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Area-by-area discussions of the components of new educational buildings and the problems that can occur once a building is in use are presented. Methods to be used in avoiding future maintenance and operation troubles are also included. Emphasized throughout is the responsibility of the educational facility planner to learn as much as he can about the building he controls. Plant planning should not be carried on with preconceived notions or lack of information. (RK)

'what went wrong?'

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Maintenance and Operation Errors To Avoid In Educational Facility Planning

1968

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Foreword

The Council of Educational Facility Planners, formerly the National Council on Schoolhouse Construction, is an organization of specialists who recognize that environment can strongly affect education. The Council as a whole strives against poor planning, questionable equipment, inadequate or dangerous facilities, and other factors that waste or dilute the effectiveness of teacher-learner relationships.

Individually, the Council's members are well experienced. Many are employees of local school districts, colleges, or universities. Others are architects, governmental agency officials, educational or engineering consultants, editors of major school-oriented periodicals, or life members. The membership is international, including representation from the United States, Canada, and several other countries.

For more than 35 years the Council has sought to improve the planning and construction of educational buildings and other facilities through the dissemination of information about tested practices and procedures in the field, *'What Went Wrong?'* is the latest publication in that tradition. It describes and discusses actual experiences in a way designed to give direction to those seeking help in solving problems and eliminating errors that can all too easily occur in the planning and construction process.

Preface

If you have never made a mistake during the planning and designing of a new educational facility, and you think you never will, this book is not for you. If, from the very beginning of a new building project until it becomes fully operational, you have no qualms or doubts about your ability to make the right decision, this book is not for you. If you have never experienced objections to your plant planning decisions, this book is not for you.

But if you are still learning about the construction of new educational facilities, if you are immersed in plant projects while under heavy pressure from other administrative responsibilities, if you face understaffing problems and would welcome solid, practical help that will aid you to avoid costly planning or design errors that your school district or institution will have to pay for and live with for years to come, then, welcome; this book *is* for you.

It is a tragedy that even now educational facilities are being planned on the basis of antiquated theories, false conceptions, or conclusions derived from ignorance or wilful disregard of known, proven fact. The resultant building errors and mishaps will be etched in brick and mortar, steel and glass; they cannot be hidden away like paper errors. They will stand for years, costly to remedy, costly to maintain and operate, and, if not correctable, costly in terms of discomfort and academic poverty among students and faculty.

Rare indeed is the completed educational facility which is a perfect solution to the original problem, and rare is the educational administrator, campus developer, project coordinator, trustee, consultant, architect, or engineer who looks upon the completed building as such. Errors do creep in to destroy the dream of producing a perfect, flawless building.

The Council of Educational Facility Planners is deeply committed to the pursuit of excellence in facility planning, as should be every member of the planning team. Planning errors can and should be minimized, if not avoided. The Council, through the pages of this volume, seeks to alert planners to the many pitfalls that lie ahead for the wary and unwary alike, for the experienced as well as the inexperienced. Problem areas based on fact, on repeated occurrence, are pointed out to help administrators and architects avoid unnecessary and wasteful plant expenditures. The arbitrary separation of this publication into a sequence of chapters is in no way intended to convey the impression that the process of planning for the construction of an educational facility is to be similarly compartmented, however.

As a supplementary assistance to planners, two appendices have been included. Appendix A (pages 222-223) lists the names and addresses of the technologically-oriented organizations mentioned in the text. Appendix B (pages 224-227) lists a number of selected additional sources. In addition, this book is indexed.

The Council committee responsible for this educational facilities planning guide has pinpointed some of today's most common plant problems and has advanced suggestions for changes in planning theory and practice to improve the buildings of tomorrow.

Complacency and contentment with the status quo are incompatible with good plant planning. Everyone involved can avoid common errors in new building design and construction, just as he can be alerted to avoid the uncommon errors. Don't be the administrator who observes his latest project and then asks himself, "What went wrong?"

"Come on in, Ralph. We'll have some coffee and you can lay it out in my place."

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'What Went Wrong?' was prepared by several members of the Council of Educational Facility Planners. The Writing Subcommittee of the Council's Publications Committee planned and organized the textual material and wrote the initial and subsequent drafts. For the most part, each chapter was written by a different member of the Subcommittee, although all concurred in the final version. The individuals comprising both the Committee and the Subcommittee are listed on the opposite page.

Following preliminary editing by Miss Georgette Manla, the manuscript was submitted to the Publications Committee for review and further editing. After that group's members approved the manuscript, it was given to Dr. Kenneth Widdall and his staff assistant, Warren I. Paul, to prepare for publication. Mr. Paul, a graduate research associate at The Ohio State University, Columbus, Ohio, suggested, participated in, and supervised the compilation of the index, designed this edition, and coordinated its production. This edition was printed by the Printing Department of The Ohio State University.

Table of Contents

1. The Site

The selection of an educational administrator is seldom based to any great extent upon his knowledge of financial management techniques or upon his familiarity with physical plants. Nevertheless, administrators universally find their efforts to provide educational leadership diluted by time-consuming assignments such as the preparation of budgets or a search for solutions to traffic and parking problems.

The purpose here is not to attempt to improve the ability of the educational administrator to cope with the day-to-day problems that arise in connection with the operation of an educational facility. Rather, it is to provide preplanning assistance to show him how to overcome many plant problems that can and do arise. The first consideration is with the site.

Certainly there are universities, colleges, and school districts that will continue to exist for decades without the need for site expansion. Nevertheless, even these institutions' administrators cannot afford to ignore projections of site needs because they probably are or will be under pressure to dispose of "excess" land.

America is in the midst of an explosion in attendance at higher education facilities that both has caused an unprecedented building boom since World War II and is expected to result in a need to double present facilities in the next decade.

School districts are faced with a tendency on the part of those not involved in education to feel that the elementary and secondary school facilities constructed since World War II have satisfied the need for expansion to accommodate the "war babies." They are also able to refer to the statements of urban planners who project that suburban communities will soon merge into "strip cities" or continuous urban areas, suggesting the end of school district expansion.

It is true that the "war babies" have passed through our secondary schools, but enrollments have not fallen off and we must now expect the impact of their children on the schools. Also, despite the merging of suburban areas and the growing scarcity of undeveloped land, there is little indication that school districts will become static and need no further facilities.

Enrollment patterns within urban school districts with relatively stable population are found to undergo constant changes as the characteristics of residential areas vary. Additional facilities are often needed to house increasing enrollments in sections with new residential construction. The factors of shifting capacity requirements, the need for facilities to keep up with modern instructional methods, and the obvious impracticability of razing inadequate and outmoded structures before construction of replacement accommodations indicate that few, if any, school superintendents can neglect the constant review of their periodic projections of facility and site needs.

Preliminary Site Planning

Having accepted preparation for the probability of facility expansion as a current responsibility, the educational administrator should consider the selection and designation of new building sites as the first specific actions to be taken. It seems reasonable, therefore, to begin "planning today to avoid tomorrow's problems" with a look at site selection and design.

As a continuing process, someone on the staff of each institution and school district should keep track of enrollment trends and the long-range plans of governmental units so that he can project future needs. As a rule of thumb, it is proposed that needs be projected ten years in advance and revised at least annually.

Once the decision has been made that an additional facility will be needed in a certain area at a given time in the future, site selection procedure should begin. The professional skills of an architect should be utilized at this point to insure that decisions will be made on the basis of true economy for the intended use.

The selection of a site in advance of the time it will be needed for a school always carries with it the possibility that planning assumptions could be erroneous, so that the acquired site would be poorly located or even unneeded. The alternative is to wait for the time of actual need and then, under pressure, attempt to obtain the needed land by negotiation or condemnation. The history of land values in this country indicates that there is little likelihood of a financial loss to a district or institution in disposing of land found to be unneeded. This assures against loss by providing an additional incentive to early acquisition.

It is recognized that the time of site purchase has only an indirect bearing upon the likelihood of future problems in operating and maintaining the proposed educational facility. Other aspects of site selection, acquisition, and planning, however, have direct effects upon the long-range economy of selecting a particular site over others that may be available.

In some states, statutory provisions require the approval of sites by the state department of public instruction. These rules are intended to assure at least a minimum of preliminary planning, but do not replace the need for planning at the local level.

The way in which a site relates to the educational purpose the facility is to serve, the terrain and soil conditions, and the manner in which site utilization is planned will all affect the operation and maintenance of the site and the new building during its years of occupancy.

The Long-Range Approach

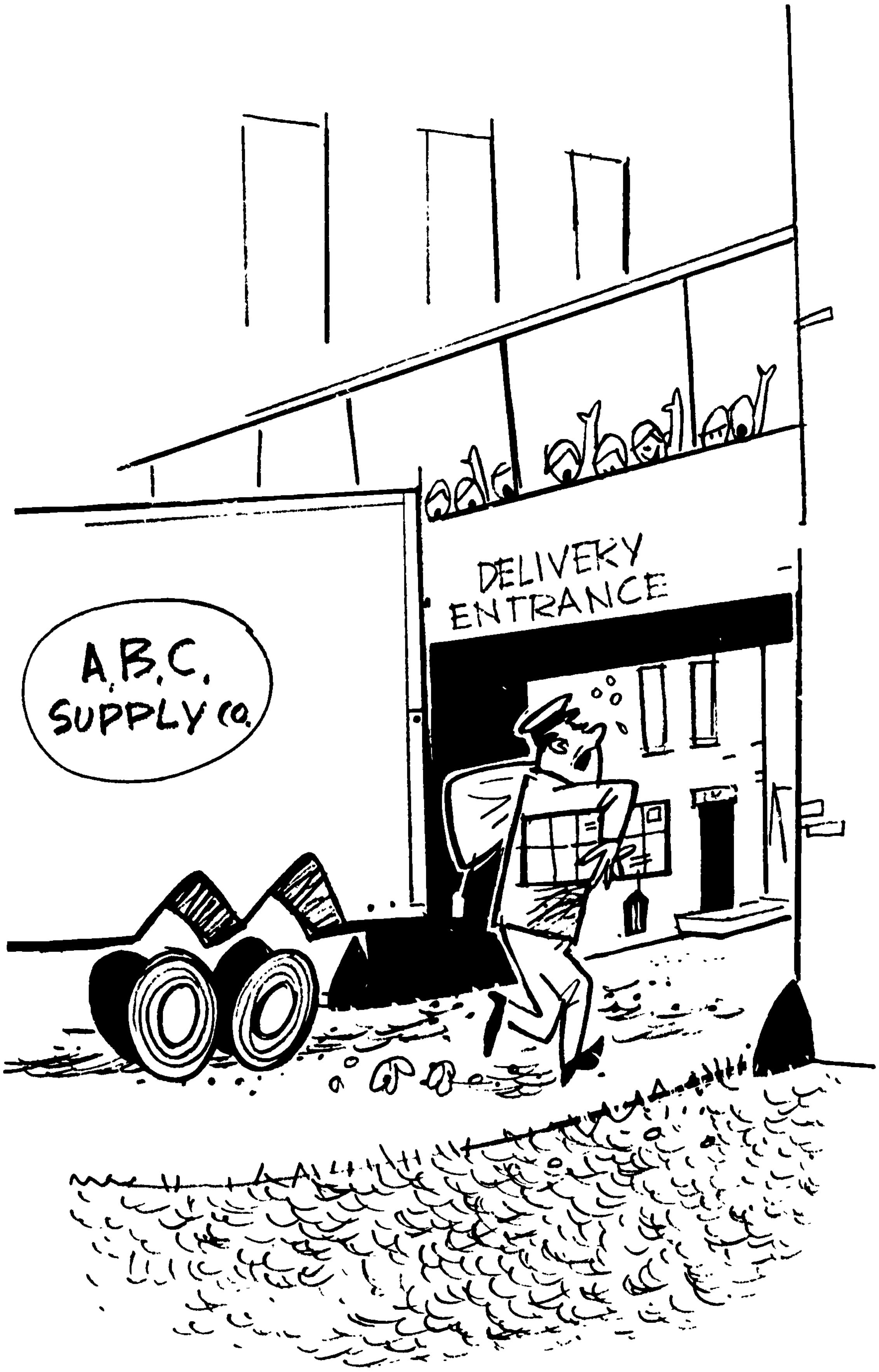
Educational facilities in use through the country provide many examples of what can happen when administrators neglect to follow a long-range planning approach for buildings and their sites. For instance, in one large city several years ago, cooperative planning brought into being a large educational-recreational site owned jointly by the city department of parks and recreation and the school district. In the development of the site, a large secondary school was constructed on one half, with the physical education unit located to permit users of the athletic fields to have access to the shower and locker rooms. The athletic fields constructed bv the city on the other half of the site were thus similarly convenient for use by pupils during school hours.

The desirability of the joint planning up to this point is subject to little question. The failure to consider fully the long-range use of the educational facility, however, is revealed in the lack of an analysis of site traffic flow. The locations of the heating plant, the food service kitchen, the parking areas, and the receiving room dictate that all vehicles making deliveries and most automobiles intending to park on the site must travel along a twenty-foot service drive that fully occupies the space between the rear wall of the health unit and the athletic field fence. Every pupil leaving one of the locker rooms for the athletic field is forced to exit through a door directly into this service drive, and step blindly into a traffic lane. The construction of a screen fence has been a most unsatisfactory solution.

Student injury and death have occurred because of improperly planned traffic patterns on the site. In addition, the use of custodial personnel to direct traffic constitutes an unforeseen long-range expenditure that presumably will continue throughout the life of the building.

To avoid problems of this nature it is necessary to prepare and closely study a detailed site utilization plan which indicates the flow of both pupil and vehicular traffic.

Another example of inadequate site planning involves an instance where an addition to a two-story secondary school encloses a court which vehicles must enter to make deliveries. Despite the vehicular entranceway into the area, an overpass constructed at the second-floor level of the school leaves a scant ten-foot clearance for entry into



"Two bits says the guy who designed this building drives one o' them little sports cars."

the court, preventing many delivery trucks from entering. If anticipated traffic had been visualized, this problem could have been prevented. The school's administrator has the alternative of financing expensive alterations to make the entrance more usable or continuing to have all shipments carried or wheeled to their destinations.

Cost Factors

The true measure of the cost of a site for a future facility goes far beyond the price quoted by the seller. In all instances it is necessary to include in site evaluation, as major items in determining "real" cost, the factors of accessibility for vehicular traffic (and, if applicable, for children on foot), of soil characteristics, and of the costs of providing and/or relocating utilities. In urban areas, additional factors, such as the removal of property from the tax rolls and the cost of razing existing buildings, further complicate the determination of true cost.

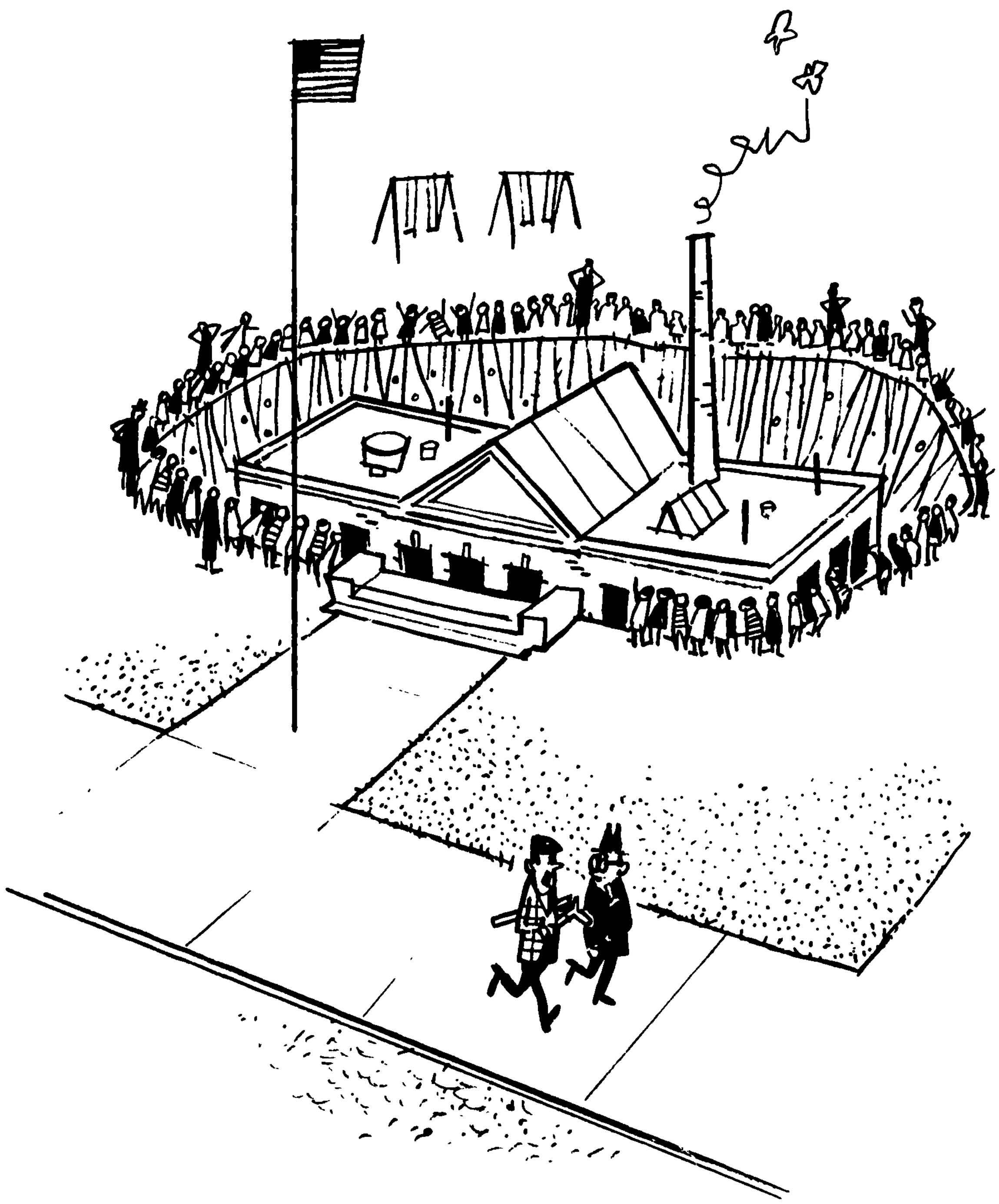
Once the administrator has projected some ten years into the future the need for a facility in a general location and has determined that several possibilities exist, he should be in a good position to evaluate and compare these factors. Close coordination with utility companies and with governmental agencies should enable him to include the future plans of these agencies in his evaluation. When this has been done, it is assured that the site can be tentatively designated.

