Technology Education

facilities guidelines

Maryland State Department of Education

Guidelines Coordinators

Maryland State Department of Education

Barbara J. Bice, Architect
School Facilities Branch

Robert C. Gray, Specialist
Career & Technology Services Branch

Sarah J. Woodhead, Architect
School Facilities Branch

Guidelines Review Committee

Joe Baker
St. Mary's County Technical Center

Charles J. Beatty
College of Education
University of Maryland, College Park

Gary M. Bolyard
Technology Education Program
Fairmont State College, West Virginia

Barry Burke
Montgomery County Public Schools

Leon L. Copeland
Department of Technology
University of Maryland, Eastern Shore

Paul Dunford
Frederick County Public Schools

Maren Johnson
Diversified Education Systems, Inc.

Robert W. Lathroum
Queen Anne's County Public Schools

Joseph Licata
Harford County Public Schools

Judy Loar
Carroll County Public Schools

Kevin Michael
Calvert County Public Schools

Susan Young Mullineaux
Duane, Cahill, Mullineaux,
& Mullineaux, P.A.

Mike Shealey
Baltimore County Public Schools

Sandra R. Smith
Cecil County Public Schools

Participation on the guidelines review committee does not imply agreement with the entire content of this document.

Technology Education Facilities Guidelines

Maryland State Department of Education
School Facilities Branch
200 West Baltimore Street
Baltimore Maryland 21201
(410) 767-0098

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Foreword

A central role of education is to offer a curriculum that provides students with basic understandings and skills needed to function effectively in society. Our democratic society is characterized by rapidly advancing technological developments. It is absolutely necessary for all people to understand technology if they are to function as informed voters, productive workers, and wise consumers of technological products and services.

Technologies spring from the human abilities to reason, solve problems, create, construct, and use materials imaginatively. Since these abilities are an integral part of our technological society, they must be developed in all students, regardless of their education and career goals. Experience in applying technology and in solving problems builds both the competence and confidence for effective interaction with technology. An understanding of the applications and functioning of technology systems is important for decision-making in the arenas of career, home, personal affairs, and government.

In today's high-tech society, all students should become technologically literate in order to become wise decision makers. Through experiences in a hands-on cooperative environment using a systematic, problem-solving approach, students should exhibit an understanding of the nature of technology, major technology systems, and the resources used in technology. Through the application of technical skills, knowledge, and processes, students should be able to solve problems in a systematic fashion. Coupled with sound work values, attitudes, and habits that include the recognition and pursuit of quality, these skills should enable students to become wise consumers, productive members of our community, and contributors to the forces of change that shape our world.

Through experiences in a well-designed technology education laboratory, students become knowledgeable about technology -- its evolution, systems, techniques, utilization, and social and cultural significance. The design and equipping of the laboratory is a major element in the delivery of an effective program. Along with curriculum and staff development, it determines the quality of the technology education experience.

I am pleased to provide these design guidelines to assist you in planning technology education facilities.

Nancy S. Grasmick
State Superintendent of Schools

Chapter 1
What is Technology Education?

Technology education is a comprehensive, experience-based curriculum in which students learn about technology-its evolution, systems, techniques, utilization, and social and cultural significance. It develops technological literacy by dealing with the ways in which ingenuity, processes, materials, devices, science, and mathematics are applied for solving problems to meet our needs and desires.

A Vision for Technology Education

An integral part of the program of studies in Maryland schools, technology education is a new basic for all students. Students work individually and in teams as they learn about technology. They learn how to utilize and interact with technology and to live adaptively in a rapidly changing, highly technological society.

Technology education programs are among the first to demonstrate an integrated approach to learning. Interdisciplinary teams of teachers train and work together for cross-curriculum planning and integrated delivery of instruction. Technology education is taught using a collaborative approach in which groups of students interact with teachers of mathematics, science, social studies, language arts, technology, and other disciplines. Ingenuity challenges, modular activities, and computer-assisted instruction are used to provide students with hands-on learning experiences.

The technology education program encourages all students to acquaint themselves with their technological environment so they are better prepared to make informed decisions about their lives and eagerly participate in controlling their own destiny. Programs recognize, capitalize on, and build on the individual's inherent potential for problem solving, imagining, creating, and constructing. Thus, technology education is a fundamental curriculum for all students, regardless of learning level, career choices, or life aspirations.

The resources for implementing the program include staffing and facilities. Staff development is required to support teachers as they employ appropriate teaching-learning strategies. Instructional materials in a variety of forms facilitate student achievement of the valued outcomes. Laboratories must be appropriately equipped to accommodate student learning through active interaction with significant technology systems. School and business/industry partnerships play a role in developing and making available these resources.

Educational Outcomes

The eight technology education learner outcomes adopted by the Maryland Board of Education describe what students should be able to do as the result of a technology education experience.

Application of Technology Systems
Students will demonstrate knowledge and skills regarding diverse technology systems, including their functioning and applications.

Nature, Impacts, and Evolution of Technology
Students will demonstrate knowledge of the nature of technology, and the relationships and impacts among technological achievement, the environment, the advancement of science, the individual, and society. The context for this knowledge shall be historical, current, and futuristic.

Problem Solving Using Technology
Students will demonstrate the ability to solve problems with technology using a systems approach, higher-order thinking skills, individual and collaborative ingenuity, and a variety of resources including information, tools and materials.

Informed Decisions About Technological Issues
Students will make ethical decisions about technological issues, including the development and use of technology and technology resources.

Use of Technological Resources
Students will demonstrate in an experiential setting the safe, effective, and creative use of technology resources including tools, machines, and materials in performing technological processes.

Application of Science, Mathematics and Other Areas
Students will apply science, mathematics, language arts, social studies and technological concepts to solve practical problems and extend human capabilities.

Career Information
Students will apply knowledge of and perform tasks representative of technology-based careers, including engineers, technologists, technicians, and craftspersons.

Multicultural and Gender Diversity
Students will recognize the multicultural and gender diversity included in past, present, and future uses of technology.

Curriculum and Facilities

The goals for technology education state what students should be able to do as a result of a technology education experience. To achieve the State goals, students must have participated in activities where they design, construct, plan, test, analyze, evaluate, measure, solve problems, calculate, research, investigate, and report. In these activities, students must have the opportunity to work with a wide range of contemporary technologies in order to learn how they work, where and how they are applied, to assess the impact of technology on everyday life, and to apply conceptual knowledge in order to solve problems. These activities require an experiential setting rich in technological resources.

The resources for program implementation must be adequate to assure the fulfillment of program goals and to meet student needs. The laboratory must be appropriately equipped to accommodate student learning through active, hands-on, multi-sensory interaction with significant technology systems. It must include design tools, fabrication tools, a variety of materials, testing apparatus and the computers that monitor and control modem technology systems.

Chapter 2
Creating Technology Education Facilities

The Process

In planning a facility, a school system must translate an educational philosophy into a three-dimensional place. In order to ensure that the facility is appropriate and well-designed, many points of view and areas of expertise must be tapped. A planning committee is assembled to bring together individuals with the diverse experience required. Sometimes the committee is charged with planning a whole facility; other times the task at hand may be restricted to technology education only. The committee will see the project progress through a number of distinct phases, from inception to occupancy. Although the process will vary from place to place and project to project, the basic sequence is consistent. The following steps outline a typical process:

Planning

- Project approval and site selection;
- Planning committee and planning subgroup formation
- Committee discussions and decisions on program, philosophy, content, staffing, organization, etc.
- Educational specifications preparation
- Selection of an architect

Design

- Pre-design meeting with the architect
- Schematic design
- Design development
- Preparation of construction documents

Construction

- Bidding and contract award
- Construction
- Acceptance of project and occupancy of facility

Occupancy

- Installation of moveable equipment and furnishings
- Occupancy
- Post-occupancy evaluation.

Planning

The planning phase encompasses the identification of a need for a project, the definition of a solution involving construction of a new facility or renovation of an existing one, and a preliminary budget and funding source. Decisions are made within the framework of a master plan. Once a project is approved to proceed, an educational specification committee is formed to define the parameters of the project. The resulting document, the educational specification, serves as the basis for the design phase which follows.

The Planning Committee for a New School or Major Renovation

The planning committee is a collection of people with diverse interests and expertise. The planning committee plays a key role in the decision making process. Although the planning process takes longer with many persons involved, divergent frames of reference and points of view provide a broad basis for valid decisions. These decisions will guide the planning and design processes, creating a functional facility.

Planning committees vary in their size and composition, but all planning committees should include at minimum the following:

- the superintendent or his/her representative
- the local school facilities planner
- the Maryland State Department of Education (MSDE) school facilities specialist
- content area supervisors
- the principal
- teachers
- students
- parents

Other members may include:

- support services staff, such as food service, transportation, security, or maintenance supervisors
- neighborhood/community members
- representatives of other government agencies
- local business/industry representatives
- project architect

The local administration insures that educational programs, budget constraints, and facilities standards are incorporated into the project. The facility planner is usually responsible for coordinating the process.

The future users of the facility are represented by the principal, teachers, students, and support staff. For a new facility which has yet to be assigned staff, personnel and students from other facilities can substitute. The participation of the users insures that theory will not overwhelm practical concerns and provides the insight that grows from daily experience.

The technology education teacher or supervisor is a key committee member for technology education facilities and must be involved from the onset of the project. This assures his/her participation in the total project and utilizes his/her knowledge and expertise in the formation of both technology education programs and facilities.

The MSDE school facilities specialist participates in an advisory role. He/she can serve as a resource on national trends, practices across Maryland, and state-level standards and references. The specialist can also serve as a link to other state agencies.

The architect may join the project at its inception or after the completion of the educational specification. It is the architect's job to turn the text of the educational specification into a design and then produce two-dimensional drawings and technical specifications which will form the contract documents for construction.

For large or complex projects, additional planning committee members may come from other government agencies, or from the neighboring business or residential community.

On a large project, the committee will be divided into interest area subcommittees. One subcommittee will include the technology education program. This may be a science, math, and technology group, or it may be a technology education-only group. Careful organization of subcommittees is critical to encourage communication across disciplines. The composition of the subcommittee itself should reflect the educational philosophy of the program.

Technology education-related subcommittees should be organized to assist and give direction to the general planning committee. The technology education subcommittee members should be knowledgeable about technology and technology education instruction. They may include technology education teachers, MSDE consultants, students, and perhaps community experts. This subcommittee will define in detail the technology education facilities requirements and monitor the design as it progresses to insure that those needs are met. They and the members of other subcommittees will also define the scope of integration of technology education with other disciplines.

The planning committee should be involved throughout the entire process of facilities development, although its major impact is in the planning and design phases. The committee will review the project at major milestones. The technology education specialist will also be involved in the preparation of detailed furniture and equipment lists. Specifically, the committee should participate in the following steps:

- Preparation of educational specifications
- Interpretation of the educational specifications for the project architect
- Development of alternative schematic design concepts
- Review of schematic design-documents
- Review of design development documents
- Post-occupancy evaluation

Educational Specifications

Educational specifications articulate the physical requirements for the project as an outgrowth of the educational program derived from national, state and local goals and instructional strategies. They must be consistent with the local educational facilities master plan and the overall project scope, capacity, and budget as approved by state and local sources. They will guide the architect through the design and construction of the project.

Educational specifications are a text document describing program, educational activities, philosophy, and performance expectations for construction projects. They are needed whether the project involves new construction, addition, or renovation. The content of the educational specifications for small and large projects should include the following:

I. Project Rationale
   - Introduction
   - The community
   - School board policies
   - Belief statements
   - Scope of work, budget, and schedule

II. The Educational Plan
   - Curriculum
   - Instructional Methods
   - Staff support
   - Technology

III. Project Design Factors
   - Site conditions
   - Building systems

IV. Activity Areas
   - General overview
   - Program functions for each education and service program in the project

V. Summary of spatial relationships

VI. Summary of spatial requirements (Net and gross square feet)

This outline is taken from Appendix D of the State of Maryland Public School Construction Program Administrative Procedures Guide. The Guide contains further explanation of the intent of each section. The final educational specifications document is a record of decisions about activities for students, teachers, and administrators, and a description of the spaces required to support such activities.

The completed educational specifications become the basis from which the project architect proceeds with the design. They also serve as a bench mark for checking the progress of the project and its responsiveness to the intended programs.

Design

After the educational specification has been completed and approved, the architect begins to transform it into a design for physical space. In designing a facility, an architect starts with a general, or schematic view of the program, and gradually develops a very specific response to the program requirements. The final design product is a set of instructions for a contractor, depicting in detail the intended facility. Each design phase builds on the previous work and reflects a dynamic process of interaction between the architect and the planning committee.

Pre-Design

When an architect assumes responsibility for the design project, he/she assumes a set of requirements. The foundation of these are the educational specifications, but additional requirements are building codes, safety/environmental regulations, local/state standards and procedures, constraints imposed by funding, and existing conditions. Often a preliminary meeting is held to identify and clarify the project requirements and to interpret the educational specifications as needed for the consulting architect. The planning committee, the MSDE school facilities specialist, and the architect should be present. When renovating an existing building, it is useful to hold the pre-design meeting at the school.

