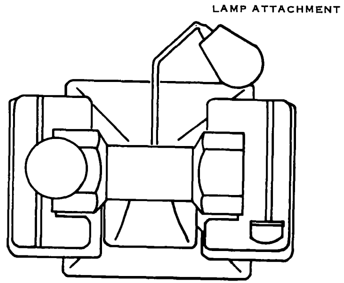
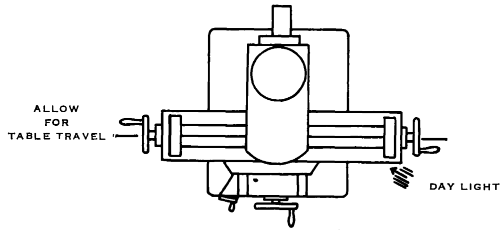


Fig. 5-13.
Principles of Machine Arrangement.
Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

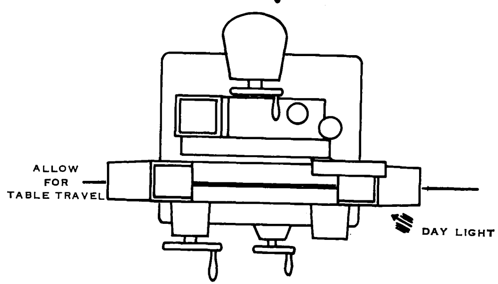


THE TOOL GRINDER

The Tool Grinder should be convenient to machine operations requiring frequent tool sharpening. Since practically all work performed with this type grinder is of a close nature, an individual light should be used for adequate illumination. Thus placement is not limited by either work size or light source. Sites along aisles, walls or at tool islands are good locations as long as adequate space is allowed at both ends of the machine for the operator and his work.



THE VERTICAL OR HORIZONTAL MILLING MACHINE



THE SURFACE, OR TOOLMAKER GRINDER

Since work pieces are usually of a similar size for both milling machines and surface grinders (generally no larger than the table surface), either machine can be located in moderately close quarters if ample clearance is allowed for table travel and aisle traffic. Care should be taken that a solid and level foundation is chosen for vibration-free operation of this type machine. If placed near windows, either unit should be positioned so that the light comes from the right and does not cast shadows on the work surface or interfere with the operator's vision. This problem is reduced when the machine is equipped with an individual lamp attachment.

Fig. 5-14.
Principles of Machine Arrangement.
Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

of information of use to the purchasing office. It always contains the quantity needed, unit price, and total price. Parenthetically, the list price of a piece of equipment is rarely the one paid by the school. Substantial savings generally result from the bid process as well as discounts for quantity purchases.

All kinds of purchasing literature – price lists, brochures, data sheets, and illustrations – are readily available from manufacturers and vendors. Industrial arts teachers should maintain up-to-date files of these materials for use in writing requisitions. They represent the major source of current information concerning specifications, options, and prices of equipment.

Placement and Organization of Equipment

A wide variety of equipment must be provided in any industrial arts laboratory.

Traffic flow and class supervision are directly related to how this equipment is organized – the more intelligent the organization, the greater the possibilities for satisfactory supervision and a good movement of students. Essentially, five principles should be observed when an equipment pattern is created on the floor of a laboratory.

First of all, equipment must be arranged to facilitate instruction. The arrangement should make it easy for the teacher to teach and for students to learn, since the amount and kinds of equipment available are directly related to rate and retention of learning. Purposeful duplication of certain pieces of equipment aids in avoiding production bottlenecks and the resultant traffic and supervisory problems.

Second, the organization of equipment must facilitate the movement of people from point to point in the laboratory, whatever the type of activity in progress. Students and the teacher must be able to walk quickly and safely from one area of the laboratory to another.

Third, equipment must be laid out so that the organization promotes safety. Dangers that a poor layout builds into a laboratory always increase the amount of supervision necessary and usually destroy the effectiveness of the traffic lane system.

Fourth, equipment should be arranged so as to assist the teacher in managing the laboratory and program. Poor traffic patterns can develop in a laboratory that cannot easily be kept clean and otherwise well managed. Time that need not be devoted to management can be used to provide better instruction and supervision.

Finally, equipment should be organized in the pattern that yields the most efficient flow of materials from storage to finished product. If this is done, the movement of semifinished projects between the project storage room, the finishing room, the bench area, or the project assembly area should present few problems.

Fig. 5-15.
Enclosed-Locked Student Storage Built into the Laboratory.
Photograph by Dury Fox, Bainbridge Island, Washington

Machines that are used chiefly to do the initial rough processing of stock should be placed very near – or, in some cases, *in* – stock rooms so that heavy, bulky pieces of stock need not be carried long distances. Some examples of this type of equipment are radial arm saws, power paper cutters, power hack saws, and metal-cutting band saws.

Fig. 5-16.
Metal Cut-off Shear Placed Near the Metal Storage Rack.
Photograph by Dury Fox, Bainbridge Island, Washington

Machines used for semifinished processing, such as table saws, planers, band saws (resawing), and jointers, should be grouped in a pattern that permits convenient, safe, and efficient operation, as well as a material flow that is in logical sequence.

To illustrate this type of organization, the safest and most efficient location for a jointer is at the right and rear of a table saw. This permits highly efficient sequential use.

Service equipment should be placed near the point of greatest use. Service equipment is used to support the operation of other equipment. It also includes equipment utilized in support of bench activities. Grinders and oil stone benches should be located near the lathes and the bench area; while shapers, drill presses, sanders, mortisers, and certain other machines should be placed adjacent to the bench area. It may be desirable, at times, to duplicate some of these pieces and install them in several areas of a laboratory in order to minimize interruptions in class activities.

Equipment which is either very specialized or unusually hazardous should be isolated from the normal flow of laboratory traffic. These work stations can be served adequately by auxiliary traffic lanes, since the traffic will consist almost entirely of the teacher and the relatively few students working there.

Versatile utility service systems also improve laboratory traffic patterns by preventing interruptions of class activities due to service breakdowns. They also minimize traffic by means of an extensive system of outlets. Even so, student movements to outlets which are not well located can add substantially to the total amount of traffic. Therefore, it is wise to eliminate all possible traffic, then attempt to make the remainder as efficient as it can be. For example, an electric outlet which is suspended over a bench will make most trips to the nearest wall outlet unnecessary.

As mentioned before, a laboratory width of thirty-five to forty-five feet will permit an effective network of traffic lanes of all kinds. But even an ideal situation can be degraded by the encroachment of added equipment as the years pass. Consequently, it is necessary to discard obsolete equipment as new pieces are added. The temptation to keep everything is a natural one which must be successfully resisted.

Color coding is closely related to equipment organization and can contribute much to the solution of traffic and class management problems. (Inquiry can be made to paint manufacturers regarding color coding schemes.) Coding, when applied to portable power tools and hand tools, makes them much easier to locate and replace in storage or on a tool panel. This reduces both students' travel and the amount of time the teacher must spend checking tools at the end of each class period. It is far easier to replace properly coded and silhouetted tools on a panel than to wander about trying to discover where to put them.

Obviously, other factors relate to efficiency of traffic flow and effectiveness of supervision; but equipment organization is highly important. Fortunately, it is a factor that a competent teacher can handle satisfactorily.

Tool Storage

Most tools used in industrial arts must be readily available to students and are usually stored in one of three ways:

1. a *comprehensive tool panel* (open or locking), which stores all common tools for the entire laboratory and is located in the main work area.

2. a *tool panel series*, which consists of several open or locking tool panels placed in strategic parts of the main work area. Collectively, the panels store all common tools.

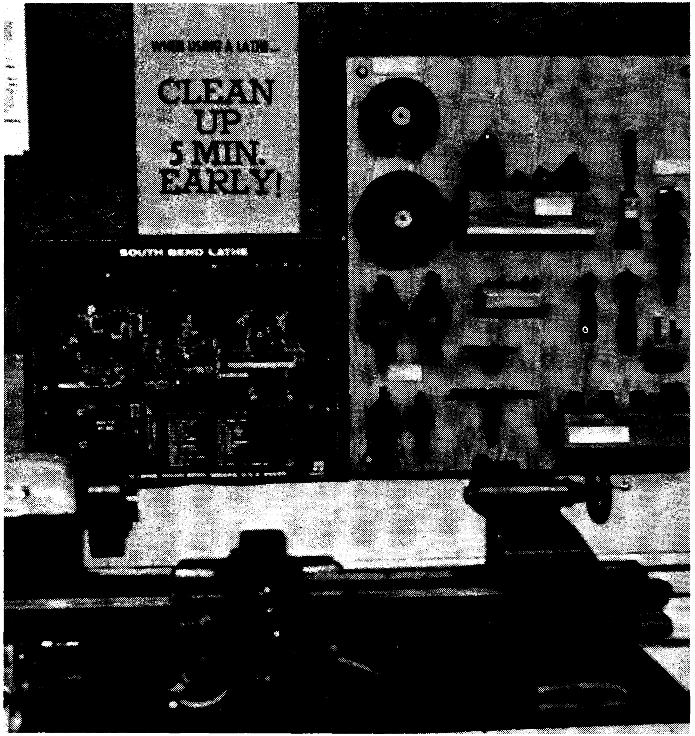
3. a *tool room*, which contains all necessary tool panels, drawers, shelves, and cabinets.

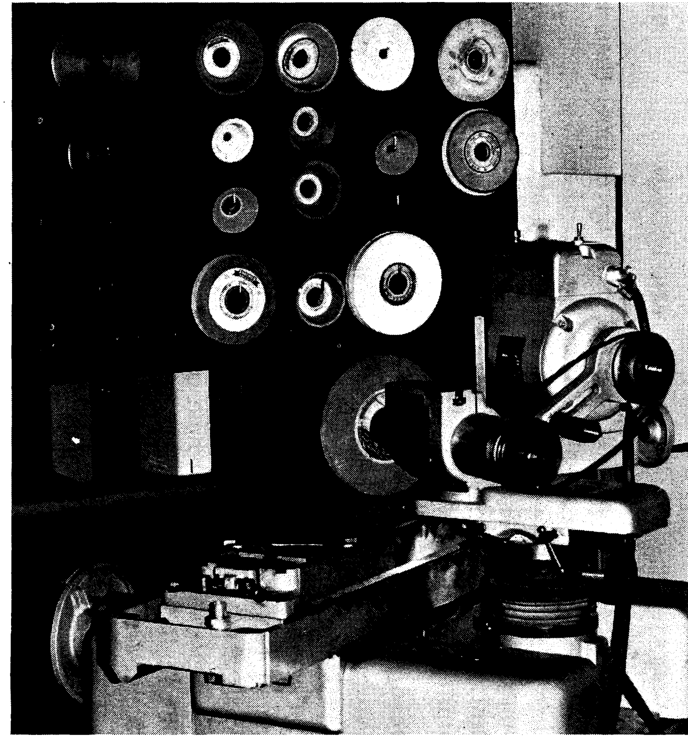
A *comprehensive tool panel* places most of the tools near the point of use – for example, the bench area – and it is easy to check at the end of each class period. If a locking cabinet is employed to house the panel, security is as good as that of a tool room. The major weakness of a comprehensive tool panel is that it does not localize tool storage to the extent desirable in many laboratories.

The height of a tool panel should be approximately forty-two inches. The lower edge of the panel should be thirty-eight inches above the floor and the top edge eighty inches high. This represents a convenient dispensing area for most students. The width of the panel will be determined by the amount of space necessary to store the required types and numbers of tools.

A *tool panel series*, utilizing open panels or locking cabinets, which localize tools in areas of greatest need, is probably the best alternative. Each panel must be complete enough to serve the area in which it is installed. Given this, student travel is minimized; and selection of the correct tool for each job is facilitated. While a tool panel series may increase the time it takes to check the tools at the ends of class periods, the task is not difficult.

If the quantity of tools to be stored in a given location is large and if locking tool cabinet storage is desired, it will be necessary to employ two or more cabinets placed side by side,





Figs. 5-17, 5-18.
Tool Arrangements Conveniently Located Near Machines. Left Photograph by Dury Fox, Bainbridge Island, Washington; Right Photograph by Robert D. Brown, Northern Illinois University

with enough room between them to permit the doors to swing back parallel to the wall. Tools, attachments, cutters, blades, and other items that are used with a particular machine should be localized on a panel installed on, or near, that machine. Four feet of traffic lane space should be provided in front of each tool panel so that access to the panel is unrestricted.

The *tool room* alternative offers excellent security, but it tends to be time-consuming to administer properly. A student tool room foreman is often required to operate a tool room.

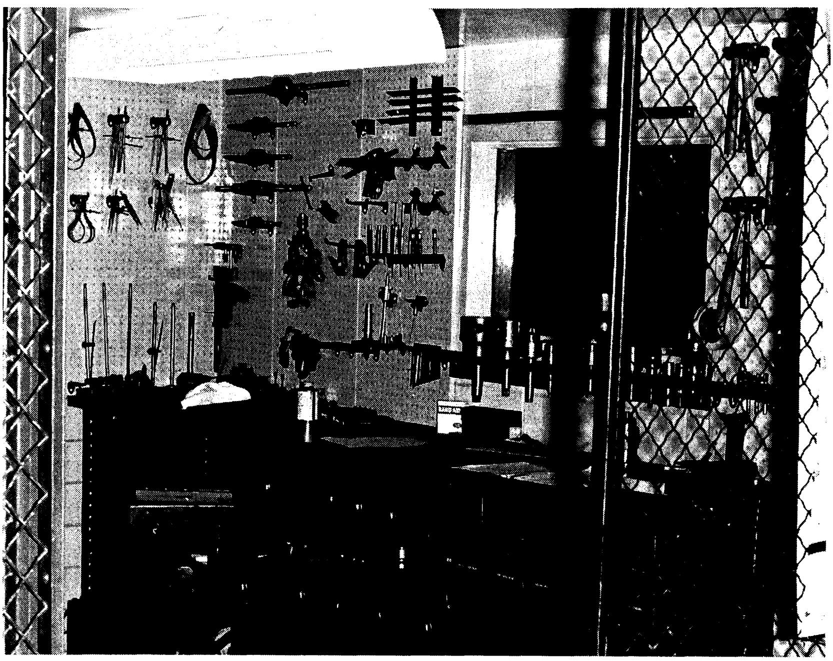


Fig. 5-19.
Tool Room Utilization.
Photograph by Robert D. Brown, Northern Illinois University

A point that the laboratory planner needs to keep constantly in mind is that tools are purchased chiefly for student use; therefore, they must be *stored*, not hidden.

Other methods of tool storage include carts of tools that can be wheeled from place to place, and tool kits. For example, body repair tools can be placed on a rolling tool panel that is very convenient to use.

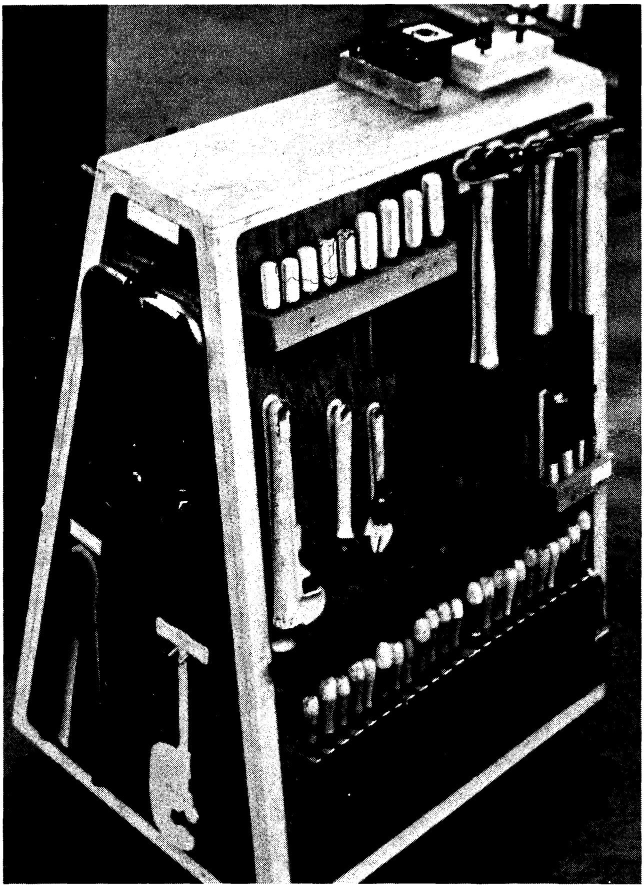


Fig. 5-20.
A Well Organized Tool Cart.
Photograph by Dury Fox, Bainbridge Island, Washington

Kits which contain frequently used tools or highly specialized items (such as test equipment) can be assembled and loaned to students for varying periods of time. They offer convenience, increase the efficiency and accuracy of student work, but are expensive to put together in the quantities needed.

Portable power tools can be effectively stored in pigeonhole storage devices installed in locking tool cabinets. The cabinets should be located in places of greatest need.

In some cases, substantially moisture-free storage must be provided for equipment that can be damaged by excessive humidity. This usually necessitates a room in which the humidity can be carefully controlled.

Tools which are used infrequently or are unusually delicate and/or expensive may be stored on shelves or in drawers or cabinets in special storage rooms. Such rooms may also be used to store a variety of jigs, fixtures, attachments, spare parts, and pieces of equipment that are out of service.

Whatever the system of tool storage chosen, it should possess the qualities of ease of dispensing and replacing tools, convenience of checking, and security. Security through education which stresses the importance of honesty, responsibility, and personal pride is, of course, the ultimate goal.

A significant portion of the validity of any tool storage system lies in the layout of each of the tool panels that form its basic component. A tool panel can be attractive, efficient, and fully capable of modification; or with the same expenditure of money, it may possess none of these qualities. The difference lies in the extent to which the designer of the panel is able to apply eight fundamental principles in his work. They are as follows:

1. The general appearance of the panel should be neat, orderly and attractive. The panel should be uncrowded but space should not be wasted.

2. Tool holders must be designed so that tools are held securely and without damage. Tools must be easy to remove and replace without injury to the user.

3. Tools with similar functions (measuring, cutting, shaping, drilling, clamping, etc.) should be organized on the panel in logical groups.

4. Duplicate tools and all sizes of the same tool should be stored together.

5. Heavy tools, tools that are used frequently, and tools that are provided in large numbers of sizes and types should be stored in the most easily reached places on the panel.

6. Infrequently used tools, and tools that are included in relatively small quantities should be placed in the least accessible areas of the panel.

7. A system of cutouts, silhouettes and/or labeling should be incorporated in the panel to expedite return of the tools to the proper location.