Among the early steps to be taken prior to purchase of the site should be the employment of an architect as a member of the planning team. Through his help, an estimate of costs can be made with regard to effects of terrain and other physical features of potential sites.

Soil Conditions

Where long-range maintenance of site and structure are concerned, soil characteristics are perhaps the largest single determinant of cost. The bearing quality of the soil has, or can have, a direct relation to the cost of a structure. The final bill for a recent addition to a secondary school in a large city, for example, included a $60,000 item for extra foundation work on the structure, required because the addition was to be located on a filled-in clay pit that had been purchased as a "bargain."

As well as possibly increasing construction costs, soil conditions present a potential long-range maintenance problem. Failure of water services and sewer lines is common in filled-in areas where there is the possibility of settling. In addition, electrolysis, attributable to the use of cinders and similar materials used for the original back filling, can result.



"Well, Mr. Roxberry, in the building biz there's what we call load-bearing-soil-characteristics . . . now . . . "

Soil problems are not limited to poor load-bearing characteristics. In areas dependent upon waste disposal through septic drain fields, the inability to dispose of the effluent can pose almost insurmountable problems. Also, in certain sections of the country, rocky areas dictate the routes for underground utilities as well as building location. Subsoil exploration, such as through soil percolation tests, is relatively inexpensive and yet fundamental in evaluating the site.

Percolation tests in areas proposed for septic tank drain fields are an absolute necessity; again, they should be made prior to site purchase. A county secondary school, constructed a few years ago in the southeastern United States, was completed before the soil was tested for drain-field purposes. The quality of the soil was found to be such that all effluent had to be pumped to a remote higher area of the site at considerable cost.

A similar potential for trouble is faced when connection is made into an inadequate municipal sewer system. There is no excuse for a failure by school district or institutional personnel to investigate the long-range adequacy of local sewers. Sometimes even good planning of building systems cannot prevent sewer water back-up because of the inability of the building to dispose of its own effluent into the municipal system. A very disturbing indication of such a problem may be overflowing drinking fountains which have their waste connections leading into the conductor lines from roof sumps.

Utilities

It is assumed that the availability of utilities has been carefully investigated prior to site selection. For colleges and universities, however, the architect and engineer must be cautioned to lift their eyes beyond the building and the campus to the town and surrounding areas. The potential impact of the facility must be taken into consideration in the long-range utility planning of the whole area.

Other Potential Problems

Other potential operating problems may not have direct economic implications but, nevertheless, deserve full consideration before final site selection.

In considerating site accessibility, one school district neglected to investigate a seldom-used railroad track along the site proposed for a secondary school. Only upon occupancy was it discovered that the railroad schedule called for a slow freight just prior to school each day, with consequent traffic tie-up and confusion.

School safety authorities recommend that schools be located at least one block from main highways and arterial streets. This otherwise excellent advice can, however, present the administrator with major community problems where student drivers are involved. In a particular instance, a large secondary school site was selected with access provided only through narrow, quiet residential streets. The impact each day of hundreds of student-driven automobiles upon the residents of these streets has caused violent reactions, and the location probably created greater safety hazards than it eliminated.

All possible long-range implications having been considered and a site having been selected well in advance of actual need, time should be available for thorough site planning as well as educational facility planning. While educational specifications have gained acceptance, they seldom contain significant analyses of site needs. The planning process for the site should be identical and simultaneous.

In addition to the investigation prior to site purchase, more refined analyses of the topography, soil conditions, and drainage are needed prior to construction. Where the terrain is irregular, locating a building on a site in relationship to roads, walks, drainage, parking, utilities and playfields becomes a major consideration. An educational facility should not be constructed without a total site utilization plan for its complete development based upon the educational specifications for the facility. Since economically the total school plant can be no better than its plans, time and talent must be devoted to investigating various possibilities, and to providing for present requirements, for orderly expansion and for unforeseen contingencies.

Before bidding documents are released, additional borings should be made where building foundations and utility lines are to be placed. Where underground rock formations are a possibility, trenching may be necessary; such information should be given to bidders to reduce the allowance for contingencies added for unknown conditions and to avoid costly extra foundation work after contracts are let.

Maintaining the Grounds

The layout of drives, sidewalks, and play areas must be carefully planned to provide proper drainage on all sites, and planning should permit extensive use of mechanical equipment for maintaining lawns and plantings.

Sometimes school districts and institutions decide to break away from traditional, unimaginative site treatments by freeing their landscape architect to prepare a really interesting setting for a new building. For one particular small elementary school the recommendations of the landscape architect were accepted and $30,000 was expended on a rather limited site to provide unusual and beautiful plantings. But problems with the maintenance of these plantings soon arose.

The school, in accordance with district policy, was staffed by one custodian during the day and cleaned by three female workers during the evening, with no one assigned to or capable of caring for the grounds. Despite well intentioned efforts by the custodian, insufficient time, inadequate knowledge and equipment, and an assist from neighborhood youngsters hastened complete failure of the experiment within a short time.

In recent years, numerous architectural plans for new projects have provided for inner courts encircled by a school building. Beautiful as such courts are on the artist's drawings, they will not be so in reality unless they are well operated and maintained. This means that such things as the availability of water outlets, drainage, access provided for lawnmowers and other equipment, and the previously mentioned ability of the school district to maintain such landscaped areas with available staff and equipment should be considered.

Many schools and colleges have extensive and imaginative landscape areas. However, the decision to provide special landscaping cannot be isolated from the obligation to furnish the equipment, talent, and labor necessary to retain the beauty of the setting.

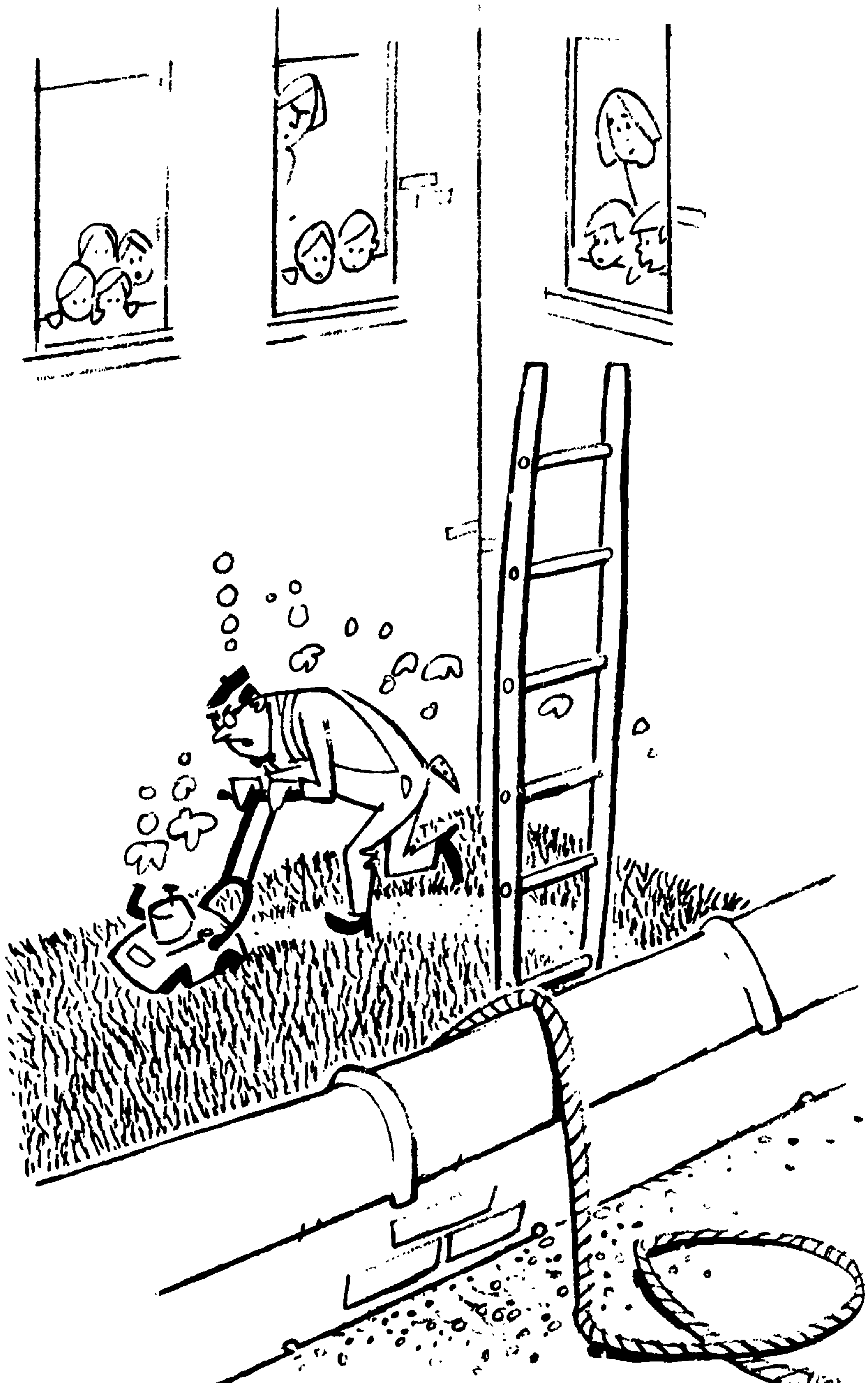
A similar situation exists with regard to exterior lighting. In many buildings, particularly in urban areas, it is most desirable to furnish exterior lighting as a deterrent to vandalism. Roof-mounted floodlights, the least expensive approach to such illumination, are not completely effective because of their tendency to cast shadows near building walls and plantings. Pole-mounted floodlights are much more satisfactory. The poles used usually range from 25 to 30 feet in height and require special arrangements for their maintenance if they are to remain in service.

Another common problem is the maintenance of lawns in the face of student disregard of signs and fences. Perhaps the most realistic approach has been taken by at least one university which erects its new buildings in a sea of grass, and then places sidewalks in pathways worn by students as they select natural traffic patterns.

In constructing a single building it is not quite possible to anticipate the "shortest line between two points" pattern preferred by the students. Walks must be laid out initially in whatever geometrical or symmetrical design is thought desirable by the site planner. Upkeep cost, however, may be minimized after the building is in operation by "joining" the students with the installation of additional walkways rather than by trying to "lick" them with fences.

Athletic Fields

Athletic facilities form an important consideration in site design. Size and topography of the total site are major determinants in the



"There's all kinds a' laws, and there sure oughtta be one against this."

placement of baseball diamonds, football fields, and other spaces. Within the limitations afforded by a given site, proper design can minimize the need for fencing and protective screening and make proper allowance for spectator and traffic flow to avoid the destruction of other site components.

Summary

Long-range site operating and maintenance costs can be avoided by looking ahead at the time of site selection. Admittedly, it is difficult to arouse interest in spending time and money years in advance of actual need. Good administration, however, demands that long-range projections be made of site needs, that these projections be constantly revised and updated, that the highway commission, urban renewal administrator, city goverment officials, utility companies, and all others whose work affects future sites be contacted, and that final site determinations be made on the basis of a trial analysis of what it will cost to operate a facility in one location as opposed to any other location open for consideration.

Also essential to good administration when a facility is being planned is the ability to work well with the landscape architect and the building architect to ensure that these professionals have all possible information about the anticipated utilization of the site. Without information about the building's educational program, the vehicular and pedestrian traffic anticipated, the policies of the district regarding student and faculty use of vehicles, and other basic factors, it will be impossible for the architects to provide a facility free of the administrative problems discussed herein.

2. Foundations and Structure

At a regional meeting of the Council of Educational Facility Planners, the keynote speaker introduced the concept of "educationally unsafe" school buildings. The term was, perhaps, borrowed from the more familiar concept of *structurally* unsafe school buildings, used to describe a situation wherein the condition of the foundations or structural systems of a building make occupancy an undue risk to students and staff.

The partial or total collapse of an educational building is dramatic proof of structural or foundation inadequacy. Such incidents fortunately are rare. Nevertheless, no section of the country is free of occasional structural failure, and each instance serves as a reminder that potential danger lurks in every building.

A recent example, occurring on an eastern college campus, was the sudden collapse of the slate roof of a building under construction. An investigation disclosed that the failure was caused by inadequate welding of the prefabricated bar joists supporting the roof.

In a similar situation, during the construction of a secondary school in the midwest, a sizable section of the structure collapsed while concrete was being poured.

Other cases, including canopies unable to withstand snow-loading, entire structures unable to survive earth tremors, and the like, have reached the headlines during the last few years, although information as to their exact cause is difficult to obtain.

Naturally, administrators are interested in positive steps to minimize the possibility of becoming involved in similar problems. It should be reassuring to know that there are preventive actions which can be taken without the need for technical engineering competency.

An initial and very effective action is to be sure that the architect selected and his structural associates are competent to handle a particular project. Moreover, since the design may be adequate but the workmanship faulty, the construction should be monitored. In such situations as each collapse cited above, for example, the potential for failure could have been detected and the mishap prevented if there had been a requirement that the contract documents insure the presence on the site of a competent structural engineer at intervals sufficiently frequent to permit detailed review of the materials provided and of the installation procedures used by the contractors.

Less dramatic than all-out structural collapse, and much more frequent, are the other signs of structural failure that become evident throughout the entire occupancy of an educational plant, adding to the cost of its year-by-year maintenance. Such signs take the form of growing cracks in walls, floors that indicate movement in structural members, and sticking doors resulting from settling foundations. Trite, but appropriate, is the tenet that the control of maintenance costs begins on the drawing board.

Foundations

Perhaps the educational edifice most common in recent years has been the single-story, slab-on-ground structure that eliminates basements, tunnels, and other below-ground structures. Where a slab-on-ground foundation is specified, the bearing quality of the soil becomes an important factor in the future structural stability of the building.

In addition to pre-construction soil test borings in sufficient quantity and in appropriate locations, compaction tests should be specified for all areas where the soil has been disturbed during construction. This involves supervision during construction to see that disturbed areas of the earth are properly compacted, as verified by laboratory tests, prior to the pouring of concrete.

A failure to observe this requirement became evident recently when a backfilled area of a university building site was not properly compacted prior to pouring the concrete slab for the building foundation. In this particular instance, an entire section of the building settled approximately three-quarters of an inch after occupancy. After corrections were made to compensate for this, the section settled still another three-quarters of an inch, and then further movement in other sections was indicated.

Foundation problems are not limited to improperly compacted soil. They can result from a poor foundation design for the particular building and site or from improper construction methods. In any event, the result is maintenance problems for the administrator that can be eased to only a limited extent by blaming the architect, the structural engineer, and the contractor.

Structural Systems

Structural systems do not necessarily present a greater overall potential for plant operation and maintenance problems than do foundations, but, because they are more diverse and extensive, they can lead to a greater variety of difficulties.

A typical problem in structural design is the failure to compensate for the expansion and contraction of building members caused by temperature changes. Such a situation developed in a two-story elementary school constructed recently in a midwestern city. This build-

"It was holding up just fine until you roofing inspectors went stomping around on it!"

ing has reinforced concrete supporting members, with a reinforced concrete roof, and an exterior finish of dark red brick. It is a long building with ample provision made for expansion in the supporting structure itself, but not in the roof or the brick walls. During the spring of the first year of occupancy, as temperatures increased and materials expanded, bricks loosened to the point where several fell to the ground.

Similarly, in a secondary school in a large urban school district, problems of a serious nature in lengthy glass-enclosed corridors have been traced to expansion joints which were not continued into the floor slab from the roof and walls. In areas on the east and west sides of the building, subjected to the sun, cracks have developed that have caused floor tiles to lose adhesion. Expansion joints will have to be cut into the floor to rectify the situation.

Mechanical systems, too, are subject to constant maintenance attention if the thermal expansion of mechanical systems and building components are not equalized.

Evidences of temperature changes in building materials show more frequently on the exterior surface of a building than on the interior because the outdoor temperature variation is greater and because door openings in interior walls tend to act as expansion joints.

Common problems resulting from defects in structure are the gradual development of cracks in floors, walls, or ceilings, falling plaster, peeling paint, sticking doors and windows, bulging floors, and the like. Repairs to eliminate such problems on an individual basis are relatively minor, but they add materially to the cost of maintaining a building. Indeed, if caused by a serious structural deficiency, they eventually could require major expenditures to correct.

A recent survey of structural maintenance needs in a major school system revealed that exterior masonry repair is the largest single item in terms of cost to eliminate structural deficiencies and potential hazards.

This survey was the first room-by-room investigation of conditions in the system in a number of years. In some buildings, it revealed cables being used to prevent further spread of building walls resulting from inadequate foundations. In other buildings, the complete rebuilding of the brick surfacing was found to be necessary because inadequate wall ties were provided during construction. Additionally, several buildings were found to be unsafe despite constant underpinning activities over a period of years on sites where sub-soil investigations had been initially inadequate.

Another aspect of poor structural design is the use of inadequately tested materials or construction methods. One school examined in the above-mentioned survey was constructed under special circumstances — the architect made a personal appeal to the members of the board of education for an opportunity to construct a school building without the "reactionary" restrictions of the administrative staff.

With the free hand granted to him, the architect chose to utilize an inexpensive roof structure composed of aggregate blocks held together into spans by reinforcing rods. During handling, the blocks were unable to resist the stresses placed upon them, and many cracked.

The underside of these structural members was painted and served as a ceiling. During the few years the building has been in use, several of the blocks have broken and fallen into classrooms or corridors. Such episodes naturally cause consternation among faculty, students, and parents. Spot repairs have been made but no long-range solution has yet been found to the problem.

Recommendations

The design of structural systems and foundations is highly technical and necessarily must vary with each building and each site. No educational administrator, and usually no member of his staff, can be expected to have the competency to check either the accuracy of a structural design or the extent of compliance with the design by the contractor. This inability does not mean that positive action cannot be taken to minimize structural deficiencies that may result in hazardous conditions, or high maintenance costs, or both.

As has been mentioned, when an architectural firm is to be selected, an important criterion should be its demonstrated ability to design structurally sound buildings. Having commissioned an architectural firm, the administrator of the school district or institution must see to it that the construction specifications include such items as provisions for adequate testing of the bearing characteristics of the soil site prior to construction and, during construction, adequate testing of such items as soil compaction, steel welding, and concrete samples; these requirements are intended to insure the contractor's compliance with the structural design.