Schematic Design

The schematic design phase develops two or more preliminary site and building design solutions, each meeting major program goals. Schematic designs are conceptual and derive from requirements set forth in the educational specifications and good architectural and engineering practice. After evaluating alternatives, the planning committee selects one solution which the architect refines through a process of review and revision lasting several weeks.

The planning committee for an entire school should monitor the schematic design closely for overall relationships between technology education and other disciplines and for the relationships among technology education spaces. Within the technology education spaces, there should be an indication that an appropriate layout can develop from the space and proportions provided, although a detailed plan will not be available yet. If the project is for technology education areas only, large scale plans showing furniture and equipment should be available at the schematic phase.

If the project entails the renovation of an existing facility, the architect should convey a thorough understanding of the existing systems and conditions within which the renovation will take place. Formal evaluations of code, existing mechanical and electrical capabilities, and other underlying conditions, if not done prior to this phase, must be completed now.

It is important to develop more than one scheme in order to fully explore alternatives. Each scheme should openly present pros and cons so that the planning committee can properly evaluate trade-offs and priorities. It may be helpful to hold schematic design meetings away from the existing building if committee members find their imaginations too limited by what they know. At its best, the schematic design process advances the project by bringing the educational specification into graphic reality and by providing a vehicle for input from the educational community. It is important for the committee members to carefully evaluate the designs and to provide constructive criticism when needed. It is easiest to make changes early in the design. Compromise is often necessary to balance competing requirements, such as the need for ample space versus the limits of a fixed budget.

After the planning committee accepts a schematic design it will be submitted for formal review at the local and then the state level. Sometimes more than one submission is required before all approvals are given.

Design Development

During the design development phase, the basic elements, articulated in the schematic design phase are developed and fine-tuned. The building's footprint and individual room dimensions are finalized; fixed furnishings and equipment are located; construction details are begun; utilities and systems are developed and located; and all aspects of the project take on greater depth and sharper focus.

The planning committee has an important role at this phase because design development represents the first opportunity to get into the details of the design and may be the last practical opportunity to make substantial changes in the project. For technology education facilities, attention to detail is critical. Building upon the approved schematic design, the architect will present the finalized size and relationships of spaces, and the layout of bulletin boards, cabinets, workstations and equipment. Plumbing, heating, ventilation, cooling, lighting, electronic communications, and power systems are developed. Safety systems are incorporated.

Design development is a critical time to convey to the architecture and engineering design team the specific furniture and equipment requirements including type, manufacturer, electrical accessories, etc. It is also a good time to discuss finish requirements and detailed storage requirements. Movable equipment and furnishings, although not typically funded and installed during construction, should be shown on design development drawings to convey the architect's understanding of the layout, circulation, and other design considerations.

Cost estimates, energy analyses, and other data are presented during design development. This phase, like schematic design, will be formally reviewed at the local and state levels.

Construction Documents

During the construction document phase, the architect produces detailed documents which will form the contract for construction. The primary documents are construction drawings and written specifications. All systems and elements will be fully described, including demolition, site work, structural work, roofing, doors, windows, finishes, equipment, plumbing, heating and cooling, fire protection, lighting, power, and electronic communications. A detailed cost estimate will be prepared.

During this phase, the design should reflect the decisions made by the architect and the planning committee. If substantial changes to the design originate outside of the planning committee, they should be brought to the key decision makers of the general committee for evaluation and acceptance. The technology education specialist continues to advise on specific concerns as they arise.

When the construction documents are complete, they will be reviewed at the local level. Locally approved documents will then be reviewed at the state level. Once approved, the project can be bid for construction.

Construction

During the construction of the facility, planning committee involvement is minimal, limited to color selections or other minor input. Significant changes to the project are unusual during construction, but do sometimes occur due to unforeseen problems. Changes which affect the technology education program in a substantive way should be brought to the notice of the technology education supervisor.

If the project is the renovation of an existing facility, construction may be phased so that the school continues to operate while renovations take place. If this occurs, coordination will be necessary between the facilities planners and the school staff to vacate areas on schedule and to isolate areas under construction. In general, school staff should bring any problems or concerns to the attention of the school system's facilities planner rather than trying to resolve issues directly with the contractor.

Installation of Furnishings and Equipment

Once the construction is substantially complete, furnishings and equipment are installed. Some components may be installed under the general contract for construction, but there may be independently contracted vendors and school system personnel involved, as well. Careful planning is required to coordinate responsibilities which typically include providing, installing, testing, and balancing equipment. All warranties, operating manuals, training, and servicing of new components and systems must be obtained.

Occupancy and Post - Occupancy Evaluation

Once construction is complete, the staff can move into the facility. Provision for training in operating new equipment and systems should be made before the students arrive. Maintenance personnel should become familiar with any new materials or finishes and their requirements, as well as with mechanical systems. Staff should note any questions and notify their facilities office of any problems encountered. It is best to correct problems before the final payments have been made and while components are under warranty.

A post-occupancy evaluation can be an invaluable learning tool. Typically, a team would visit the facility in the second year of occupancy. A checklist forms the basis of the evaluation, but there should be provision for comments from users. The facilities planners will use this information to revise local standards. The next planning committee will benefit from the information.

Chapter 3 The Technology Education Program

Elementary School Technology Education

The purpose of technology education in the elementary school is to develop the students' awareness of technology. The technology education program is not a stand-alone curriculum, but rather is integrated into other subjects. It reinforces basic learning through hands-on technology-related activities such as technology investigations, technology challenges, and product development.

In elementary school, students will:

- become aware of the evolution of technology.
- become aware of the utilization of technology to meet human needs and desires.
- become aware of the social impacts of technology.
- learn safe work habits.
- use tools and materials to fabricate devices to solve problems.
- utilize written and oral communication skills.
- develop cooperative work habits.
- develop problem-solving skills.

Middle/Junior High School Technology Education

Technology Education at the middle/junior high school level is characterized by the term "exploration." At this level, students should be involved in broad, introductory experiences in communication, construction, manufacturing, transportation, and bio-related technologies.

In middle/junior high school, technology education students will:

- define technology.
- explore technology systems.
- utilize a problem-solving strategy to solve technology-related problems.
- develop a positive self-mage by meeting success in hands-on-experiences.
- develop skills in the safe use and operation of basic tools, machines, materials, and processes of technology.
- identify their individual talents, abilities, and interests in technological fields.
- develop cognitive (mental), psychomotor (physical), and affective (ethical) problem-solving skills by researching, designing, producing, operating, and analyzing technology systems.
- identify various technology-related careers, the opportunities in these fields, and their education requirements.
- experience the organization and management structure of industry.
- appreciate the nature of technology and its impact on the individual, society, and the environment.
- work collaboratively to solve technological problems.

High School Technology Education

All high school students are required to earn one credit in technology education through an experience that develops general technological literacy. These courses enable students to achieve the eight educational outcomes identified in Chapter 1. In addition, many high school students will take advanced technology education courses. The scope of these courses is more narrow than the initial high school course, allowing students to develop more advanced skills and deeper understandings of selected technological systems or processes. The learner outcomes for technology education remain the basis for these advanced courses with one exception. The first learner outcome states that students will demonstrate knowledge and skills regarding "diverse" technology systems. Advanced technology education students will demonstrate knowledge and skills regarding "selected" technology systems and processes such as engineering design, technology assessment, and research and experimentation.

Teaching/Learning Strategies and Laboratory Requirements

The teaching/learning strategies provide the experiences that enable students to achieve the learner outcomes for technology education. They require students to design, construct, test, analyze, evaluate, measure, solve problems, plan, calculate, research, investigate, and report. Five teaching/learning strategies have proven effective in producing the desired outcomes. They are:

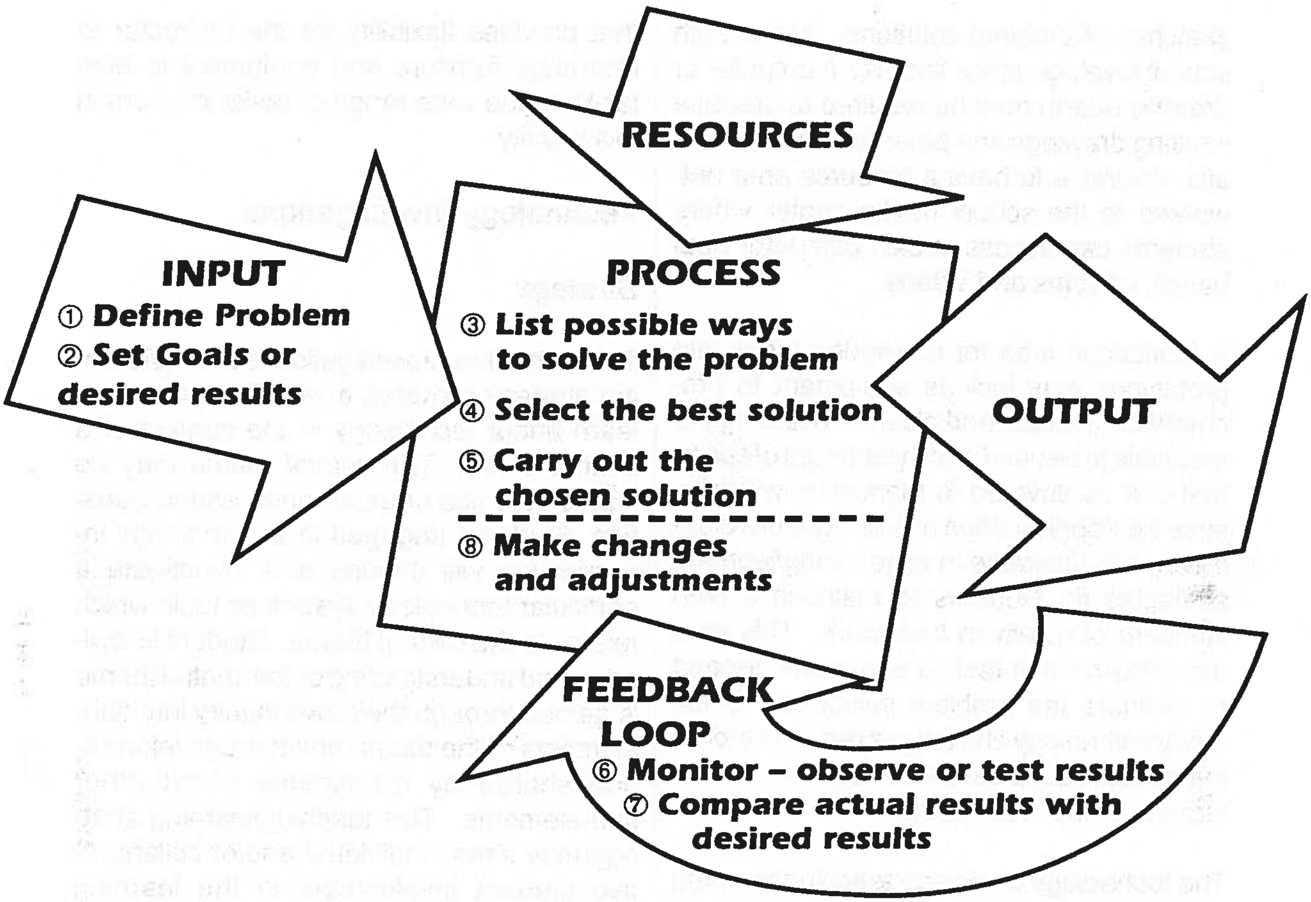
- Technology Challenges
- Technology Investigations
- Modular Technology Activities
- Product Development
- Research & Experimentation

Technology Challenges

Strategy

The technology challenge teaching/learning strategy is designed to develop problem solving skills. It incorporates both the explicit teaching of problem solving and laboratory practice. The explicit teaching of problem solving is based on a conceptual model that provides a structure for solving problems. An example of such a model follows.

Steps in Problem Solving



The practice of problem solving by students is greatly enhanced in a laboratory setting. Students can engage in multi-sensory learning through hands-on involvement by transforming their ideas into tangible materials using a variety of resources in the problem solving process and gaining feedback by testing solutions to problems.

It is important that the explicit teaching of problem solving and the laboratory practice of problem solving should not be phases of learning isolated from each other. Teachers need to cause students to reflect on and apply what they have learned in a formal class setting while they are practicing in the lab. Likewise, teachers need to cause students to reflect on their laboratory experiences to understand the more explicit teaching about problem solving.

Laboratory Requirements

The technology challenge teaching/learning strategy is most effective in a laboratory that enables a group of students to function as a design team. This involves work areas where two to six students can work together comfortably with some degree of privacy to brainstorm, do research, and produce preliminary sketches of problem solutions. At the high school level, graphics facilities (computer or drawing board) may be required to produce working drawings and other illustrations. It is also desirable to have a resource area networked to the school media center where students can access books, computer data bases, cd-roms and videos.