8. All tool holders should be fastened to the panel from the front to facilitate future expansion and reorganization.

9. Dangerous and unwieldly tools should be stored in the lower one-third of the panel.

(See Figure 5-21 for a good illustration of the above-mentioned points.)

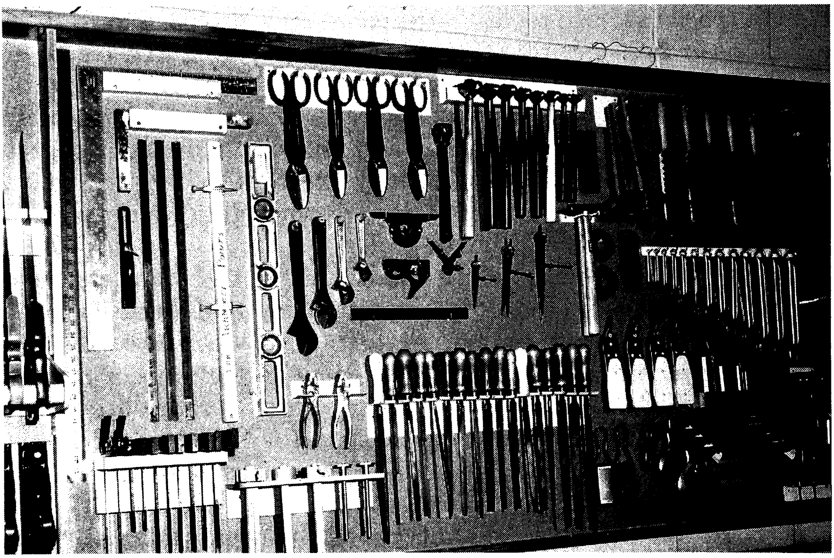


Fig. 5-21.
An Illustration of a Well Planned Tool Panel.
Courtesy Iver H. Johnson, Mankato State College

One very beneficial technique of tool panel design is to use cardboard or heavy wrapping paper as a full-size maneuvering board to determine the locations of tools. If the paper is laid flat on a smooth floor tools can be placed on it, moved around until the best arrangement is obtained, and finally outlined with a pencil. The sheet can then be used as the master plan for building the panel.

Silhouetting is essential if a tool panel is to achieve its purpose. In fact, no tool panel can be fully effective without it. Silhouettes make it easy to replace tools and check panels at the ends of periods. They save a great deal of students and teacher time and are well worth the effort required to prepare them.

Silhouettes can be painted on a tool panel in solid area form, solid outline form, or dashed outline form. They can also be made from adhesive backed paper or vinyl or they can be cut from thin material, such as 1/8″ plywood, and fastened to the panel with escutcheon pins. They may also be routed in blocks of wood that are fastened to the panel to serve as combination holder-silhouettes. Whatever the method selected, the following suggestions should be observed:

1. The color of a tool panel should contrast noticeably with the color of the wall or partition on which it is mounted.
2. The silhouette color must contrast sharply with the color of the panel.
3. Each tool should be color coded with the silhouette color.
4. Each separate tool panel should be assigned its own, highly visible, silhouette color.

SUPPLIES AND STORAGE SYSTEMS

A reliable supply system is a fundamental part of any industrial arts program. Some programs, largely drawing and electronics, are not heavy users of materials; but most are dependent on their supply systems.

Materials may be stored within each laboratory, as is usually the case, or they may be kept in a central supply room and dispensed to the entire complex of laboratories from that point. Central storage requires the services of a full-time stock manager and a number of clerks. Students must leave the laboratory, go to the supply room, and return each time stock is needed – a time-consuming process. On the other hand, the industrial arts teacher is relieved of the tasks of storing, dispensing, and accounting for materials, and this is a substantial advantage. Finally, stock security is excellent in a central supply room.

Laboratory storage, even with its several disadvantages, is the system that is in almost universal use. It offers a degree of flexibility that is important to smooth laboratory operation, because it places materials as near as possible to the point of use.

Storage Facilities

Every industrial arts laboratory should be equipped with storage *rooms*, where the bulk of the materials are kept, and storage *areas*, which store small quantities of materials for day-to-day use. In some cases, rupture-proof and fireproof containers must be provided for flammable materials, such as solvents, finishes, fuels, and lubricants. Small quantities of nonflammable materials can be stored in student lockers.

A *major* storage room and a *minor* storage room should be included in the design of most laboratories. Both types of rooms should have several features. They are:

1. a convenient location;
2. adequate floor space;
3. storage devices that classify materials and keep them in good condition;
4. an efficient dispensing system; and
5. adequate provision for security.

A major storage room is employed to store bulk quantities of raw materials used in the construction of projects, e.g., lumber, metal, leather, and plastic. A minor storage room is designed to handle supporting materials. These include adhesives, abrasives, finishes, hardware, and other materials. If a minor storage room is large enough and properly equipped, it can also be used to store spare parts and special equipment.

Students should not have unrestricted access to either type of storage room; therefore, small quantities of certain materials such as fasteners, dowels, finishes, and welding rod, should be stored where needed. At these points, students should have open access to the supplies, except in the case of materials which are to be purchased.

Balcony storage for materials does not permit efficient unloading and dispensing, and it is not desirable from the standpoint of safety. Unless there is no other choice, this type of storage should be avoided, even though it increases the utilization of floor space. If a balcony must be used, a 4′-0″ wide stair equipped with two handrails should be provided for access to it. The balcony ceiling and the ceiling of the room(s) below it should be no less than 7′-0″ high.

Approximately two cubic feet of locker space should be made available to each student in a laboratory. Several lockers should be reserved for the use of the teacher, and a small number of lockers should be provided for class overloads and for students who need more than one locker.

If possible, student lockers should be recessed in walls. The tops of the upper lockers in a group should be no higher than 72″ above floor level. Locker groups which form bases for bench tops are also very useful.

Storage Devices

The effectiveness of storage rooms and storage areas depends largely on the types of storage devices with which they are equipped. Horizontal and vertical racks, shelves, cabinets, bins, and drawers are the most common devices. However, pigeonhole storage, tote boxes, and other less common storage equipment may be required in specific cases. Steel equipment is readily available and superior to most other types.

Vertical storage is the best for lumber. This type of storage utilizes air space that would otherwise be wasted, keeps lumber in the best possible condition, makes dispensing and replacing easy, and is much safer than flat storage. Metal rods, angles, bands, and other forms should be stored horizontally if their length exceeds eight feet.

Sheet materials – especially those which are uniform in size and appearance – such as hardboard, plywood, particle board,

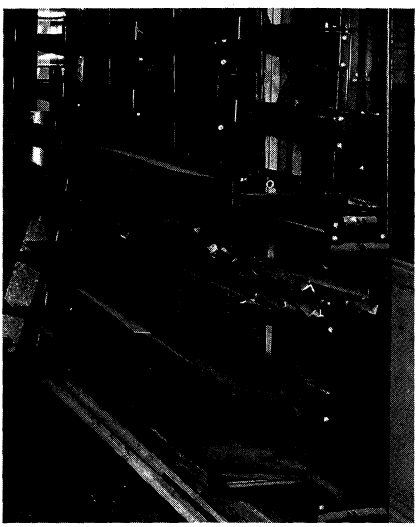


Fig. 5-22. (Left)
Horizontal Metal Storage.
Photograph by Robert W. Brown, Northern Illinois University

Fig. 5-23. (Right)
Vertical Wood Storage
Photograph by Dury Fox, Bainbridge Island, Washington

and sheet metal, should be stored flat. This is essential where warping will ruin the stock for many purposes. Plywood, especially, cannot be stored vertically without losing its straightness and suffering damage to the edges. Flat storage is effective, however, only if materials are firmly supported in a horizontal position. Each thickness, type, and gauge of sheet material must have its own section in the rack to facilitate dispensing.

Fig. 5-24.
Super Graphics Used to Identify Storage Cabinets.
Photograph by Dury Fox, Bainbridge Island, Washington

Supporting materials which are neither long nor bulky (dowel rods, welding rods, mouldings, etc.) may be stored either horizontally or vertically, whichever is more convenient. A storage device should separate such materials into the various sizes and types so that the user will not have to sort through the entire supply to find what he needs. Semiround horizontal "trough" storage for these items usually works well.

The familiar tall steel cabinet, if equipped with appropriate storage devices, can provide excellent storage for many kinds of small materials. It offers durability, security, and ease of classifying and dispensing; and it is relatively low in cost. Steel storage equipment, in general, rates highly with respect to all design criteria, including appearance, convenience, and fire resistance. If several locking steel cabinets are used in a laboratory, they should be master-keyed.

Lockable steel storage units are ideal for storage of costly and/or valuable materials. Two or three such storage units should be provided in the instructor's office area.

A significant amount of "live" materials storage should be planned into every industrial arts laboratory. Live storage is storage that is provided for materials being processed and for projects in all stages of completion. A project storage room capable of storing 120 or more projects of various kinds (approximately 400 square feet of floor space, in the case of a woods laboratory) and a project assembly area of at least 200 square feet will provide sufficient live storage for laboratories in which large projects are undertaken.

As materials are processed, short stock results. Since much of it is usable in projects and instructional media and for performing practice operations, it must be stored. Unusable scrap should, of course, be discarded at frequent intervals so that it does not become a fire and safety hazard.

Material storage facilities should classify short stock with reasonable accuracy and make individual pieces conveniently available to prospective users. Many storage devices do not do this and, as a result, do little more than allow such stock to accumulate to the over-flow point. Bins, for example, are wholly ineffective because only what is on the top layer is available without a tedious search. Shelf storage of short stock materials is usually the most satisfactory.

Materials which must be discarded after use may require storage in fireproof containers until they can be removed from the laboratory. Oil- or solvent-soaked rags, for example, must be placed in a metal container having a tight cover. Such a container should have a foot-operated cover for convenience; and it should be approved by Underwriters Laboratories, Inc. Flammable storage devices should be emptied daily.

Scrap materials collect in large quantities in the storage hoppers of dust collection systems. Hoppers require periodic unloading, if systems are to operate properly and if laboratory safety is to be maintained.

Materials Flow

Interruptions in production due to lack of materials – with the resultant frustration and loss of student time – can be avoided, if a 1½-2-year supply of most materials is maintained. Certain materials have a finite "shelf" life and, consequently, should not be stocked in quantities greater than will be consumed during the usable period. Proper storage will preserve useful shelf life and, in some cases, extend it. Photographic film, for example, should be kept in a refrigerator so that it will remain in good condition. If this is done, the usable period will be extended well beyond the expiration date, particularly in the case of black-and-white film.

In times when prices are increasing, school districts may well find it economical to stock industrial arts supplies in greater-than-normal quantities. Lumber, metal, plastics, and other materials purchased one year will almost certainly cost less than they will the following year.

The first task in achieving a satisfactory flow of materials is that of establishing a good procurement system. In other words, the first stage of the flow is from the supplier to the school.

Supply procurement represents a diligent search for: (1) reliable sources of supply, (2) acceptable quality in every type and grade of material to be purchased, (3) favorable prices, and (4) good dealer service. Satisfactory dealer service is manifest in immediate answers to inquiries, prompt submission of bids, maintenance of adequate stocks of all advertised materials, careful checking and packing of shipments, rapid shipment, free technical literature, and honest warranty service when defective materials are received by the purchaser.

It is desirable to develop a list containing the names of several reliable suppliers of every kind of material consumed in each laboratory. Local vendors should not be overlooked when such a list is compiled, although their prices will often be among the highest. They make it possible for students to obtain materials directly and immediately, thus saving the school the tasks of ordering and stocking large amounts of materials. Special items, such as automobile engine parts, should be handled mainly in this way. If a teacher is to depend on local suppliers to furnish some of the materials he uses, the supply must be entirely reliable, and the prices must not be so high that they exploit students.

School purchasing policies should permit frequent ordering so that shortages due to deterioration of materials or unusually heavy use will not restrict class activities. In addition to the regular budget, it is desirable that a 5-10% contingency fund be set up to provide for emergencies. If this is done, it is essential that the teacher should *not* consider the contingency fund as a part of his regular budget for materials.

Delivery and placement in storage represent the second stage in a materials flow system. Every industrial arts laboratory should have adequate facilities for handling incoming materials – including a service drive and a loading dock, is necessary. Overhead doors that open into major storage rooms are helpful in most laboratories. Handling is reduced substantially where heavy materials, such as lumber, can be unloaded directly into storage facilities.

The flow of materials within a laboratory should be planned so that the movement is from one basic operation to another in reasonably logical sequence. The general flow will be from storage room to rough-cut machines to benches to finish-cut equipment to assembly area to finishing room to finished product.

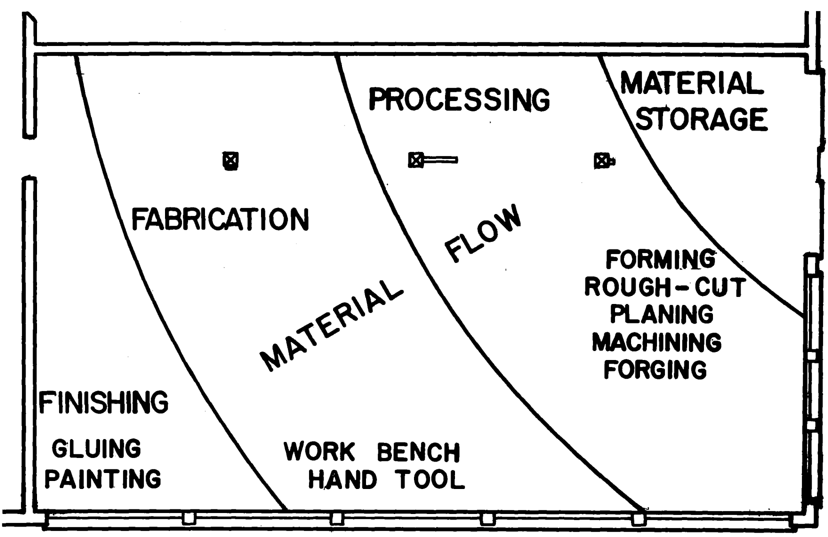


Fig. 5-25.
Determining the Flow of Materials and Students – Four General Areas Are Visualized Emanating From the Storage Area.
Courtesy Daniel W. Irwin, Rockwell Manufacturing Company

However, any kind of precise flow is impossible, and probably undesirable, to obtain. Industrial arts laboratories are not factories and therefore cannot be organized to conform to industrial standards for economical production. Normally in industrial arts laboratories traffic lanes are depended on to handle the flow of materials. If they move people efficiently, materials should move well, also.

Issuance of materials is another segment of the total materials flow pattern. Each teacher must plan his system so that it takes full advantage of the design of his laboratory and so that students can obtain needed materials easily. Time that is wasted at this point reduces the efficiency of the entire laboratory operation.

Four common methods of issuing materials include the following:

1. *the self-service system.* The student locates the materials he needs and informs the teacher of the quantities taken.

2. *the student materials foreman system.* A student foreman helps students to check out materials and records quantities issued.

3. *the teacher-operated system.* The teacher checks out all materials and records the quantities issued.

4. *the central storage system.* A stock manager operates a central storage room. He and his clerks issue materials and record the amounts received.

Payment for materials should be handled in a way that is convenient for students, does not deny educational opportunities to students who cannot afford high materials costs, conserves class time, and does not oblige the teacher to handle money. In brief, all financial transactions should be carried on in a school's business office. Four methods of handling student materials payment are:

1. *the laboratory fee system.* The student pays a laboratory fee at the beginning of each term and enjoys more-or-less unlimited use of available materials. Construction of unusually large projects may require the payment of additional fees.

2. *the materials ticket system.* The student buys a materials ticket in the school business office, and the teacher punches out the cost each time materials are issued. When the ticket has been completely punched, the student purchases another one. Unused portions of tickets can be redeemed for cash in the business office

at the end of the term.

3. *the immediate statement system.* When a student obtains materials, the teacher prepares a bill which is paid in the business office immediately.

4. *the periodic statement system.* Bills are prepared as materials are issued. Copies are forwarded to the business office, and the student is billed at the end of each specified period.

The laboratory fee system is the simplest to operate. It has the disadvantage of automatically requiring slower students, as well as the school district, to subsidize the materials purchased by the more capable students.

The materials ticket system is simple enough but consumes an inordinate amount of teacher time. Ticket punching can be a lengthy and tedious job. In this respect, however, it is probably no worse than any system in which a statement is prepared each time materials are issued. There is, of course, the problem of the student who arrives in class having forgotten his ticket, or with a ticket that is punched out, or having lost his ticket.

All in all, either of the two materials statement systems is probably best, especially if the student is taught to prepare the statements himself for the teacher's approval and signature. Bills should be presented to the student at relatively short intervals: every six weeks or two months.

If the materials flow in a laboratory is to be all that it should be, the teacher must maintain a reasonably accurate inventory of each material that is stocked. In this way, he can monitor his supplies and avoid class-disrupting shortages. A running inventory kept in a card file can work well, although it requires careful accounting, if it is to be accurate. In this type of system, the teacher keeps a card file which contains a separate card for every type of material stocked. Additions to, and withdrawals from, stock are recorded on the cards, and the balance on each card shows the amount of that material actually on hand at any given time. A simple card heading of DATE – STOCK ADDED – DATE – STOCK ISSUED – QUANTITY ON HAND is all that is needed. This type of system does not, and need not, function with pin-point accuracy; but it is sufficiently precise to provide good stock control.

Finally, small quantities of materials must be available to the teacher for making repairs, constructing laboratory equipment, and preparing instructional media. His efforts can do a great deal to develop a smooth, efficient laboratory operation, and the school should encourage it. Materials used in this way for instructional purposes should be carried in a separate inventory, or not carried on inventory at all.

EDITOR'S NOTE: An *Industrial Arts Facility Checklist is* provided in APPENDIX B.

REFERENCES

American Council on Industrial Arts Teacher Education. *Planning Industrial Arts Facilities.* Bloomington, Ill.: McKnight Publishing Company, 1959.

Brown, Robert D. *Industrial Arts Laboratory Planning and Administration.* Beverly Hills, Cal.: The Bruce Publishing Company, 1969.

Coverdill, Ernest J. "Specification Writing for . . . . Equipment Procurement," *Industrial Arts and Vocational Education* (March, 1965), p. 70.

Finsterbach, Fred C., and William C. McNeice. *Creative Facilities Planning for Occupational Education.* Berkeley Heights, N. J.: Educare Associates, 1969.

Grassell, B. Milton. "Tool Storage in the School Shop," *Industrial Arts and Vocational Education* (March, 1953), p. 91.

Irvin, Daniel W. "Suggestions for Effective Ways to Specify Industrial Arts Equipment You Want," *The Journal of Industrial Arts Education* (May-June, 1964), p. 42.