The administrator should also be prepared to take a firm position on higher-than-minimum standards for the fire ratings and other safety features of structures and on the elimination of low-initial-cost, high-maintenance types of building exteriors and structural components, even though there might be a resulting increase in initial cost.

Closely allied to the adequacy of structural design and completeness of specifications is, of course, the quality of the work done by the contractor. As in the selection of the architect, the educational administrator should take positive action to eliminate a low bidder when the likelihood of obtaining a sound structure is in doubt. Such a decision presumably would be based upon the bidder's demonstrated incompetence or his lack of experience in the type of construction proposed. Administrators should always try to select the lowest and *best* bid; with this in mind, they might well consider pre-qualifying bidders by requiring them to meet certain standards.

During construction, supervision is most important. The staff of the school district or institution should include a competent "owner's representative" as a means of obtaining adequate construction supervision. Such a person, employed in addition to the supervisors arranged by the architect, provides not only continuous inspection but also a liaison among owner, architect, and contractor, which can be most important in minimizing delays and extra charges.

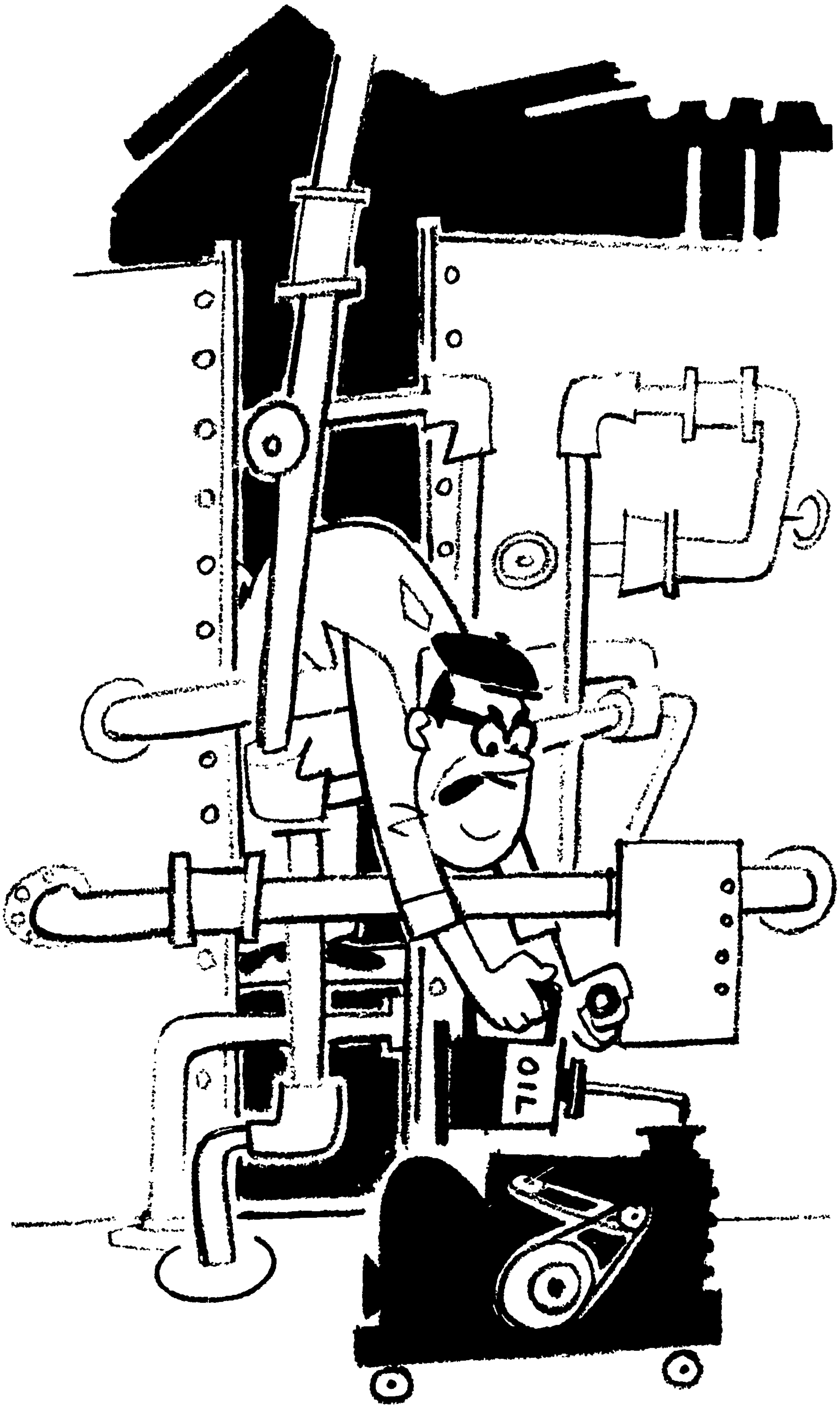
Typ... standard architectural contracts specify general architectural supervision by the firm as needed. On all major projects, however, a "clerk of the works" should be engaged. Such a construction supervisor is selected cooperatively by the architect and the owner on the basis of his overall knowledge of construction and consequent ability to see that plans and specifications are followed. He is paid by the owner and is responsible to him.

A number of recent architectural contracts have included arrangements wherein the architect provides a "clerk of the works" as a member of his staff. Such an arrangement can be considered a desirable alternative to staff administrative inspectors or an institution-paid "clerk of the works" only to the extent of the owner's confidence in the architectural firm.

The contract with the architect should insure personal involvement by structural engineers at specific points during construction. For example, inspection of the reinforcing rods installed in a concrete slab, beam, or column is a most critical item, and the structural engineer should be required to be present and give his approval before concrete is poured.

The architect and the structural engineer can be expected to base their designs upon such considerations as investigations of soil characteristics, climatic conditions, and applicable codes and ordinances. In addition, and of utmost importance, are the educational specifications provided by the educational administrator. Present-day curricula are recognized to be undergoing major changes with important implications for building design.

As the expert in educational programs, the school superintendent or educational administrator has the major responsibility for pro-


OIL

"@#!!*+*# . . . !"

viding the architect with educational specifications which include all possible information regarding the long-range utilization of the structure. This information can be expected to indicate that a "modifiable" building structure is essential.

An additional factor to be considered is that a low initial cost for the structure must be reconciled with the desire for a capability to change the building as the need occurs. Additional initial costs may be expected if buildings are to be truly changeable. Heating and lighting systems, for instance, should be located in modules to assure a good thermal and lighting environment for the variety of shapes and sizes of spaces desired. Where such modular systems are not provided, changes in partition location will also involve expensive changes in the heating and lighting systems. Major problems arise when desired changes involve the penetration of the floor, walls, or r f with components of heating, plumbing, drainage, or electrical ices.

The administrator may find it more economical over the life of a building to utilize a structural system consisting of a supported slab floor over a basement or crawl space, of masonry walls, and of a poured concrete roof, even though higher initial costs may be involved.

It is not unusual for a structural system to be economical but to fail to provide access to machinery, piping, and conduits for repair purposes. In the search for low initial costs such items as tunnels, crawl spaces, pipe chases, and access doors may be eliminated, and pipes placed inaccessibly in walls or in or under floors. Equipment rooms may be too small to allow access for lubrication and adjustment. In such cases it is not only expensive to gain access to the points of difficulty, but it may also be necessary to disrupt the educational program in the process.

Summary

It is understandable that the educational administrator facing a construction project takes less interest in the foundation and structural aspects of the construction than in other less technical and more educationally oriented phases.

It has been the intent to suggest that even without the technical know-how required to become involved in structural design, an administrator can and should take positive action to ease his long-range responsibility to operate his facility efficiently.

The educational administrator can say he has taken all the positive actions open to him short of having a technical background in the field when the following have been accomplished:

1. Competent architects and engineers have been employed.
2. Adequate specifications have been prepared, including requirements for independent laboratory tests of concrete and steel.
3. Efficient construction supervision has been provided.
4. Complete educational specifications have been prepared and include present and future uses of the structure.
5. Expenditures have been authorized for systems which lend themselves to change and ease of maintenance.

3. Utilities

A building is lifeless and useless until the utilities, its life lines of energy, are provided. Not until the utilities have been brought in and a building has been provided with the equipment and machinery needed to convert the energies or services supplied to a useful purpose is the building ready to perform the function for which it was designed and constructed.

Although the planning of new building utilities involves some of the most important decisions educators, architects, and engineers have to make, too often little consideration is given to the utility plan of educational facilities. Certain criteria must govern the selection of utilities for educational facilities. In the past, failure of school administrators, architects, and engineers to consider all the necessary criteria has cost educational institutions untold extra millions in maintenance and operation. Much needless waste can be avoided by proper design and installation of the utilities needed for educational facilities.

Among the basic criteria that should govern the selection of utilities for educational facilities are:

1. Supply and services should be available to meet any potential demand.
2. Amount, capacity, potentials, and pressures should be sufficient for peak loads.
3. Provision for utility expansion should be provided.
4. Maintenance, operation, and initial cost should be considered in the total cost.
5. Quality materials must be used in the utility distribution system, metering apparatus, and controls.

The utilities considered important for the function of an educational facility may be divided into two categories: *necessary*, such as water, sewage disposal, power, and fuel; and *supplementary*, such as telephone, closed-circuit television, and fire alarm detection and protection. A new utility is "computer power," which encompasses information kept in computer storage and available to all computer stations connected into the computer network.

Properly locating utilities to protect them from vandalism and accidental disruption is important. Planning for expansion of buildings or possible change in site utilization often is a major economic advantage during the life of a building. For example, at one school a parking lot was expanded to include an area where a power pole supporting the main building service was located. Service was periodically disrupted by vehicular damage to this pole. Eventually, the power line had to be relocated, at additional cost to the school district. One way to avoid such problems would be to run power lines underground.

Since school officials have the primary responsibility of promoting education, their schools should not compete in the operation of power plants, water systems, or other utilities, unless there are proven engineering and economic advantages.

Water

Water is necessary for every educational plant. Decisions as to the source, quality, and quantity of the water which will be needed should be made well before the site is purchased or construction begun. The location of the facility often dictates the source of water. If water from a public water system is available, it is usually advisable to use that source. Water costs, anticipated usage, and drilling depth to secure well water are among the factors which must be analyzed in order to make a sound decision on the source of water for a school facility.

The source, quality, and quantity of water can affect the cost of maintenance and operation of a facility throughout its lifetime, especially if proper decisions are not made in the planning stage.

The source should be able to supply water at all times. Even short intervals of interruption can be quite costly or possibly disastrous. Regardless of the source of water, some uses will require additional filtering and conditioning, so that chemical analysis and a planned program of water treatment usually will be necessary. This is especially true for the water used in steam boilers, heat generators, and chillers. Accumulation of scale reduces the heating and cooling capacity of mechanical equipment, and reduces life expectancy of equipment. It also increases operating cost and the frequency of repeated maintenance procedures. Chemical elements dissolved in the water and foreign matter carried in suspension can cause damage to equipment, piping, and valves through pitting and sedimentation. Where water-type cooling towers are utilized, treatment is needed to reduce algae growth, which impairs efficiency and requires frequent cleaning of the unit.

Similarly, the quantity of water will have a profound impact on the operational cost. If there is not enough water to insure adequate amounts for fire fighting equipment, fire insurance cost may be affected. Landscaping, too, will suffer from a shortage of water. Moreover, there are many failures of equipment which can be traced back to an insufficient or improperly treated water supply.

In one particular instance, a decision to drill a well and develop a private water system for a high school resulted in the waste of several thousand dollars. Initially, on a cost projection basis, the contract with the driller for the well, pump, distribution system, and storage tank was somewhat less than the amount which would have provided a main to a municipal water system two miles away.

After the driller had been awarded the job, however, he failed to find a satisfactory quantity of water at the anticipated depth. As a result, school officials had to decide whether to contract with the well driller to drill deeper, to start a new well, or to approach the municipal system for a water main to the school. They finally negotiated a settlement with the well driller and contracted with the municipal water system to install a water main to the school. The delay of construction and additional cost could have been averted if the maintenance and operating cost of the private system had been considered in the planning stage and applied to the cost of extending the municipal system. Total planning should have been done, but it wasn't, and, as a result, tax dollars were wasted.

Another example involves the extensive municipal water system owned and operated by a city in the southeastern United States. As the system developed, many nearby rural schools that formerly depended on well water converted to its facilities. Few of the school administrators involved with the conversion, however, considered how the chemical differences and changes in quality between the well water and the municipal water supply might affect their equipment. As a result, they discontinued most of their well water filtering and conditioning systems because of the excellence of the municipal water processing system.

Subsequently, many costly maintenance problems have developed in these schools' heating systems. For instance, the municipal water contains appreciable amounts of free oxygen, causing expensive corrosion problems. Also, the neutral quality of the water is absorbing some of the chemicals formerly deposited by the now-discontinued water treatment equipment, which is causing extensive descaling inside the system as the absorption process loosens the scale. Administrators must remember that, when a change is made in the source of water, precautions must be taken to protect the equipment that may be affected.

Sewage Disposal

Early planning must determine the composition of sewage from school operations. Laboratories will produce chemical waste that may have a direct influence on sewage disposal. Food disposal units dump high percentages of solids into waste lines and should by-pass catch basins in order to avoid excessive stoppages. Grease traps usually are necessary for kitchens, and some other area waste lines are needed in order to reduce the grease content of the sewage. Careful consideration must be given to the type of sewage and preliminary treatment or physical separation that is to occur before it is passed into public or private sewage systems.

A close correlation exists between the amount of water used in a building and the amount of sewage requiring disposal. Studies in Florida indicate that the two are so closely related that the amount of water supplied is within a few percentage points of the amount of sewage which is to be treated.

This is true because 95 to 98 percent of the sewage from a building is actually water which has been added as a carrier of refuse. There are two basic methods of disposing of the sewage from a modern facility:

1. Public sewerage systems
2. Private sewerage systems

Two essential steps to be taken prior to the selection of the system to be used are:

1. A feasibility study of the site, relating to sewage disposal should be conducted, and
2. A determination of the exact distance and elevation for access to a public system should be made.

It is usually advantageous from a maintenance and operating standpoint to use a public sewerage system if possible. Individual sewerage systems are costly to construct, occupy special space, and are susceptible to maintenance problems. It is important that every possibility of gaining access to a public sewerage system be explored before a decision is made to construct a private system.

Sometimes a long extension to a public sewerage system can be constructed more economically than an individual system can be constructed. In computing initial cost, the operating and maintenance cost of the individual system must not be neglected. Often these additional costs, when computed over a number of years, will show that a long extension, or the installation of a lift pumping station in order to utilize a public sewerage system, is the most economical solution. If a public sewerage system is not available, then a private system must be constructed, or a small sewerage plant installed.

A lack of communication and understanding between educational administrators and public officials too often has led to costly errors in facilities planning.

"Sorry, Chief, but all I can find down there is a disgruntled gopher and two arrowheads."

In one case, the design for a large consolidated high school specified that it was to be built on a site within the limits of a small municipality. The mayor had made a number of promises in his efforts to have the school located in his town and had declared that a sewerage system was available. The school officials assumed that the system could handle the effluent from the school. The architect employed for the project produced a set of plans showing an eight-inch sewer line terminating at a boundary street with a notation: "Connect to city sewerage line at this point." So, the contract was let.

The building was about 90 percent completed when the request was made to connect the sewerage line from the school into the city system. Only then did school and city officials discover that there was no sewer main in the street. Furthermore, they found, the additional sewage from the school would materially overload the town's sewage disposal plant. The dismay of the school administrators and the embarrassment of the mayor's office may be imagined.

The officials ascertained that both problems could be solved but that action by the town would require time and money. Although it was urgent that the new school open at the start of the next term, one year was the best estimate that the town could make to enlarge its facilities and construct a trunk line to the school site. As a result, the administration had to provide a temporary sewage disposal plant for the school at an additional cost of several thousand dollars.

Firm commitments and contracts for utilities and services must be a part of early planning.

Power

It has been said that everything in a modern school is controlled by a switch except the children. School buildings today contain more mechanical and electrical equipment than at any other time in history, and the trend will continue. Such equipment is dependent upon electric power; therefore, careful attention must be given to the selection of the power source — whether a public utility or an on-site generator — in planning a new educational facility. It is usually less complicated for an educator to stay out of the utility business and to purchase all electric power from a utility company, but on-site generation and total power systems are gaining in popularity and must be considered.

The selection of on-site generation equipment should depend on the results of thorough studies of plant size, availability and cost of fuel, standby equipment, maintenance cost, and availability of qualified personnel to operate such equipment. Generally, it has been found that on-site generation is not economical unless the byproduct, heat, is utilized by the facility.

The voltages, loads, and current characteristics for the various areas of the project must be defined during the plant planning process. Even when this is done carefully, however, problems in the maintenance and operation of electrical equipment may arise.

In most sections of the United States, the common power supply to school buildings is a four-wire service from a Y-connected transformer bank. This service usually gives 120 volts from any one of the three "hot" legs to ground and 208 volts between any two of the phases.

These voltages are satisfactory for most of the equipment used in educational facilities except for home economics departments, where domestic electric ranges are used. Such ranges usually are designed for 220-volt power, so the lower voltages both decrease the efficiency of their utilization of the electricity and slow their rate of temperature rise. The latter, especially, by forcing adjustments in originally specified cooking times, has created a dislike of electric ranges on the part of many home economics students, a circumstance implying that future purchases of electric ranges may be affected.

In order to meet this situation, many electric utility companies provide for each range a small transformer to step up the current to the proper voltage. A number of objections to this "solution" have arisen, however. One is that many ranges in use will never have the auxiliary transformer installed. A second is that the transformers, although small, do take up space. Most often, they are behind the ranges, causing the ranges to be set out from the wall a few inches. A third objection is that while the transformers are usually furnished without charge to schools by utility companies, they represent an extra cost that could later be reflected in increases in the companies' rates. In addition, costs incident to the installation and maintenance of the transformers usually have to be met by either the companies or the schools.

The real solution to this problem, and to others like it, is for the equipment specifications to state the exact voltage and electric current characteristics which are needed in each area of the facility. To do otherwise can lead to inefficient operation of electrical equipment.

An increasing number of schools are installing medium high voltage distribution systems. In these systems, 277/480 volts or even higher voltages are distributed to the electrical panels and step-down transformers within the building.

Many electrical devices are being developed to use these higher voltages without the necessity of a step-down transformer. Lighting fixture manufacturers have been forerunners in the development of higher-voltage equipment. Motors, automatic valves, and other electric equipment used in connection with the mechanical system in a building can be specified, and they are available for use with these higher voltages.