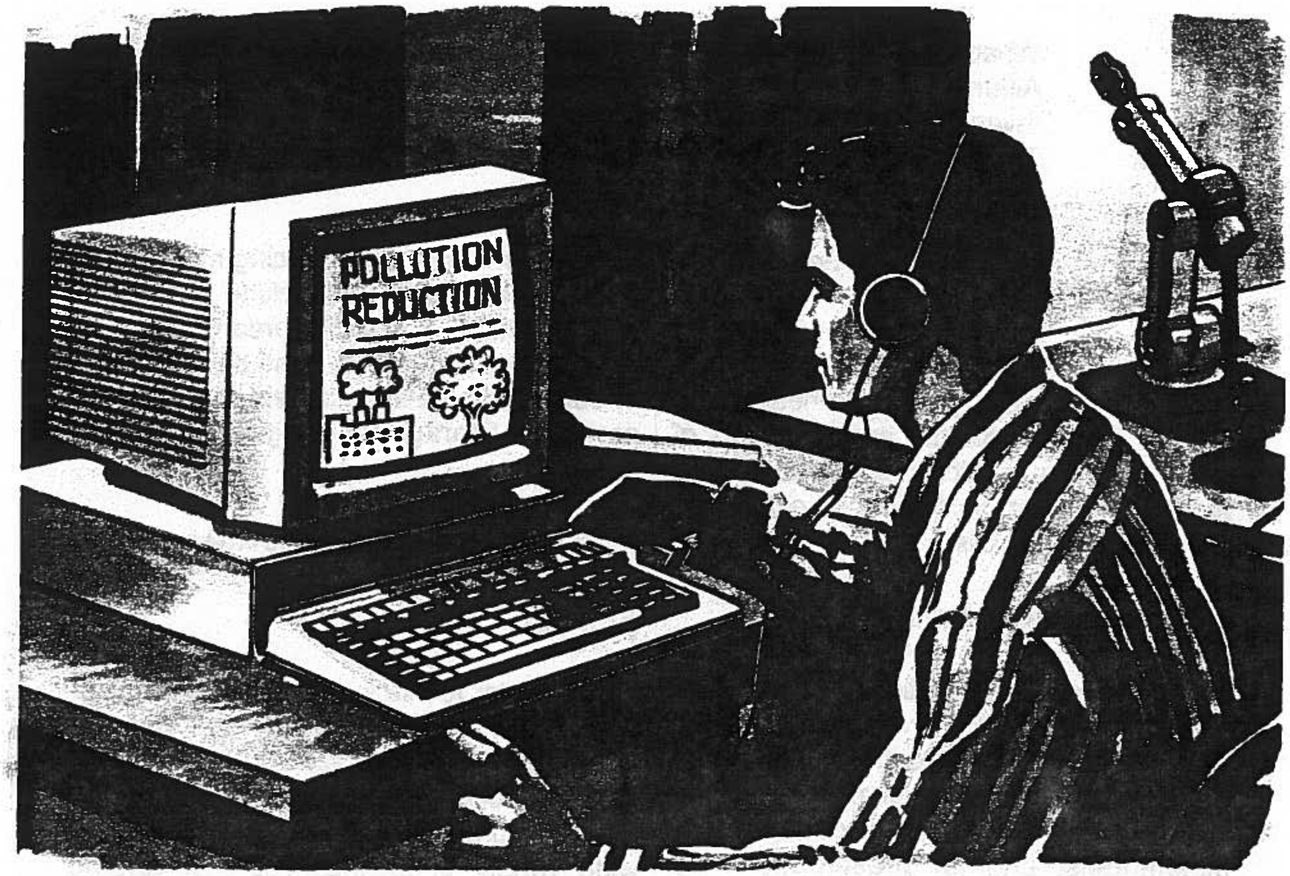
A fabrication area for converting ideas into prototypes may include equipment to process wood, metal, and plastic. The range of materials to be used and the amount of space that can be devoted to fabrication will influence the sophistication of prototype development. It is desirable in all teaching/learning strategies for students to maintain a high standard of quality in their work. This area may also contain testing apparatus needed to evaluate the problem solutions. Since many technology challenges require student teams to produce devices, adequate, secure storage areas are required.

The technology challenge teaching/learning strategy is most successful in a laboratory that provides flexibility for the instructor to rearrange furniture and equipment to best facilitate the wide range of tasks inherent in this activity.

Technology Investigations

Strategy

The technology investigation teaching/learning strategy provides a way for students to learn about technology in the context of a central theme. The central theme may be stated as a title or as an open-ended question. Students engaged in a technology investigation will choose and investigate a particular technology system or topic which relates to the central theme. Student knowledge and understanding of the central theme is gained through their own inquiry into sub-elements of the theme and through information shared by classmates about other sub-elements. This teaching/learning strategy may stress individual and/or collaborative student involvement in the learning activities.



If the central theme relates to technology systems, the kinds of information students investigate can be standardized with only occasional exceptions. For a wide variety of technology systems, students can investigate its origin and development, its functioning, its use in solving problems to meet needs and extend human capability, its impact on people and the environment, and its applications of science and mathematics. The students' investigations lead to the production of devices, models or other audio-visual aids that help them communicate to others something of significance about their chosen systems. Written and oral reporting about the chosen technology system are significant parts of student experience in the technology investigation teaching/learning strategy.

Some examples of central themes for investigating technology systems are presented below.

- Technology Around Us
- Transportation Of The Future
- Space Exploration
- The Development Of Tools and Machines
- How Does Technology Shape Our Lives?

- What Are Our Energy Alternatives?
- Inventors Around The World
- Technology Assessment For Shaping The Future
- What inventors belong to my culture?

Technology investigations are rich in opportunities for developing an awareness of the diverse nature, impacts, and evolution of technology in a multicultural society. They are also ideal for developing re: earch and communications skills.

Laboratory Requirements

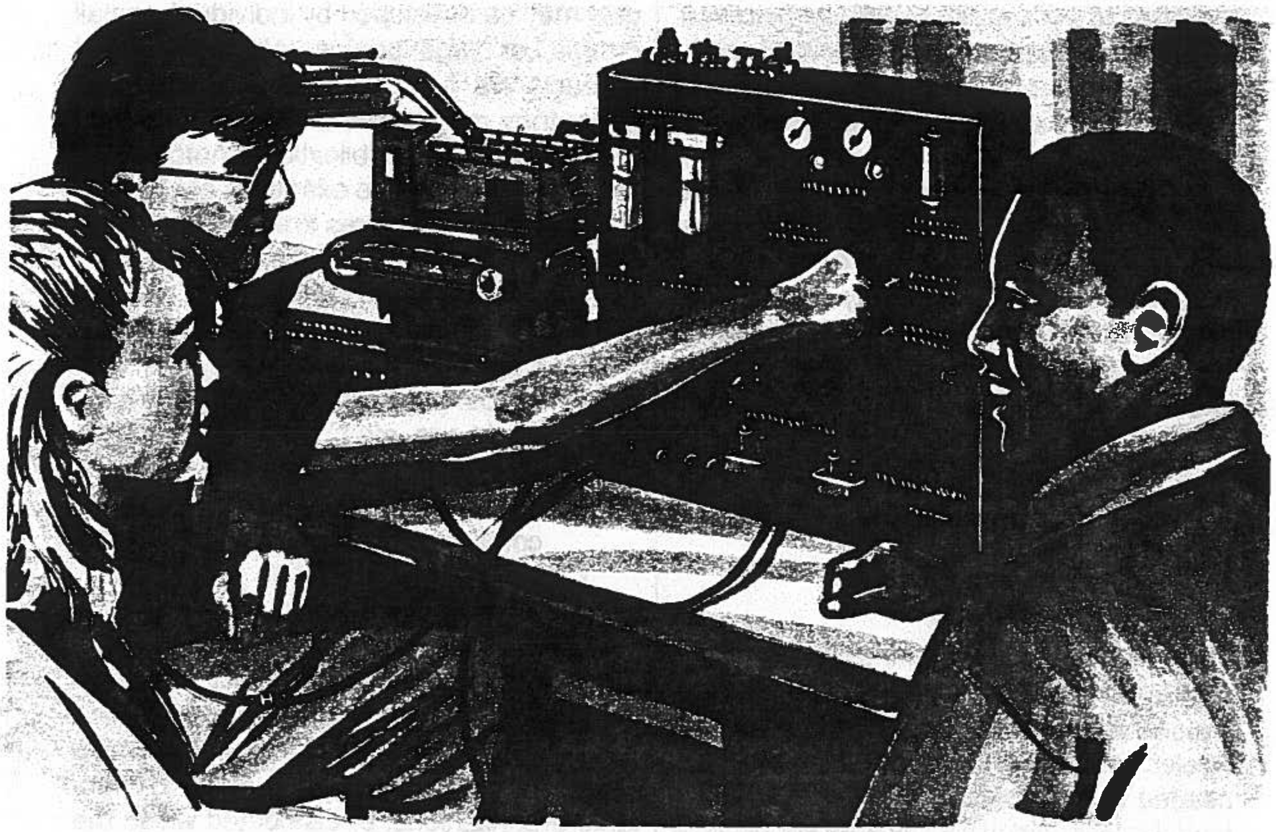
The technology investigation teaching/learning strategy is most effective when carried out in a laboratory environment. The laboratory should incorporate areas for research, report writing, designing and producing audio-visual aids/models, and for presentations by students to their classmates. Displays and video recordings serve this strategy by enabling students to share the products of their labors after their formal presentation is completed.

Fabrication areas for producing models and other visual aids should include basic tools and materials. A graphics area is useful for project topics that are best demonstrated through photographs, diagrams, charts, and graphs. Storage for large graphics is essential.

Modular Technology Activities

Strategy

The modular technology activity strategy allows the student to interact with specific technology systems that are not available in quantities for whole-class instruction. Through a rotation process, students can work with a wide variety of technologies that can be changed or updated as technology changes.



The modular technology activity teaching/ learning strategy involves the use of self-contained stations where one or two students spend from 3 to 20 days studying a specific technology. The modules are highly structured, self-paced instructional packages that include a variety of resources and media. The teacher provides an overview and instruction before students use the modules. At the stations, direction is provided through computer software, videos, and written instructions. Hardware and materials needed for completion of the activity are also included in the package. The teacher acts as a resource person and facilitator to assure that students are successful in their endeavors.

Some examples of modular technology activity packages are computer animation, audio communications, robotics, lasers, pneumatics, alternative energy systems, space systems, electronics, computer control and aeronautics.

Each module has a step-by-step curriculum that includes topics such as career exploration, interdisciplinary linkages, and social and environmental impacts. Students use computers, VCRs, TVs, and a variety of reading materials to accomplish specified objectives. They are required to use their skills in mathematics, social studies, and language arts to complete daily assignments. Completion of a daily learning log, periodic reading assignments, and formal presentations that include visual aids may be incorporated into the modular activity. Assessment is an on-going process that is the responsibility of both the student and the teacher. The objectives for the activity may include the development of a knowledge base, skills related to the specific technology being utilized, and more general skills in the areas of problem solving, data acquisition, and reporting.

Laboratory Requirements

The modular activity teaching/learning strategy requires the placement of furniture to house the modules. In addition, utilities such as electric power and compressed air may be needed at some stations. The layout of the modular technology activity area should provide easy supervision and student movement. Since students will be spending long periods of time at specific stations, the furniture should be comfortable and the workspace large enough for some movement within the area. Many modular activities require students to construct solutions to technological problems. It is important to include some fabrication capability adjacent to or in this area.

Product Development

Strategy

The product development teaching/learning strategy involves students in the processes of design, development, and production. Products may be developed by individuals, small groups, or large groups. Although typical products are functioning devices or structures, they may take the form of an audio-visual production, publication, photographic story, or model. Some examples of functioning devices or structures are:

- games or toys for children
- household products (cutting boards, clocks, lamps, etc.)
- school products (locker organizers, bookbags, etc.)
- clothing
- outdoor products (bird feeders plant containers, decorations, etc.)
- sports equipment

Students identify a need or desire that can be satisfied through the development of a product which meets criteria developed by the class. The products of this teaching/learning strategy may be marketed, donated to charitable organizations, or distributed within the class. Some examples of criteria are that the product or process will:

- reflect favorably on the school.
- incorporate resources available to students.
- require the development of schedules.
- require student inquiry to gather information for design and development.
- enable students to assume various roles in design, development, and production phases.
- incorporate student evaluation of the development process.

If the product is a device or structure the criteria might include the design and fabrication of specialized tools to facilitate high volume production. This phase provides opportunities to incorporate the problem solving model. The design phase of this teaching/learning strategy provides opportunities for students to express ideas in graphic forms including sketching and technical drawing. After selection of several possible designs, students construct mock-ups or prototypes. These are evaluated and tested by the group to see if they meet the stated needs and if they can be produced in large numbers.