McGirr, Clint. "A Tool-check System That Works," *Industrial Arts and Vocational Education* (March, 1964), p. 82.

Radcliffe, George V. "Toolholders – Panel or Crib," *Industrial Arts and Vocational Education* (March, 1954), p. 115.

Schmidt, Marshall L., and James L. Taylor. *Planning and Designing Functional Facilities for Industrial Arts Education.* Washington, D. C.: U.S. Government Printing Office, 1968.

Titre, Peter J., and Robert A. Pelikan. "Safe S-P-A-C-E Standards in School Shops," *Industrial Arts and Vocational Education* (March, 1964), p. 68.

Woolridge, Robert E. "Planning Facilities for Effective Teaching," *Industrial Arts and Vocational Education* (March, 1964), p. 36.

CHAPTER VI

New Facilities for New Programs

Thomas A. Jasnosz
San Jose Regional Vocational Center
San Jose, California

INTRODUCTION

During the past two decades, the field of industrial education has developed discipline-centered approaches to its curricula, organized around primary elements within the field. The initiative for this movement was a direct result of a critical examination of traditional programs. Curriculum committees have been actively discussing, planning, and testing to find more meaningful ways to present basic content. Spurred by research calling for a broader educational base, attention has been focused on developing in students an awareness of concepts, ideas and principal modes of inquiry.

As a result, the sixties produced more innovative programs in industrial education than did any of the preceding decades of this century. Moreover, the emergence of each new program introduced other concerns and wide implications: Is it really new, or only a new title to disguise old practices?; what implication does it have for staffing?; and, most germane to the inquiry of this chapter, what sort of facility does this new program require?

The seventeen programs initially identified represented every region of the United States and the broadcast range of curricular approach. Experts in each of these new programs were contacted; some declined to contribute information on the new program because it requires no special facilities.

The variety of the contributors as well as the variety of the programs accounts for the varied approaches to the subjects. All contain a brief explanation of the philosophy and operation of the program, as a rationale for their facilities design. Most include a suggested floor plan; some provide a recommended materials or equipment list.

Yet through this variety of approach and diversity of programs, several principles of facilities planning beyond those traditionally observed appear to have been developed. Rather than space and facilities being designed simply to encourage effective instruction, innovative programs frequently attempt to create an atmosphere characteristic of modern industry. In addition to designing an atmosphere and setting conducive to the health and safety of pupils, an attempt is frequently made to keep both space and equipment flexible to accommodate and stimulate a variety of activities and learning experiences for large and small groups of students. Beyond planning for efficient and convenient space for the storage of tools, materials and student projects, new programs also plan around the effective use of electronic and mechanical teaching and self-instructional aids and their storage. Perhaps these trends may be summed up as flexibility – flexibility of size, of design, of function, and of direction for future development.

It seems that industrial education is increasingly being viewed as a phase of general education which (1) contributes significantly to students' understanding of industry and technology; (2) helps students identify and develop their innate technological talents; and (3) strengthens their academic studies. On that premise, this chapter is dedicated to a bright educational future for the generations of our youth who will use for years to come the industrial education laboratory facilities now being planned and built.

AMERICAN INDUSTRY

Contributor:
Douglas D. Stallsmith
Associate Professor of Industrial Arts
University of Wisconsin-Stout
Menomonie, Wisconsin

The American Industry curriculum has made industry the body of knowledge from which to draw its content. Because of its complexity, industry must be organized into manageable content.

This was accomplished by identifying concepts which are necessary to understand industry. The thirteen basic concepts are: communication, finance, transportation, property, research, procurement, relationships, marketing, management, production, materials, processes, and energy. These are set in an environment of government, private property, resources, competition, and public interest, all of which, in our society, makes industry uniquely American.

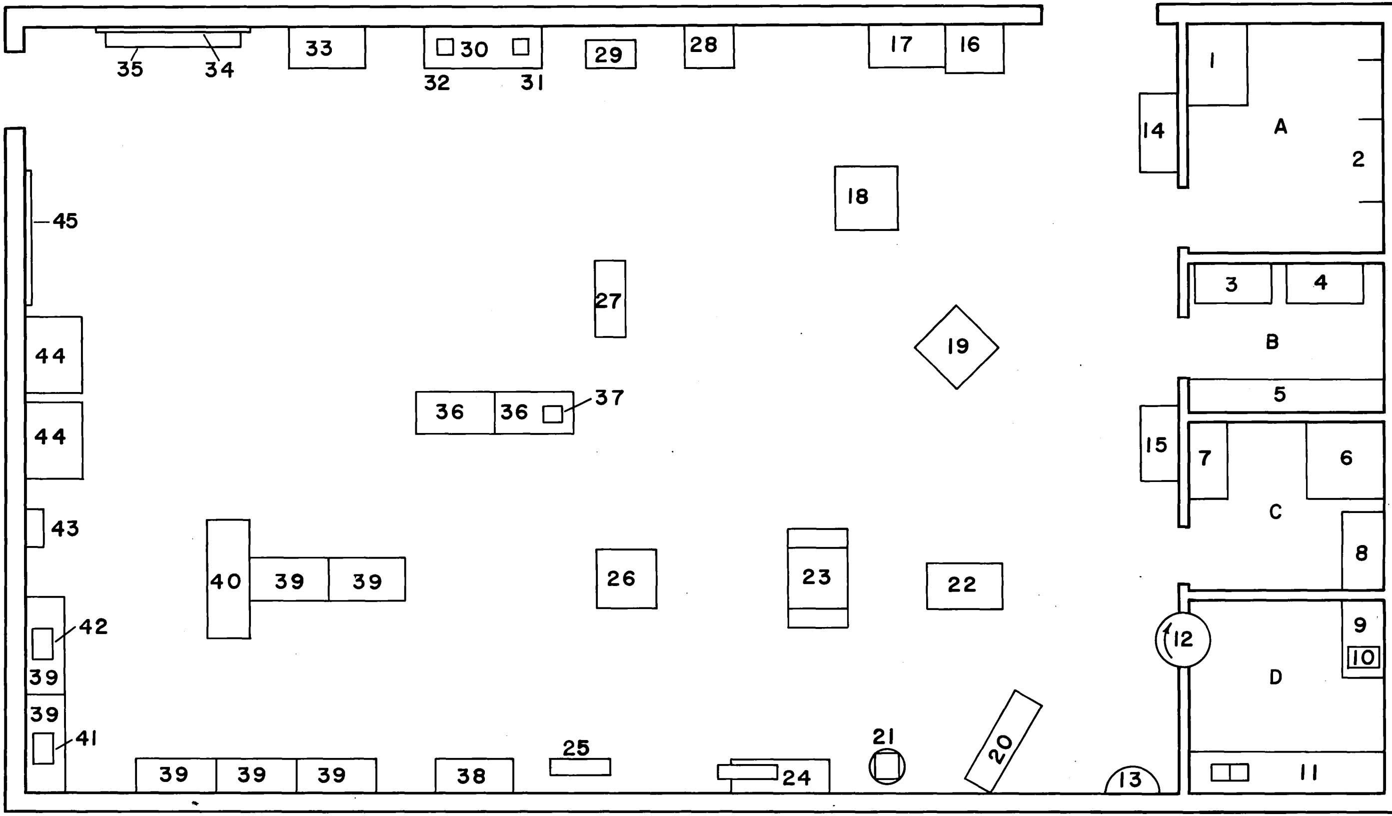
These concepts are not studied as separate entities but are interrelated into a total picture by having students establish simulated, life-like enterprises during the course of the year.

In order to establish an environment oriented to teach American Industry, some changes will have to take place in our present facilities.

The real changes in the laboratory for implementing American Industry comes with better utilization of our present space and equipping the shop with a variety of machines and tools, media, and new industrial applications to enable the student to better explore and comprehend the workings of industry.

An open, comprehensive laboratory would be the ideal environment, but is not essential. This laboratory gives the student freedom to move through and interrelate a variety of materials and processes, and view them as interrelated rather than individual entities. Permanent walls act as barriers and tend to restrict the student's opportunity to interrelate the activities. Where unit-laboratories are designed, it may mean the removing of a wall or providing access between laboratories by placing large doorways. Where this cannot be done it presents problems of intra-plant transportation and communication which become part of the simulated enterprise.

An environment for teaching American Industry should be subject to changing conditions and lend itself to a rearrangement of machines, tools, work stations, and service utilities. Industry is not static, nor are its facilities. The space should be economically adaptable to curriculum changes and capable of serving many functions. Work stations should be mobile so that different configurations may be established depending on the activity taking place. These work stations may be independent work areas, operational stations, assembly areas, or small group activities. Most work benches existing in present laboratories, such as the 4 x 5 benches, can be cut in half to provide modular configurations.



AMERICAN INDUSTRY LAB

LEVEL ONE

A–MATL. STORAGE
B–TOOL STORAGE
C–FINISH ROOM
D–DARKROOM

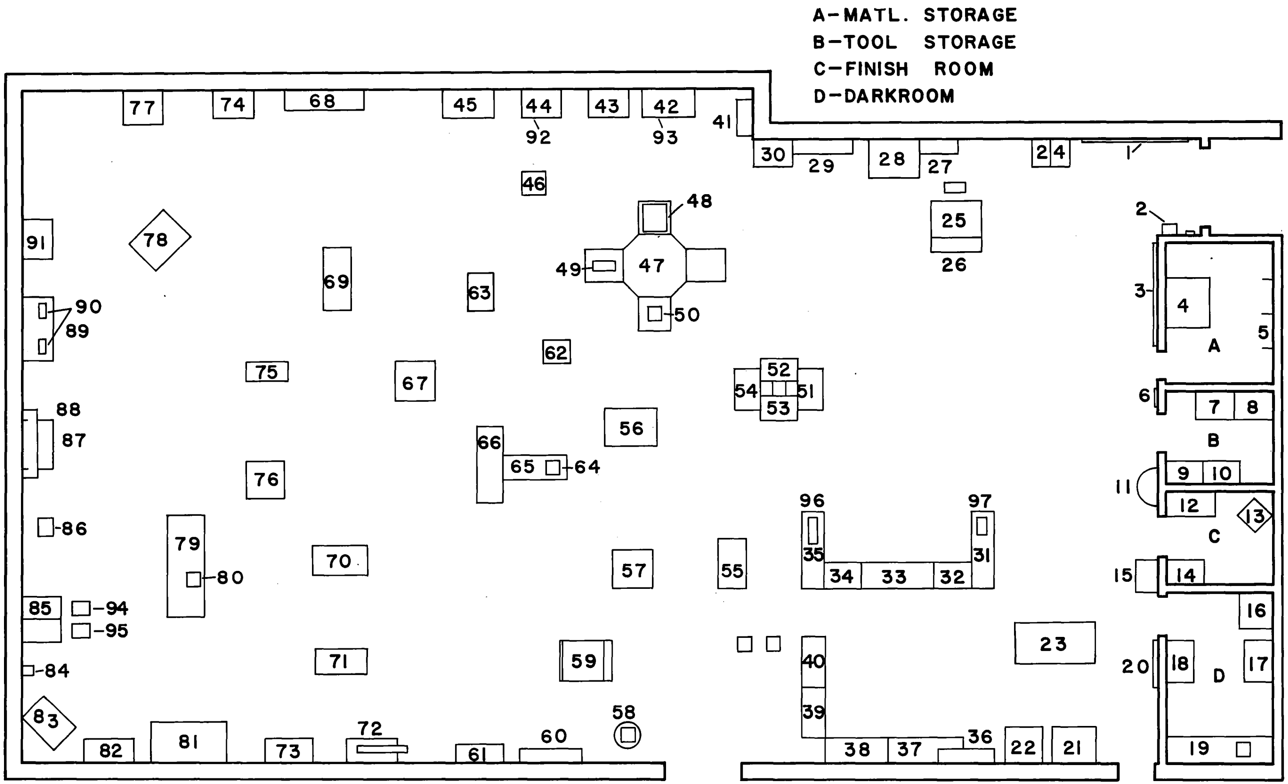
Fig. 6-1.
Floor Plan Supplied by Douglas D. Stallsmith

Since educational events will be varied and often integrated, the American Industry facility must be capable of permitting and effectively supporting the necessary activities to understand industry. All thirteen concept areas must be represented to some degree.

The space requirements should fall somewhere between 2400 and 5000 square feet of main laboratory work area. This does not include space for classroom, finishing room, darkroom, office, storage areas, or clean-up areas, which are supplementary to the main area and should be designed separately.

The laboratory layout should be pictured as a transformable environment that will change as activities and problems present themselves. The machines should be movable. Their position on the floor is either a work station or a temporary storage position

1. Vertical metal storage rack 48" w x 41½" d x 109" h
2. Horizontal lumber storage rack
3. Tool storage cabinet 48" w x 18" d x 7'3" h
4. Supply storage cabinet 48" w x 18" d x 7'3" h
5. Storage shelves
6. Spray booth
7. Bench, metal top & base 4' w x 2' d x 32" h
8. Finishing cabinet
9. Bench, micarta top & wood base 4' w x 2' d x 32" h
10. Photo-englarger
11. Sink cabinet w/ micarta top
12. Circular darkroom light trap door
13. Clean-up sink
14. Combination vertical/horizontal cutoff saw
15. Bench, maple top & base 4' w x 2' d x 32" h
16. Radial arm saw, 10"
17. Bench, maple top & base 4' w x 2' d x 32" h
18. Planer, 12"
19. Table saw, 10"
20. Combination wood/metal spinning lathe
21. Bender, ½"
22. Box & pan brake
23. Sheet metal bench w/ 24" shears and 24" rollers
24. Metal lathe/horizontal mill w/storage bench
25. Pedestal grinder, two 6" wheels
26. Bandsaw, combination wood/metal 20" w/blade welder
27. Jointer, 8"
28. Drill press, variable speed 15"
29. Buffer, two 6" wheels
30. Bench, maple top & base 5' w x 2' d x 32" h
31. Vacuum former/sealer
32. Injection molder
33. Tool storage cabinet
34. Bulletin board 4' x 8'
35. Library bookcase
36. Bench, steel top & base 4' w x 2' d x 32" h
37. Spot welder
38. Tool storage cabinet
39. Bench, maple top & base 4' w x 2' d x 32" h
40. Bench, maple top & base 6' w x 2' d x 32" h
41. Bench platen press
42. Offset-lithography press
43. Wall tool cabinet
44. Drafting table w/ drafting machine
45. Chalkboard and overhead screen



AMERICAN INDUSTRY LAB
UNIV. OF WISC. - STOUT

Fig. 6-2.
Floor Plan Supplied by Douglas D. Stallsmith

1. Bulletin board 4′ x 10′
2. Time clock
3. Chalkboard & overhead screen
4. Vertical metal storage rack 48½″ w x 41½″ d x 109″ h
5. Horizontal lumber storage rack
6. Pocketed wall rack (for job sheets) 9¾″ w x 35″ h x 1¼″ d
7. Tool storage cabinet 36″ w x 7′3″ h x 18″ d
8. Tool storage cabinet 36″ w x 7′3″ h x 18″ d
9. Supply cabinet 36″ w x 7′3″ h x 18″ d
10. Supply cabinet 36″ w x 7′3″ h x 18″ d
11. Wash-up sink
12. Bench, metal top & base 4′ w x 2′ d x 32″ h
13. Spray booth
14. Finishing cabinet
15. Clean-up sink
16. Refrigerator
17. Photo-enlarger
18. Vertical process camera
19. Darkroom sink & cabinet w/ micarta top
20. White printer & developer
21. Drafting table w/ drafting machine
22. Light table
23. Drafting table w/ drafting machine
24. Film cabinets
25. Desk & chair
26. Display cabinet
27. Bookcase
28. Display cabinet
29. Wall mounted tool cabinet
30. Bench, maple top & base 3′ w x 3′ d x 32″ h
31. Bench, maple top & base 5′ w x 2′ d x 32″ h
32. Bench, maple top & base 3′ w x 2′ d x 32″ h
33. Bench, maple top & base 4′ w x 2′ d x 32″ h
34. Bench, maple top & base 3′ w x 2′ d x 32″ h
35. Bench, maple top & base 5′ w x 2′ d x 32″ h
36. Wall mounted tool cabinet
37. Bench, maple top & base 6′ w x 2′ d x 32″ h
38. Bench, maple top & base 4′ w x 2′ d x 32″ h
39. Bench, maple top & base 4′ w x 2′ d x 32″ h
40. Bench, maple top & base 4′ w x 2′ d x 32″ h
41. Material sample storage drawers
42. Material tester, hydraulic 10,000 lb.
43. Bench, maple top & base 3′ w x 2′ d x 32″ h
44. Steel storage cabinet
45. Tool storage cabinet
46. Drill press, 15″ floor model/variable speed
47. Flexenter work bench stations
48. Temperature test chamber
49. Injection molder
50. Vacuum forming/sealer machine
51. Bench, maple top & base 3′ w x 2′ d x 32″ h
52. Bench, maple top & base 3′ w x 2′ d x 32″ h
53. Bench, maple top & base 3′ w x 2′ d x 32″ h
54. Bench, maple top & base 3′ w x 2′ d x 32″ h
55. Numerical control console and vertical mill
56. Powdered metal center
57. Index turret drill press
58. Bender, ½″
59. Sheet metal bench with 24″ shears & 24″ rollers
60. Wall mounted tool cabinet
61. Box and pan brake
62. Thermoformer plastic press
63. Jointer, 6″
64. Electrical discharge machine
65. Bench, maple top & steel base cabinet 4′ w x 2′ d x 32″ h
66. Bench, maple top & base 6′ w x 2′ d x 32″ h
67. Surfacer, 12″
68. Combination wood/metal spinning lathe
69. Bench, maple top & steel base cabinet 5′ w x 2′ d x 32″ h
70. Combination vertical/horizontal cutoff saw
71. Metal shaper, 8″
72. Combination metal lathe/horizontal mill
73. Tool storage cabinet
74. Bench, maple top & base 3′ w x 2′ d x 32″ h
75. Combination belt and disc sander

(Continued on P. 118)

76. Bandsaw, 20″ metal/wood
77. Radial arm saw, 12″
78. Table saw, 10″
79. Sheet metal table w/ stake plate
80. Drill press, 15″ bench model
81. Bench, steel top & base w/bench furnace & bench oven
82. Foundry unit
83. Crucible furnace
84. Spot welder
85. Arc/gas welding bench
86. Wood welder
87. Bench, maple top & base 3′ w x 2′ d x 32″ h
88. Wall mounted tool cabinet
89. Bench, maple top & steel base 4′ w x 2′ d x 32″ h
90. Bench grinder & buffer
91. Bench, maple top & base 3′ w x 2′ d x 32″ h
92. Hydraulic equipment (cylinders, hoses, mounting frame)
93. Air pneumatic equipment (cylinders, air vise, linear table, rotary table, drill press feed, hoses, lubri-air units)
94. Cylinder truck
95. Arc welder, AC/DC
96. Offset-lithography press
97. Bench platen press

Screen printing kits

Electronic modular communication systems (record player, public address, radio receiver/transmitter, telegraphy, telemetry, light beam)

Machine building block components (columns, couplers, tables)

until needed for a particular activity. Permanently installed equipment does not give flexibility and should be kept to a minimum. American Industry uses cushioned-vacuum pads for mounting machines; they not only prevent creep from vibration, but they absorb vibration and sound.