The advantage of such a distribution system is its lower cost. Smaller wire and conduit is used. New and improved insulating materials have made these higher voltage distribution systems possible.

In planning electrical power availability, the most economical system that will provide the services needed should be sought.

Energy Sources

The principal sources of energy used for heating and cooling educational buildings are coal, oil, gas, and electricity. Of these, both gas and electricity are gaining in popularity. The number of all-electric commercial buildings has increased rapidly, and a significant number of school buildings and additions are electrically heated and/or cooled.

Atomic fuel cells are likely to be another source of heating in the future, even though they and the equipment to use them are as yet still too costly for economic usage.

Among the important factors of building maintenance and operating costs is the type of fuel used. Factors usually considered in choosing a fuel are availability, cost dependability, cleanliness, control, storage requirements, and operating requirements. Failure to consider all of these, or to give them proper weight, might well lead to the wrong selection. Cost per unit of a fuel is a poor indication of the total cost. Equipment efficiency, labor, storage space, relative cleanliness, delivery cost, and convenience are all factors which must be analyzed.

The energy to be used in an educational facility must be determined early in the planning stage. In the past, this selection has not been too difficult because, in most areas, one fuel dominated the market. Today, the selection is becoming more difficult because of the increased competition among fuel sources. This situation has developed with the advent of faster transportation, pipelines for both gaseous and liquid fuels, the liquefied gas industry, and improvements in electric power.

The source of energy will determine the type of heating and air conditioning equipment for a facility. This, in turn, will considerably influence the design of the building with regard to such aspects as fuel storage space, size of mechanical equipment rooms, space above ceilings, and chimney heights. Not to be minimized are the maintenance and operational costs which are directly related to the type of fuel selected.

Television

Educational television has made rapid progress in recent years. Many state departments of education are allocating millions of dollars for television programs, production facilities, and equipment. To use these facilities effectively, classrooms should be equipped to receive TV programs.

Teaching by means of closed circuit television has become increasingly popular. Such an internal system has unique possibilities in the realm of instruction, and planners must consider the implications it has on building design. They must be aware, for example, of the system's need for increased lighting, acoustical treatment, increased power demands, and new shapes of classrooms.

Along with other utility planning, an antenna system and a cable system should be planned for each classroom building and for other buildings where television reception or origin will be expected. Some state departments of education now require that an antenna system be installed in new buildings. The antenna should be capable of receiving quality color as well as black and white transmissions.

Fire Safety

Adequate fire detection devices, signaling equipment, and fire extinguishing equipment must be a part of the utility planning for an educational building. The omission of these important services from the utility plan can result in higher fire insurance rates and unnecessary fire risks.

Fire extinguishing equipment of the most effective kind is desirable in all facilities because, despite all reasonable precautions, fires still occur. The problem is to control and extinguish such fires without personal injury and with minimum property damage.

The first step in accomplishing this involves the design of the building. Openings through floors, such as stairways, dumbwaiters, air ducts, and pipe shafts, serve as transmitters of smoke and fire and should be kept to a minimum. Where they are necessary, they should be enclosed and equipped with self-closing fire doors. In addition, placing sprinkler heads in such danger areas as tops of stairways, elevator shafts, dumbwaiters, and storage closets will limit the spread of fire from those locations.

"Either somebody goofed or this is a gift of the S.P.C.A."

Every building should have a sufficient number of approved-type fire extinguishers. The kind, location, and accessibility of extinguishers are a part of planning.

Fire resistance capabilities and fire extinguishing equipment within a building are important. But when fire occurs, nothing is so important as quick notification of the nearest fire department. The telephone is an indispensable item in areas where no faster means of commuication is available. Internal fire alarm and detection systems should be provided, and, where large areas are involved, they should be coded so that the affected zone or location can be readily identified.

In the fire equipment area, especially, inspection is vital. There is the classic case of the two fire hydrants specified for the site of a proposed high school. Both were installed, and the school building was completed and in use for ten years before it was discovered that the hydrants had never been connected to the water supply system. Fortunately, there had been no need for them during that period, but a thorough checking before the school was accepted would have revealed the deficiency.

Security System

Vandalism is costing untold thousands of dollars in the operation and maintenance of school plants, not to mention the value of stolen property taken from within the buildings. To combat this loss, a number of items of equipment and proven techniques have been developed.

Radar systems, hidden cameras, infrared signaling, sonar devices, electric eye units, floodlighting, fences, and other security controls all have been used. In urban areas where schools are near police stations and detective bureaus, signaling devices should be connected to them. Vandalism problems must be dealt with by educational administrators, and no better time will be afforded than in the early stages of planning the building.

In summary, this chapter has been designed to stress the importance of early and thorough planning for the utilities of educational buildings. A total utility plan should be developed for all new construction programs.

4. Mechanical Facilities

The equipment, machinery, and apparatus which create the thermal, sonic, and visual environment in a building make it habitable and useful. These facilities are important and need much consideration in building planning.

A few years ago, the mechanical and electrical systems of an educational facility consisted of simple heating units, minimum ventilation, crude sanitary facilities, and minimum lighting. These systems required little advance planning. Often building plans were nearly complete before mechanical and electrical engineers were consulted.

Indeed, many buildings were built without benefit of any specialized consultants. The design and installation of mechanical equipment would go to the low bidder in the specialized fields. As a result, taxpayers often paid the equivalent of a consultant's fee many times over in the expensive process of correcting conditions that should not have existed in the first place.

The complexity of today's mechanical and electrical systems requires better working arrangements between architects and engineers. Too many buildings have been built where little consideration was given to the location and layout of space for mechanical and electrical equipment. Equipment rooms are apt to be relegated to areas for which the architect finds no other use. When budgets are trimmed, mechanical areas are among the first to be sacrificed, often resulting in lower ceiling heights than desirable, exposed equipment, unrelated pipe chases, and noise problems. All of these detract from the appearance of a building's interior and its satisfactory use.

Administrators, architects, and engineers are now taking steps to insure a close working relationship among themselves in the design of educational facilities. Early consideration of mechanical and electrical systems by the architect is essential if he is to design an easy-to-operate facility at moderate cost. It is equally important that the mechanical and electrical engineers plan systems compatible with the overall design. Thus, the first step in planning a new facility is a joint meeting of the educational administrators, architect, and engineer, with the understanding that all are working toward a common goal.

To describe in detail the components of the various mechanical and electrical systems used in educational facilities is beyond the scope of this book. There are numerous technical manuals which define and describe mechanical and electrical components and systems normally installed in school and college buildings. The Council of Educational Facility Planners *Guide* gives considerable space to a discussion of mechanical systems.

However, the limitations, as well as the maintenance and operating problems, of mechanical and electrical systems are rarely discussed. Adequate, early, and proper planning can help avoid many pitfalls if they are known.

Equipment Room

Many maintenance and operation problems which involve the mechanical and electrical apparatus of a building are directly related to the space (mechanical rooms) in which the equipment is installed. Expensive mechanical and electrical equipment is often installed in spaces produced with minimum planning and expenditure of funds. A good educational plant provides special facilities and areas to house the equipment which keeps the building in operation. Such areas are necessary adjuncts to the real purpose for which educational facilities are built, and no building is adequate without them.

Lighting, reflectance values of finished surfaces, and ease of cleaning all contribute to a better mechanical room environment and, at the same time, aid in fostering good maintenance with a minimum of delay and cost.

Ideally, equipment rooms should be centrally located within a building. However, when accessibility, ventilation, equipment replacement, and sound problems are considered, these spaces are better located in outlying areas. Efficient pumps and fans have long since overcome the old distance problems that once dictated that prime equipment be close to the space it conditions.

A number of criteria govern decisions concerning equipment rooms. Size and location rank foremost. Size, of course, depends upon the type, size, and service clearance requirements of the equipment to be installed in the room. The planner must also consider future equipment which the plant may require, and the service space needed for the removal and replacement of component parts. The mechanical room should be located where it will best serve the building and, at the same time, be accessible to utilities, ventilation sources, and the operational personnel.

Fire-retarding measures such as ensuring the proper treatment of walls and ceilings and the installation of fire doors are prerequisites for all rooms where combustion equipment is installed.

Sound and vibration from equipment rooms can be detrimental to instructional spaces, as indeed they are in many facilities. The use of

"Don't know where you can put it, Max. For an equipment room,
this would make a great janitor's closet."

solid masonry walls, vibration eliminators, isolation pads, and selection of quality equipment will reduce the transmission of noises that disturb quiet areas.

The installation of mechanical cooling equipment has greatly increased the noise level of central mechanical areas. Such sound levels not only are uncomfortable, they can damage the hearing of a person subject to them for long periods of time. The possibility of acoustical treatment of these areas to reduce sound levels should be considered. Ear protectors similar to those seen at jet airports are advisable for personnel who must be frequently or for extended periods of time in noisy mechanical rooms.

Mechanical rooms — whether for heating and air conditioning, switch gear, telephones, pumping, or any other service equipment — require the very best in facility planning.

Housekeeping facilities are often closely related to and located in the same general area as mechanical equipment rooms. Such facilities include central storage for housekeeping supplies, a small work area or shop, rest room facilities, and laundry equipment. Careful study should be given to the use of incinerators because of the growing air pollution problem.

The location of the incinerator, if used, should make it accessible for burning cafeteria trash and other refuse as well as for paper collected in regular housekeeping activities. Custodial closets with service sinks, equipment storage space, and some supply shelving should be located throughout the building on the basis of a well-planned housekeeping program.

Thermal Control Equipment

The equipment which controls the thermal environment is the most important mechanical system in a building. A large share of the total operating cost of an educational building is attributable to maintenance and operation of the thermal control equipment — whether it be heating, cooling, ventilating, or a combination of these.

There are many solutions to the problem of providing a suitable thermal environment for a building. Heating is basic and requires the attention of mechanical engineers more than any other factor in building design. The energy to be used, the heating and cooling system, and the distribution system all affect building design. These should be selected in the early planning stages.

Steam, hot water, warm air, and radiant panels are media used to distribute heat. Piping, wiring, or duct systems carry these media to the areas to be heated. A mechanical engineer is responsible for the design of the distribution system best suited for a building. The cost of maintaining and operating a heating system is greatly affected by how the distribution system is designed.

Numerous maintenance and operation problems that arise in heating systems are caused by many factors. Improper design, failure to follow specifications, poor workmanship, lack of inspection, and inferior equipment all contribute to the high cost of maintaining and operating heating equipment. Early planning by qualified engineers can be lower significantly or preclude many of these expenses.

The design of educational buildings began to change after World War II from buildings with basements and crawl spaces to slab-on-ground structures. Concepts in heating changed also. More efficient heat exchangers, pumps, boilers, and other equipment had been developed during the war and were being converted to civilian use. Water became a popular medium for educational facility heating and cooling systems.

For convenience, space saving, and architectural considerations, mechanical engineers designed underground piping systems for the circulation and distribution of hot water. Subsequently, malfunctions often resulted in high maintenance and replacement costs after only a few years of operation. Trouble with underground piping became so acute that some state legislatures passed laws prohibiting its installation in school facilities, while other states advised against its use.

Dissatisfaction with underground pipe installations perhaps was warranted. Contraction and expansion of such piping make virtually impossible the prevention of fracture in its insulation and moisture-proofing. Ground water and moisture then come into contact with the piping. The combination of moisture, heat, and soil chemicals speeds the process of corrosion. Electrolysis, common near the buildings, also enters into the corrosion problem.

There are some situations, however, where underground piping must be used. In such cases, in areas where soil conditions contribute to corrosion, the pipe should be set in tunnels or conduit designed to prevent the contact of earth or water with the pipe. Where poor soil conditions exist, underground piping systems should not be used at all. Nevertheless, economy and expediency combine to make underground installations quite prevalent.

Thermal shock in boilers of all types, both steel and cast iron, has been another major maintenance problem, heightened by the growing use of hot water heating. Much of the responsibility for this rests with boiler manufacturers who do not provide built-in protection in their equipment or specify piping systems that protect boilers from thermal shock.

Various types of internal distribution tubes to diffuse the return water uniformly inside boilers have been developed as thermal shock preventatives. Externally, the installation of by-pass piping prevents the circulation of water through a boiler until the water returning to the boiler reaches a temperature that will decrease the possibility of thermal shock. Use of low pressure and low water cut-off controls also help to reduce this problem.

To discuss all the maintenance and operating problems related to boilers and heating systems is not possible here. The most important point to remember is to employ competent mechanical engineers who will help select equipment and design systems which minimize long-range maintenance and operational expenditures.

Complete Climate Control

Construction of completely climate-controlled educational buildings in every state has increased dramatically. In some states the non-climate-controlled building is the exception. The trend has brought about many architectural design changes. More than ever, the architect must know in advance the administrator's preference for climate control. All such requirements, of necessity, must be supplied by the educator to the architect. This does not mean that administrators specify in detail the design of the mechanical systems to be used in the facilities. However, it is important that administrators know what kinds of performance they may expect from environmental control systems available and that they transmit these expectations to their architects and engineers.

The basics of various mechanical systems should be understood by administrators and examined personally through visits to new buildings with the latest in environmental systems. The administrator cannot be expected to know the specifics of particular systems, but in this matter he should rely heavily on his technical staff, if he has one. If he does not have such a staff, he must be particularly emphatic as to what he expects a system to do for his new building, and he must make his performance requirements perfectly plain to the architect and engineer. Above all, the administrator must make sure that the architect and engineer involved are well qualified to fulfill his performance requirements.

The administrator is justified in feeling particularly inadequate when faced with questions involved in selecting environmental systems, but he should not hesitate to appeal to local chapters of profes-

" . . . and, as you see, the great Roman legions stood at the gates of Carthage, threatening to descend on the masses in a crashing crescendo of men and equipment!"

sional groups for aid. The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) has a thorough *Guide*, and the chapter on schools is particularly helpful.

Only a qualified mechanical engineer can properly design and select systems for heating and cooling educational facilities. However, it is most helpful for administrators responsible for plant planning to have some general knowledge of the factors involved.

Since most buildings are expected to remain in service for extremely long periods of time, it is vitally important to maintenance and operating programs that equipment be both lasting and heavy duty. This will help ensure long-range economy for the life of the building.

Control systems for maintaining the thermal environment are becoming more complex and sophisticated. The controls usually found in new buildings are of two basic types: pneumatic, and electronic or electric. In some applications there will be combinations of these systems. The pneumatic system operates on a central air system and utilizes thermostats and other control devices to activate various air operated motors and valves. Similarly, electronic or electric controls activate electric motors, valves and other devices to provide the required temperature. There are good features of both systems, and the determination of which to specify is influenced by the equipment to be controlled and the local availability of competent service for the control system.

The choice of a heating and air conditioning system for an educational facility depends on many factors which must be evaluated by the educational administrator, architect, and engineer if satisfactory results are to be obtained.

Even when every reasonable effort is made to obtain competent engineering design, the following maintenance and operation problems frequently appear:

1. Heating and cooling coils and pipes are damaged by inadequate freeze protection.
2. Controls and valves on mechanical equipment are exposed in occupied areas, and are difficult to adjust and maintain.
3. Mechanical components in occupied areas lack the heavy duty enclosures, well braced and securely anchored, required to reduce maintenance cost.
4. Classroom activities and assembly programs are interrupted by noisy heating and cooling equipment.
5. The entire heating and cooling system of a building must be operated to maintain the desired temperature even when only one small area is to be used for after hours activities.

6. Exposed insulation on piping in occupied areas is damaged through inadequate protection. People can be burned by hot pipes; condensation can accumulate on cool ones.
7. Lack of proper air control on water or hydronic systems causes blocks to water circulation, with the result that some areas have no heating and/or cooling.
8. Mechanical equipment is not accessible for service, so that items such as air filters cannot be changed.
9. The noise created by turbulence and vibration of water circulating through a cooling tower connection as it passes above a suspended ceiling can make normal conversation impossible.
10. A condenser for the air conditioning system of a new addition can create a noise problem in the existing non-air-conditioned building if windows are left open.

These problems should be kept in mind when mechanical facilities are being planned. Geographic area, atmospheric conditions, possible types of energy, and availability of qualified maintenance personnel are also important and must not be overlooked when selecting heating and air conditioning equipment.

Inadequate ventilation, whether gravity or mechanical, often seriously deters successful maintenance and operation of a building. Range hoods should collect and exhaust cooking odors, heat, and fumes from combustion. Dishwashing areas must have hot, humid air removed for proper air drying of dishes and comfortable working conditions. Custodial closets, food storage rooms, athletic storage rooms, garbage rooms, large rest rooms, chemical laboratories, and similar areas need adequate and continuous ventilation if supplies and equipment are to be protected and undesirable odors minimized.

Electrical Systems

Closely related to all mechanical systems is the electrical system. Whether power is supplied to a building from a public utility or from an on-site power plant within a building, the electrical distribution system will be the same.

The increased demand for electric power to all areas of a building and the flexibility that is a part of today's designs have created problems in designing electrical distribution systems. Movable walls, movable furniture, and changeable shapes and sizes of space have made it necessary that flexibility be built into electrical systems.

The administrator, through his educational specifications, must describe to the architect and engineers the educational program to be conducted in a building. Interpreting and transforming these specifications into a building demanded by the program requires the best in architectural and engineering talent.

The total electrical distribution system of a modern building must comply with applicable electrical codes and should be designed by qualified electrical engineers. Electrical equipment should be dependable heavy duty items for which replacement parts and service are readily available. Provisions for expansion of the system are of particular importance as related to the growing electrical demand in existing buildings and to any future plant additions.

These highly complex networks should receive thorough electrical servicing as required by the fire alarm system, by the intercom, public address, and other communication systems, by central control systems, by lighting and mechanical units, and by television systems. Otherwise, a building soon will become cluttered with a maze of wiring, often cumulatively installed by unqualified or inexperienced people.

Keeping lighting equipment in serviceable condition is one of the most costly areas of electrical maintenance. Lighting fixtures should have durable, non-yellowing, easy-to-clean finishes. Keeping light fixtures clean has a direct relationship to the maintained lighting level. Where plastics are used, they should be light, stable, and of a non-yellowing type. Ballasts to operate fluorescent and similar type lamps should be highpower factor, CBM (Certified Ballast Manufacturers Association) approved, and the complete fixture should bear the UL (Underwriters Laboratory) label.

Gymnasium and other high-bay lighting equipment may require guards and special provisions for re-lamping, either by lowering the fixture or with pole-type lamp changers.