With the selection of a design, the students assume the roles of production planners. They develop special tooling, materials handling devices, flow charts, facility layout drawings, an inventory management system, quality control plans, and time schedules. All of these elements are tested and evaluated by the group before the production phase.

With the production planning completed, the students play the roles of managers and production workers, both making decisions and carrying them out. The production system is then employed to create the specified number of products.

If the product is a video production, publication, photographic story, or model, a similarly appropriate design process will be developed by the students.

The product development teaching/learning strategy provides opportunities for students to gain an understanding of how the products we enjoy in our everyday lives are produced. It enables students to assume a variety of roles related to the manufacturing process and demonstrates the importance of ingenuity, creativity, and quality control.

Laboratory Requirements

If the product in this teaching/learning strategy is made from wood, metal, or plastic, the laboratory should provide adequate space and equipment for the design and fabrication of fixtures to support high volume manufacturing and the use of tools capable of high levels of accuracy. Permanently secured machinery such as universal saws, drill presses, and planers are best for these processes. These machines may be computer controlled. Many products will involve finishing, so some provision for the safe use of paint, lacquers, varnishes, etc. should be included in the laboratory design.

Another type of product development involves creation of graphic and presentation materials. Videos, photo stories, newsletters, handbooks, and audio recordings are examples of products. These activities are best facilitated in a laboratory that contains a wide variety of technologies. Computer graphics software, darkrooms, drawing areas, video studios, and audio-visual production areas enable students to produce high-quality products about technological issues. Such a laboratory can serve the whole school.

Research and Experimentation

Strategy

The research and experimentation teaching/learning strategy is a student-centered approach that focuses on student interests and a scientific approach to problem solving. It utilizes systematic procedures in identifying problems, asking questions, gathering data, analyzing results, and drawing conclusions.

Research and experimentation is a specialized problem solving strategy used to study some object, process, or application that is of particular interest to the individual. An example of a research and experimentation study is the examination of promotional statements made about consumer products such as oils, paints, abrasives, soaps, fabrics, or preservatives. Other topics might be the design and construction of airfoils or the effects of corrosion on certain metals.

Research seminars are an important part of the reporting and communicating process used in this teaching/learning strategy. The seminar enables students to share their research questions and provides opportunities for classmates to contribute to the efforts of others. The challenges and questions raised in the seminar sharpen the work of the student presenting information. Students learn about each other's studies. The seminar also provides opportunities for students to improve communication skills and to gain recognition from peers for quality work.

Laboratory Requirements

The research and experimentation teaching/learning strategy is most effective when carried out in a laboratory that includes a variety of tools and equipment. This enables students to design, construct, analyze, compare, and generalize on the basis of systematic inquiry. Facilities should provide a wide range of material processes, including wood and metal machining, drawing, assembly, heat treating, and fabrication. Specific research apparatus such as microscopes, balances, scales, presses, structural analyzers, wind tunnels, and a refrigerator should be available.

Computers with graphics capabilities, drawing equipment, and other educational technology are required for the development of reports and the sharing of information. Storage space, test benches, gas, air, portable ventilation, floor drains, large sinks, light-control areas, and a networked computer research and design area are needed to fully implement this program. A seminar setting, including tables and chairs arranged for optimum interaction between students, is critical if students are to share their findings with other students.

Chapter 4
Technology Education Facilities Design

Overview

Laboratory design must accommodate and facilitate the teaching/learning strategies that enable students to achieve the learner outcomes for technology education. Clearly identifying functional areas within the laboratory helps both students and visitors understand the nature of technology education activities. Technology education facilities should be adjacent to mathematics and science areas to support interdisciplinary studies. The technology education laboratory should include the following areas:

- Classroom seating area
- Small group meeting area
- Design area
- Research area
- Modular instructional activities areas
- Dynamic testing area
- Production/fabrication area

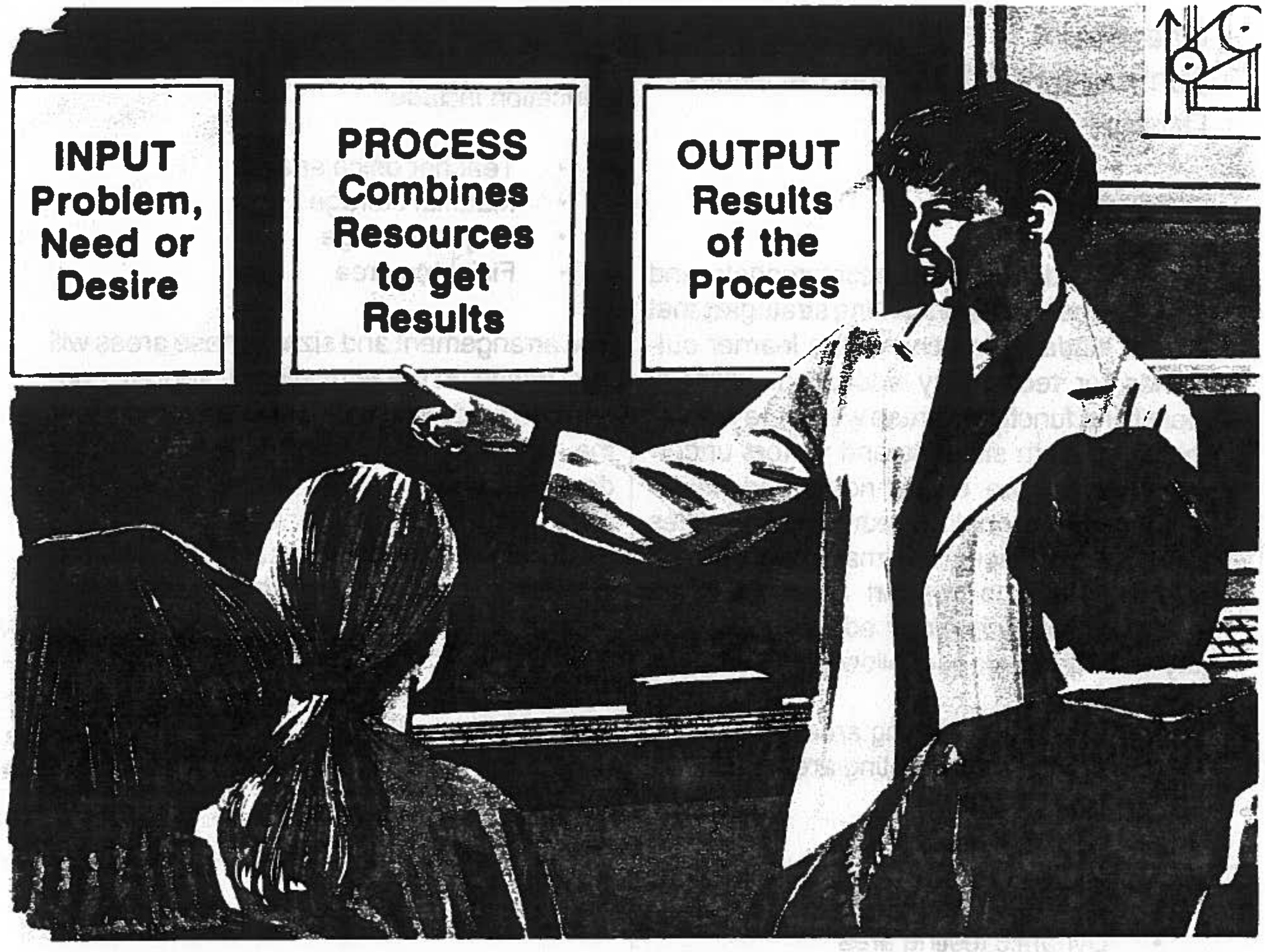
Support spaces necessary for technology education include:

- Teacher office space
- Material storage
- Project storage
- Finishing area

The arrangement and size of these areas will vary based on the educational program content, the grade level, enrollments, staffing and the space available. While each area is described separately in this chapter, the floor plans included at the end of the chapter, illustrate likely combinations and multiple uses of space in the middle and high school laboratory.

Space requirements are shown in net square feet (nsf).

The Technology Education Laboratory



Classroom Seating Area

Activities:
Students assemble in this area at the beginning of each class session and work on warm-up activities while the teacher attends to administrative chores such as taking attendance. The classroom seating area provides a comfortable environment for teacher-led discussions, demonstrations, and student presentations. It is used at the end of each class session to summarize and bring closure to the day's activities. This designated meeting area provides the structure needed for efficient learning and control of instructional materials.

Users:
24-28 students, predominately in whole class groups
Teacher.

Space:
600-700 nsf
Allow approximately 25 nsf per student, seated at tables, including a teaching wall and a teacher demonstration table. Provide exterior windows for natural light and views outside. Provide 9' - 6" minimum ceiling height to allow good visibility of projected images.

Spatial Relationships:
This area may be combined with research, design, dynamic testing, and modular instructional activities and/or small group areas in a large laboratory. Ideally, production/fabrication, finishing, storage and teacher office spaces would be in separate, but adjacent rooms.

Acoustics:
This area must be suitable for teacher-led discussions, student presentations, viewing videos, and reading. It should be isolated from noisy equipment ranging from power tools to computer printers.

Display:
Chalk and/or dustless markerboards, a projection screen, video monitor, and easels will be used for instruction and demonstrations. Photographs, posters, newsprint and wall charts will be exhibited on tackboards and wall surfaces. Student work, models, samples, and completed projects will be displayed on open or glass enclosed shelves.

Storage:
Audio-visual (AV) equipment, such as televisions, video projectors, overhead projectors and liquid crystal display (LCD) panels for computer images, should be securely mounted or locked in place after use. Teaching supplies such as markers, erasers, tacks, tape, magnets, should be readily available. Some demonstrations will be prepared in other areas and brought into the classroom on carts. Students must store bookbags and notebooks. Under seat racks or individual cubbies may be used. Limited textbook storage is required in the room.

Surfaces:
Wall, floor, and ceiling surfaces should be durable, easy to maintain, and if damaged, easy to repair. Ceilings should contribute positively to lighting and acoustic properties of the room. Walls should be able to be used for display purposes. Provide tack strips or wall surfaces which will accept masking tape without damage. Floors must withstand high traffic and resist damage from water, dirt, or dust which may be tracked in. Low pile carpet may be used only if a high level of daily maintenance can be assured.

Furnishings:
Provide furniture which is easily moveable and adjustable to accommodate students of different sizes. Two-student tables are preferred over individual desks or tablet arm chairs. Provide student chairs, and a teacher desk and chair. A demonstration table may be fixed in place. Provide blinds or shades on exterior windows.

Equipment:
Provide a television and video projector, an overhead projector and a teacher's computer with projection capability. Either LCD panels or red-green-blue (RGB) projectors may be used. Moveable carts for equipment provide more flexibility than wall mounted brackets.

Mechanical:
Provide a classroom sink for clean up or use in demonstrations. Provide a heating, ventilating, and air conditioning (HVAC) system for year-round comfort. Address generated heat in system design if this area is combined with the modular instructional activities area and contains numerous computers.

Electrical:
Provide power outlets at the front and back of the room for projectors. Provide outlets and connections for computers, cable television, etc., at the front. Provide general purpose outlets for display and demonstration areas. Provide uniform, glare free lighting, convenient access to switches, and lighting level controls such as dimmers or on/off switches for portions of the room. Computers may be linked to the school network or stand-alone. Provide intercom system, preferably using telephone handsets, to connect the room to the office, media center and other classrooms with options for outside lines. The electronic communications must be linked to the school network which may include satellite dish receiving equipment, cable television feeds, and distance learning broadcasts.

Small Group Meeting Area

Activities:
Students working collaboratively utilize this area to brainstorm solutions to technological problems, select optimum solutions, plan work, and review and refine solutions. It may also serve the school generally as a meeting/ seminar room. It may be assigned to a single project team for several weeks.

Users:
Groups of 2 to 10 students, or a 20 person meeting room

Space:
80 - 400 NSF
Allow a minimum of 20 nsf per person but not less than 80 nsf per space. When a separate room is provided, include vision panels into the classroom to allow visual supervision. Provide exterior windows for natural light and views outside.

Spatial Relationships:
This area may be formed by rearranging furniture within the classroom seating area. If a separate room is provided, a separate entrance to a main corridor will encourage shared use of this space by other teachers and students for interdisciplinary projects.

Acoustics:
The area must be isolated from distracting noises of larger class groups and production areas. It must be suitable for small group discussion, reading and viewing.

Display:
Tack, chalk and/or dustless marker boards, a projection screen, video monitor, and easels will be used for collaborative work efforts and meetings. Photographs, posters, newsprint, and wall charts will be mounted on tack and wall surfaces as work evolves.

Storage:
Since this space will be used by numerous different groups, permanent storage is limited to supplies such as markers, erasers, tacks, tape, and magnets. AV equipment should be securely mounted or locked in place after use. If assigned to a single group for a long term project extending over several days or weeks, materials may be stored and locked in the room.