The layout of auxiliary rooms should not interfere with the main work space by breaking up the continuity. The auxiliary areas supplement the main area and should be designed in addition to and not within the main area. It is recommended that the auxiliary rooms be placed across the width of the room at one end. A classroom space should be provided for within or adjacent to the laboratory. The American Industry curriculum makes extensive use of audio-visual materials, so it is essential to design an area where they may be used efficiently. If space must be provided for within the laboratory for classroom content, it should be transformable so that it may also be used for production activities. This may be done by using folding tablet-arm chairs and moving a few pieces of equipment. A separate classroom may be hard to justify because of utilization, but in the American Industry curriculum it serves as a multi-activity space. It may be used as classroom, research, audio-visual, technical library, individualized study, planning, designing, management, marketing, or small group discussion, all related to problems and activities occurring in the main work area.

In a facility where machines, tools, and work benches are flexible, we cannot be restricted by having the service utilities rigidly placed. An overhead mechanical service system which is supplemented by a service system around the perimeter of the laboratory gives the flexibility necessary.

The service utilities which should be available include air, electrical, exhaust (dust and fumes), gas, and water. The gas and water are probably the most permanent. Electrical, air, and exhaust systems should be provided with quick disconnects to provide mobility. An overhead electrical bus-bar system provides easy connection and maintenance which are not possible with under-the-floor systems. Each machine will be equipped with a flexible cord and power module which may be plugged into the bus-bar virtually anywhere along it. The power module is wired according to the voltage requirements of the machine. Drop-down air coils should be provided for air pneumatic tools or for hook-ups to air-assisted components mounted on machines for simulated semi-automatic of some operations. Dust exhaust systems should have flexible tubular drop-downs which can be disconnected at the exhaust outlet in the ceiling. Cover plates which are vacuum sealed cover all exhaust outlets not connected to a machine on the floor.

The equipment for the American Industry program should be representative of industry, but not necessarily duplicate it. The equipment should be smaller in scale, bench models in many cases, but representative of a variety of industrial processes which may be applicable to production and/or experimentation. At the basic level of American Industry the equipment should provide for working with a wide variety of materials. At the more complex levels of the program there is a need to provide equipment which will permit the student to develop his own mechanisms and interact components to form automated systems. Such items as modular machine building components, power sources, hydraulics, pneumatics, material testing, and material handling conveyors should become common pieces of equipment in the school laboratory. The laboratory must be ready to challenge and provide equipment to work with materials, graphics, design, marketing, production control, management, and communication.

GEORGIA PLAN

Contributor:
Keith F. Hickman
Associate Professor of Industrial Arts
Georgia Southern College
Statesboro, Georgia

The Georgia Plan for industrial arts is a comprehensive program; the study of technology in Georgia is aimed at the improvement of technical literacy in the educational system. The elementary industrial arts program in Georgia is centered around informal constructive activities developed from the world of work, designed to complement and enrich the general elementary learnings program. Industrial arts for grades seven, eight, and nine is a technology program offering communications, manufacturing and transportation. Construction is being offered in several schools in accordance with the Ohio Plan. The tenth grade industrial arts program is technology oriented, consisting of drafting, graphic arts, electronics, power, metals, and woods as electives; or a student may choose to study American Industries, a liberal-technology course with content focusing on an overview of how American industries were developed, and their impact upon society.

The general courses listed above become a portion of early prevocational preparation; the American Industries course reflects a trend toward college preparation in some field of the technologies.

The program for eleventh and twelfth grade students is divided again. Unit courses in drafting, woods, metals, electronics, mechanics, printing and photography are offered for pre-vocational preparation. Students interested in a career requiring a college degree may enroll in courses such as engineering drawing and descriptive geometry in the eleventh grade, and research and development in the twelfth.

Additional general education outcomes for terminal living are developed in addition to prevocational and college preparation offerings in the Georgia Plan. Such outcomes enable students to pursue and enjoy crafts, hobbies, health and safety, home maintenance, consumer knowledge, constructional activities, occupational information, and work experience.

The major physical requirement for facilities to implement the Georgia Plan is flexibility. This is especially important in the elementary and junior high programs. The elementary program may be conducted in standard elementary classrooms with all equipment and supplies located in a "technology corner." A classroom may be converted into an industrial arts laboratory but students may not become involved in the interrelationship of technology and the general elementary learnings program as when the means of implementing technology are in the classroom.

The floor plan shown is suitable for a comprehensive junior-senior high school and permits up to twenty-four students in a class of communications using the general area or unit course approach and additional faculty. Movable partitions permit flexibility in space utilization. Justification for space and equipment comes from the courses of study.

The facility plan shown has two laboratories separated by a central arrangement of auxiliary spaces. The office may be divided into two offices by extending the panel between the desks. The class-planning room may be used by groups from either laboratory. Students in manufacturing may go into the communications laboratory through the class-planning room to use drafting equipment.

Individualized instruction is possible in carrels at the rear of the classroom. Tables may be used instead of arm chairs if desired.

The communications laboratory is zoned for convenience and may be used as a single communications laboratory or may be divided by movable partitions so as to permit two or three unit courses to be taught at the same time. Further zoning in the communications laboratory makes much student movement unnecessary, as a color coding system enables students to stay in an area zoned by color. If a student has an activity in a green area, all tools and supplies are kept in the green area and are so coded. A perimeter wall storage system enables the teacher to have an abundance of storage where items are needed, and reduces the time necessary to pass out materials.

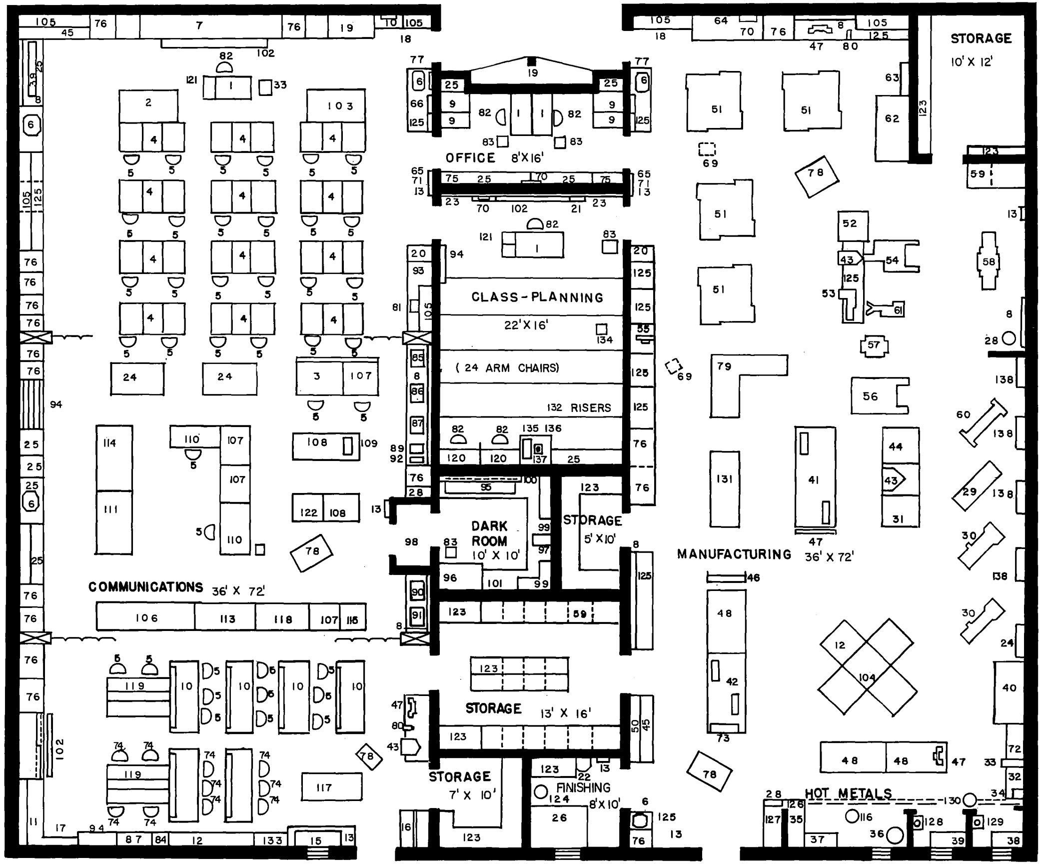


Fig. 6-3.
Laboratory Plan in Which to Implement the Georgia Plan.
Floor Plan Supplied by Keith F. Hickman

1. Teacher's desk
2. Layout table
3. Tracing table
4. Drafting tables, dual type with storage
5. Stools, drafting
6. Sink enclosed with storage cabinets below and work surface above
7. Chalkboard
8. Tack board, bottom located at least 40″ above floor level
9. File cabinet, legal size
10. Electrical tables with storage below and power supply mounted on top, 110-V electrical connection in floor for each
11. House and industrial electrical work area, locker storage below, three 110-V outlets 36″ above floor level, one 220-V outlet
12. Tool panel, electrical tools
13. Fire extinguisher, appropriate type as located.
14. Small motors work surface with storage cabinets below, 110-V outlets 36″ above floor level along the wall
15. Electroplating work area, 110-V outlets, 36″ above floor level
16. Electronics test area with storage cabinets below, four 110-V duplex outlets along wall 36″ above floor, one 220-V outlet 36″ above floor
17. Demonstration panel, 110-V outlets 36″ above floor level.
18. Coat rack with book storage shelf above
19. Display case with glass front and light inside, outlet needed
20. Water fountain, 110-V outlet
21. Chalkboard
22. Janitor sink
23. Tackboard, 4′ long, 36″ above floor level
24. Planning table-conference
25. Book shelves
26. Finishing area complete with spray booth, compressed air outlet, hood, and work surface. Finishing room may be relocated after consulting the State Consultant for Industrial Arts, State Department of Education
27. Exhaust fans located high on the wall, (may be located in roof) are required for ventilation if facility is not air conditioned
28. Broom rack with trash can below, provided in locations as shown on plan
29. Metal spinning lathe, 220-V, 3 ph
30. Metal Lathe, 220-V, 3 ph
32. Soldering table, three 110-V outlets 36″ above floor level
33. Spot welder, 220-V 3 ph. outlet 36″ above floor level
34. Gas furnace, natural gas outlet and 110-V outlet.
35. Foundry work bin
36. Furnace, crucible, natural gas outlet and 110-V outlet
37. Heat treating furnace, natural gas outlet
38. Welding table for arc welder, 220-V outlet in back wall, exhaust fan and hood over welding area
39. Welding table, gas, exhaust and hood above welding area
40. Power mechanics work area, three 110-V outlets 36″ above floor level
41. Work table, metal, 42″ x 96″ with 2 stake plants, lockers below
42. Work bench, metal, 42″ x 96″ with storage shelves below for sheet metal and combination machine, bar folders, and finger brake mounted on top
43. Drill press, 3 ph
44. Metal shaper, 220-V, 3 ph
45. Power hacksaw, 220-V, 3 ph
46. Squaring shear, no power needed
47. Grinder, 220-V, 3 ph
48. Work bench, 36″ x 6′ with lockers below
49. Slip form roll, floor mounted
50. Tool panel for metal working tools, lock type
51. 4-station wood work bench, complete with 4 vises, storage lockers below, 110-V outlet dropped from above table to 4′ above floor line
52. Wood shaper, 220-V, 3 ph., connected to dust and chip system
53. Belt and disc sander, 220-V, 3 ph., connected to dust collector system
54. Bandsaw, 220-V, 3 ph., connected to dust and chip system
55. Overarm saw, 220-V., 3 ph., connected to dust and chip system
56. Tilting arbor saw, maximum size 10″, 220-V, 3 ph., connected to dust and chip system

(Continued on P. 124)

57. Wood surfacer, 220-V, 3 ph., connected to dust and chip system
58. Jointer, 6-8″, 220-V, 3 ph., connected to dust and chip system
59. Lumber rack, vertical
60. Wood lathe, 220-V, connected to dust and chip system
61. Jigsaw
62. Portable glue table
63. Clamp rock
64. Tool storage, woodworking tools, lock type
65. Recommended location for power panels; may be relocated
66. First aid cabinet
67. Dust and chip collector unit, adequate wiring for unit installed; may be relocated.
68. Air compressor, adequate wiring for unit installed; may be relocated; pipe air to finishing room and provide at least one additional outlet in shop area as marked
69. Floor openings for dust collector system for cleaning floor. Make provisions for closing and opening holes
70. Clock outlet, 8′ above floor level or other appropriate location
71. Location for push button for clean up buzzer. Clean up buzzer should be located on inside wall directly above switch
72. Storage racks for power mechanic parts, etc.
73. Metal bender
74. Electrical table stools
75. Teachers coat rack
76. Storage cabinets, small supplies
77. Mirror, bottom 48″ above floor

NOTE: (1) Windows are not shown in plan since size and type will depend on architectural design. Window sills should be 4-7 ft above floor level.
(2) Exhaust pipes for dust and chip collector should be under floor.
(3) Office and small storage rooms can be deleted and toilets added in this space if unit is detached.
(4) Skylights may be used for natural light in shop laboratory
(5) Doors opening into laboratory should have polished wire glass in upper half of doors.

78. Movable table-carts
79. Plastics unit
80. Vise
81. Jig saw for model making
82. Office chair
83. Waste paper basket
84. Safety glasses
85. Thermofax
86. Spirit duplicator
87. Mimeograph
88. Stapler
89. Rubber stamp equipment
90. Cold foil
91. Paper drill
92. Model area — with equipment
93. Magazine racks
94. Darkroom sink
95. Camera
96. Enlarger, 35 mm 7 2¼ x 2¼ 50 mm and 75 mm lens
97. Light trap
98. Wall cabinet
99. Shelves
100. Counter top — formica with splash back
101. Projection screens
102. Large drafting table with machine
103. Power mechanics
104. Wall storage cabinets
105. Type case
106. Work table
107. Offset press
108. Plate maker
109. Desk with typewriter
110. Silk screen unit
111. Book binding
112. Letter press
113. Print making table
114. Paper cutter
115. Anvil
116. Work bench for electronics
117. Table
118. Electronics lab bench
119. Study carrels
120. Overhead projectors
121. Drying rack
122. Shelves container
123. Fire proof
124. Counter with storage below
125. Welding and foundry supply can
126. Metal supply cabinet or optional industrial ceramics
127. Acetylene welder
128. Arc welder
129. Water container
130. Work bench

131. Riser
132. Etching
133. Arm chairs (24)
134. 16mm motion picture projector
135. Carousel and slide projector with remote control
136. Projector Table 1
137. Tool panels for machines
138. Ozalid process reproduction system

INDUSTRIAL ARTS CURRICULUM PROJECT

Contributor:
William D. Umstattd
Assistant Professor of Industrial Technology
The Ohio State University
Columbus, Ohio

The Industrial Arts Curriculum Project (IACP) was an effort to develop innovative instructional systems considered to be elements of the liberal education for all junior high school boys and girls. IACP portrays a broad conceptual approach to current industrial practices through the study of management, production, and personnel technologies relevant to contemporary construction and manufacturing industries. From this research and development thrust two one-year courses have evolved: "The World of Construction" (WOC), a seventh or eighth grade study of the industrial activities which result in production on a *construction site*, and "The World of Manufacturing" (WOM), an eighth or ninth grade exposure to the industrial practices which result in finished products being produced *within a plant.*

Industrial technology was used as the term to name the body of knowledge of the manufacturing and construction industries. The research established that at the highest conceptual level, man employs the same practices and technologies in the construction and manufacturing industries. To both at this level, he applies common management, production, and personnel technologies.

Management is planning, organizing, and controlling. Production includes pre-processing, processing, and post-processing. Personnel practices involve hiring, training, working, advancing, and retiring.

Both "The World of Construction" and "The World of Manufacturing" are designed to study conceptual commonalities, through diverse activity alternatives, in an effort to communicate that alternative solutions to industrial problems can be found. WOC and WOM are structured for one 50-minute period 5 days per week for 36 weeks, or the equivalent. Twenty optional days may be omitted in order to allow time for special assemblies, snow days, etc., during the school year.

Suggested minimum length of each class period is 45 minutes, and an average class size of 25 students is recommended. Many of the students' activities are planned for small groups (5 pupils) in which the student plays a unique role or performs a specialized task, as would occur in industry. The IACP instructor does have flexibility in adjusting these units of instruction to his particular time requirement, but the value of the course is diluted and objectives lost if the program is constricted to one semester.

WOC is a one-year exploratory course which provides an opportunity to learn and apply basic knowledge and skills of the construction industry. Students first read and discuss the practices which are required to build any structure, such as a road, dam, utility network, building, tower, or tunnel. Concepts of construction then are applied to occupationally-oriented laboratory activities to reinforce the students' understanding of how man plans, organizes, and controls all available resources to produce products as diverse as skyscrapers and superhighways on a site.

WOM is designed to help youth understand the basic concepts of management, personnel, and production techniques for creating finished goods in a plant or factory. Students are introduced to the problems of custom-produced goods, then to the benefits, basic concepts, and methods of an organized manufacturing system that efficiently integrates men, machines, and materials.

Students research, design, engineer, and produce many different products, of varied materials, using selected processes. Learning experiences vary from consumer research and data collection to estimation of costs and principles of mass production. Activities include role-playing situations, as well as "hands-on" lab experience in developing and mass producing products.

The IACP system utilizes textbooks, laboratory manuals, teacher's guides, and achievement tests for each course, as well as apparatus, equipment, and supplies for both teacher demonstration and student lab experiences. Related components including films, transparencies, games, miniaturized demonstrations and simulation devices, tools and construction materials also are included.

The spatial needs for IACP can be identified in a conceptual framework also – FLEXIBILITY. As students progress through the courses, the teaching strategy often recommends rearranging benches and equipment for a day's activity.