Vandalism of exterior lighting fixtures, a constant problem, can be reduced by mounting the fixtures high on the building or by using heavy duty guards. A school's neighbors should be considered when exterior lighting is designed, for an arrangement that illuminates the school may well be a nuisance to adjoining property owners.

Placing bracket-type fixtures in stairwells often will make them serviceable from an 8-foot stepladder, so that replacing a burned-out lamp would not have to wait until a longer ladder or scaffold can be brought. Key- or lock-type light switches have proved very effective for stairs, corridors, rest rooms, and other locations where a carelessly turned-off light can create a safety hazard.

Clocks and program bells, operated from a master clock and programer, are usually made part of a new building. These consist of

"Last year, old Phineas did a triple gainer and placed third in the high dive."

the following types: direct-wired minute impulse, direct-wired synchronous, and electronic. The selection as to type is influenced by building size, availability of suitable service, flexibility required for the program, and future modifications that may be necessary due to remodeling or expansion of building areas. Exterior class bells should be placed with consideration for adjoining property owners as well as for the educational program. Guards or safety-type lenses to protect clocks customarily are needed in gymnasiums and other activity areas.

On occasion, service personnel have found it difficult after hours to attract the attention of a building custodian to admit them. This is especially true for large air conditioned buildings where windows are both less numerous and often closed. Key-operated call stations, connected to the program bells and located adjacent to the outside mechanical room door, can help solve this problem for maintenance personnel.

Water Piping and Water Supply System

Water piping requires competent engineering design if proper volumes and pressures are to be available to meet the needs of plant operations. Certain problems occur rather frequently, and these merit special attention if a building is to have good maintenance and operations characteristics and be free from disturbing noises. Here are aspects of equipment needed or desirable to meet seven such problems:

1. Shock absorbers should be installed to eliminate noise caused by water hammer and resulting noisily rattling pipes.
2. The installation of key-type hose bibb faucets is desirable in large restrooms, kitchens, garbage rooms, and other areas where floors are to be hosed down.
3. In cold weather areas, key-operated, freeze-proof outside faucets should be located to provide most efficiently for watering grounds, washing windows, and other maintenance and operation requirements.
4. Freeze protection is needed for water piping, even in attic spaces, pipe chases, and other concealed locations. There have been cases where grading work done after water piping was installed left insufficient earth cover, so that when the temperature later dropped, the yard service (piping) froze, shutting off water to the building.
5. Underground piping is often subjected to corrosion and electrolysis and requires special selection and protection if reasonable service is to be obtained.

6. Valves should be provided to shut off water service for large rest rooms and other areas so that trouble areas can be isolated without interrupting water service to the entire plant.

7. The selection of plumbing fixtures and brass is important also. Good quality heavy-duty items that can be securely anchored are required. Replacements should be readily available. Faucets should have removable seats for easy maintenance and long life. Plumbing equipment should be as tamperproof as reasonably possible.

Many rural areas rely for water on wells or other sources rather than on a municipal or public water system. Deep-well pumps, filtering and chlorinating systems, storage tanks, controls, and piping systems — each one a potential problem — then add to the maintenance and operation tasks of those rural areas' educational facilities. A plentiful supply of water is one of the most important necessities of a building. The source and equipment must supply abundant water without interruption and with a minimum of maintenance.

Deep wells are the usual source of water supply in rural areas, so the quantity and quality of water for different uses of a facility must be determined early in the planning stage. Even with early and accurate determinations, it is often necessary to compromise when drilling operations reveal that calculated needs cannot be achieved without excessive cost.

Larger water storage tanks or reservoirs than those planned are necessary when a well fails to produce water at the anticipated rate, and experience has taught that many wells have had to be drilled deeper than originally intended in order to reach a suitable water supply. In turn, the greater depth makes necessary the installation of larger or different-type pumps than planned. Well depth, system pressure, and the quantity of water to be pumped are factors which influence the selection of pumping equipment.

The cost of well drilling depends on the sub-strata which must be penetrated in order to reach a satisfactory water supply. The amount of casing, screens, and strainers needed to keep surface water, gravel, and sand out of the well all enter into the drilling cost. The diameter of the well also affects the cost greatly. Generally, the minimum diameter needed to accommodate the pumping equipment is the size that should be drilled.

Although early planning is needed for the water system of an educational facility, plans and specifications must be kept flexible enough to cope with changes associated with drilling, pumping equipment, and storage requirements.

Waste Piping and Sewage Disposal Systems

Waste piping design and layout require the services of a qualified engineer. Certain provisions are frequently omitted that are very important to a good program of maintenance and operations. To ensure their inclusion, specifications should stipulate that builders:

1. Use metallic or glass acid-resisting piping for handling chemical waste from laboratories.
2. Use cast iron piping in areas where roots from trees or shrubs are likely to cause stoppages.
3. Install an adequate number of properly located floor drains in kitchens, large toilet rooms, mechanical equipment rooms, and other areas where it is planned to wash down floors, drain equipment, or provide building protection from water leaks in mechanical equipment.
4. Install a direct waste connection for the food disposal unit in order to reduce stoppages.
5. Provide an adequate number of cleanouts that are readily accessible for clearing stoppages.
6. Exercise care in locating grease traps and catch basins, since these require frequent cleaning — a messy operation that usually involves obnoxious odors.

When these provisions are omitted to hold down initial cost, false economy results.

Sewage Systems

When new facilities are built where municipal or county sewage systems are not available, it becomes necessary to provide a separate, independent sewage disposal system. The primary objective of a sewage treatment and disposal system is to prevent the contamination or pollution of the land and water to which the solids and liquids return after treatment. By careful planning and good design, it is possible to construct a separate sewage disposal system that will give a long and satisfactory performance with a minimum of maintenance.

Unfortunately, there is a great lack of knowledge among administrators concerning the equipment, function, space requirements, and maintenance and operation procedures of sewage disposal systems. It is recommended that expert professional services be engaged for this problem. No other single factor affects the selection of sites more than the suitability of the terrain, soil, and space for the sewage disposal system, if one is needed.

Sites have been purchased in situations where sewage plant requirements were ignored, with the result that the land could not be used. In other cases, administrators have belatedly discovered that additional land had to be purchased at premium prices to accommodate a sewage system.

Briefly, a separate sewage system can consist of almost any combination of these component parts:

- Grease trap
- Septic tank
- Dosing chamber
- Distribution box
- Nitrification (tile) field
- Subsurface sand filter
- Oxidation pond
- Package plant

Since so little is known, outside health-engineering circles, about these component parts, a brief description and statement of function may be of some value:

Grease trap. The grease trap is basically a holding or cooling chamber through which sewage from kitchens is diverted for the purpose of congealing and collecting the grease, thus preventing it from entering the remainder of the system. Grease traps are generally installed in the ground, but are extended to the surface with a movable cover for convenience of cleaning.

Septic tank. The septic tank is a chamber installed to retain and digest most of the solids contained in sewage. Anaerobic bacteria digest most of the solids in the septic tank. Since these bacteria do not require oxygen from the air, in most instances the septic tank is installed completely below the ground surface. Manholes are provided in the tank tops for inspection and cleaning purposes.

Dosing chamber. In most sewage systems used for schools, a dosing chamber is required. Dosing chambers contain siphons, or pumps, which rush the sewage into the nitrification field or subsurface sand filter, causing the entire length, or area, to be utilized. Were the sewage allowed to flow by gravity, only a small portion of the field or filter would be used. All nitrification fields containing over 500 feet of trench, and all subsurface sand filters, require a dosing device.

Distribution box. The distribution box is a chamber from which branches of tile trenches of a nitrification field and subsurface sand filter originate. The purpose is to provide more even distribution of sewage to the field or filter.

Nitrification field. A nitrification field is a system of specially designed tile trenches. The trenches are an extension of the septic tank, since the sewage that flows into the tile field is still septic and since additional digestive processes have to take place in the field. Aerobic bacteria are present in the trenches and complete the digestive process. Digestion by these bacteria, which require oxygen from the air, does not leave a sludge.

All the remaining solids from the septic tank, which flow into the nitrification field, are converted into nitrates and absorbed into the ground along with the liquid. The size of the nitrification field needed for a given facility depends upon the rate at which the soil will absorb the liquid. This rate is determined by percolation tests.

Subsurface sand filter. The subsurface sand filter is a modified version of a nitrification field. It is used where a nitrification tile field is not feasible because of soil conditions, or when the size becomes impracticable. In the subsurface sand filter, the remaining solids leaving a septic tank are filtered out of the sewage with a special type of sand. Digestion by aerobic bacteria takes place here much the same as in a tile field. The liquid from a subsurface sand filter must be directed into an all-weather stream, which limits the use of subsurface sand filters.

Oxidation ponds. An oxidation pond is a shallow natural or artificial basin containing two-and-a-half to three feet of water into which sewage is directed. Bacterial decomposition of organic waste releases carbon dioxide to the water, which causes heavy growth of algae. The algae, during daylight hours, release oxygen which, in turn, allows a high level of aerobic bacteria to digest the solids. Oxidation ponds need considerable sunlight to function efficiently. Also, they cannot be used where long periods of subfreezing temperatures prevail.

Package plants. A package plant is a mechanical type sewage disposal system containing filters, oxidizers, pumps, dryers, and other equipment which can be used to accelerate the process of oxidation and digestion of sewage.

Some of the major mechanical systems which are common in educational facilities have been dealt with here. There are many other types of mechanical and electrical systems which have not been discussed. The most important fact for administrators to bear in mind is that early planning for the mechanical and electrical systems of buildings is a prime factor in the later smooth functioning of the buildings.

5. Building Exterior

When insight and understanding are truly reflected in design, a quality is added to educational architecture that is something above and beyond problem solving. There is a vigor that will not diminish, a freshness that will not wither, an agelessness that will not fade with the years.

Aesthetic qualities in a building exterior not only are important to the students and faculty who use the structure, but more often they provide the sole image of the educational facility to the rest of the community. Additionally, the selection, use, and maintenance of proper materials is necessary to obtain maximum value from capital investments in physical plant.

Beauty Need Not Be Expensive

The challenge to architects and administrators is to use available funds for the greatest educational benefit. Budget problems, severe and difficult as they often are, are not nearly so acute as is a lack of creative, constructive ideas.

Among the many maintenance problems encountered, moisture is perhaps the greatest. Exposed surfaces must be protected against the elements; in turn, the surfaces must be kept in condition to protect the interior of the building.

Moisture penetration of a building exterior not only can damage interior finishes, it frequently results also in chipping of masonry and discoloration of the outside of the building. Since exteriors are subject to different climatic conditions, and since, in addition, the amount of air pollution varies with geographic locations, care should be exercised in determining the local suitability of the building materials to be used.

The thermal insulating qualities of the exterior "skins" of buildings become critical when related to building, operating, and maintenance costs, particularly with regard to the cost of heating and cooling equipment. Protection of interior areas from solar heat gain is another factor that must be considered.

With the advent of supersonic jets, noisy, heavily traveled streets and expressways, and other outside or school-generated noise, great consideration must be given to sound transmission through exterior surfaces. A mass such as a solid wall is an effective means of reducing unwanted sound. However, small openings in exterior surfaces permit airborne sounds to penetrate and disturb the instructional program.

Careful planning to limit these openings and provide for sound absorption will be necessary where high noise levels exist.

Operating components in the exterior walls, such as windows and doors, must be durable and able to withstand the heavy use to which they will be subjected. Special needs should be considered, too; for example, approaches to exterior doors should be constructed to accommodate physically handicapped students.

The Roof

Many people today cannot believe that in this age of advanced technology it is almost impossible to apply an absolutely watertight roof to a new educational building. There is no way to assure an administrator that the roof on a new building will not, at some time, leak and require maintenance. For this reason, it is extremely important that the proper type of roof is selected, that expert supervision is provided, and that qualified workmen are engaged.

The selection of a roofing system is influenced by architectural design, life expectancy of the structure, local climatic conditions, type of roof deck provided for the structure, and the availability of materials and competent workmen in the particular locality. Some of the more common roofing types are built-up roofing, shingles, roll roofing, and thin plastic applications.

Probably the most used type is built-up roofing — multiple layers of felt bonded together with a bituminous coating and topped with a gravel wearing surface. The best procedure is to use products of a well-established manufacturer, and to install the roof in accordance with the manufacturer's recommendations. Most manufacturers provide information on the installation of roofing with life expectancies varying from 10 to 25 years.

Administrators should not let themselves be lured into a sense of false security by exaggerated claims of roof performance or durability. Liability, under the provisions of a roofing bond, is usually limited to roofing material cost and seldom includes labor or damage to building or contents. Thus, in the use of built-up roofing, the quality of the manufacturer's product and the performance capabilities of the contractor installing these materials are foremost considerations. The roofing sub-contractor should be an experienced, capable company with a good record of performance and financial stability.

Careful consideration must be given to the expansion and contraction of the structure and the resulting effect on the roof deck. This factor has become more important in recent years because of the increased use of precast concrete structural components. Fre-

"Have you considered becoming an early drop-out?"

quently a light-weight insulating concrete fill is used to provide all, or a substantial part, of the roof insulation. The expansion and contraction of this type of structure usually involves more movement than hairline cracking. If the roofing membrane is too securely attached to the rigid roof deck, the movement will rupture this membrane. Ways to reduce the possibility of this type of roof failure include spot or strip mopping of the base sheet, nailing the base sheet to the roof deck, applying a softer or more pliable insulation over the rigid deck.

For example, in one case, a 20-year bonded type built-up tar and gravel roof was installed over a precast roof structure where channel joists were used to span from beam to beam. A rigid-type poured insulation provided all of the roofing insulation. The built-up roofing was then solidly mopped (i.e., affixed) to the rigid insulation. The movement of the building caused a crack in the roof deck along the main supporting girders; the crack varied as much as three-eighths of an inch with changing temperatures. The result was a continuous rupture of the membrane where each of the supporting girders occurred.

To correct this, the contractor removed three strips of the roofing, each approximately four feet wide, across the entire building where the membrane was ruptured. A dry sheet was utilized against the roof deck, and new sections of membrane were installed. The use of this type of installation distributed the stress of building movement over a larger width of membrane and was successful in eliminating the problem.

Shingles are either asphalt-type flexible shingles or hard, rigid types such as slate, tile, and cement asbestos. In most areas, it is advisable to install roofing felt or some other type of membrane over the roof deck, prior to the installation of shingles. The asphalt shingle commonly used in residential construction is susceptible to wind damage, and probably should not be used in areas where severe wind storms occur. Heavy-duty bondable asphalt type shingles that will withstand greater wind velocities provide much longer life expectancy. These should be given serious consideration where sloping roofs are used and other conditions make a flexible shingle desirable.

Shingles such as slate, tile, and cement asbestos usually have a much greater life expectancy than the asphalt shingle. However, they are more vulnerable to the type of damage caused by hailstones, rocks, or other falling objects.

For instance, a cement asbestos individual tab shingle was applied on a pitched roof in an area where light hailstones occur periodically in the summer months. These hailstones were never known to be much larger than one-half inch in diameter. However, during one summer storm, stones as large as two inches in diameter fell. The cement asbestos roofing was damaged so badly it had be completely removed and replaced. This is an unusual case, and similar size hailstones have not fallen in this area for more than 20 years. Yet the possibility of such a major roofing loss does exist.

Thin film roofing membranes, usually of a spray-type plastic variety, have become quite popular in recent years where architects have been concerned with the appearance of roofing applications on thin shell or folded plate concrete structures. Extreme care should be exercised in the selection and use of this type of roofing. A roof coating of demonstrated performance must be applied in accordance with the manufacturer's recommendations, and specific provisions must be made for supervising and determining the thickness of the membrane after it is applied.

As a general rule, these membranes have a much shorter life expectancy than most types of conventional roofing. Ice and other physical forces can rupture this membrane, and it should never be utilized in areas where it is subject to physical damage by thrown rocks, or where servicing of equipment would cause traffic to pass over it. In addition, this type of membrane is easily ruptured if structural movement creates cracks larger than hairline size.

More specifically, physical damage to a thin plastic membrane over a folded plate roof structure creates real maintenance problems. The result will be a considerable expenditure of money to replace the roofing membrane and to repair any interior damage. An example is cited of a membrane of this type being broken apparently by objects thrown onto the roof. Moisture penetrated the membrane and saturated portions of the light-weight insulating concrete fill on the roof deck. Resulting freezes caused the fill to deteriorate so that large sections had to be replaced. Large areas of the roof membrane also had to be replaced, and finally a more durable roofing material was provided.

Flashing for roofing should be in accordance with manufacturer's recommendations and can be of bituminous material or metal. Most manufacturers provide details of acceptable types of flashings to be used with their roofing. However, care should be exercised to ensure that the appearance of the building will not be damaged by staining, which might occur from the use of copper, raw steel, or other materials exposed to the weather.

Where thermal insulation is provided over the roof deck, careful consideration should be given to the effect of moisture in reducing or destroying the insulating values if the roofing membrane is ruptured. Some insulating materials can be dried in an acceptable manner, while others would be permanently damaged, so that it would be impossible to restore their insulating qualities. This reduction in the capability of the roof structure to reduce the heat gain or loss could have a pronounced effect on the thermal environment of a building. Saturated insulating materials create an added maintenance hazard where a corrosive type of metal decking is used.

In one particular case, a built-up roof was installed over fiberboard insulation on a metal roof deck provided with a shop coat of paint. Intermittent moisture penetration of this built-up roofing membrane caused the fiberboard insulation to be saturated with water over an extended period of time. The insulating qualities of the fiberboard were reduced, the deck rusted, and large areas of the deck had to be replaced. A corrosive resistant deck might have saved the roof, despite the breakdown of the insulation.

On flat roofs where parapet walls are used, scuppers will permit the water to overflow before it rises over the roof flashing. Obstructed downspouts can cause considerable damage when there is no alternate way to dispose of the accumulated water.

Skylights are often installed in roof structures. Careful consideration should be given to waterproofing these installations and controlling light and heat transmission. Installing the skylight on a raised curb around an opening in the roofing is usually the most successful installation. Skylights flashed directly into the roofing have caused problems in maintaining the integrity of the roofing membrane.

Planning should guard against hot spots inside the building directly under skylights. Shutters or blinds will control both light and heat transmission. Also, condensation accumulating on the inside of the skydome is a possibility. Where condensation is likely to occur, proper provision should be made to collect and dispose of the moisture.