Surfaces:
Wall, floor, and ceiling surfaces should be durable, easy to maintain, and if damaged, easy to repair. Ceilings should contribute positively to lighting and acoustic properties of the room. Walls should be able to be used for display purposes. Floors must withstand high traffic and resist damage from water, dirt, or dust which may be tracked in. Low pile carpet may be used only if a high level of daily maintenance can be assured.

Furnishings:
Provide blinds or shades on exterior windows. Interior vision panels should not be covered to allow visual supervision from the adjacent classroom. Provide table(s) and chairs to seat a maximum of 20 persons.

Equipment:
Items may be permanently assigned to this room or brought in as needed. Equipment may include, television/video projectors, overhead and/or slide projector(s), an easel for newsprint pads, one to four computer workstations, and a projection screen.

Mechanical:
Provide a HVAC system for year round comfort.

Electrical:
Provide power outlets at the front and the back of the room for projectors. Provide outlets and connections for computers and cable television, etc. Provide general purpose outlets on all walls. Provide uniform, glare free lighting, convenient access to switches and lighting level controls. Link this area to the school electronic communications network, computer network, intercom and P.A. system.

Design Area

Activities:
The design area provides students with the tools and equipment needed to translate their ideas into working drawings. Depending on the level of the program, the design area may be a designated area for mechanical drawing and computer aided-drawing (CAD), one of the modular instructional activity stations, or it may be another activity accomplished at tables in the classroom seating area.

Users:
4 to 12 students, often working in two person teams.
Teacher

Space:
Allow 50 nsf/student for drafting tables. Allow 75 nsf/student or 150 nsf for each two-person CAD station. Provide exterior windows for natural light and views outside.

Spatial Relationships:
This area may be combined with classroom seating or modular instructional activities. It should be convenient to production/fabrication area. Provide direct access to a main corridor to encourage shared use by other teachers and students for interdisciplinary projects.

Acoustics:
This area must be suitable for teacher-led discussions, student presentations, viewing videos, and independent work by students. It should be isolated from noisy equipment.

Display:
Chalk and/or dustless marker boards, tack surfaces for wall charts, projection screens, televisions, and computer displays will all be used for instruction. Student drawings, renderings and models will be presented and exhibited. Provide open and enclosed shelving of various widths.

Storage:
Provide drawers/bins/cabinets for drafting equipment and materials. Provide flat files for large drawings and cabinets for packs and rolls of printer and drawing paper.

Surfaces:
Wall, floor, and ceiling surfaces should be durable, easy to maintain, and if damaged, easy to repair. Ceilings should contribute to desirable lighting and acoustic properties of the room. Walls should be able to be used for display purposes. In CAD areas, wall surfaces should be matte finish. The color selected should provide contrast with the monitors to lessen eye strain. Floors must withstand high traffic and resist damage from water, dirt, or dust which may be tracked in. Because of the use of traditional drafting materials - graphite, ink, drafting powder, and erasers in this room, carpet is not recommended unless a high level of daily maintenance (daily vacuuming and immediate spot removal) is assured.

Furnishings:
Provide 4 - 6 CAD student workstations and/or 2 - 4 maximum student drafting tables and stools. Provide cabinets and flat files for drafting equipment, drawing papers, supplies, and large drawings. Provide open and enclosed shelves for display of models. Include some shelves 2-3 feet wide. Provide blinds or shades for exterior windows.

Equipment:
Provide 4 - 6 CAD systems, a teacher's CAD system with projection capability and 1 plotter.

Mechanical:
Provide HVAC for year round comfort.

Electrical:
Provide surge protected power for computers, printers, projectors, etc. Provide uniform, glare-free lighting overall. At drafting tables provide 100 foot-candles (FC) for drawing. Computer aided drawing requires glare free illumination of the screen and much lower lighting levels (50-70 FC). Selection and placement of lights is critical to eliminate glare. Link this area to the school's electronic communications network.

Research Area

Activities:
Information resources required for solving technological problems are available in the research area. This area contains printed and electronic materials such as books, video tapes, laser discs, and computer-based information networks. These materials are best utilized when a separate, quiet area is provided for research activities.

Users:
1 - 6 students at a time, as individuals or in small groups.
The teacher will also use this area for class preparation and advising student researchers.

Space:
Allow 25 - 30 nsf/student, but not less than 100 nsf per space. Provide windows for natural light and views outside.

Spatial Relationships:
This area may be combined with classroom seating, small group meeting, design, and/or modular instructional activities areas. It should be convenient to the teacher's office.

Acoustics:
This area should be a quiet area suitable for individual reading, notetaking, study, listening, and limited conversation.

Display:
Instructions on use of computer network and research materials may be displayed. Limited tack space is required.

Storage:
Provide open and closed shelving for books, notebooks, periodicals, journals, video tapes, computer disks, laser disks, etc. All storage must be clearly labeled. Some storage should be lockable.

Surfaces:
Wall, floor, and ceiling surfaces should be durable, easy to maintain, and if damaged, easy to repair. ceilings should contribute to desirable lighting and acoustics properties of the room. Floors must withstand high traffic and resist damage from water, dirt, or dust which may be tracked in. Low pile carpet may be used if a high level of daily maintenance can be assured. Provide blinds or shades for exterior windows

Furnishings:
Provide individual study carrels or tables and chairs for computers, video monitors, etc. Provide open and closed shelving units with adjustable shelves Provide reference tables and chairs, if space allows.

Equipment:
Provide at least one computer with modem and telephone line connection. Provide access to television, video projectors, laser disk players, and a facsimile machine.

Mechanical:
Provide HVAC system for year round comfort.

Electrical:
Provide surge protected power for equipment. Include task lighting for reading at study carrels and reference tables. Provide uniform, glare free lighting with special attention to computer research stations to ensure good visibility of the screen. Provide computer network connections linked to the school's electronic communications system.

Modular Instructional Activities Area

Activities:
Modular instructional activities areas contain two-person work stations where students develop knowledge and skills related to fundamental technologies, such as mechanics, electronics, and fluidics, or where they explore selected applications of technology such as computer animation, audio communications, robotics, lasers, alternative energy systems, space systems, computer control and aeronautics.

Users:
24 high school students
24 - 28 middle school students
Teacher
Typically, students in two-person teams rotate through all modulars over the course of many weeks. Some students will work individually at a particular station for independent research or testing.

Space:
1080 - 1260 nsf typical
Allow 45 nsf/student or 90 nsf for each two student modular workstation. A limited middle school program may include only 6 - 8 modular stations. Provide windows for natural light and views outside. Interior finishes and furniture should present the image of a clean, professional workplace.

Spatial Relationships:
Modular workstations may be in a separate room or may be combined with classroom seating, research, design, and/or dynamic testing areas. They should be convenient to the teacher's office, production/fabrication area, small group meeting area, and project storage. Direct access to a main corridor will encourage use by students and teachers from science, mathematics, or other departments.

Acoustics:
This area should be suitable for work by pairs or individuals, with the teacher serving as a coach to provide clarifications/assistance when needed. Several different video tapes or instructional computer programs with sound will be running at the same time. Overall noise level must be quiet enough to allow teams to focus on their module.

Display:
Each module will include a computer and video monitors, and other electronic devices. Wall charts and posters will be used. Small models or components may be displayed.

Storage:
Each module includes an instruction manual and student notebooks, small components for assembly and testing, and video tapes, computer disks and CDs. Some pertinent reference books are also required. Student work in process must also be stored. Provide drawers, open and enclosed shelves and cases for disks and tapes.

Surfaces:
Wall, floor, and ceiling surfaces should be durable, easy to maintain, and if damaged, easy to repair. Ceilings should contribute to desirable lighting and acoustic properties of the room. Walls should be able to be used for display purposes. Glare and high contrast with computer screens should be avoided. Floors must withstand high traffic and resist damage from water, dirt, or dust which may be

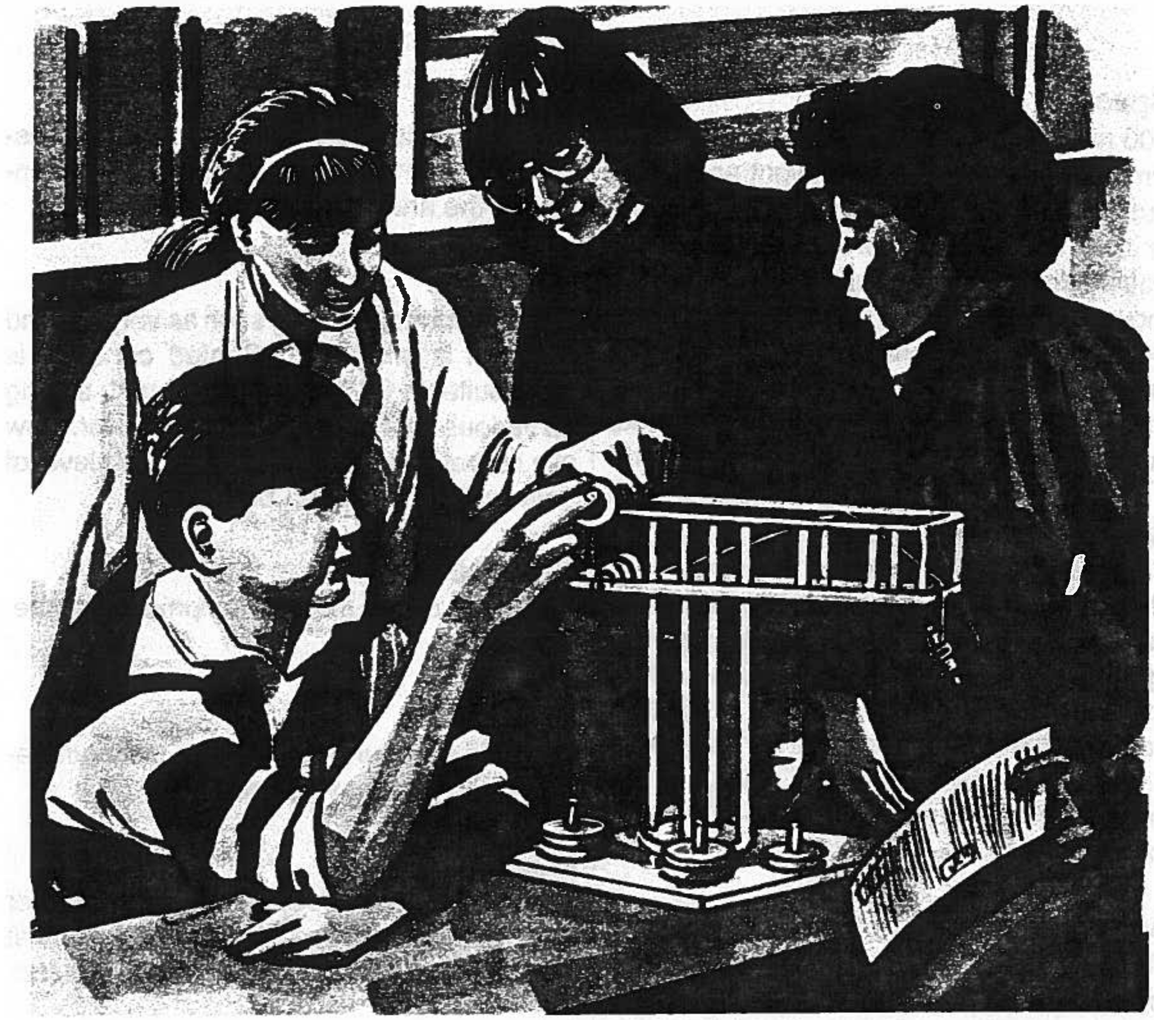
tracked in. Low pile carpet may be used if a high level of daily maintenance can be assured.

Furnishings:
Workstations are to include writing surface, keyboard, monitor reference/worktable, drawers for components, shelves for student notebooks and reference books, two-student chairs/station-ergometrically designed.

Equipment:
Each station will include, a modular technology panel connected to a CPU with a keyboard and a monitor with video disk technology.

Mechanical:
Provide HVAC for year round comfort. Address computer generated heat in system design.

Electrical:
Provide surge protected power for equipment. Provide the ability to vary lighting levels. Overall, provide low level glare-free lighting suitable for work on monitors and task lighting over work surfaces for assembly of small components. Link this area to the school's electronic communications network.



Dynamic Testing Area

Activities:
The testing of student constructed prototypes is an ongoing activity in the problem solving process. Easy access to testing apparatus and equipment facilitates the refinement of designs. Structural analyzers, wind tunnels, and electronic test equipment all interfaced with computers are located in the dynamic testing area.

Users:
24 students
Teacher
Students will work as individuals, in pairs, small teams or whole class groups. School and/or outside visitors may also be present to witness tests and demonstrations.

Space:
100 nsf minimum.
Provide windows for natural light and views outside. Provide open area, free of columns or floor obstructions, to accommodate test equipment, such as small wind tunnels on moveable carts, brought to the area as needed. Some tests will require a long and narrow space approximately 7 feet x 40 feet minimum. For example, many classes use school corridors as race tracks for testing CO_2 cars.