The degree to which environmental modification is prescribed can be determined by the type of movement which occurs – students and/or materials. If students are circulating, consideration must be given to traffic flow. This suggests open aisles. During times of material flow, students would be working in close proximity to each other and passing materials among themselves.

To minimize the confusion which results from excessive student movement, a small group (5 pupils) class organizational structure is recommended. Each group member has responsibilities. One person obtains and returns supplies and equipment for his group from a central distribution point.

Both WOC and WOM can be operated within the spatial standards prescribed in most states for general shop, woodworking, and metalworking laboratories. Teachers' offices, classroom space, work areas, storage (accessible to students), store rooms (exclusive for teachers), display cases, visual and color considerations, noise control, air circulation, toxic fume evacuation, utilities, toilets, and wash stands should receive the same priorities as they do in designing for the traditional programs. The commonly accepted minimum of 75 to 100 square feet per student is adequate. One important point to remember is that, even though the courses require flexibility, WOC and WOM cannot reasonably be taught conjunctively. If both coures are desired and only one facility is available, the courses should be scheduled during alternate years.

In the WOC and WOM classroom areas, practically every period begins with the students seated in tablet arm chairs or at tables. After a short overview, lecture, demonstration and/or discussion, facility needs usually change. If the activity of the day requires student and material traffic, the chairs may have to be pushed aside if the facility is minimal in size.

Within these classroom areas the following instructional support elements must be considered:

1. Teacher Needs (proximity to illumination controls, electrical outlets, and water are suggested)
   - 1.1 Demonstration table (approximately 2′ x 5′)
   - 1.2 Overhead projector (equipped with wide angle lens)
   - 1.3 Filmstrip projection

- 1.4 Record player (used with filmstrips)
- 1.5 Mounted screen (adjustable to eliminate keystoning)
- 1.6 Chalkboard
- 1.7 Tackboard

2. Student Needs (one of the following alternatives)
   - 2.1 Tablet-arm chairs
   - 2.2 Small group tables
3. Storage Needs
   - 3.1 A-V material (filing cabinet)
   - 3.2 Textbooks and laboratory manuals (often needed during class)
   - 3.3 Drawing materials (paper, pencils, marking pens, etc., used numerous times during the course).

WOC requires an on-site area, in addition to a classroom area. The open space concept normally associated with a construction site is imperative, especially during the steel erecting, concrete and masonry work, and module building phases. However, there are times interspersed within these phases when small groups work at four-station type work benches. As was the case in the classroom area within a minimal total space, work benches can be mounted on lockable casters and moved in order to allow for flexibility of the learning environment. Folding tables are also an option.

Within the on-site area the following needs should be considered:

1. Teacher Needs (no special considerations except to provide for visibility of on-site demonstrations)
2. Student Needs
   - 2.1 Four-station work benches (one per group of five students)
   - 2.2 Common tools (those used throughout the course)
   - 2.3 Special tools (available in small group tote trays such as pipe dies, trowels, etc.)
   - 2.4 Construction module space (approximately 8′ x 10′ per small group module)
   - 2.5 Utilities (electrical outlet or cord reel per small group)
   - 2.6 Out-of-doors space (weather permitting, some activities have moved outside if convenient)

3. Storage Needs
   - 3.1 Common tools (central panel for woodworking type portable electrical and hand tools)
   - 3.2 Modules (five classes of twenty-five students could mean 25 modules to be left in place or moved out from the wall during class)
   - 3.3 Special tools (small group tote trays in cabinet for current activities – tray contents may change daily)
   - 3.4 Common construction hardware (bins or drawers for nails, etc.)
   - 3.5 Small student lockers (safety glasses, aprons, small components, etc.).

To support and sustain the efficient instruction of WOC, it is essential to have a systematized inventory and storage control routine for tools, equipment, and supplies. The materials to be housed are primarily related to the construction industry. If the working area is minimal, table saws, jointers, bandsaws, dust collectors, etc., should be able to be moved aside. (These are not considered on-site equipment.) Therefore, power machine connections of the nonmetallic type, with 110V and/or 220V plugs, are recommended. Overhead bus-bars or around-the-wall outlets would have an advantage over permanent floor connections.

A storage facility is essential for tools and supplies used only during short segments of the course. Such items as steel "I" beams, the Jenny Winch Boom, bricks, concrete blocks, sand, gravel, dimensional lumber, sheetrock, and plywood, present the same problems as traditional "woodshop" storage for standard stock or bulk material. The most difficult to store are a ton of sand, a ton of gravel, and 5 bags of cement per year (needed for 5 classes of 25 students). In the laboratory, 30 gallon garbage cans with lids will serve for this storage. Outside, a box or bin which is dry and securable is suggested for the sand and gravel.

Shelving is also needed. Fifty to 75 linear feet of 12″ deep and 12″ high shelving is sufficient. Small hardware and tools (pipe fittings, electric supplies, etc.) can be most conveniently placed in containers labeled with the activity number in order to identify when they are needed. With this system the instructor can quickly transfer material from storage to tote trays and back to storage, as directed by assignments and activities.

Flexibility in storage is an essential part of a flexible facility. For example, one phase of the course is to design and build a model "dream house." Students work within specified size constraints. Storage is a problem only when these are underway and the students are not in class. Standard size racks on casters could be made and moved to and from the "on-site" area as classes change. If these were designed to fold or be disassembled when not in use, they could be stored easily.

The following general tool and material list illustrates the classification of products required for WOC and should serve as a conceptual reference for storing equipment and standard stock items:

1. Tools
   - 1.1 Carpentry
   - 1.2 Plumbing
   - 1.3 Sheet metal
   - 1.4 Electrical
   - 1.5 Painting and finishing
   - 1.6 Model making
   - 1.7 Iron working
2. Fixtures and Supplies
   - 2.1 Paper and office supplies
   - 2.2 Wood and composition material (up to 12′ lengths)
   - 2.3 Plumbing fittings and supplies
   - 2.4 Fasteners (screws, nails, bolt, glue, etc.)
   - 2.5 Metal material (up to 8′ lengths)
   - 2.6 Concrete and masonry supplies
   - 2.7 Roof, wall, floor, ceiling material
   - 2.8 Electrical fixtures and supplies
   - 2.9 Finishing materials
   - 2.10 Model making and landscaping material

The space to accommodate WOM simulates that of the normal manufacturing plant. Product size, number of operations, equipment sophistication, and personnel needs dictate the layout. For the industrial arts facility this suggests certain adequacies.

Within the "in-plant" area the following needs must be considered:

1. Teacher Needs (no special space considerations except for visibility of operational demonstrations)
2. Student Needs
   - 2.1 Four-station work benches (one per group of five students)
   - 2.2 Common tools (those used throughout the course

and usually found in the bench or sheet metal area of the traditional "metal shop")

2.3 Special tools (available in small group tote trays, such as jigs and fixtures, etc.)

2.4 Production area (flexible space for rearranging benches, machines, etc., to establish sequential work stations for mass production activities)

2.5 Utilities (electrical bus-bar 110-220V connected outlets for machines and small portable tools on production line as dictated by available equipment)

3. Storage Needs

3.1 Common tools (central panel for portable electrical and hand tools)

3.2 Special tools (small group tote trays in cabinet for current activities – tray contents may change daily)

3.3 Small student lockers (safety glasses, aprons, individual products in process, etc.).

World of Manufacturing Support Area

Spatial requirements to sustain WOM include tool, equipment, and supply storage. More of the traditional industrial arts metalworking or woodworking machines and tools are adaptable to this course than to WOC. The drill press, portable drill, sander, and woodcutting band saw are but a few which can be used on the production line of certain products and for out-of-class teacher preparation.

A central supply facility is as essential to WOM as it is to WOC. However, the materials stored for this course are more like those of a traditional program. Wood screws, nuts, bolts, pop rivets, abrasives, finishing materials, etc., require the normal drawers, shelves, or cabinets. Approximately 75′ to 100′ of 12″ deep and 12″ high open shelving is recommended for the storage of boxes and cartons containing jigs and fixtures labeled according to activity number. As the course progresses, the instructor rotates materials to and from the tote trays used by students, as directed by the daily activities.

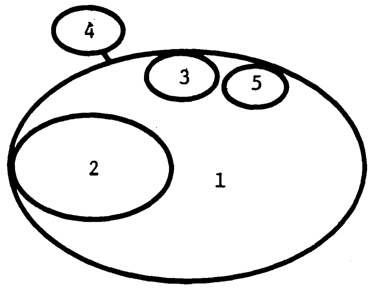
A special problem exists with the storage of materials with restricted shelf-life. Casting resins, plastic foam, and liquid latex are some of the items which should not be stored for a long period of time. If local school once-per-year requisitioning practices make this necessary, these items should be stored in a cool place.

The following general tool and material list illustrates the classification of products required for WOM and should serve as a conceptual reference when planning to store equipment and standard stock items:

1. Tools
   1.1 Metalworking (bench and sheet metal)
   1.2 Woodworking (hand tools)
   1.3 Foundry and melting
2. Equipment
   2.1 Jigs and fixtures for individual products
   2.2 Chemistry (flasks, beakers, culture tubes, etc.)
   2.3 Graphic arts (screen processing)
3. Supplies
   3.1 Paper, cardboard, and office material
   3.2 Hardware (screws, screw eyes, washers, nails, etc.)
   3.3 Sheet metal (up to 8′ lengths)
   3.4 Adhesives
   3.5 Finishing material
   3.6 Plastics (sheet, rod, and liquid)
   3.7 Chemicals
   3.8 CO_2 cartridges
   3.9 Rocket engines and accessories

The following models are presented to graphically illustrate the relationship between different area requirements for adequate and excellent accommodations for WOC and WOM.

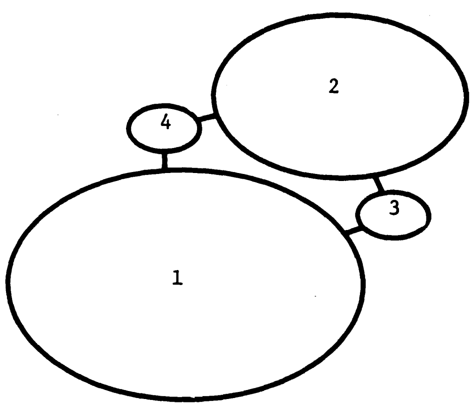
In the first model all classroom, activity, student storage, and machine storage areas are located in a common room. Only the store room for the exclusive use of the teacher is separate.



Adequate Area Recommendations:

1.	Activity	2000 square feet
2.	Classroom	400
3.	Storage for students (wall cabinets)	100
4.	Storage for teachers	150
5.	Machines storage (when not in use)	100
	Total	2750 square feet

To approximate the space relationships where a larger area can be appropriated the following would be considered more than adequate.



Excellent Area Recommendations:

1.	Activity and Machines	2500 square feet
2.	Classroom	1000
3.	Storage for students	100
4.	Storage for teachers	150
	Total	3750 square feet

Fig. 6-4.
Relationship Diagram. Courtesy William D. Umstattd

MARYLAND PLAN

Contributor:
Lorin V. Waitkus
Cleveland-Heights-University Heights
City School District
Cleveland Heights, Ohio

The Maryland Plan interprets industrial arts as a curriculum area devoted to the study of technology and industry and their relationships to other culture systems. The plan attempts to develop an individual's understanding of the contribution of technology and industry and his ability to participate meaningfully as a citizen living in a highly technological period.

Contemporary units in industrial arts is a subsystem of the Maryland Plan where newer technologies are studied. Technology, defined broadly as tools and techniques, is studied in relation to human purpose and achievement utilizing a process of technology.

Technology is studied in the following contemporary unit topics: (1) manufacturing, (2) power, (3) transportation, (4) communication, (5) construction, and (6) management. Contemporary units provide an opportunity for the study of current material utilization, processes, and depth of technological knowledge.

General shop facilities can be used effectively in providing a suitable environment for the study of contemporary units.

Laboratory facilities are located at the end of the general

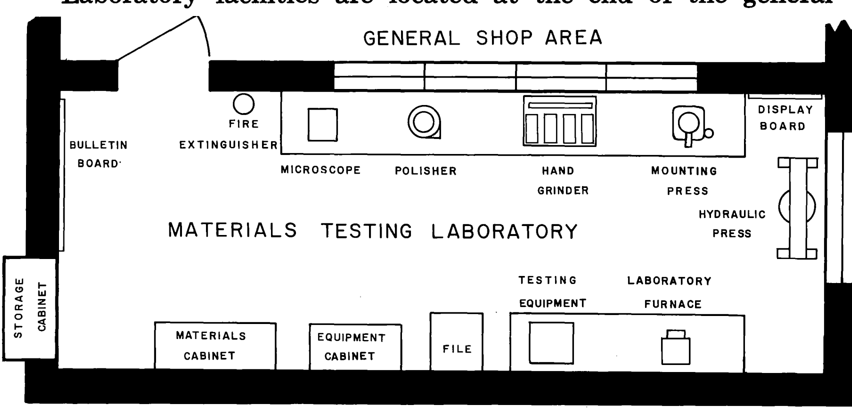


Fig. 6-5.
Materials Testing Laboratory for the Maryland Plan. Floor Plan Supplied by Lorin V. Waitkus

laboratory area, as illustrated in Figure 000. The enclosed area measures 9′ x 25′ and has a ventilation system to remove fumes from the laboratory furnace and keep the area free from dust. A bulletin board, display board, and one cabinet are built in features of the laboratory.

An important area in all grades of Maryland Plan is the seminar area. Due to the variety of topics studied and the class size, a seminar may be held in the unit laboratory, general laboratory area, or adjacent drafting room. In planning new facilities, seminar areas should be included in laboratory areas. However, in other facilities usual classrooms near the laboratory area may be utilized for weekly or periodic seminars.

The seminar room or area may be used as a planning area. A drafting room is ideal since a variety of drawing instruments are readily available.

The reference area includes a bookcase, file cabinet, and portable rack for periodicals. Many technical reports, research reports, NASA bulletins, and trade journals provide information important for studying contemporary units. These references may be stored in the planning area.

The following is a list of machines and equipment for a materials testing laboratory for general industrial arts facilities:

Specimen Mount Press
Hand Grinder
Polisher/Grinder
Metallurgical Microscope
Polaroid Camera Attachment
Hydraulic Press (25 ton)
Laboratory Furnace

A universal testing outfit is adequate to study concepts of materials in contemporary units in industrial arts.

The following list of selected supplies is suggested for the materials testing laboratory of a general industrial arts shop:

Bakelite Powder, Silicon Mold Release, Specimen Protective Lacquer, Metal Thermometer (0-150°C), Engraver, Gloves, Abrasive Strips Grit 240, Abrasive Strips Grit 320, Abrasive Strips Grit 400, Abrasive Strips Grit 600, Diamond Polishing Compounds (6 micron), Polishing Compound (alumina), Lapping Oil, Polishing Discs, Micro Cloth, Nylon.

The following list of broad groups of laboratory supplies is suggested for study in contemporary units in industrial arts:

Ceramics, Woods, Plastics, Powdered Metals, Leather, Fiber Glass, Paints, Varnishes, Lacquers, Synthetic Finishing Materials, Lubricants.

Many topics are usually selected where the necessary materials may not be available in the industrial arts facilities. Students, when researching their selected topics, can request and obtain needed materials from industry.

OCCUPATIONAL VERSATILITY

Contributor:
John Lavender
Industrial Arts Consultant
Highline School District
Seattle, Washington

Occupational Versatility was developed in the State of Washington in response to the challenge of designing an educational environment in industrial arts laboratories whereby students could develop attitudes and abilities which would enable them to be occupationally versatile.

The primary objective for the student of Occupational Versatility is for him to "find his role in the industrial arts environment and have the opportunity to develop the abilities of self-sufficiency, productivity, and adaptability."

To accomplish this objective, the student is encouraged to:

1. Select the area in which he wants to work, elect the project he wishes to produce, make the project and evaluate the results.
2. Manage his activities in the shop. (This includes being responsible for attendance and time utilization, material purchases, project planning, performance records, and facility maintenance.)
3. Instruct himself in planning procedures, material changing processes, and tool and equipment usage.
4. Investigate career opportunities and make judgments about these with consideration to his own abilities and interests.

These experiences occur *under the guidance* of an instructor – but *not the direction of* an instructor. The instructor is the facilitator of the learning, while the student is the director. The instructor is a resource for the student to call upon for assistance and counseling; the student is the manager of his activities. These roles are different than they were before, but are considered to be essential to facilitate the desired student growth and development.

The personalization of the program, with each student entering the shop as an individual and setting his own goals and working toward them at his own pace, was determined as the key to meeting the student objectives. To permit students to work independently on their own interests necessitated other methodological changes. These changes occurred in the following areas: Facility Design, Student Management System, Self-Instructional System, Non-Graded and Ungraded Program, Teaming Activities, and Career Guidance.

In the area of facilities, the separate unit laboratories for wood, metal, and drawing were remodeled into a large, single-room, general laboratory. Two or three teachers were teamed together as instructors. Activity areas were expanded so the program could offer experiences in woods; plastics; power; electricity and electronics; bench, sheet, art and machine metals; forge and foundry; arc and gas welding; graphics; planning and drafting; general industries including construction, manufacturing, masonry, glass, tile, etc.; crafts; and career guidance.

Each area is self-contained and is organized with open storage, making all tools, supplies, instructional materials, and project samples readily available to the students. Planning areas and necessary power equipment are easily accessible.

All areas are color coded for easy maintenance, and all tools and materials are labeled to make them readily identifiable. Machines are also color coded to national standards, to facilitate improved operational learning.

Supporting Facility Requirements

Objectives

The facility will be designed as a place where individuals come to work in a self-instructional system. The design of the areas will enhance exploratory activities and cooperative work experiences.

Student convenience is of utmost importance. Efficient student operation is essential for a productive learning environment.

The facility objectives are:

The student will be able to freely and safely commute throughout the facility as required by his work in as short a time as possible.

The student will work in areas compatibly located as to common tools and equipment, and general material combinations.

The student will have ready access to the necessary instructional media, materials and supplies and planning stations in the area in which he is working.

The student will work on furniture designed for the activity he is participating in and also designed to meet his physical needs.

To permit a student to function efficiently in the program described, the following recommendations for the facility are offered.

Large, Single Room General Laboratory

This permits the student to freely observe all types of activities. His exploration can then consist of vicarious experiences as well as actual experiences. He is motivated by what he sees.

He can also make projects that require activity in more than one area easily and does not have to wait for the quarter or semester to change to complete his work. If an area is crowded, he can work someplace else. Machines can be used all 180 days.

This program can operate with an average of 73 sq. ft. per student. This is quite a bit below the nationally recommended square footage, but adequate.