The roofing and insulating system should be selected with regard to sound transmission. For example, an un-insulated metal roof deck becomes extremely noisy in a heavy rain or hail storm. In some areas, sounds from aircraft or other sources are a problem.

A number of problems involving moisture condensation and penetration are blamed on roofing installations. Condensation will cause water to accumulate on the bottom side of metal decking if proper ventilation or roofing insulation is not provided. This moisture will accumulate and drip down onto the ceiling much the same as a roof leak. Proper ventilation of the space between the ceiling and roof deck will, in most cases, eliminate this.

Another moisture problem that resembles a roof leak involves the penetration of water into parapet walls and other masonry elements of a building exterior. In areas where this is common, it would be advisable to waterproof the wall or to extend the waterproofing membrane up the back side of the parapet wall as well as providing a membrane under the wall coping.

The selection and installation of roofing is one of the most important decisions to be made in planning a new educational plant. Continued efforts must be made to find better materials and methods of application for this vitally needed protection.

Exterior Walls

Exterior walls should be constructed of materials with non-porous surfaces. Window sills, coping, and horizontal masonry surfaces should be water repellent. Some of the most common exterior wall materials in buildings are concrete, solid masonry, masonry cavity walls, metal curtain walls, and glass. Whatever type or combination is used to form the exterior walls, a careful study should be made to determine the wall's thermal insulating properties and their effects on heating and cooling costs. Waterproofing and moisture-proofing also must be provided for exterior walls if satisfactory maintenance is to be achieved.

In constructing exterior walls, it is necessary to allow for the drainage of moisture that may be absorbed into the face of the wall or that may condense inside the wall. Weepholes and flashings will insure that this moisture returns to the exterior instead of penetrating to damage interior finishes.

The appearance of exterior wall textures and finishes cannot be maintained throughout the life of the building if smoke, soot, and other harmful fumes and soil discolor the exterior finishes. It would be extremely difficult to maintain a light-colored masonry finish in a heavy industry area; there, material that will resist soot and other discoloring action would be preferable.

Walls below grade should have an exterior waterproofing or membrane application to prevent moisture or water under hydrostatic pressure from penetrating the wall and damaging the interior. It is also desirable to insulate the building wall against the earth fill. These measures reduce heat loss and gain through the wall, improve comfort, and reduce the possibility of condensation. Where hydrostatic water pressure is likely to occur at a below grade wall, provision should be made to relieve the pressure; one of the most effective ways is to install a drain tile on the outer perimeter of the wall as a water course away from the area.

Masonry walls are most commonly used for building exteriors. If properly selected, masonry usually provides good fire resistance and an enduring quality of exterior finish. In selecting brick, stone, or terra-cotta for the exterior of a building, the standards of the American Society for Testing and Materials (ASTM) in regard to water absorption and other physical properties should be considered. Material that does not adequately resist moisture penetration could fail to prevent spoiling and discoloration. An exterior application of a transparent waterproofing material could eliminate these hazards.

Many colors and textures are available in clay masonry materials. If the masonry wall is properly constructed and structurally sound, it will require little maintenance over a period of years. Full waterproofing and tooled joints help reduce moisture penetration of exterior masonry walls. Expansion joints should be provided at frequent intervals to reduce cracking. Where walls incorporate concrete block, only cured concrete block should be used. High-pressure cured block is more resistant to expansion and shrinkage caused by moisture and will, in some cases, permit control joints to be as much as 50 feet apart. Concrete block walls should incorporate bed joint reinforcing to reduce the possibility of large unsightly cracks.

Concrete walls are of two principal varieties: (1) poured-in-place concrete, and (2) precast concrete. Aggregates should be selected in accordance with ASTM standards in order to assure a finished material that will meet the needs of the particular situation. If the aggregate is too porous and absorbs a large amount of water, freezing will cause the aggregate to fail and leave a pock mark on the surface of the wall.

Patching and repairing of blemishes or defects in concrete are best accomplished immediately after the forms are removed and before the concrete has obtained its full strength. If the concrete has been poured for a considerable period of time, it is advisable to utilize a bonding agent in attempting to repair any blemishes or defects in the surface. It is usually impossible to match texture and color when patching monolithic concrete.

Some type of waterproofing is needed to protect the concrete from crumbling when it is subjected to freezing and thawing cycles. This can be accomplished by use of waterproofing admixes in the concrete or by a surface application of a masonry waterproofing material.

In order to assure high-quality concrete for use in structures, it is necessary to have a rigid laboratory test of the concrete mix and of the field specimens taken at the time of placing. These laboratory tests should be in accordance with ASTM standards.

Qualified supervision will help assure proper handling, placing, and curing of the concrete. The best concrete mix in the world can be ruined by adding too much water, by delay in placing, by other faulty work techniques, by inadequate protection from weather conditions, and by lack of proper curing. There have been significant advances in the use of concrete in building structures. However, it is difficult to obtain full benefit from the latest laboratory developments because of the difficulty in controlling the varied field operations.

Curtain walls are primarily of aluminum or steel. Curtain wall installations should be designed to provide proper structural strength to resist wind storms and to make adequate provisions for expansion and contraction of the metal components. An excellent waterproofing system is also required to prevent moisture penetration. Weepholes and other measures to eliminate water that may penetrate into a curtain wall are absolutely necessary. One of the latest developments in this area involves the use of large weep openings to balance the pressure so that water drains out, rather than into inside areas.

Curtain walls usually incorporate glass and solid panels. The insulation and durability of the panels are important, not only for heating and cooling, but to resist physical damage and for permanence of color and texture. A proper sealant or caulking material should be used in the installation of curtain walls. The most satisfactory types have a rubber, silicone, or polysulfide base. Design should conform to standards adopted by the Architectural Aluminum Manufacturers Association.

When wood finishes are used on building exteriors, they should be treated for moisture proofing and for protection from fungus and termites. Maintaining wood exterior finishes is quite difficult in many sections of the United States; it is not easy to obtain a long lasting paint finish on wood that is exposed to moisture and sunlight. Materials of proven performance under local conditions should be used.

Damp-proofing and caulking of exterior surfaces is of utmost importance; a sealing or caulking material of a rubber, silicone, or polysulfide base should be used to seal cracks where different materials join, as well as at construction and expansion joints.

Insulation of exterior walls should be carefully studied in relation to the type of heating and cooling system to be used. Frequently the addition of cavity wall fill insulation or other types of sidewall insulation will result in a lower-cost building with reduced operating cost. This is particularly true when electricity is used as the energy source. Good thermal design will not only reduce cost, it also will increase the thermal comfort of the interior area.

For example, during the design of a 15-classroom, compact, air conditioned elementary school, the architect and consulting engineer made a careful study of the relation between thermal insulation and the cost of providing, maintaining, and operating the heating and cooling system. This study revealed that the expenditure of an additional $54 per classroom on thermal insulation would result in a $100 per classroom reduction in equipment cost. It also became obvious that there would be a reduction in the cost of energy to operate the equipment.

Other factors to consider in the selection of materials is the ease of replacement, local availability of material, life expectancy in relationship to life of building, suitability to climatic conditions, aesthetics, and ease of maintenance.

Repetitive units which can be produced at a reasonable cost should be considered. Pierced walls and walls with projecting units that can cause problems, if they are within reach of children and can be climbed, should be avoided. Much needless damage has been done to roofs and mechanical equipment located on roofs by persons who use accessible walls as ladders to the roof.

Windows

Many types of windows are available today, and it is difficult to make a selection just by viewing a sample unit. Most window frames are fabricated from steel, aluminum, or wood; the type of material selected should be determined by climatic conditions, cost of initial unit, aesthetics, and long term economy of maintenance. Organizations such as the Architectural Aluminum Manufacturers Association, Steel Window Institute, and National Woodwork Manufacturers Association classify windows according to air infiltration, structural strength to resist winds, rigidity of components, and resistance to water penetration. These standards are helpful in comparing different products and serve as an excellent guide for selecting windows.

Both the selection of the finish for the windows and the protection of this finish during construction are important if the desired appearance is to be maintained throughout the life of the structure. Many window installations with factory finishes have not provided a satisfactory appearance because of improper handling during construction. The long-range cost of maintaining window finishes should be determined, especially with regard to local climatic conditions which may present unusual problems.

The quality of the hardware and the method of its attachment to the window are also important because they affect the cost of maintaining these units. All hardware should be securely attached. In

"Will ya do that again, Mister? My sister didn't see it."

many cases, grommets or other special means of attachment are desirable on soft metal, such as aluminum, to insure the heavy-duty service they will receive. Frequency of use should be a prime consideration in selecting windows and hardware. The operation of window vents, for example, is greatly reduced in an air conditioned structure, and this lessens the need for heavy-duty durability.

Hinged or casement-type windows need positive operating hold-open devices to protect building occupants, as well as the windows themselves, from the hazards of strong winds.

In one case, casement-type windows with friction-type hold-open arms were installed in an elementary school. A sudden gust of wind through the open windows overcame the friction of one hold-open arm and slammed the window closed with such force that the glass shattered into the classroom.

The type of glazing provided in windows demands careful selection. A window specified for normal clear-glass glazing is not usually constructed to receive heavy wire glass, thermopane, double glazing, or other special glazing. Some thought should also be given to heat resistant and low light transmission glass. In a gymnasium, brightness contrasts can be reduced by using a low transmission glass or plastic glazing for day lighting purposes. Helpful for maintenance is the ability to replace broken windows from the inside — a real time and money saver, especially in multi-story buildings. Pivot windows, or those provided with inside glazing, are available.

Safety-type glass should be provided wherever required by hazardous conditions. Where there are large areas of clear glass, provision should be made to prevent people from carelessly crashing into or through the glass. Strategic placement of furnishing and plantings reduces this danger.

Projecting, or casement, windows are a hazard when they open out into areas where students may be passing or playing. Numerous people have been injured by striking projecting vents on the outside, or hoppervents on the inside, of buildings. For example, projecting-type metal windows were installed in a new high school around the perimeter of a paved outdoor court. One window wall paralleled a commonly used traffic area in the court and the windows were in reach of the people crossing the court. After several students were injured or had their clothing torn, this hazard was eliminated by building a planter box along the wall to keep traffic away from the dangerous projection.

Window screens must be supplied where required by health codes. This is particularly important at the initial installation because it can be difficult to obtain the correct screens once the original windows are in use.

In recent years, the widespread use of air conditioning has made it possible to reduce the amount of window area in buildings. Less expensive and more durable wall materials which reduce heat gain and loss through the walls should be considered if a new building is to be air conditioned.

Doors

The selection of doors, frames, and hardware which are durable in quality and reasonable in cost is one of the most important decisions affecting building maintenance. Consideration must be in terms of frequency of operation, aesthetic appearance, fire rating requirements, and general maintenance characteristics. The majority of doors are of steel, aluminum, or wood, with varying amounts of glass. For most of these types of doors, there are industry standards which serve as good guides for comparison and selection. Organizations such as the National Woodworking Manufacturers Association and the Steel Door Institute provide reliable comparisons of stability, durability, and freedom from warping and delaminating.

There are many standard stock doors available which are ideally suited for low usage areas such as classrooms, closets, and utility rooms. There are even a few standard stock items presently able to meet the heavy usage and high abuse requirements of exterior doors, stairwell doors, and restroom doors. Every effort should be made to obtain heavy-duty, low maintenance doors. The repairs and replacements needed to maintain proper door operations are by far the most common general building maintenance problem.

Satisfactory door operation requires both quality hardware, securely attached to both the door and door frame, and a thorough preventive maintenance inspection program. Metal doors must have adequate heavy-duty reinforcing, both in the door and the frame, before either surface type or mortise type hardware can be applied.

Dragging doors caused by distorted frames are a major source of malfunction. Reinforcement of the upper hinge or pivot point is especially important where door closers and hold-open devices are used. In one specific case, the exterior doors and stairwell doors of a new high school building began to drag against the floor. Several pairs of doors actually overlapped. In each case the reinforcement and the door frame were distorting and changing the relationship of the hinge to the door. Traffic through these doors was unusually heavy and in some cases abusive. As a remedy, the frames were straightened and additional stops and limiting devices were placed on the floor and on each door. This measure improved the situation at first, but the same problem recurred at three- to four-month intervals. The final solution involved cutting into each door frame and adding additional heavy-duty reinforcement to eliminate distortion.

If the type of hardware to be applied is not clearly indicated in the specifications, a persistent maintenance headache may result. In selecting specific pieces of hardware, heavy-duty durable items should be chosen. Hinges and pivots for high-use doors should include heavy-duty ball bearings along with properly sized door closers. Door holders, stops, or other safeguards will protect exterior doors from being damaged or torn from hinges by a sudden gust of wind.

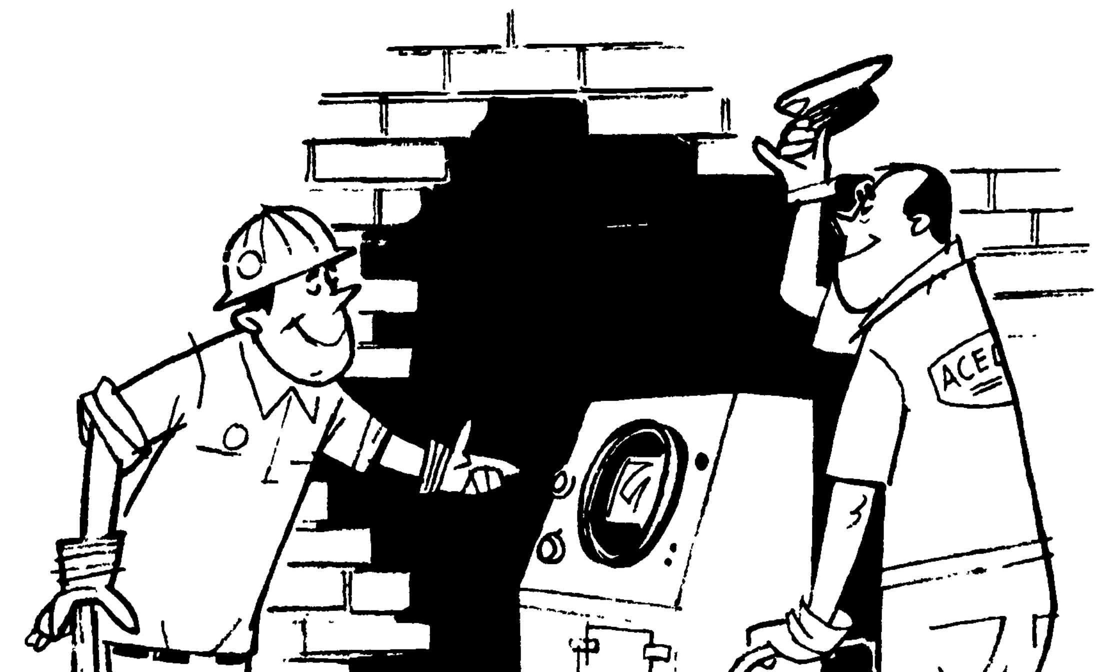
Generally, stainless steel, chrome-plated, and aluminum hardware have an easy-to-maintain finish and, if carefully selected, give the necessary heavy-duty operating service.

Thresholds seldom receive enough attention, but they are extremely important items, especially where paired doors are used in a single opening. Thresholds are available in various materials, and should be selected in light of the function they will perform, with consideration also given to the needs of handicapped students. Where paired doors are used in a single opening, a latch track threshold will provide a stop across the bottom of the door as well as offering a means of locking surface mounted vertical panic bars. However, care should be taken to avoid using a threshold where wheeled furniture or equipment must be moved with any degree of frequency.

When paired doors are used in exterior openings and both doors are operating, it is desirable to have split adjustable astragals on the exteriors. (An astragal is a small, convex molding.) In this way it is possible to control the amount of air infiltration around the door, and to improve security where retractable-type panic latches are utilized.

Where pairs of exterior doors are provided with panic hardware in a single opening, forced entry from outside will be relatively easy unless a threshold stop is provided. Pressure at the bottom of the door leaf that has the latch bolt makes it easy to open the latch with a knife blade, fingernail file, knife, or similar object. One large city school system that was plagued by this type of entry into buildings reduced the problem considerably by installing new thresholds with continuous stops at the bottom of doors. This installation was done on a system-wide basis and proved to be a good investment.

A wise practice is to protect door entrances by recessing them or by providing overhead shelters. Doors are thus protected from deterioration caused by exposure to heat, cold, and moisture, and the penetration of wind-blown water through the cracks around the door


ACE

openings is reduced. Where rain blows against exterior doors, a split-type astragal on the outside can help to reduce the water infiltration.

Various types of finishes are available for doors, ranging from paint to metal to plastic laminates. On doors receiving high use, durable finishes or protective push and kick plates must be installed. Exterior finishes should be selected to suit the climate of an area. In most locations, moisture resistance is an important consideration.

Obviously, the door unit requires dimensional stability, freedom from warping and corrosion, and rot resistance. Some wood doors have a tendency to expand and contract with changes in humidity and differences between the exterior and interior exposure. Under such conditions, it is difficult to keep doors both working well and secure against intruders.

If large areas of glass are used in doors, each door should be rigid and free from distortion. This provision will reduce breakage under normal usage. In all cases, safety glass, such as tempered glass or wire-reinforced glass, should be specified.

If wood doors are used in exterior walls, they should be properly built for such exposure and only waterproof adhesives should be used. When a door is sealed on all sides and edges, moisture content will not vary with weather conditions. Many installations receive such heavy use that they require first-quality solid-core doors whenever wood is utilized.

Careful study should be made of equipment and traffic in and out of buildings. Doors may not be large enough to handle some of the equipment used in kitchens, shops, mechanical areas, and other special purpose areas. Interesting proof of this inadequacy occurred in a new building where a laundry area was provided in conjunction with a new athletic dressing room. When the laundry equipment was being moved into the building, it was found that the doors were not large enough to permit entry of the clothes dryer. It was necessary to remove a section of the finished wall in order to move the equipment into the area.

A screen door rarely gives a satisfactory and long-lasting performance. Protection must be provided for the lower part of the door to reduce physical damage to the screen. Another requirement is for hardware that will protect the door from strong w nds and hold it in an open position when required. If the screen door is placed on a single frame with another door, the frame should be wide enough so that hardware can be installed for protection from the weather.

A door closer on an exterior door, and on some other locations, can be installed on a bracket in the door opening. A doorway must be high enough to permit tall adults to pass under the door closer without striking it.

Door closers and other building hardware require space and must be considered when door and room layouts are prepared.