Spatial Relationships:
The testing area should be combined with classroom, design, modular instruction, and/or production areas. Some tests may be set up along the edges of other spaces. Other tests require a square space around a particular piece of equipment with room for an operator and spectators. Testing is an integral part of the process and should be an integral part of the laboratory.

Acoustics:
This area must be suitable for small and large group discussions. This may be a noisy area during spirited competitions. Some isolation from research and small group meeting areas is desirable.

Display:
Test results will be displayed on monitors, wall charts, newsprint, etc. Access to tack and chalk/marker boards is required. Access to open and enclosed shelving for models is required. Both successful and failing models may be exhibited.

Storage:
Most test equipment will be on easily accessible carts or tables stored along the perimeter of the area when not in use.

Surfaces:
Smooth surface flooring such as vinyl tile and linoleum is preferred. Sealed concrete is most suitable for moving equipment, setting up various floor tracks, and using water. Low pile carpet may be used only if a high level of daily maintenance can be assured.

Furnishings:
Carts and tables for test equipment may be required.

Equipment:
A mobile wind tunnel and other testing/measuring devices may be required.

Mechanical:
Access to water through hoses, sinks, or tanks is required. Provide floor drains in wet areas. Provide HVAC for year round comfort.

Electrical:
Provide power for equipment, uniform, glare-free lighting and task lighting at equipment as required. Link this area to the school's electronic communications network.

Production/Fabrication Area

Activities:
The defining activity of a technology education program is the opportunity for students to translate an idea into a three dimensional device or product. To accomplish this essential task, a fabrication area containing tools, machines, and materials is required. Because of the noise and dust produced, it is desirable to separate this area from other areas.

Users:
6 - 12 students,
Teacher
Students will work individually or in pairs.

Space:
480 - 960 nsf
Allow 80 nsf per student. Provide safe operating zones around all tools. Provide 12' ceiling height minimum. Provide windows for natural light and views outside. Consider providing high clerestory windows to minimize distractions. Except perhaps in middle school laboratories, the production/fabrication area should be fully enclosed.

Spatial Relationships:
This area should be adjacent to the classroom seating area with interior vision panels to allow supervision. It should be adjacent to the finishing, material storage and project storage areas. Convenient access for students in adult education programs or occupational completer programs may be required. Provide convenient, but controlled, access to the rest of the school for use by teachers and students in science, art, drama, or other subjects who may need access to the tools.

Acoustics:
Isolate this space from classroom and research areas to minimize distractions. Noisy mechanical dust control and ventilation units should be located in auxiliary rooms or outside the building.

Display:
Safety and instructional posters may be displayed, but the focus of attention in this area should be on the safe use of equipment with little distracting material.

Storage:
Provide safety equipment and hand tool storage cabinets. Provide limited material storage in bins or racks for small quantities of lumber, plastics, metals and model-making materials, balsa wood, etc.

Surfaces:
Provide hardened, sealed concrete, non-slip floor. Designate operators' zones at machines on the floor with tape or paint per federal and state occupational safety standards. Walls, ceilings, and trim are to be finished with durable, easily cleaned materials. A suspended acoustic tile ceiling is acceptable if 12' ceiling height is maintained.

Furnishings:
Provide blinds or shades on exterior windows. Vision panels into adjacent rooms should not have blinds or shades. Include safety equipment cabinets, tool storage cabinets, material storage racks and work benches with vises.

Equipment:
Provide tools to meet curricula, such as table saw, joiner, planer, jig saw, drill press,

universal saw, scroll saw, grinder pedestal, belt sander, disc sander, lathe, radial arm saw, and spot welder pedestal.

Mechanical:
Provide a sink with bubbler for drinking water and a separate, stainless steel scrub sink with hot and cold water, appropriate traps and waste line for oil, paint, clay, ink, plaster of Paris, etc. Provide a safety shower and eye wash with floor drain. Provide HVAC for year round comfort, including a dust collection, and exhaust systems to meet ASHRAE standards. Compressed air systems are optional in middle school programs. In high school programs, portable compressed air units may be run to specific modular stations or fabrication equipment.

Electrical:
Provide power for equipment. Provide a minimum 70 foot-candles of light at bench height. Higher levels are required where precision work is done. Provide uniform, glare-free, shadow-free light overall. Link this area to the school's electronic communications system.

Teacher Office

Activities:
The teacher office is home base for the instructor - a place to review professional references, do administrative paperwork, prepare lesson plans, and talk with other teachers. It may also be used as an area to counsel students and meet with parents or business and industry representatives.

Users:
Teacher

Space:
80 - 120 nsf
Allow a minimum of 60 nsf per professional, but no less than 80 nsf per space. Provide windows for natural light and views outside.

Space Relationships:
Space for teacher planning should be centralized in a school to foster blended curriculum and instruction. Frequent contact with teachers in other disciplines, particularly science, mathematics and language arts, is important for the technology education teacher and the program.

If teacher planning areas are decentralized throughout the school, the teacher office should be adjacent to the classroom seating area. It does not have to be fully enclosed, but must include appropriate space and furnishings to be viewed as a professional's workstation.

Acoustics:
The office area must be suitable for private conversations, reading, and concentrating.

Display:
Personal photos, certificates, artwork, plants, etc. may be displayed. Small tack and chalk and/or dustless marker boards will be used for planning and scheduling.

Storage:
Class records, lesson plans, lecture notes, reference books, manuals, and journals will be maintained in this area. Personal belongings (coats, handbags, etc.) must be secure.

Surfaces:
Wall, floor, and ceiling surfaces should be durable, easy to maintain, and if damaged, easy to repair. Ceilings should contribute positively to desirable lighting and acoustic properties of the room. Walls should be able to be used for display purposes. Low pile carpet may be used only if a high level of daily maintenance can be assured.

Furnishings:
Provide a professional workstation including a writing surface, drawers, file space, a computer station, access to printer, book shelves, a desk chair, chair(s) for guests, and a coat hook or access to a coat rack.

Equipment:
Provide a telephone/intercom and computer system.

Mechanical:
Provide HVAC for year round comfort.

Electrical:
Provide surge protected power for equipment. Provide uniform glare free lighting with special attention given to eliminating glare on the computer monitor. Task lighting at writing surfaces is desirable, 50 foot candles minimum. Link the office to the school's electronic communications network. An outside telephone line is desirable.

Material Storage

Activities:
This area will be used for receiving, sorting, storage of materials (lumber, plywood, plastics, metals) for use during the school year on student projects.

Users:
Teacher
The building manager will have access during deliveries. Access by students will be limited.

Space:
80 - 150 nsf
12 foot ceiling height minimum.

Spatial Relationships:
This area must be convenient for unloading delivery trucks. An overhead door or double door may be required. It must be adjacent to the production/fabrication area with easy access to tools for the teacher to use in cutting large materials into smaller sized components for student use.

Acoustics:
No special requirements.

Storage:
See Furnishings.

Display:
Not required.

Surfaces:
Wall, floor, and ceiling surfaces should be durable, easy to maintain, and if damaged easy to repair. Floors must withstand high traffic and resist damage from water, dirt, or dust which may be tracked in.

Furnishings:
Provide wall and floor mounted racks and bins.

Equipment:
Not applicable.

Mechanical:
Provide HVAC for year round comfort and dust control.

Electrical:
Provide convenience outlets, 10 - 20 foot candles illumination. A school PA and intercom are required.

Project Storage

Activities:
This area will provide protected storage of student work in progress (components and partly assembled pieces) in lockers, cubbies, shelves, or racks.

Users:
24 - 28 students per class
150 students per teacher

Space:
100 nsf
Lay out to minimize congestion at the start and end of classes.

Spatial Relationships:
Locate project storage adjacent to classroom seating, production/fabrication and dynamic testing areas. Project storage may be an extension of these areas or a separate room(s).

Acoustics:
This space will be noisy at the start and end of classes when all students will be in the area.

Display:
Not required.

Storage:
See Furnishings.

Surfaces:
Wall, floor, and ceiling surfaces should be durable, easy to maintain, and if damaged, easy to repair. Consider specifying surfaces to deaden noise. Floors must withstand high traffic and resist damage from water, dirt, or dust which may be tracked in.

Furnishings:
Provide lockers, open cubicles, shelves, bins, and/or racks, to accommodate a variety of sizes and project types. At maximum accommodate all students in the program (approximately 150 required) with a 12" x 12" x 12" locker or cubbie. Also provide 24" x 24" x 24" spaces in cabinets or shelves (approximately 96 required). Provide storage for rolls of drawings and an area for stacking tall objects.

Equipment:
Not required.

Mechanical:
Provide HVAC for year round comfort.

Electrical:
Provide convenience power outlets and 10 - 20 foot candles illumination. A school PA and intercom are required.

Finishing Area

Activities:
This area will be used for painting, staining and/or coating products and for storage of finish materials.

Users:
6 students
Teacher
Students will work as individuals or in pairs. The teacher will demonstrate and coach techniques.

Space:
100 nsf

Spatial Relationships:
The finishing area may be located under a hood in a corner of the production/fabrication area or in a separate room adjacent to the production/fabrication area. It should be convenient to the project storage area. Provide interior windows to the production/ fabrication area for supervision.

Acoustics:
No special requirements.

Display:
Instructions and quality standards may be posted.

Storage:
Small quantities of paints, stains, etc. will be stored. Brushes, cloths, sponges, and sprays for application will be used. Finished objects will be stored in area until dry.

Surfaces:
Wall, floor, and ceiling surfaces should be easy to maintain, and if damaged, easy to repair. Ceilings should contribute positively to desirable lighting and acoustic properties of the room. Walls should be able to be used for limited display purposes. Floors must withstand high traffic and resist damage from water, dirt, or dust which may be tracked in.

Furnishings:
Tool and equipment storage racks and cabinets. Appropriate storage cabinets for flammable materials are required. Provide drying racks. Provide work benches. Both perimeter and free-standing benches with access from four sides are desirable.

Equipment:
A spray facility is not required in technology education laboratories.

Mechanical:
Provide convenient access to clean up sink(s) for cleaning brushes, rollers, etc. Provide an exhaust system to remove painting fumes and minimize dust. Provide HVAC for year round comfort.

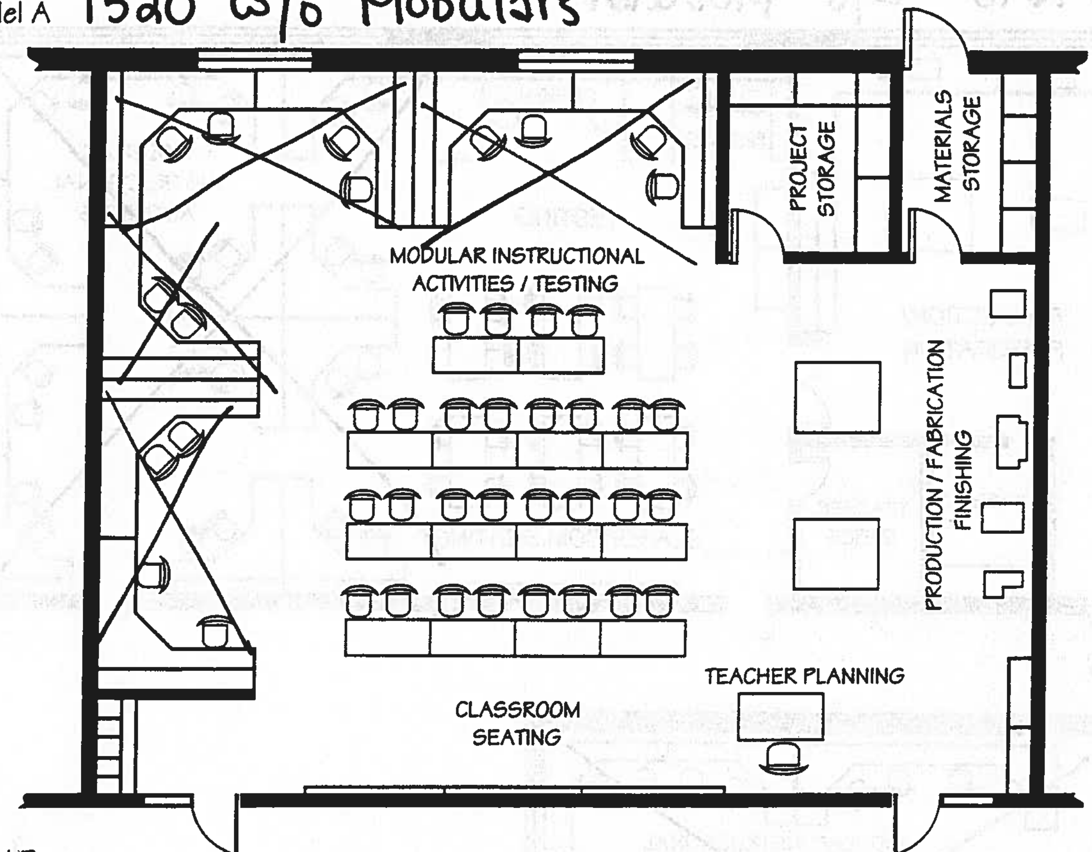
Electrical:
Provide convenience power outlets. Anti-spark switches desirable. Provide uniform glare free lighting overall with 50 - 100 foot candles illumination on the bench surface. Provide task lighting such as drafting lamps, at benches to focus light on objects being finished. A school PA and intercom are required.