Team teaching is natural in a single room.

Stand Up Activities

All chairs and stools have been removed from the shops featuring the Occupational Versatility program. This was done for the following reasons:

Each chair or stool takes up needed floor space.

The classes are rarely assembled as the program is personalized.

The only activities that would necessitate sitting down are the planning activities. For this, specially designed 36″ and 42″ planning stations are provided.

Open Storage

In the Occupational Versatility programs all materials are openly stored and clearly marked. Students cut materials as they need them, compute their price, and enter the price on a materials cost record.

The convenience for the student is greatly improved in the open storage system, and the instructor is relieved of clerical duties thus giving him more time with the learning problems of his students. This also lessens the square foot requirements; little used storage rooms use too much valuable floor space.

Self Contained Areas

The self contained design of the Occupational Versatility program eliminates a lot of traffic. All materials are located in or immediately adjacent to where the student is working. This convenience improves the efficiency of the students' work both in performance and attitude; the students' production went up to 104% in the Occupational Versatility program.

Compatibly Located Activities

One advantage of a general laboratory, which may be better described as a supermarket of activities, is the project that encompasses two or more areas, such as a color organ for a stereo set. To complete this project a student needs to work in wood, metals, plastics, and electricity. The convenience of his operations must be considered.

In designing a supermarket of activities, care must be taken to compatibly locate areas. Areas that are similar in operation, areas that are naturally combined, and areas that are common in noise, dust, etc., must be organized with efficient student operation as a design base.

Considerations must also be given to the location of the power equipment areas. For example, the plastics and woods area should both be easily accessible to the bandsaw, belt sander, drill press, and so forth. Planning stations and media centers should be located by watching students work and determining where they are needed and where they can best be located. The more efficiently this is done again will benefit the student both in performance and attitude.

Isolated Machine Areas

Safety is always a prime concern in laboratory design, but many times one of the prime requirements, the traffic pattern, is overlooked. Laboratories have been designed with work benches at one end, material storage at the other end, and the machines in the middle. This means that materials are continually being carried past machine operators.

The machines in the Occupational Versatility program are combined into two machine areas that are carefully located so the normal traffic flow does not go through the area. The area is also marked with a double safety line and with two or three large signs hanging from the ceiling. This helps warn the students that the area is reserved only for machine operators.

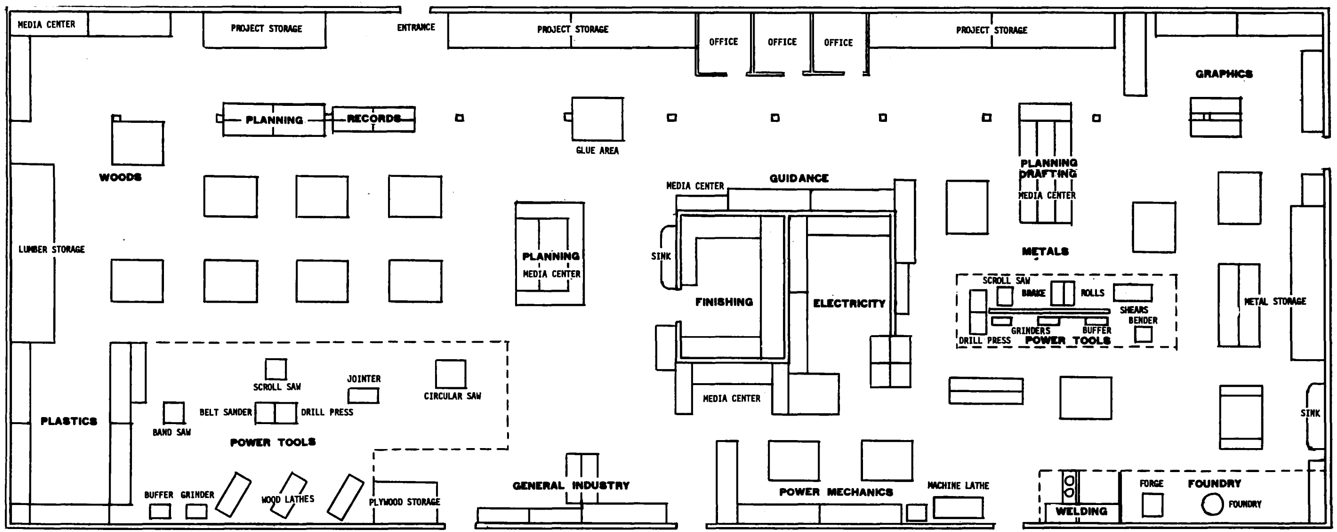
Color Coding

Each area in the Occupational Versatility programs is color coded. For example, all the tools, media panels, and furniture fronts, instructional sheets and project ideas in the wood area are green. In cold metals they are blue, hot metals red, plastics salmon, and so forth. This is done for two major reasons.

One is the image factor. When the laboratory is brightly colored and routed wood signs mark each area, it is a much more attractive place in which to work.

The second reason is to help develop respect in the students for materials and tools. If the laboratory is organized, neat, and all items have a clearly identified place, the students are more likely to learn to practice respect.

The machines are also color coded. National standards are used. This assists the students in their self-instructional processes; color identifies function and machine operation becomes understandable through functional analysis.



Chinook Junior High Highline School District Seattle, Wash.

Fig. 6-6.
Floor Plan Supplied by John Lavender

ORCHESTRATED SYSTEMS APPROACH

Contributor:
Lewis W. Yoho
Professor of Technology
Indiana State University
Terre Haute, Indiana

The Orchestrated Systems Approach treats the individual as a dynamic creative element of a functional system. As a functionary he has an effect upon the system and the system has an effect upon him. The individual and the system both grow and change dynamically under this mutually effective relationship. The Orchestrated Systems Approach stresses the importance of dynamic interrelationships which exist only when the total system is functioning. This concept may be expressed best as "game effect" and is explained by analogy to the ballgame. Baseball pre-game practice and activities reveal all elements of the whole game (its bits and pieces) but the added "orchestration" or dynamic interrelationships of the elements can be present only in actual game-play (in the functioning system). To pitch the ball in pre-game practice is quite different from pitching the ball under actual game dynamics. Removal of the opportunity for participation in the actual game-play will reduce motivation and purpose for skill and knowledge development. Educational programs generally include the "pre-game" practice concepts, but fail to provide the actual "game-in-play" which tests the effectiveness of the preparation, and is in fact the synthesizer of the total process. When pre-game type preparation is alternated with real game participation, dynamic cumulative change toward improvement and perfection of the whole system results. The Orchestrated Systems Approach seeks the "game-effect" as a positive influence in the learning experience.

In industrial arts, the specific problem for the educator and planner is the design of the environment representative of that environment valued by our society for producing our goods and services. Furthermore, the designed environment must accommodate dynamic growth and changes as an integral element of operation.

The major thrust of the Orchestrated Systems Program has been a product manufacturing type of environment. (Other environments for construction enterprises and service enterprises are developing in other adapted space.) It is presently housed in a facility which was formerly a service garage. Approximately 7500 square feet of floor space was available for the manufacturing environment. Approximately 5500 square feet of the total was retained as open flexible space with overhead service of electricity and compressed air. The remaining 2000 square feet of space was divided into meeting rooms, resource areas, offices, and individual study and work stations to accommodate the total group in general session or varying sizes of smaller groups or individuals. Time and experimentation has proven that the space is probably not ideal but it is quite adequate for a complement of 100 students and four instructors.

The generalized schematic also utilizes the ballgame analogy to illustrate the "game-in-play" production area surrounded by the "bull pen" learning and practice centers which are supportive of the production. The Orchestrated Systems Laboratory environment utilizes approximately half of the open flexible floor space for the "game-in-play" production area and half for the "bull pen" learning and practice centers. In addition to the "bull pen" support facilities, the traditional laboratories for electronics and for machine shop also serve as "bull pen" type resources. A completely self-contained operation would possibly need an additional four to six thousand square feet of space.

The lines of the schematic do not represent walls; the area should be as open and exposed as possible in order for the total environment to teach, or to present perceptual experiences to the inhabitants. The individual should be able to pursue depth study, research, and practice in his own speciality, yet benefit through perceptual experience from other individuals who pursue their own specialties. In addition to needed resources for learning and practice, the "bull pens" should deliberately exhibit developmental work and physical evidence of problem solving of many kinds to encourage perceptual experiences and to make the environment "speak" to and "teach" the inhabitants. Design of space for display is therefore an important consideration of facility design.

Space for storage was not included in the schematic but it is important to the operation. The Orchestrated Systems program has several products and several additional products are in process of development. A production facility for each product includes certain specialized equipment, fixtures and other paraphernalia which must be stored except when the product is set up for production. Much of the paraphernalia also has teaching value and

Space Relationship Schematic
for
Consumer Goods Manufacturing Environment--Orchestrated Learning System

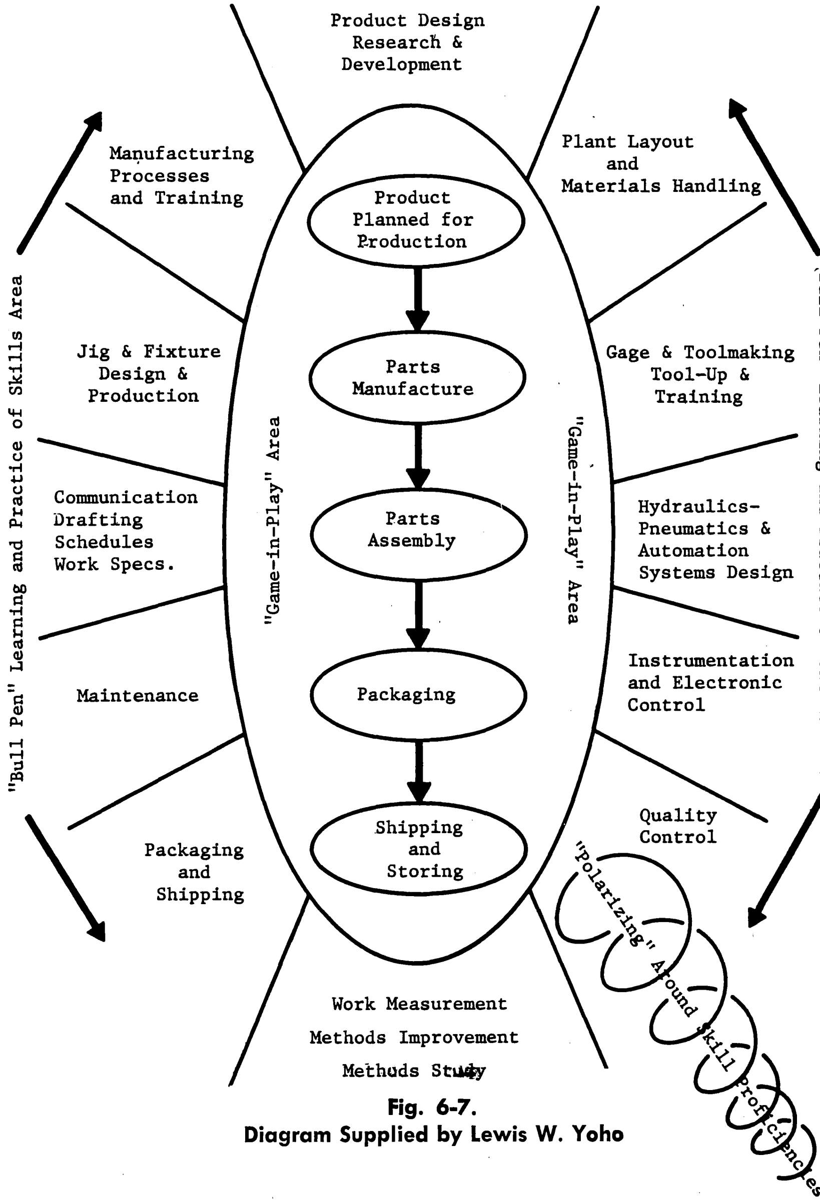


Fig. 6-7.
Diagram Supplied by Lewis W. Yoho

should be seen to trigger ideas for other related situations. The Orchestrated Systems program uses a variety of storage techniques, placing some items in open areas of the "game-in-play" area or even in the "bull pens." A balcony area is also available with approximately a thousand square feet of space. Possibly fifteen hundred to two thousand square feet of space should be available for storage of equipment and supplies.

A summary of the uniquenesses of the physical plant which accommodates the Orchestrated Systems program would include the following:

1. Open space operation designed to make the environment "speak" to and "teach" the inhabitants.

2. Production floor space and service facilities which facilitates change-over from one product production set-up to another is desirable. Air bearings are utilized to move rather heavy equipment quite easily, thus a smooth surface floor is important for air bearing operation. A sealed concrete floor functions very well.

3. Exhibit space for work in progress, and for developmental ideas are important features of the space needs.

4. Equipment location should be a determination of production requirements, time, and efficiency rather than being determined by location of service outlets. Service connections should be accessible throughout the open area.

5. All equipment should be considered movable; fixed space equipment should be held to a minimum.

Based upon the experience gained during several years of operating the Orchestrated System program, it seems feasible to consider many alternatives and variations in techniques of operating. Our faculty seem to prefer the guideline unit of 100 students and four faculty in teamed teaching. Smaller schools with one or two teachers may carry out the concepts of the program with fewer students by phasing the program throughout the semester or the year. Larger school systems may operate several enterprises simultaneously and central trade schools or area trade schools may be integrated into the total system as service centers to the high school or junior high enterprises. Traditional facilities may be adapted to carry out the concepts even though they restrict opportunity for perceptual learning or for the total environment to "speak" to the inhabitants.

It seems important to have classroom space for occasional total group sessions and other space that will accommodate sub-groups of various sizes. Progress evaluations and reviews are excellent for keeping the whole group informed on the whole operation and for relating parts to the whole. Smaller groups and units can meet in an area of the open flexible laboratory if separate rooms are not available. Individual study and work carrells are useful as the work situation makes demands upon certain individuals.

Resources for video-taping and for closed-circuit TV are important features to include. Many problems from processing and production are reviewed or studied in depth through replay of video tape.

There is great need for modular machine components which may be assembled on the "erector-set" concept. Some materials are on the market but machine components designed for versatile use are difficult to locate.

The facility problem for innovative programs has two major concerns including design of new facilities and conversion of existing facilities. Most existing facilities can accommodate new programs if the teachers and professional personnel are committed to operate such programs. The conversion should be viewed in terms of the existing industrial enterprises which also reveal great variety of facilities, many of which are far from ideal. Departmentalization, subcontracting, purchasing of components, etc., are techniques which may be simulated or employed to carry out innovative programs in less than ideal facilities.

TRANSPORTABLE INDUSTRIAL ARTS LABORATORIES

Contributor:
George H. Schwalm
Coordinator of Vocational Education
San Lorenzo Unified School District
San Lorenzo, California

Placing industrial arts on wheels was a unique concept developed by the San Lorenzo Unified School District as a solution for school districts with limited financial resources desiring to implement and expand course offerings.

Because of the unavailability of classroom space and the improbability of duplicating new classroom and laboratory spaces in four of San Lorenzo's junior high schools with their attendant tools and equipment, transportable laboratory facilities were provided which serve all schools equally.

Description of Program

Instruction

Instruction is provided in six areas: drafting, graphic arts, electricity, metalworking, power mechanics, and woodworking. The drafting and woodworking classes are housed in existing structures and do not rotate between schools. The other four areas are housed in the transportable structures. Each instructional area is of nine weeks duration with students electing two or more areas. Emphasis is focused upon the development of understanding rather than manipulative skill. The student project method is used as a motivating force and centered upon problem solving techniques, research and experimentation, and production line activities.

Transportable Laboratories

A stationary prefabricated 40 x 36 foot structure housing the classroom area and work stations was erected at each of the four junior high schools. Four additional 10 x 36 foot mobile structures, housing the specialized equipment for each of the four new areas – metalworking, graphic arts, electronics, and power mechanics – were attached to the stationary structures. Each nine weeks the equipment capsules were detached and rotated among the four sites. Distances between the four junior high schools range from 1 to 2 miles. Most streets on the route are 2-lane, 40 to 50 feet in width, with maximum overpass clearance of 14′6″. (Overall capsule height is 14′0″.) Traffic is from medium to heavy. Moves are made between the hours of 8 to 5 on either a Friday or Saturday, depending upon whether school is in session.

Advance preparations for moving the overall 10 x 44 foot capsule units consist of removing roof, wall and floor caps, disconnecting electrical service, and removing four bolts attaching the capsule to the permanent structure. The tongue of the capsule unit is elevated to receive the towing vehicle. All four capsule moves are completed in one day by two towing trucks with drivers, well within the planned criteria. Two district maintenance employees assist in the moves. The open sides are covered with tarps during the moves. No special lashing of equipment is required. There has been no discernable evidence of equipment shifting in the moves to date. Exiting and docking of the capsules is accomplished with ease and no structural damage.

All structural and mechanical installations conform to both State and Federal code regulations.

The permanent structures as well as the transportable capsules, when docked, rest on concrete foundations.

Each 10′ module is rigidly constructed of welded "I", channel, and tube beam. Each is a free-standing unit bolted to the foundation and to each other. The capsule unit is of heavier construction designed to support a 10,000 lb. live load.

Replaceable wall panels are finished inside with fabric over ½″ plywood. Exterior finish is heavy gauge enameled sheetmetal.

Floors are constructed of 1⅛″ plywood with vinyl tile surface. Ceilings are acoustical tile.

The structure is completely insulated and all wiring, ductwork and piping is concealed.

The electrical system incorporates a centralized public address system, clock, fire alarm and telephone, all connected to the main office of the school.