An important problem is to control the transmission of sound through doors and door openings. A thin, single-layer panel-type door, where diaphragm action occurs, is not nearly so effective in controlling sound as some flush-panel insulated doors. If sound transmission is a serious problem, weatherstripping around the opening will minimize the sound seepage.

The door and its operating hardware are among the most used and abused items in a building. There is no substitute for a door properly designed and carefully selected with consideration for the functions it is to perform. A small amount of extra money spent to satisfy specific needs is a real investment in long-term economy. In the selection of exterior doors, resistance to forceful entry and vandalism is particularly important. Use of doors by handicapped students also is a consideration of major importance.

Building Hardware

An architectural hardware consultant should be asked to assist in the selection of building hardware. The hardware schedule should be developed with due consideration for local maintenance experiences, which tend to vary widely among different areas. Not only is hardware selection important, but proper installation and maintenance is an absolute necessity if good service is to be obtained. In general, heavy-duty standard items for which repair and replacements are readily available prove to be the best from the standpoint of maintenance.

Applicable fire and exit codes must be complied with in the initial planning; otherwise, replacements and modifications can become expensive. Durability of finish and ease of maintenance are pre-requisites to any hardware selected. Proper selection can result in lower maintenance cost, functional use, and enduring beauty for the educational building.

Exterior Concrete

Sidewalks, steps, and entrances are subject to the same climatic conditions that have eroded mountain ranges in many parts of our country. Freezing, moisture changes, thermal shock from temperature change, physical abuse, and traffic wear have adverse effects on exterior concrete. Too little consideration is given to the curing and care of exterior concrete walks, pathways, and paving.

Selecting concrete with suitable admixes of other waterproofing treatments can greatly prolong the anticipated life span of exterior concrete. In some areas, air entraining mixes have proved effective in reducing the deterioration of concrete slabs when subjected to freezing and thawing cycles. Equally important to concrete life expectancy is the porosity and strength of aggregate.

Careful handling and placing of concrete is critical to the quality of the finished product. If the concrete is worked excessively, it has a tendency to stratify and create dissimilar layers within the slab. In some cases this creates a condition where the surface of the concrete has a high cement content. Cycles of freezing and thawing will cause the surface to break away from the main slab, leaving the structure unsightly, unusable, and in need of replacement.

Steel trowel finishes should not be applied on exterior concrete surfaces where traffic is involved because they become slick and hazardous when wet. Special non-slip treatment is desirable on steps, ramps, and other hazardous areas. In some situations involving high frequency foot traffic, surfaces that appear initially to be adequate soon wear down to create a hazardous condition. Special consideration must be given to these areas to obtain safety and low maintenance throughout the life of the building.

The use of salt to melt snow and ice from masonry surfaces has in some cases contributed to the deterioration of the concrete. Water-soluble salt absorbed by the concrete accumulates in crystal form, creating forces that rupture to the surface. Planners should investigate the possibility of using either a salt with an additive designed to reduce this problem, or other equally effective commercial products.

Information on the proper care and curing of concrete is available from the Portland Cement Association. This organization is involved in developing new methods to provide better concrete to meet the needs of the building industry. Concrete, in many ways, is a superior material. However, it is not a cure-all for everything, and is still subject to problems.

Summary

In summary, exterior building maintenance problems consist primarily of protecting the structure from moisture penetration, maintaining the aesthetic appearance, providing thermal insulation to control heat gain and heat loss, controlling sound transmission through exterior walls, and maintaining operating components incorporated in the building exterior.

6. Building Interior

The ability to maintain a comfortable, safe, and healthful interior environment, in keeping with the educational function, can be achieved by careful study and selection of materials and finishes. Practical and aesthetic considerations can be skillfully blended to avoid a sterile institutional environment.

Specifications alone do not give full assurance of quality results. Careful planning and close supervision can assure that the finished product is in accordance with educational specifications, manufacturer's recommendations, and industry standards. Similarly, it is essential that the needs of handicapped as well as normal students be considered.

Ceilings

A major problem in ceiling specifications involves the selection of appropriate materials — materials suited to the function of the area with regard to appearance, acoustical properties, resistance to moisture or other matter carried by air currents, and the physical abuse to which it may be exposed. Physically, there are several other points of concern, such as accessibility to the above-ceiling area and fire resistance requirements.

Most ceilings are conventional or acoustical-type plaster, painted concrete, tile, or suspended panels of acoustical material made from metal, mineral, fiber or glass materials. Durability and suitability of a ceiling application involve a number of items best illustrated by referring to several specific areas. A smooth, dense, cleanable ceiling is usually preferred. In kitchen areas where the surface must be periodically cleaned, a hard ceiling will cause acoustical problems, but noises can be isolated from other areas by making special acoustical provisions.

Soft, fragile ceilings that are easily marred usually are damaged through curiosity or deliberate vandalism when placed in restrooms and other areas where little or no direct supervision is maintained. These mishaps also occur in stairwells where acoustical applications are placed on the back side of stairs within easy reach of anyone who wishes to tamper with them.

Defacing of the soft materials may not impair their function, but it does detract from their appearance, and attempts to restore the original finish cut into maintenance budgets. Some shop areas present special ceiling problems because of impurities in the air and physical abuse associated with the operation of equipment.

For example, sawdust and other impurities caused by saws or welding equipment quickly form deposits on rough-textured acoustical plaster, so much so that the original finish can only be restored by applying an additional layer of the plaster. The shop facility cannot be used while this work is being done. Furthermore, ceiling finish will have to be restored more frequently than would be necessary if ceiling materials that can be washed, brushed, vacuumed, or otherwise cleaned were used.

Ceilings are areas that invite practical applications of acoustical materials and are commonly used for acoustical purposes because their surfaces are better protected from physical abuse and are less involved in the actual use of an area. However, the solution to acoustical problems involves the use of more than just ceiling areas. Acoustical problems become particularly complex in places like auditoriums and music rooms, where the services of an acoustical consultant will be required.

Acoustical ratings of various materials are supplied by most manufacturers and take into consideration not only the materials used but the method of attachment to other surfaces. Comparative guides to the acoustical properties of materials and ceiling systems can be obtained from the Acoustical Materials Association (see Appendix A, page 222, for the address).

The ease of maintenance or renewal of finishes varies widely, depending to a great extent on density, surface porosity, resistance to moisture and other impurities in the air, and resistance to physical damage. Many newer materials are supplied factory-finished and do not require on-the-job applications of paint or other finishes. This type of material helps accelerate construction of a building and gives greater quality control of the finished product.

Light reflectance of ceiling areas should be closely coordinated to provide proper brightness within a room, in accordance with the *Guide for Planning School Plants*, as published by the National Council on Schoolhouse Construction, now the Council of Educational Facility Planners. The texture and light reflectance qualities of the ceiling influence the number of lighting fixtures needed to maintain satisfactory lighting levels. It should be noted, too, that a gloss finish may create problems of glare.

Accessible-type suspended ceiling systems are available in fire rated, as well as non-fire rated, materials. Accessibility to piping and mechanical areas above the ceilings can be vitally important to maintenance. In such cases, it is necessary to equate the advantages of accessibility against those of a more durable system in determining the most appropriate ceiling installation.

Interior Walls

In selecting interior walls or partition material, the appearance, durability of the surface in keeping with traffic conditions, cost of maintaining original finish, and acoustical properties are important factors. Most educational buildings have interior walls and partitions of fire-resistant construction. Common types are concrete or lightweight block with or without a plastered surface, wood or metal stud walls with sheetrock, wood paneling or plastered surfaces, structural glazed tile, and glazed facing on concrete block or clay tile partitions. Movable partitions or room dividers made of metal, wood, or inorganic materials are becoming popular.

Usually-heavy traffic calls for wall finishes that are resistant to dirt, wear, and abrasion; have permanence of color; and are economical to maintain. Shower rooms, toilet rooms, corridors, stairwells, and kitchens illustrate such needs. Suitable surfacing might be glazed tile, ceramic tile, dense smooth-face brick, or special glazed-type wall coatings. Much useful information on the selection of tile, based on industry standards, is available from such organizations as the Facing Tile Institute, the Tile Council of America, and the Structural Clay Products Institute.

Some less-durable finishes and materials are suited to gymnasiums and shop areas, where wear and abuse on surface finishes are less obvious. Using a flat paint to finish corridors and stairwells may mean a reduction in initial costs; however, the accumulation of dirt, hand marks, and other forms of abuse become evident very shortly. Maintaining the appearance of such wall finishes requires frequent painting, whereas a more durable surfacing would provide an economical, long-term material. Wall spotting problems which occur in wet areas near drinking fountains, around wash sinks, and under dirty-dish-return windows require a durable wall surfacing to withstand water and abrasion.

Most wall finishes used in school buildings are resistant to flame. However, today more consideration is being given to selecting interior finishes that do not produce smoke or toxic fumes, or contribute fuel to a fire. With the advent of the compact air conditioned building, with its considerably fewer exterior wall openings, the use of noncombustible interior finishes should receive greater consideration by educational facility planners.

By reducing the amount of combustible components used in interior walls and partitions, the spread of fire through a structure is impeded and a limit is placed on the areas affected by smoke. Standards established by Underwriters Laboratories are helpful in evaluating various interior finishes.

The light reflectance and finish of wall surfaces, as with ceilings, must be coordinated with other interior finishes and furnishings to maintain brightness balance in the room. The *Guide for Planning School Plants* provides excellent brightness balance guidelines, which should be followed.

Planners are increasingly aware of the need for buildings that are adjustable to the ever-changing curriculum. This requirement places great emphasis on the ability to move and relocate walls to provide variable-sized areas for changing programs. To insure this capability, movable partitions should be free from utility and service lines that would make relocation difficult and costly. One of the most common walls helping to provide this flexibility is the light-weight concrete block wall.

New products, however, have been recently developed which afford even greater flexibility. Various demountable wall systems and movable partitions are available that ensure adaptability in a shorter period of time, with minimum disturbance to the educational program. Demountable or movable partitions of desirable quality may reflect a considerable increase in initial cost. However, over the long range they may prove to be the most economical installation.

Newer designs are incorporating folding or operable walls to create larger or smaller areas. A prerequisite to the successful utilization of operable walls is the ability of the teacher to open and close the wall either manually or electrically for an immediate response to program needs.

Various surfacing materials are available for operable partitions. These should be selected on the basis of appearance, durability, and suitability. If an acoustical barrier is mandatory between rooms to prevent sound transmission from one side of the operable wall to the other, partitions are available with noise reduction qualities adequate for use between classroom areas.

For example, in one school, operable partitions were installed that did not provide adequate sound reduction between areas. Then it was found that alternate rooms could be used to obtain adequate sound reduction and eliminate interference from activities in adjoining rooms. This discovery greatly reduced utilization of the area.

The construction and finish of interior partitions and walls definitely influence both sound reduction within a room and the transmission of sound to adjacent areas. Selection of interior walls and partitions should involve due consideration for relative noise levels in adjoining areas. A 35-decibel reduction in sound transmission is usually adequate between normal classroom or office situations. However, much greater

"OK, kids . . . all together now . . . PULL!"

noise reduction than this must be achieved between quiet zones and such places as band rooms, vocal music rooms, shop areas, and mechanical areas.

To solve some of the more difficult sound transmission problems, it may be necessary to provide structural isolation, to utilize a mass of masonry or other material, to include sound-trap vestibules, and to install sound-sealing hardware on connecting doors. The failure to carry a masonry partition above the ceiling to the roof deck, openings around pipes, and uncaulked cracks may reduce the effectiveness of an otherwise efficient sound barrier.

Sound control of mechanical system equipment has become extremely critical in air conditioned buildings where noise is created by chillers and the high volume of air being moved about. Sound reduction and control are especially critical considerations in planning band and choral practice rooms. A qualified consultant can quickly identify acoustical and sound transmission problems in buildings; his services should be utilized.

Floors

Educational buildings have many different situations requiring a variety of floor finishes. Some finishes must be hard, durable, and impervious. At the other extreme are the "soft" floors, such as carpeting. No single flooring material will meet the needs of all areas. Many studies have been made to determine comparative maintenance costs of different floors, and in some areas the decision is relatively easy. However, there are a number of controversial areas where local experience must be relied upon. Any selection of floor covering should be made according to the principles of brightness balance, as set forth in the *Guide for Planning School Plants.*

Of the resilient floors, vinyl asbestos tile is practical and widely used in educational buildings. Other resilient-type floors, such as asphalt tile, vinyl, rubber, cork, and linoleum, are both available and suitable for use in many situations, whenever properly installed and maintained.

Extra care should be taken to see that the proper adhesive is used in installing resilient floors, especially where waterproof adhesives are required or where there is a moisture hazard from a ground floor slab. Additional information on the selection, installation, and maintenance of asphalt and vinyl asbestos tile is available from the Asphalt and Vinyl Asbestos Tile Institute.

Concrete floors appear in shops, storage areas, and mechanical rooms. A major objection to concrete floors is dusting, caused by the disintegration of the surface. This condition makes it extremely difficult to maintain a clean, dust-free environment. To avoid dusting, a sealer designed for that specific purpose should be applied. The selection of such a seal should avoid products that create slippery situations. The Portland Cement Association and the American Concrete Institute have established guides and standards for the design, placing, and care of concrete.

One of the newest floor coverings in educational buildings is carpeting, a dual-purpose material that covers floors and serves as an acoustical or sound control medium. Most carpeting is applied over the entire floor area. Proper stretching and anchoring of the carpeting is important if wrinkling and buckling are to be avoided.

A good commercial grade of carpeting used with adequate backing is usually the best long-range investment. Quality carpets are available in both wool and synthetics, such as nylon, and information on cleaning and care may be received from the manufacturers or from the American Carpet Institute. There are almost limitless color selections, and choice of color should be made not only with consideration for brightness balance and aesthetics but for spotting and tracking. A carpet-like material is also available which is installed with an adhesive and cemented directly to the floor.

Carpeting is effective in reducing impact noises that occur at the floor level; it is particularly effective in libraries where there is infrequent movement of individuals. Carpeting creates a feeling of warmth and allows children to sit on the floor without the usual discomforts. Some localities require fire-resistant treatments for carpets used in educational buildings.

Lobbies, foyers, laboratories, restrooms, and heavy traffic areas require a dense impervious floor. Terrazzo floors, which have proven satisfactory in these applications, when considered on a long-range basis are accepted as a good, economical investment. Cleaning of terrazzo varies with the traffic load, and resealing is usually performed once or twice a year.

Ceramic tile is widely used in restrooms, dressing rooms, and kitchen areas. Quarry tile appears in these areas when a lower-cost installation is required. Major problems with tile and terrazzo are obtaining uniformity of materials, and quality of workmanship. In selecting tile materials for floors, it should be remembered that slip-resistant materials can reduce the hazard of falling on wet floors.

There are many localized areas in a building that need special attention in the selection of floor materials. Wet areas, such as those found near drinking fountains, work sinks, and dirty-dish-receiving areas, are particularly troublesome. Complete information on tile floors is available from the Tile Council of America, and similar industry standards are available for terrazzo floors.

The most practical wood floors for most applications are the dense hardwood floors such as maple or oak. However, soft woods make good stage floors and have other special applications. The use of wood has been commonly limited to gymnasiums, shops, and stage areas.

One of the biggest problems in using wood floors occurs with inadequate provision for expansion and contraction, which cause a floor either to work or to buckle. In addition, moisture can cause rotting of a floor; when installing wood floors, a moisture barrier should be provided to eliminate water penetration to the bottom side of the wood flooring.

If a hardwood gymnasium floor or other heavy-duty wood floor is laid over screeds, care should be taken to see that the end-matched joints occur over the screeds, or are sufficiently supported to prevent the breaking of the flooring at these joints (particularly on basketball courts).

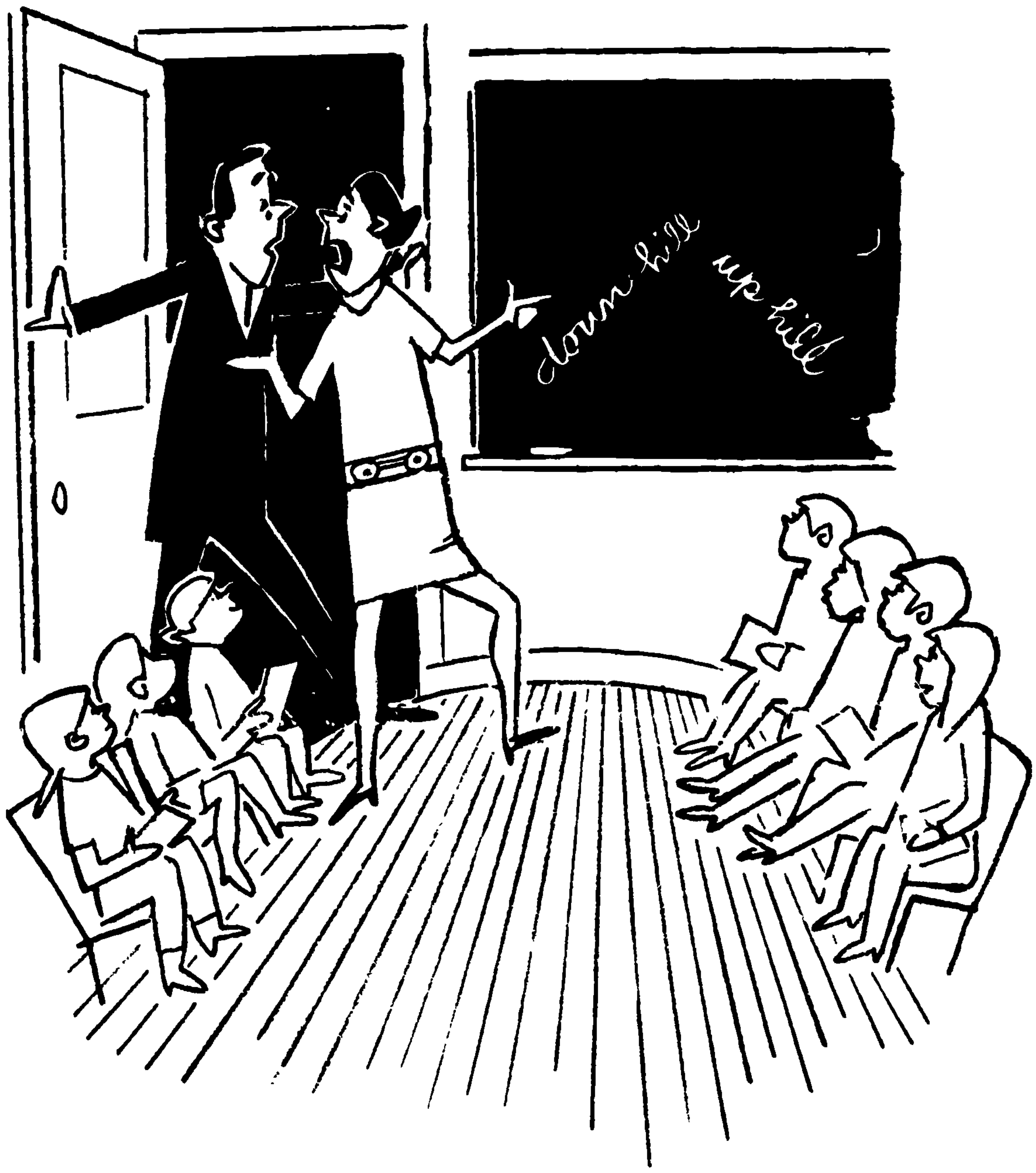
Installation and care of hardwood floors should conform to recommendations of the Hardwood Dimension Manufacturers Association. Also important is protection of wood floors from attack by fungus and termites. Methods of treating and installing wood floors to reduce the possibility of attack varies widely, depending on locality; therefore, local experience, as well as national standards, should serve as a guide.