Space Summary and Model Floor Plans

Model	A	B	C	D	E
School Level	Middle	Middle/ High	Middle/ High	High	High
Number Teaching Stations	1 TS	1TS	1TS	2TS	2TS
Capacity	24 - 28	24 - 28	24 - 28	48	48
Laboratory Areas					
Classroom Seating	700	~~in below~~ 900	600	600	600
Small Group Meeting	in above	in below	in above	80	400
Design	in above	in below	100	150	300
Research	in above	in below	50	100	150
* Modular Instructional Activities	540 - 720	1260	1080	1080 - 1260	1080 - 1260
Dynamic Testing	in above	in above	100	100	100
Production/ Fabrication	640	960	480	960	960 - 1200
Support Areas					
Teacher Office	in above	80	80	120	180
Material Storage	80	80	80	150	150
Project Storage	100	100	100	200	200
Finishing	in above	100	100	100	100
Total Net Square Feet	~~2060 - 2240~~ 1520	~~2580~~ 2220	~~2770~~ 1690	~~3640 - 3820~~ 2560	~~4220 - 4640~~ 3140-3380

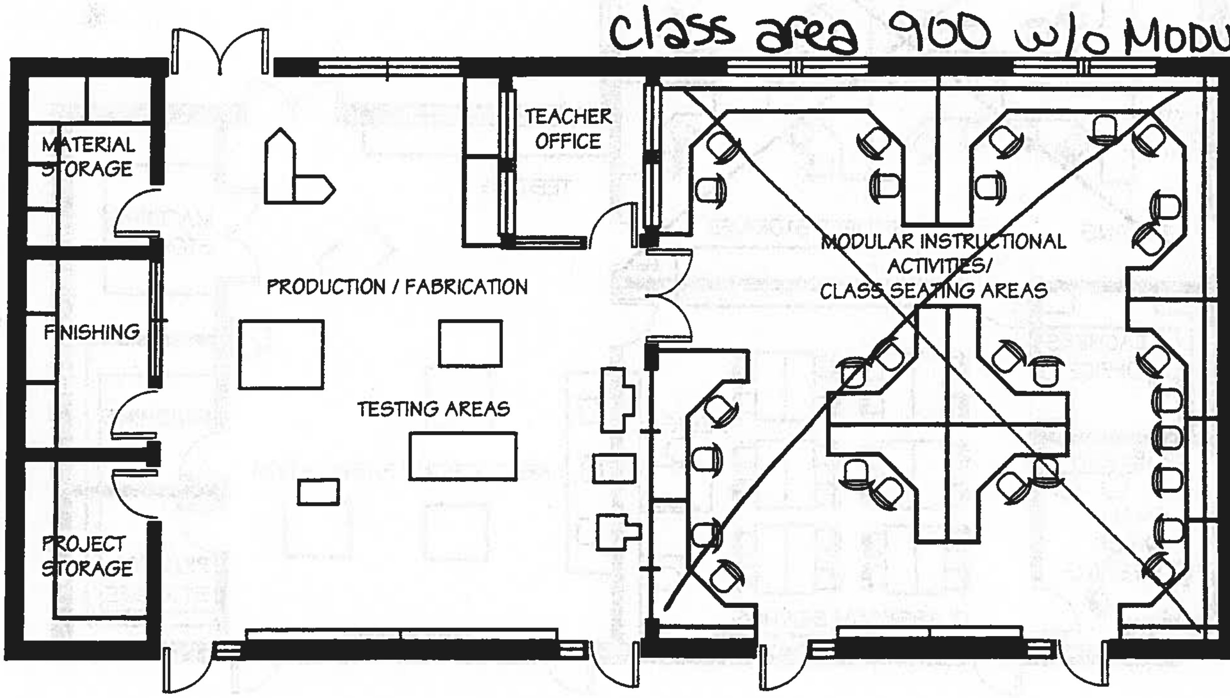
Revised 2/9/06

Model A 1520 w/o Modulars



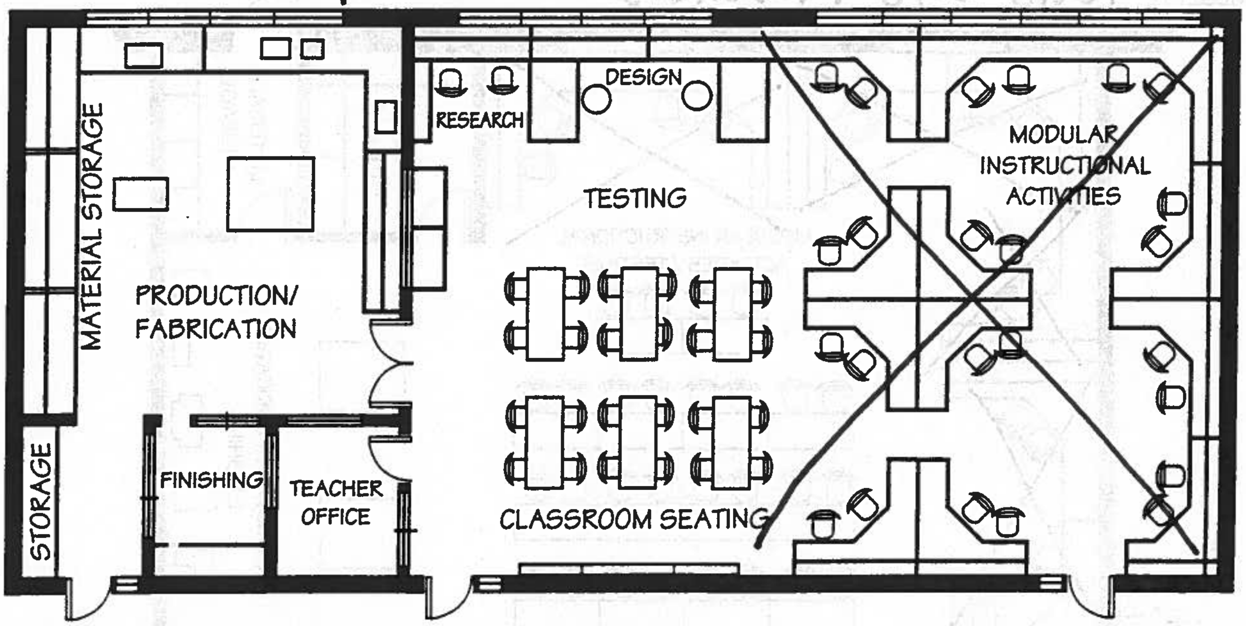
Model B

Class area 900 w/o Modulars

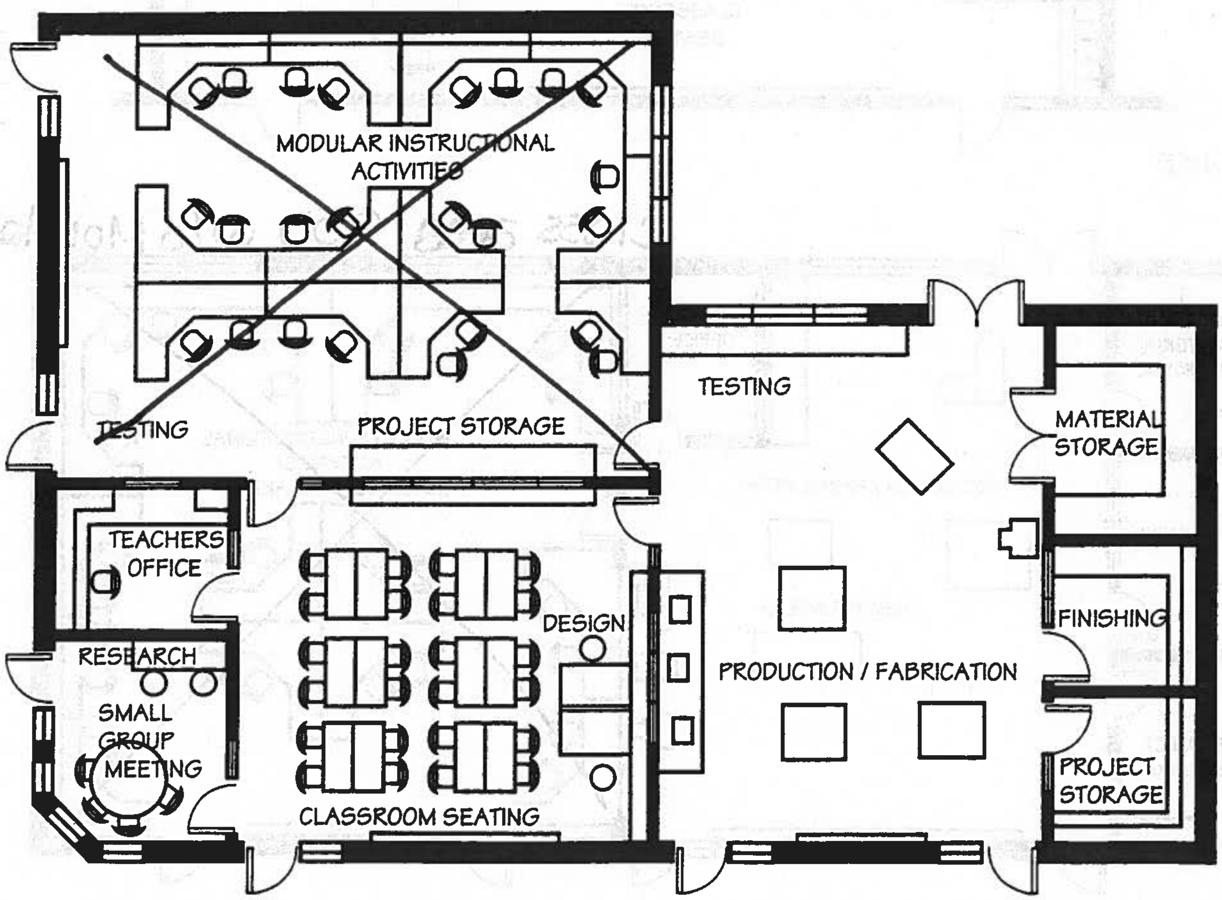


Revised 2/9/06

Model C 1690 w/o Modulars

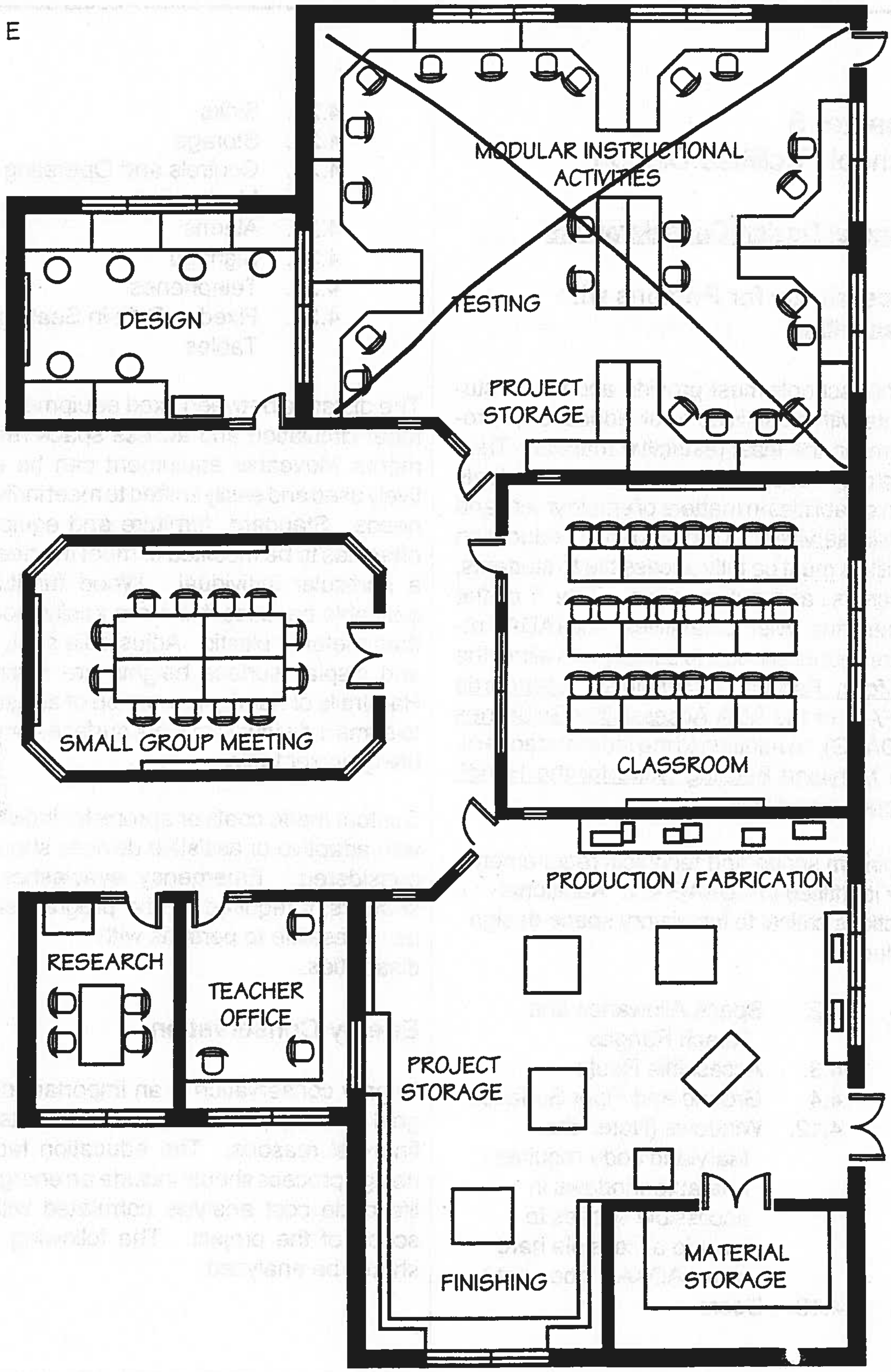


Model D



Revised 2/9/06

Model E



revised 2/9/06

Chapter 5
School Facilities Design

General Design Considerations

Accessibility for Persons with Disabilities

Public schools must provide access for students with disabilities to all educational programs in the least restrictive manner. They also may not discriminate against individuals with disabilities in matters of employr ient and public services. Consequently, education facilities must be fully accessible to students, teachers, and public users. Title II of the Americans With Disabilities Act (ADA) requires public schools to comply with either the Uniform Federal Accessibility Standards (UFAS) or the ADA Accessibility Guidelines (ADAAG). In addition to the federal standard, the Maryland Building Code for the Handicapped also applies.

Minimum scope and technical requirements are identified in ADAAG 4.1. Additional sections critical to laboratory space design include:

4.2. Space Allowance and Reach Ranges
4.3. Accessible Route
4.4 Ground and Floor Surfaces
4.12. Windows (Note: the Maryland code requires operable windows in accessible spaces to include accessible hard ware; ADAAG does not.)
4.13. Doors
4.24. Sinks
4.25. Storage
4.27. Controls and Operating Mechanisms
4.28. Alarms
4.30. Signage
4.31. Telephones
4.32. Fixed or Built-in Seating and Tables

The distance between fixed equipment must meet circulation and access space requirements. Moveable equipment can be effectively used and easily shifted to meet individual needs. Standard furniture and equipment often has to be modified to meet the needs of a particular individual. Wood furniture is desirable because it is more easily modified than metal or plastic. Adjustable seat, table and display surface heights are desirable. Handrails or handgrips may be of assistance to some individuals at work surfaces or when using power tools.

Custom made coats or aprons for individuals with adaptive or assistive devices should be considered. Emergency eyewashes and showers, if required for the program should be accessible to persons with disabilities.

Energy Conservation

Energy conservation is an important design goal in every project for environmental and financial reasons. The education facilities design process should include an energy and life cycle cost analysis correlated with the scope of the project. The following items should be analyzed:

- Site orientation, wind screens, and other natural factors
- Building envelope and spatial volumes
- Fenestration, shading devices and use of natural daylight
- Thermal characteristics of materials
- Initial costs of materials and systems
- Maintenance requirements and costs
- Operating expenses based on occupancy, use, and fuel sources
- Types of illumination and power
- Types of heating, ventilating, and air conditioning systems including special exhaust and ventilation systems.

The professional design reference commonly used is American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE)/Illuminating Engineering Society of North America (IES) Standard, 90.1-1989 Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.

Building Ecology

All acts of building have impacts on the natural environment. Building ecology attempts to minimize the negative impacts of the construction and inhabitation of a building through design and material selection.

Information about the environmental impacts of design decisions is increasingly available. Presently, many facility designers already consider factors such as:

- human health effects associated with specific materials and systems
- indoor air quality
- energy consumption
- regulated environmental issues, such as chlorofluorocarbons (CFCs) and underground storage tanks.

Building ecology incorporates these issues within a broad framework. Materials or systems are analyzed from "cradle to grave," studied for its environmental implications from its raw material origins through manufacture, packaging, transportation, installation, maintenance, and ultimate demolition and disposal. Appropriate questions to be answered include:

- How much energy is used to bring a product to its point of use?
- Is the material derived from a sustainable or renewable resource?
- In addition to those factors considered at a product's point of use, are there environmental costs arising from other phases, such as manufacture, transportation, or disposal which should be considered? Are the materials recyclable?

- Are there aspects beyond indoor air quality which affect the compatibility of this product with its occupants?

When describing general design criteria in the educational specifications, incorporate a statement encouraging the architect to consider global environmental impacts in selecting materials. By comparing Material Safety Data Sheets (MSDSs) for similar products, environmental impacts may be assessed. MSDSs also may provide some indication of maintenance concerns, which should also be considered.

Consider recyclability of materials, both for the built environment and for the activities which take place within the occupied space. Design recycling areas into laboratory spaces.

Indoor Air Quality

Indoor air problems can be discussed under two categories: the thermal environment and air contaminants. The thermal environment involves several variables that cause relative degrees of human comfort or discomfort. These include air temperature, radiant temperature of surrounding surfaces, uniformity of air temperature, humidity, and air movement. Adverse thermal conditions can stress students or staff and, in turn, affect the quality of the learning situation. Air contaminants consist of numerous particulates, fibers, mists, fumes, bioaerosols, and gases or vapors that can impair human performance as well as present a full range of implications from mild irritation of the upper respiratory system to a serious health threat.

In the development of technology education facilities, designers must be aware of the potential health hazards associated with specific educational activities. While technology education programs are "cleaner" than the laboratory programs of the past, many of the same potential health hazards are present, albeit in smaller quantities.

Technology education operations which have potential health hazards include machining, ceramic coating, wet or dry grinding, forming and forging, melting metals, maintaining open surface tanks, paint spraying, plating, vapor degreasing, gas furnace or oven heating operations (annealing, baking, drying, etc.), hot casting, and gas or electric arc welding.

Recommended control methods for reducing or eliminating the risk are to substitute a less harmful material for one that is dangerous to health, change or alter a process to minimize student contact, isolate or enclose a process or work operation to reduce the number of persons exposed, use wet methods to reduce generation of dust in operations, use appropriate personal protective devices as recommended by the manufacturer, and to exercise good housekeeping, including cleanliness of the workplace, waste disposal, and adequate washing.