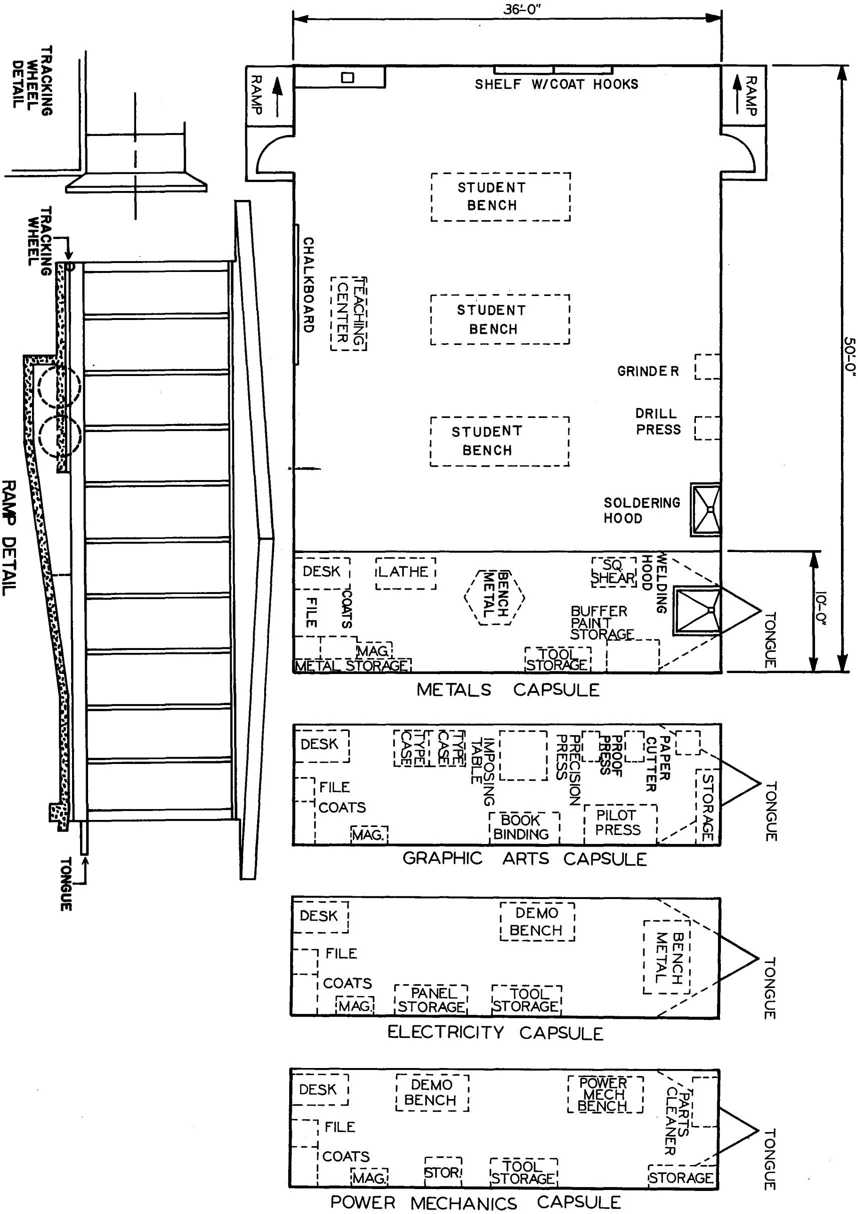
The mechanical system includes plumbing, heating and air conditioning. Cold water and natural gas is piped. Hot water is obtained by means of an under the sink electric heater. Waste drains to the sanitary system.

The aesthetic appearance is of a low profile unified structure. Depressing the capsule running gear in the recessed ramp reduced the distance from ground level to floor height by 27 inches. The capsule and the permanent structure appear as one, having no breaks in wall or roof lines.

Fig. 6-8. (Facing Page)

The four drawings show the final floor plan design for San Lorenzo's Transportable Industrial Arts Laboratories. Each of the four shops, with its "capsule", measures 36 x 50 feet. Total elapsed time for erecting a complete shop – four modules and one transportable capsule – is seven working days.

Each of the four rotating capsules is mounted on dual axles and towed by a tongue attached to the end of the unit. Docking is achieved by backing the "capsule" down the ramp, then positioning it exactly by means of tracking wheels on the rear corners.


TRACKING WHEEL DETAIL
TRACKING WHEEL
RAMP DETAIL
TONGUE
36'-0"
50'-0"
10'-0"
RAMP
RAMP
SHELF W/COAT HOOKS
CHALKBOARD
TEACHING CENTER
STUDENT BENCH
STUDENT BENCH
STUDENT BENCH
GRINDER
DRILL PRESS
SOLDERING HOOD
DESK
LATHE
FILE
COATS
BENCH METAL
SQ. SHEAR
WELDING HOOD
BUFFER
PAINT STORAGE
MAG.
METAL STORAGE
TOOL STORAGE
TONGUE
METALS CAPSULE
DESK
TYPE CASE
TYPE CASE
IMPOSING TABLE
PRECISION PRESS
PROOF PRESS
PAPER CUTTER
FILE
COATS
STORAGE
BOOK BINDING
PILOT PRESS
MAG.
TONGUE
GRAPHIC ARTS CAPSULE
DESK
DEMO BENCH
BENCH METAL
FILE
COATS
PANEL STORAGE
TOOL STORAGE
MAG.
TONGUE
ELECTRICITY CAPSULE
DESK
DEMO BENCH
POWER MECH BENCH
PARTS CLEANER
FILE
COATS
MAG.
STOR.
TOOL STORAGE
STORAGE
TONGUE
POWER MECHANICS CAPSULE

The adaptability of this plan to other situations is limitless. The size of the structure itself can be increased by any number of 10′ modules. Capsules could be placed at both ends of the permanent structure to increase flexibility. Rotation of capsules could be achieved with a minimum of two to any number. The capsule concept can be used in almost any education program desiring to make full use of specialized equipment.

The continued use of the transportable units is a necessary functional part of the total program in San Lorenzo.

VISUAL COMMUNICATIONS EDUCATION

Contributor:
Thomas A. Jasnosz
San Jose Regional Vocational Center
San Jose, California

The information explosion is creating expanding opportunities for and need of persons who can select, design and prepare communications material or supervise teams that do. They must understand the audience and its needs, select the information, and choose the appropriate medium or combination of media. They must be familiar with business operating procedures and managerial functions. Effectiveness and economy are as important in communications as in other aspects of production activities. To meet the changing demands of the communications industry, industrial education must change.

Visual Communication Education, or VICOED, was developed by Dr. Ray Schwalm of Western Washington State College. It is much broader in scope than the traditional graphic arts education, with the emphasis upon the process of understanding and being understood through the sensory organs of sight. It includes not only printing and publishing, but also all facets of photography, graphic design, advertising and advertising production, the graphics of motion pictures and television, cartography, engineering graphics, and other fields related to visual communications techniques and processes. The importance of relating subject matter from other disciplines such as science, mathematics, sociology, psychology, English, journalism, economics, art and technology cannot be overstressed. As a result, team teaching and/or correlation is essential.

The following are the general objectives of VICOED, stated in terms of what is expected of the student.

1. To develop an awareness of visual communication and the need for effective visual communication.
2. To understand the various visual communication media.
3. To understand the social, economic, and political importance of visual communication.
4. To develop an awareness of the realm of the visual communication industry, including both commercial and in-plant operations.
5. To develop an understanding of the concepts of visual communication and to apply these concepts to the best of his or her ability in the production and dissemination of effective visual communication materials.
6. To prepare for entry into the visual communication industry.
7. To keep informed of current research and development in the industry.
8. To understand, develop, and use systems for the storage and retrieval of visual information.
9. To develop perceptual awareness and aesthetic judgment.
10. To develop an awareness of the responsibility of the originator, producer, and disseminator of visual communication in influencing human behavior.
11. To develop an understanding of the language employed in the various visual communication media.
12. To understand the interrelationship of visual communication, the arts, the humanities, and sciences, and technology.

These general objectives determine the design of VICOED facilities.

Optimum design for VICOED facilities would provide one large area subdivided into nine smaller areas. These areas are all interrelated in the instructional program, and need easy access to one another. Team teaching permits several individual classes to operate simultaneously, for high utilization of space. Where budgets are limited, facilities planners will need to be highly selective in deciding which special features and equipment to include. Recommendations given here are for 'ground-up' facilities planning with ample budgets. With this in mind, it is noted that several of the smaller rooms within the larger space need to be sound insulated and/or light proofed, while others need only a

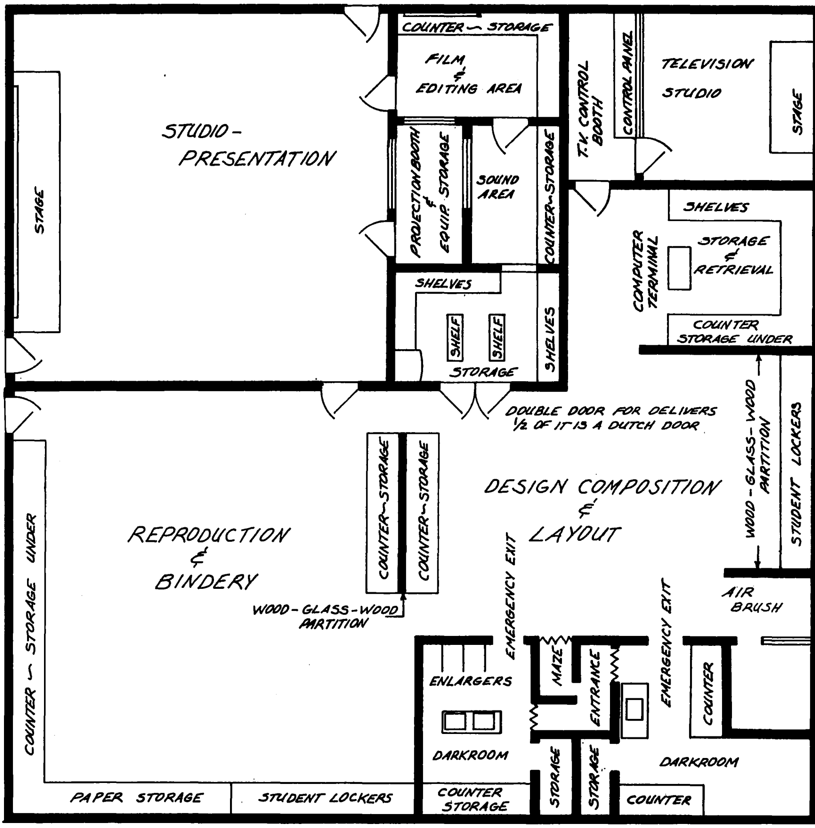


Fig. 6-9.
An Ideal Design for a Visual Communication Laboratory.
Floor Plan Supplied by Thomas A. Jasnosz

wood-glass-wood division between for cleanliness. The whole complex for the VICOED program would require no outside windows to permit more even and constant light control for color reproduction and other functions. T.V. cable and monitors in each of the small areas and also from the studio-presentation area to other areas is essential, as is compressed air to each area. The total area should be air-conditioned and humidity controlled with exceptional ventilation for those areas which use toxic fumes, such as the reproduction area and the darkroom area. Several of the rooms would also need carpets to control dust and act as sound depressors.

The first of the smaller areas is the studio-presentation area. It may be used for classroom instruction, demonstrations, student presentations, a central meeting place, or movie shooting. Its special features include a stage, a projection booth, light dimming controls, T.V. hook-ups and sound isolation. It should contain the equipment necessary to present most audio-visual productions or materials, such as a 35mm slide projector, an overhead projector, a moving picture projector, a rear-view projection screen, and a tape recorder and playback system.

The second smaller area is to be used for design, composition, and layout. It should permit preparation of both print and non-print visual communication materials for reproduction. Its features include a wood-glass-wood partition between this area and reproduction-bindery area, and carpeting on the floor. Idea, art and character generation are the main concepts taught in this area. The equipment must support both the hot and the cold type processes, and the cold type equipment should represent both strike-on and photo-generated methods. Art and design aids, such as an air brush, should be available, as should layout equipment such as light tables and drafting tools. A copy stand, slide copier and slide mounter should be among the photographic equipment available to students in this area.

The third smaller area, for reproduction and bindery, will house the more traditional graphic arts equipment. The furnishings should represent each of the four basic printing processes and their support equipment.

The fourth small area is the photographic darkroom, to be used for both process photography and general photography. Its features include white, yellow and red light controls, light traps to enter the two areas of the darkroom, and a subdivision within the room to provide one area for process photography and one for general photography. It must also be high pressure air controlled to keep dust out. Its equipment will include developing sinks with temperature controlled water recirculator; process cameras built into the walls, each in a separate cubicle; light isolated from the others and the main portion of the darkroom; enlargers; and a color separator enlarger with electronic controls, built into the room.

The fifth small area is for the storage of all VICOED supplies for students and classes. It features solid walls except for a dispensing "dutch" door and a large access door for deliveries. It contains wall shelving with a built-in refrigerator for film, and a desk and filing case for use by an attendant.

The sixth small area, the storage and retrieval of information area, is for preparation of and storage of document and graphic information; retrieval of same; instructional resources; computer graphic input and output for storage and retrieval and also for graphic design. It should be dust free, have carpeting, and be partitioned from the remainder of the area with a wood-glass-wood partition. It is basically a library facility, containing books, magazines, audio-visual materials, microfilming equipment, and storage for microfilm aperture cards. It should also have a terminal linked to a computer with microfilm storage capabilities.

The seventh smaller area is to be used for preparing magnetic tapes with script, music and projector impulses, and placing sound on motion picture films. It should be located adjacent to the studio-presentation area so that the projection equipment may be shared. It should feature sound isolation from the other sub areas, carpeting, and a "Recording" light outside its access door. Its equipment should include a recording console with magnetic tape recorders.

The eighth smaller area is to be used for editing, splicing, assembling and previewing motion picture films made by students, and for previewing commercial films. It also should be located close to the studio-presentation area so that projection equipment may be shared. It should be carpeted and sound treated, and have ample working surfaces.

The ninth smaller area is for producing video tapes of demonstrations, advertisements, and short programs. It should also provide recording ability for on-air recording. The entire room must be sound proofed and isolated from the remainder of the sub areas. It must have adequate lighting for video taping; a small raised stage; smooth carpeting for dolly movement and sound control; a control booth isolated from the remainder of the studio; sound controls between the shooting area and the control booth with a large window for observation and control; overhead extension cords for lights, microphones, and cameras; "Recording" light on outside access door; and access from control booth to live area. It should be furnished with a control panel built in with the following components: video recorder, magnetic tape recorder, monitors for indicating camera images, switching mechanism, turntable, two-way audio sound to the live area and back, a special effects generator, and a video chain for slide projector. It should also have cameras (black and white or color), overhead drop microphones, camera dollies with large, soft rubber wheels, and a large video monitor.

Project-Program Requirements

PROJECT ______________________________

Room ______________________________

Number of rooms identical to this one ______________

1. Room capacity (Number of student or faculty occupants) ______________
2. Approximate area in square feet ______________

   Standard used ______________
3. Factors affecting room location: ______________

   ____

   ____
4. Special room requirements: (Light, controls, heat, ventilation, acoustics, floor, walls, ceilings, doors, etc.) ______________

   ____

   ____
5. Built-in equipment: (include diagrams and required services where known.) ______________

   ____

   ____
6. Utilities: (Electric, water, gas, drains, etc.) ______________

   ____
7. Movable equipment: (indicate which items are to be purchased in project.) ______________

   ____

   ____

On reverse side list special considerations which may affect design.

NOTE: This form has been provided by:

H. A. Goltz, Director
College Planning Office
Western Washington State College
Bellingham, Washington 98225

APPENDIX B

Facility Evaluation

The previous chapters of this book identify specific information and standards for consideration when planning industrial arts laboratories. Obviously, all standards should be applied to an evaluation of a laboratory. To do this would require an extensive checklist of specific items. The following checklist is suggested as a guide for an evaluator. When an explanation or further information is required on any one criterion, the evaluator is referred to the other chapters.

The criterion statements in this checklist are concise, broad items which indicate major factors of concern when planning facilities. The checklist is intended to consider only the physical facilities. No attempt is made to analyze the appropriateness of the instructional program to be offered in the facility. Yet the program should dictate the physical facility. When planning laboratories, educational specifications must be prepared prior to any physical layout designing.

The criteria are broadly stated also so that the variety of state standards may be applied in judging items such as the size of the rooms. Individual state standards and regulations should be known by the evaluator. The general nature of the criteria permit their adaptation to the complete range of diverse laboratories from the basically simple drafting room to the complex, heavily equipped machine laboratory.

The checklist is written for application to an individual laboratory. It does not assess the total industrial arts program and its adequacy for the school in which located. The checklist further assumes that it will be used by persons knowledgeable about facility standards for industrial arts programs.

An efficient, adequate industrial arts laboratory is a vital requirement for an effective program which requires also a well defined instructional program, a qualified teacher, and sufficient instructional and consumable materials.

Note: This checklist has been provided by: Ralph V. Steeb
Consultant to Industrial Arts
Florida Department of Education
Tallahassee, Florida 32304

Industrial Arts Facility Checklist

SCHOOL ______________________________

LABORATORY TITLE ______________________________

	Superior	Adequate	Inadequate	Missing	Not Applicable	Remarks
I. Laboratory Orientation						
1. Location of laboratory in respect to main plant						
2. Entrances and delivery access: size and location						
3. Driveway access to laboratory						
4. Laboratory is secure from outside entry						
II. Open Laboratory Space						
1. Location relative to other instructional areas						
2. Laboratory size: meets state and local standards						
3. Proportion and Shape						
a. Rectangular						
b. Not greater than 1:2						
4. Ceiling heights appropriate for instruction area						
5. Floors						
a. Material appropriate for instruction area						
b. Easily cleaned						
c. Non-slip						
6. Wall treatment and color						

Industrial Arts Facility Checklist

SCHOOL ______________________________

LABORATORY TITLE ______________________________

	Superior	Adequate	Inadequate	Missing	Not Applicable	Remarks
7. Accoustical treatment						
8. Temperature and ventilation controlled						
9. Open laboratory assembly area						
10. Visual supervision						
a. Safety glass or plastic partitions						
b. Cabinets and/or equipment does not obstruct view						
11. Traffic Flow						
a. From one laboratory to another and/or auxiliary areas						
b. Adequate size for efficient traffic flow						
c. Equipment placement to avoid detours						
d. Traffic lanes free of projections						
e. Traffic lanes of adequate width						
12. Proper maintenance of laboratory and equipment						
III. Equipment: Machines, hand tools, etc.						
1. Machines						
a. Placement and spacing						
b. Flexibility — easy to move						

Industrial Arts Facility Checklist

SCHOOL ______________________________

LABORATORY TITLE ______________________________

	Superior	Adequate	Inadequate	Missing	Not Applicable	Remarks
c. Variety necessary for instructional content						
d. Appropriate for physical needs of students						
e. Quality of manufacture						
f. Appearance: simplicity of design and structure						
2. Dust Control System.						
3. Sufficient work stations for largest class enrollments						
4. Quality of benches and/or tables						
5. Hand Tools						
a. Quality of hand tools						
b. Adequate for instructional content						
c. Appropriate storage facilities						
d. Quality of storage cabinets and/or panels						
6. Chalkboard area: location and size						
7. Tackboard area: location and size						
8. Space and racks for supply and material storage in laboratory						
IV. Utilities: Availability and flexibility						
a. Compressed air						

Industrial Arts Facility Checklist

SCHOOL ______________________________

LABORATORY TITLE ______________________________

	Superior	Adequate	Inadequate	Missing	Not Applicable	Remarks
b. Sufficient electrical receptacles: convenient location and grounded						
c. Electrical service to machines						
d. Lighting: natural and artificial						
e. Master controls in laboratory						
f. Water: hot and cold						
1. Wash-up facilities						
2. Drinking fountain						
3. Availability for appropriate machines						
g. Gas: at appropriate locations						
V. Safety Provisions						
a. Adequate guards on equipment						
b. Safety zones outlined						
c. First aid kit						
d. Color coded equipment						
e. Fire extinguishers						
f. Power cut-off switches						
VI. Auxiliary Rooms						
1. Pupil project storage room: size and convenience						

Industrial Arts Facility Checklist

SCHOOL ____________________________________

LABORATORY TITLE ____________________________

	Superior	Adequate	Inadequate	Missing	Not Applicable	Remarks
2. Material storage room						
a. Size: adequate for instruction area						
b. Material storage racks; safe and adequate for instruction area						
3. Finishing room						
a. Size adequate for instruction area						
b. Explosion proof electrical installations						
c. Exhaust system						
4. Teacher office space: size and location						
5. Planning room or area in laboratory						
6. Toilet facilities; convenient to laboratory						
7. Separate evening class storage						
8. Dark room						
9. Provision for showing AV materials in laboratory or separate room						
10. Resource Center						

APPENDIX C

Laboratory Safety Evaluation Form

HUMAN SAFETY

MATERIALS, STORAGE, AND HANDLING

PHYSICAL FACILITIES

MACHINES AND TOOLS

Editor's Note:

This *Laboratory Safety Evaluation Form* was developed by Trade and Industrial Instructors, Industrial Arts Instructors, and a safety committee for Prince William County Public Schools, Manassas, Virginia. It is reproduced here by permission of John Bonfadini, Supervisor of Industrial Arts and Trade and Industrial Education for Prince William County Public Schools.

Introduction

A safe environment is an essential part of the school laboratory safety education program. The safe environment will exist if hazards are discovered and corrected through regular and *frequent* inspections by school personnel – administrators, teachers, and students. Safety inspectors are to determine if everything is satisfactory.

Procedure

Who inspects?

After familiarizing yourself with the laboratory safety evaluation form, inspect your laboratory(ies) with one of your school administrators using one form per laboratory. Inspections should be systematic and thorough. No location that may contain a hazard should be overlooked. Fill out the form including comments in deficient areas.

Follow-up

Each unsafe condition should be corrected as soon as possible through channels at the local level. Any steps taken to correct any deficient area should be noted on the evaluation form. The inspection team will go through each laboratory making their own evaluation and comments. At the end of the inspection the team should sit down with the teachers and school administrators to discuss their findings.

Checking Procedure

Circle the appropriate letter, using the following letter scheme:

S – Satisfactory (needs no attention)

U – Unsatisfactory (needs immediate attention). Recommendations should be made in all cases where a "U" is circled. Space is provided for such comments.

NA – Not applicable.

PERSONAL PROTECTION		Comments	Recommendations
1. Goggles or protective shields are provided in adequate number, and are required for all work in accordance with the State Law.	S U NA	______	__________
2. Adequate means for sanitizing the glasses is available.	S U NA	______	__________
3. Shields and goggles are provided for welding.	S U NA	______	__________
4. Rings and other jewelry are removed by pupils when working in the lab.	S U NA	______	__________
5. Sleeves are rolled above elbows when operating machines.	S U NA	______	__________
6. Clothing of students is free from loose sleeves, flopping ties, loose coats, etc.	S U NA	______	__________
7. Safe method to control long hair is provided.	S U NA	______	__________
8. Adequate number of aprons or labcoats are provided for students.	S U NA	______	__________

PERSONAL PROTECTION		Comments	Recommendations
9. Proper type of wearing apparel is worn and worn properly for the job being done.	S U NA	______	______
10. Special protective clothing is used in appropriate areas.	S U NA	______	______
11. Adequate numbers of leggings, gloves, and aprons are available in special areas.	S U NA	______	______
12. Adequate storage is provided for aprons or labcoats.	S U NA	______	______
13. Students are examined for safety knowledge ability.	S U NA	______	______
14. Adequate controls are in existence for accounting for safety equipment.	S U NA	______	______
15. Gloves are provided when lumber is to be handled extensively.	S U NA	______	______
16. Adequate instruction in personal safety equipment is provided.	S U NA	______	______
17. Laboratory safety is taught as an integral part of each teaching unit.	S U NA	______	______
18. Safety rules are posted at each danger station.	S U NA	______	______
19. General safety rules are posted in each laboratory.	S U NA	______	______
20. Each student has signed a safety agreement.			
21. Class organization chart includes the position of safety engineer.	S U NA	______	______
22. Motion and/or slide films on safety are used in the instruction.	S U NA	______	______
23. Safety tests are used.	S U NA	______	______

PERSONAL PROTECTION		Comments	Recommendations
24. Safety posters are used.	S U NA	______	______
25. Periodic safety inspections of the shop are made by an instructor.	S U NA	______	______
26. Instructor has adequate record of instructions in safety procedures for each student.	S U NA	______	______
27. Activities undertaken reflect the maturation level and ability of youngsters involved.	S U NA	______	______
28. Students receive instructions and demonstrations in the use of all tools and equipment they are expected to operate.	S U NA	______	______
29. Instruction is reinforced by continuous proper examples through deeds and actions.	S U NA	______	______
30. Students are checked and permission granted before machines may be operated.	S U NA	______	______
31. Supervision is always provided when classes are in session.	S U NA	______	______
32. Pupils are instructed and alerted to all possible hazardous operations and are scrutinized in these activities.	S U NA	______	______
33. Students are instructed in the proper methods of handling and lifting materials.	S U NA	______	______
34. Students are instructed to stand clear of machines when turning them on, to never leave a machine while it is still running, nor stop one with their hands or a piece of material.	S U NA	______	______

PERSONAL PROTECTION		Comments	Recommendations
35. Students are instructed to stay clear of others operating machines, and if necessary, to approach an operator in a way which will not annoy or alarm him.	S U NA	________	____________
36. Parents are informed in writing that their child is taking industrial arts and are requested to provide any information regarding the emotional or physical make-up of their child which would inhibit their safe use of equipment.	S U NA	________	____________
37. Students taking industrial arts are encouraged to take school accident insurance.	S U NA	________	____________
38. General safety rules are given each student.	S U NA	________	____________
39. Adequate seating and storage of seating is provided.	S U NA	________	____________
40. Students are instructed in proper precautions when working in an environment that could involve the inhaling or smelling of solutions.	S U NA	________	____________
41. The instructor exhibits and practices good safety procedures.	S U NA	________	____________
42. Students' sense of responsibility is promoted by examples, posters, and conditions which reflect an industrial atmosphere.	S U NA	________	____________
43. Ground rules are established and enforced for safe, efficient laboratory operation.	S U NA	________	____________

PERSONAL PROTECTION		Comments	Recommendations
44. Students' attitudes reflect respect for machinery and the operations which take place in the laboratory.	S U NA	________	______________
45. Students who continuously exhibit correct attitudes and work habits during the year receive safety awards.	S U NA	________	______________
46. Laboratory atmosphere is enhanced by safety zoning, color coding, neatness, and organization.	S U NA	________	______________
47. The administration and industrial arts department have a policy for handling people who are chronic abusers of safe practices.	S U NA	________	______________
48. There is a written first aid policy and proper instruction outlining the proper procedure when and if a student is seriously hurt.	S U NA	________	______________
49. Adequate accident statistics are kept.	S U NA	________	______________
50. Accidents are reported to the proper administrative authority by the instructor.	S U NA	________	______________
51. Accident reports are analyzed for instructional purposes and to furnish the basis for elimination of hazards.	S U NA	________	______________
52. Home address, phone number of child's parents is available in case of emergencies.	S U NA	________	______________
53. Standard accident report form exists.	S U NA	________	______________

STORAGE AND HANDLING OF MATERIALS		Comments	Recommendations
1. Storage racks and shelves are well constructed for their use.	S U NA	________	______________
2. Doors on cabinets and their handles are in good working condition.	S U NA	________	______________
3. Poisonous chemicals or concentrated disinfectants are properly labeled and stored in secure areas.	S U NA	________	______________
4. All chemicals are identified by readable labels.	S U NA	________	______________
5. Compressed gas or aerosol sprays are stored in a cool place.	S U NA	________	______________
6. Sanitized linen is stored in a closed cabinet.	S U NA	________	______________
7. All empty containers are cleaned and properly stored with sealing devices where applicable.	S U NA	________	______________
8. Storage of bulk products is in an organized, safe manner.	S U NA	________	______________
9. All cleaning utensils are stored in specified areas.	S U NA	________	______________
10. Supplies are not protruding over the edge of shelves into aisles.	S U NA	________	______________
11. Soiled linens are stored in metal lined containers which have tops on them.	S U NA	________	______________
12. Pupil's projects are stored in such a manner as not to create a safety hazard.	S U NA	________	______________
13. Storage space for student projects is adequate.	S U NA	________	______________
14. Adequate storage of hardware and software is provided.	S U NA	________	______________

STORAGE AND HANDLING OF MATERIALS

		Comments	Recommendations
15. Adequate number of ventilated fire-resistant cabinets are provided for the storage of combustible materials.	S U NA	________	______________
16. An area outside of the school is provided for safe storage of flammable bulk materials.	S U NA	________	______________
17. Safety cans are used for local supply of acids and flammable liquids.	S U NA	________	______________
18. Oily rags and waste materials are removed from the work area each day and placed in spring lid metal containers.	S U NA	________	______________
19. Portable electrical equipment is properly stored but easily accessible to all students.	S U NA	________	______________
20. Storage space for portable electrical equipment is adequate.	S U NA	________	______________
21. Tools are safely stored and adequately identified as to their placement on tool racks or tool cribs.	S U NA	________	______________
22. Storage space for tools is adequate.	S U NA	________	______________
23. Tools are kept in cabinets that lock.	S U NA	________	______________
24. Tools that are being used are the only tools out of the cabinet.	S U NA	________	______________
25. Brick and block that are not being used are kept in a designated storage area.	S U NA	________	______________
26. Brick and block are stacked so each tier ties the tier below and do not exceed five feet in height.	S U NA	________	______________

STORAGE AND HANDLING OF MATERIALS

		Comments	Recommendations
27. Lime and sand are stored out of all traffic aisles.	S U NA	______	__________
28. Acetylene and oxygen tanks are secured so they can not be turned or tipped over.	S U NA	______	__________
29. Tanks not in use are capped.	S U NA	______	__________
30. Threads for gauges on tanks are in good condition.	S U NA	______	__________
31. Cylinders are marked for content.	S U NA	______	__________
32. There are no flammable materials within 30 feet of the welding area.	S U NA	______	__________
33. All wheelbarrows and ladders are stored at a height that is easily accessible.	S U NA	______	__________

PHYSICAL FACILITIES

		Comments	Recommendations
1. Total floor area is consistent with accepted standards, dictating safe conditions. Floor space should be 100 to 125 sq. feet of space per student (depending on the activities involved — exclusive of storage and special rooms).	S U NA	______	__________
2. Floors are in good condition and are suited to the area in which they are located; precautions are taken against slippery floors, special attention being given to machine areas.	S U NA	______	__________
3. Where needed, properly designed and located gas, water, electrical and compressed air facilities are provided.	S U NA	______	__________
4. Utility lines are properly identified.	S U NA	______	__________

PHYSICAL FACILITIES		Comments	Recommendations
5. Each school laboratory facility has a minimum of two entrance-exit doors that each measure 36 inches or more in width and are properly identified as exits. Where bulk materials are concerned all laboratories should contain an outside door.	S U NA	________	______________
6. Ceiling height is appropriate, (i.e., between 12 feet and 14 feet) in all school laboratories and drawing rooms; and where applicable, ceilings are constructed of a material having a high coefficient of sound absorption. The laboratory operating level should be no higher than 80 db.	S U NA	________	______________
7. Shop walls are durable and easily cleaned epoxy paint from floor to top-of-door height. Sound-absorbing materials are used on upper wall surfaces wherever the amount of noise suggests special wall treatment.	S U NA	________	______________
8. Washing facilities and a drinking fountain of appropriate design and location are provided.	S U NA	________	______________
9. Equipment is arranged with reference to the sequence of operations and their relationship to other areas. Adequate clearance, as dictated by the function of the machine, is provided around all equipment.	S U NA	________	______________

PHYSICAL FACILITIES | Comments | Recommendations

10. Work stations are sufficient in number to provide flexibility. S U NA ______
11. Screening is provided between and around welding stations. S U NA ______
12. Finishing room contains the following safety features:
    a. Solid fire door
    b. Exhaust system
    c. Proper venting
    d. Proper explosion - proof lighting
    e. Unlocking fan and switch S U NA ______
13. Finishing room should be at least 200 sq. feet per teaching station. S U NA ______
14. Additional storage facilities are provided to equal at least 20% of the working area. S U NA ______
15. Temperature is controlled and maintained in 68°-72° range. S U NA ______
16. Illumination is safe, sufficient, and well placed, and at a level of 100-125 lumens. Natural light is effectively controlled to eliminate glare. Graphic arts, electronics, and drafting areas use higher figure. S U NA ______
17. Faulty illumination is replaced. S U NA ______
18. Fire extinguishers are of proper type, adequately supplied, properly located, and maintained and marked. S U NA ______

PHYSICAL FACILITIES — Comments — Recommendations

19. Teachers and pupils know location of and how to use proper type for various fires. S U NA ________
20. Fumes or gas vapors are exhausted or vented. S U NA ________
21. Controls on venting devices are operational. S U NA ________
22. Proper procedures have been formulated for emptying the room of pupils and taking adequate precautions in case of emergencies. S U NA ________
23. Teachers know the procedure in the event of fire including notification of the fire department and evacuation of the building according to the school policy. S U NA ________
24. Walls are clear of objects that might fall. S U NA ________
25. Stairways are clear of foreign objects, lighted, and are provided with handrails and safety treads. S U NA ________
26. A clear area is provided at the bottom of the steps. S U NA ________
27. Window ledges are clear of objects. S U NA ________
28. Traffic aisles are clearly marked and free of obstacles. S U NA ________
29. A private area which is vented is provided for the masonry saw. S U NA ________
30. There is no temporary wiring in evidence. S U NA ________
31. Regulators are provided all gas outlets. S U NA ________

PHYSICAL FACILITIES		Comments	Recommendations
32. Gas appliances are properly insulated with asbestos or other insulating material from tables, benches, adjacent walls, or other flammable materials.	S U NA	______	______
33. No gas hose is used where pipe connections could be made.	S U NA	______	______
34. Warning signs are posted when hot metals are to be or have been poured.	S U NA	______	______
35. The pouring of hot metals is done in an area safe to all involved.	S U NA	______	______
36. Individual utilization of the facility and equipment should be limited to qualified personnel who have received proper training as to the safe operation of the said facility.	S U NA	______	______
37. Individuals using safe facilities for other than for instructional purposes will abide by prescribed safety procedures and have satisfactorily passed the safety test.	S U NA	______	______
38. General appearance of laboratory is one of orderliness.	S U NA	______	______
39. Sufficient scrap boxes are provided.	S U NA	______	______
40. All waste materials and oily rags are promptly placed in the containers.	S U NA	______	______
41. A toe-board or railing exists around a mezzanine used for storage or washing facilities.	S U NA	______	______

PHYSICAL FACILITIES		Comments	Recommendations
42. Floors are free of oil, water, and foreign material.	S U NA	________	______________
43. Floors, walls, windows, and ceilings are cleaned periodically.	S U NA	________	______________
44. Exists and fire fighting equipment are clear of materials which might obstruct their use.	S U NA	________	______________
45. Custodial help is provided periodically to insure a healthy and safe environment.	S U NA	________	______________

MACHINES AND HANDTOOLS		Comments	Recommendations
1. All equipment not in operating condition and equipment awaiting repairs should contain out of order signs. Parts and work orders are initiated immediately to repair inoperable equipment.	S U NA	________	______________
2. All machines requiring guards have guards and are properly used.	S U NA	________	______________
3. Proper individual machine accessories are easily accessible, properly displayed, and safely used.	S U NA	________	______________
4. Adjustments are made correctly according to service manuals.	S U NA	________	______________
5. Blades and other cutting accessories are in good working condition.	S U NA	________	______________
6. Worn belts, disc wheels, and etc., that reach unsafe conditions are replaced.	S U NA	________	______________
7. Preventive maintenance program is in existence for each machine in the laboratory.	S U NA	________	______________

MACHINES AND HANDTOOLS		Comments	Recommendations
8. Location of machines in laboratory area provides for safe operation.	S U NA	________	______________
9. Proper switches, plugs and electrical connectors exist for each machine.	S U NA	________	______________
10. There is a safety switch cut-off near major power tools.	S U NA	________	______________
11. Operational safety rules are posted on or near each machine.	S U NA	________	______________
12. Broken equipment requiring a long repair time is removed from lab.	S U NA	________	______________
13. All moving parts of machines are color coded.	S U NA	________	______________
14. Bench brushes are used to clean machine benches.	S U NA	________	______________
15. All waste material and other objects are removed from machines and floor areas around machines.	S U NA	________	______________
16. Exhaust systems for machines and motors are properly installed, utilized, and kept in safe, operating condition.	S U NA	________	______________
17. All hoisting devices are in safe, operational condition.	S U NA	________	______________
18. Danger zones are properly indicated and guarded.	S U NA	________	______________
19. All gears, moving belts, etc., are protected by permanent enclosure guards.	S U NA	________	______________
20. The main power is "locked-off" when the instructor is out of the room.	S U NA	________	______________
21. Nonskid areas are provided around machines and stairways.	S U NA	________	______________

MACHINES AND HANDTOOLS		Comments	Recommendations
22. Machines are shut off while unattended.	S U NA	______	______
23. Welding equipment is not used on containers such as gasoline tanks or other similar storage tanks.	S U NA	______	______
24. Tools are kept sharp, clean and in safe working order.	S U NA	______	______
25. Tool cabinets are located in the area of maximum use.	S U NA	______	______
26. Spark lighters are provided at the welding stations and are in working condition.	S U NA	______	______
27. Welding hoses are in good condition.	S U NA	______	______
28. All portable electrical equipment is properly grounded.	S U NA	______	______
29. Adequate precautions are taken to eliminate machinery from vibrating or moving while being operated.	S U NA	______	______
30. All extension cords are of adequate size, type, and properly used.	S U NA	______	______

Index