Mechanically, technology education facilities must be thermally treated for year-round use with special attention being given to mechanically forced air systems that provide for the ventilation and circulation of fresh air. The amount of ventilation air required is dependent upon the types of activities to be conducted. This should be determined early in the design process, because it is important for student and teacher comfort and the protection of equipment from rust and corrosion damage due to excess humidity. Special consideration must be given to local exhaust from labs for special activities, such as for fumes generated by welding, and spray painting. Polyester or stainless steel exhaust hoods and ducts are recommended for fumes from the use of plastic materials. Separate HVAC controls for technology education laboratories should be provided if evening/weekend use of the facility is anticipated.

The professional design references are ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Quality and guidelines of the American Conference of Government Industrial Hygienists (ACGIH). The Maryland State Department of Education has published a series of nationally recognized guidelines on indoor air quality topics specifically related to schools. These are listed in the bibliography.

Building Automation Systems

Energy monitoring and control systems are frequently included in school design. These allow technicians to regulate one or more buildings from a central localtion. The technology education facilities will be linked to the central system. After-hours use may be scheduled into the control system or manual overrides may be used when necessary.

Fire Suppression and Supervisory Systems

Public safety is an integral part of school design. Building and life safety codes address construction, protection, egress, and occupancy features necessary to minimize danger ernment agency reviewers are knowledgeable about the requirements. Fire suppression systems (sprinklers) are recommended, if not required, in technology education laboratories. Provisions for the storage of flammable materials are also required.

Alarm and Detection Systems

Electronic security systems are frequently included in school design to guard against unauthorized access and theft. The technology education laboratory must be included in the school's building - wide security plan. Alarm systems must meet ADAAG specifications for persons with vision and/or hearing disabilities.

Electronic Communications

Continuing developments in electronic communications affect many aspects of educational facility design. In general, electronic systems and the more traditional tools of technology education are complementary. Some technology investigations rely entirely on the computer or other electronic systems; many use both conventional and electronic tools; some remain traditional in their use of mechanical materials and processes. The facility must accommodate this variety. Electronic communications systems provide information from the world outside and from within the facility.

The boundaries between discrete voice communication tools have blurred as telephone and fiber optic technology have developed. Systems integration continues to increase. Voice communication must be seen as an aid to instruction, capable of conveying many levels of information. It belongs in every classroom.

Provide enough outgoing lines and telephones to serve all staff members and school offices with a minimum of disruption and delay. Provide enough incoming lines to meet community and administrative needs. Consider a direct-dial system. Provide adequate telephone lines for the remote transmission of hard copy, such as from fax machines. Provide hearing aid compatible and volume control telephones and text telephones to meet ADAAG requirements.

Build for the future. Even if extensive electronic equipment is not in the current equipment budget, design for its future integration. Do not design in isolation. Work with the school and school system to master plan for technology. Provide sufficient capacity in the system to allow for such developing technologies as voice mail and access to computer bulletin boards and databases. Provide a public address system that can be heard in all necessary locations with originating capabilities in appropriate locations. Consider both hard-wired and lap-top technology. Provide ample work surfaces adjacent to computers to allow for comfortable use.

Site Design Considerations For Technology Education

Solar Orientation

In planning new facilities, designers have the opportunity to maximize daylight through the use of orientation, configuration, and architectural controls. Daylight may be used for visual tasks or ambient lighting, supplemented with electric lights. Daylight is psychologically desirable and biologically beneficial. It provides a contact with the outdoors which people find satisfying. Technology education facilities should provide as much daylight as possible. Of concern is the location of the sun relative to the building fenestration. North facades may provide soft, diffuse light without sun controls, but need glare control. East and West facades require louvers to avoid bright early and late direct sun. South facades offer the best opportunities for daylighting and can be designed to admit sun in the winter and block it in the summer.

Service Access

Today's technology education programs use considerably less construction material than did yesterday's industrial arts programs. Nevertheless, the material storage room needs occasional access to a delivery and receiving area suitable for lumber trucks and other large vehicles. Access may be provided through an overhead door at a loading dock or through double doors into a corridor at a secondary building entrance. The ability to move lengthy materials and large pieces of equipment is important. A ground floor location should be considered, but service access should not dictate design. A large elevator in the school may be necessary.

Service driveways, parking, and turnarounds must be designed to accommodate the delivery vehicles anticipated, must not cross student pedestrian paths, must not block other traffic, must drain away from the building, and must be easy to plow for snow removal.

Environmental Study Areas

An outdoor environmental study area should be included in every school site. As the curricular links between science and technology education increase, the importance of the relationship between the study site and the technology education laboratory will also increase. Convenient access to the outdoors from the laboratory is desirable.

Schoolyard habitats may be developed in urban, rural, and suburban settings. They can vary in size and complexity depending on existing conditions and funding available. Study areas may include wetlands, small ponds, reforestation areas or meadows and feature native plants and wildlife. Resources are available from MSDE, the Maryland Department of Natural Resources, the Chesapeake Bay Trust, and the U.S. Fish and Wildlife Service. For further information, contact the MSDE specialist in environmental education.

Outdoor Work Areas

Access to a protected outdoor area is desirable for technology education labs. An open space with a paved surface (concrete or asphalt), somewhat protected from wind, may be used for material storage, production, and testing.

Renovations Of Existing Facilities

Renovation projects are inherently limited by existing conditions and will include more design compromises than new construction. The design criteria in this guide should be followed as much as feasible. Creative combinations of space and innovative designs may be developed to meet particular situations and should be encouraged.

IAC Projects

The State of Maryland provides construction funding to school systems through the Public School Construction Program (PSCP) governed by the Interagency Committee on School Construction, the IAC. Technology education facilities may be funded through this program as a part of a new school construction, a renovation, or an addition to an existing school. Staff from the PSCP and its supporting agencies, the Maryland Office of Planning, Department of General Services, and MSDE, are available to assist in all phases of project development. Refer to the PSCP Administrative Procedures Guide.

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Also refer to local school system design, construction, maintenance standards and county/city building codes. In addition, specialists at the Maryland State Department of Education are available to consult with and assist local school board staff during all phases of project development and design. (410) 767-0100.

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Equity Assurance and Compliance Branch
Maryland State Department of Education
200 West Baltimore Street
Baltimore, Maryland 21201
(410) 767-0426 Voice
(410) 333-6442 TTY/TDD
(410) 333-2226 FAX