Many specialty floor coverings are on the market today. Some products are trowelled in place, others are sprayed on. Some are good for special problems. All should be considered in respect to long-term use because some of these products have been misused in their application.

Non-slip treatment for stair treads and inclined ramps should be provided to reduce the hazard of slipping. If a non-slip type nosing is used on stair treads, it should be stopped three to four inches from the end of the treads to facilitate sweeping.

Doors

Interior doors are not subject to the same severe climatic conditions as exterior doors, and warping and delaminating are not as prevalent. Some interior doors require rating as fire doors. The Underwriters Laboratories label for fire doors involves definite standards for hardware and door frame construction, as well as for the door itself.



" . . . and not only that, it's beginning to slant their point of view."

The classifications and standards for rated fire doors are available from the Underwriters Laboratories.

Fire doors are usually installed to separate definite building elements or where high-hazard areas adjoin other building areas. If these doors are not specified and installed initially, replacement with rated doors and frames can be very costly. In addition, glass in corridor and other interior doors must comply with applicable fire and safety codes.

It is important to select doors with functional use as a criterion. Also, needs of handicapped students should be kept in mind. Particularly, door widths and threshold designs are important.

Windows

Consideration of interior windows is similar to that of exterior windows. However, in most applications, weather tightness is not a major factor. Most interior windows, or vision panels, are installed for visual contact between spaces or to borrow light from adjoining areas. If windows provide vision between areas where sound transmission would be a problem, glazing should be installed with a good sealant where dissimilar materials meet. Any operating vents also need sound-seal weather stripping.

Fire and safety codes require that many interior windows be of wire glass or other types of safety glass. Failure to check these codes can mean costly changes later, before the building can be approved for occupancy.

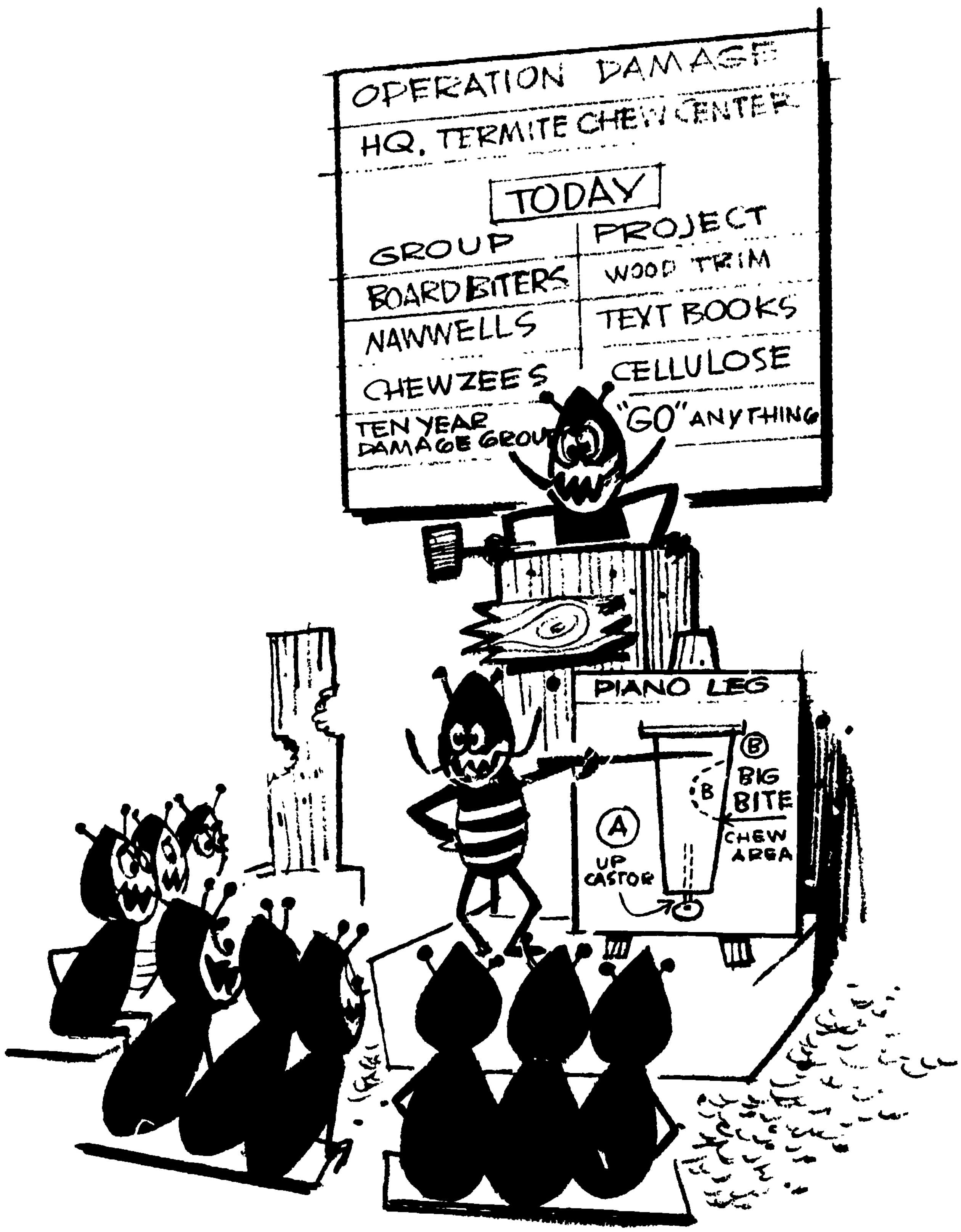
Special Equipment

All entrances are potential sources of soil which is brought into a building via the feet of entering persons. Items for soil control are available to reduce the amount of dirt tracked in. One of these is a recessed frame into which a link-type mat is placed. Although this is far from an ideal solution, it does reduce the amount of soil brought into the building provided the mat is broad enough to allow both feet, instead of just one foot, to come in contact with it. Carpet mats are also useful at entranceways to reduce dirt.

Painting and Decorating

Painting and decorating supplement those finishes supplied as an integral part of building components.

Painting and decorating decisions should be made in light of fire resistance qualities and suitability to all possible exposures. Areas subjected to heavy traffic should have exceedingly durable finishes.


OPERATION DAMAGE
HQ. TERMITE CHEW CENTER
TODAY
GROUP
PROJECT
BOARD BITERS
WOOD TRIM
NAWWELLS
TEXT BOOKS
CHEWZEES
CELLULOSE
TEN YEAR DAMAGE GROUP
"GO" ANYTHING
PIANO LEG
A
UP CASTOR
B
BIG BITE
CHEW AREA

A number of synthetic-type paints and coatings are washable. However, many of these do have a gloss that shows imperfections in walls to a greater degree than flat paints. Considerable progress has been made in improving synthetic-type paints, and they merit consideration when planning buildings where long-term maintenance costs are important.

Painting and decorating bring building components into proper relationship and should provide brightness balance in the building interior. Painting and decorating are related equally to the visual environment and to the aesthetics of an interior. Interior finishes, then, should be carefully coordinated with both artificial and natural lighting in each particular area.

Termite Treatment

In many parts of the United States, especially in the warmer regions, termites attack buildings even though many of the edifices are constructed with inorganic materials. Even when there is nothing in an actual building structure for termites to consume, considerable damage can be inflicted on furnishings, textbooks, and other cellulose products.

Well-established standards have been set for preventive termite treatment. Where buildings have the lower floor on grade, the usual treatment is to saturate the earth fill in and around the foundation with soil poisoning before pouring the ground floor slab. With proper execution and maintenance in accordance with manufacturers' recommendations, this treatment usually acts as a permanent deterrent to termites.

As an example, a new elementary school was built in 1950 that was modern and up-to-date in every way. It was a fireproof structure with the lower floor built on grade. Within a few years termite damage became apparent. Termites were nesting under the floor slab in the earth fill, and traveling upward through openings in the concrete floor slab and through tile wall cavities into most of the interior areas. Widespread damage to books, furniture, tackboards, and similar components resulted in considerable dollar expenditures to restore and protect the building.

Most of the tackboards, wood trim, and casement work on the first floor had to be replaced within ten years after the building had been completed. Considerable difficulty is still being experienced in treating and controlling this termite problem, and widespread infestation has resulted from the wood and other sources left under the structure when it was erected.

Ironwork

Miscellaneous and ornamental ironwork covers quite a wide range of items. However, in most buildings, primary concern is with handrails, guardrails, and security devices. Problems with these items center around secure anchorage, proper and durable finishes, and safety to individuals. These items usually require welding of metals which, if not properly ground, presents rough spots that detract from a building's appearance.

In addition to grinding, metal should be primed or otherwise prepared to receive the finish. Improper preparation results in pitting and scaling and is especially noticeable where items are exposed to the weather. Care in design will avoid sharp projections or other hazards to individuals.

Stair rails in elementary schools should be designed without openings through which children can climb or fall. Open stairs also present a hazard. Miscellaneous iron work or ornamental rails are frequently, and properly, installed along the tops of walls or at grade changes to keep children from tripping or falling. All railings should have designs that discourage children from sliding down or climbing on them. These devices are costly, and should not be a detriment to the aesthetic values of a project through improper design.

As continued developments are made in the control of the interior environment, increased attention must be given to aesthetic values to avoid an artificial and uninspiring environment. All this must be accomplished with due consideration for durability, function, and long-range economy.

7. Building Traffic and Space Relationships

This chapter is concerned with the subject of building traffic and space relationships. Planning decisions cannot be based upon internal conditions alone, but must provide good space relationships and traffic patterns for both the buildings and the site.

Current architectural practice in the translation of educational specifications into sketch plans involves the use of devices, such as bubble diagrams, to enable the architects and educational administrators to experiment with various space interrelationships for the best possible arrangement. The effectiveness of such a procedure depends completely upon the ability of the architect to conceptualize educational activities to be conducted within each of the various areas and upon his awareness of the interrelationships that may exist.

It is hoped that the changes in society for which students are being prepared will be reflected in the design of each new educational facility. If so, the architect will hardly find feasible a design based upon traditional assumptions regarding curriculum content and student programming. Rather, he will require an educational specification spelling out in detail the latest thinking of the educators concerning what is to be taught, in what fashion, and to whom.

The purpose in discussing traffic and space relationships within a building is to assist the educational administrator to avoid potential educational or economic problems in the long-term operation and maintenance of the new structure. Traffic patterns are, of course, determined primarily by space relationships within the building and on the site. Space relations are discussed not only in terms of the traffic patterns that result therefrom, but also in terms of the building economies and such factors as noise and odor transmission.

The movement of personnel and materials within a building must be planned to allow each student to move to his destination in the shortest period of time with a minimum of disturbance to others. This requires that facilities be located with consideration of the auxiliary areas which require access for certain courses of study. This, in turn, suggests that areas in elementary and secondary schools such as the library, lunchroom, administrative offices, and the like, be centrally located. At the same time, areas for music, art, and the industrial arts, as well as physical education, may well be located in more distant buildings or portions of the main building, assuming that such areas are not used by all students each day. In institutions of higher learning the traditional campus plan makes these determinations a part of site planning.

One example of other considerations for attraction might be the separation of sound-producing areas, such as music rooms and shops, from such quiet areas as academic classrooms and the library. Another might be the placement of the receiving room to serve the building adjacent to the custodian's office for supervision and to the lunchroom kitchen for convenience. In one-story buildings, economics dictate the grouping of areas requiring higher than normal rooflines, such as the fly-loft of an auditorium stage and the physical education gymnasium.

It is not possible to separate completely a discussion of site traffic and building traffic. This is particularly so in multi-unit or campus-type educational facilities plans. It is also true, although to a lesser extent, in single buildings where the traffic within the building is influenced by the placement of exterior walks, parking lots, athletic facilities, and the like. As in all aspects of design, safety is the prime consideration in traffic patterns. Solutions that are practical and workable must be provided in the design of each institution to offset the potential hazards presented by the loading and unloading of school buses and interrelating vehicular and pedestrian traffic patterns.

The implications for safety are perhaps not so great in interior traffic as in site traffic design. On the other hand, heavy traffic and confusion can produce accidents, particularly in large multi-storied buildings. The most obvious safety consideration is the provision of adequate fire exits. The Building Exits Code and the regulations of the National Fire Protection Association are incorporated in many state and local laws to ensure that no educational facility is constructed that does not provide adequate exits for building occupants in the event of a fire. The mere adoption of such regulations, however, does not ensure that the intent is achieved.

In one recorded situation, flames were discovered in the fly-loft of the stage of a secondary school at a time when the building was occupied. The design of the building provided a choral room adjacent to the balcony of the auditorium. The primary exit of this room was through the balcony of the auditorium, down a narrow twisting stairway past the stage onto a landing between the second and third floors. A second means of egress was provided which required occupants to pass through a crowded three-room business department and, thence, out onto the third floor adjacent to the lunchroom.

When the fire broke out, the school principal was notified quickly, since under administrative regulations he was the only one authorized to sound the fire alarm. Fortunately, he was available, but, less fortunately, the alarm signal was the same used to signal class changes. Since the fire was discovered just at the time the automatic class change bell was scheduled to ring for lunch, approximately one-third of the student body left their classrooms and proceeded towards the lunchroom on the third floor when the alarm sounded. However, as the alarm continued to ring, the students finally recognized the fire alarm, reversed their direction and exited the building. In a matter of seconds, the built-up roof over the fly-loft exploded into a fireball approximately 100 feet high.

This example has a happy ending and a moral. Luckily, only a few abrasions and bruises resulted from the incident. Two or three minutes more and the incident could have resulted in tragedy due to the poorly planned, tortuous exits. Needed preventive measures lay not so much with administrative procedures, although these were subsequently improved, as in properly placed building traffic and space relationships. Had the architect and administrator analyzed the necessity for having the choral music facilities adjacent to the stage and considered the possibility of fire, another location surely would have been selected. Educators involved in planning must be prepared to indicate whether the educational program actually requires such specific facility locations as placing the chorus room next to the stage.

The location of practice rooms for instrumental music similarly should be questioned. In most secondary institutions, the band performs on the auditorium stage only a few times each year. Under such circumstances, it is of doubtful advantage to locate rehearsal facilities next to the stage, particularly if the auditorium is used during school hours for purposes that are incompatible with the practice sessions of the instrumental music and the choral groups.

Circulation problems can be grouped into two types. Most easily recognized are those that occur during class changes and involve large occupancy areas such as the auditorium, the physical education facilities, and the lunchroom. These areas should be placed to minimize the length of travel for each individual involved. Such devices as having the shower and locker rooms located between the gymnasium and the outdoor playgrounds will help meet this objective.

The second type of interior traffic problem arises when a small group of students moves from one area to another at a time not used for simultaneous class changes. Other groups may be disturbed by such movements.

Such problems may be minimized with a bubble diagram analysis in which the administrators, pupils, teachers, and custodians are mentally moved from one area to another to determine what problems could be involved and to insure that the architect is familiar with all potential traffic flow.

"Can you imagine what would happen if this were a drive-in cafeteria?"

Concurrent planning should involve space adequacy surveys similar to the one developed by the California Bureau of School Planning. This device is an objective tool, of considerable mathematical precision, which enables planners to take actual data about a given program for a specific number of students and, from it, to determine the number and size of classrooms required. This procedure is not so complicated or involved as it may sound, and it becomes a logical way to determine the number and size of various spaces needed to house a given program of education.

Consideration should be given in the review, prior to the development of sketches, to involving department heads and teachers. Few administrators can visualize all of the relationships between the various areas in service. For example, a teacher of English in a departmentalized situation is operating daily in a situation where his students are arriving from or departing for the library, the physical education facilities, the cafeteria, the lavatories, and other classrooms. Questions that instinctively would arise in the mind of such a teacher (and others) might concern the distances involved in going to the library during class period. Thus: Are lavatories readily accessible? Are drinking fountains located nearby? Are access and service for handicapped students convenient? Is adequate storage provided on the particular floor level for the easy portability of audio-visual aids? Will it be necessary to move any of this type of equipment from one level to another? From and to what classrooms are his students most likely to travel prior to and subsequent to his class period? It is obvious that such questions can only assist in the search for the best possible solutions.

Traffic movement, distance, and time are related in a very realistic fashion to the cost of maintenance and operation. The building custodian and his staff will also have many practical suggestions and questions concerning the design and maintenance of facilities and should be given an opportunity to air their ideas. If, for example, terrazzo corridors, stairways, and lobbies are used, the maintenance problems will differ considerably from those involved with asphalt or vinyl asbestos tile. Therefore the location and size of storage and maintenance areas complete with shelving, service sinks, and so forth, become important in terms of both initial and long-range cost.

Questions have been raised regarding safety, traffic flow patterns, adequate services, educational program planning, and the practical aspects of plant maintenance. Having visualized potential problems, it becomes possible to visualize probable solutions. At a recent meeting of the Council of Educational Facility Planners, the group touring a new college facility ate in the student cafeteria. When they arrived at the cashier with their trays, they found that access from that point to the tables was through the lines of students waiting both for cafeteria service and to return their trays and dirty dishes. The congestion, with its numerous collisions of people and resulting food spillage, reduced the capacity of the cafeteria during rush periods by perhaps 20 percent or more. The Council group could only assume that the administrator and the architect had failed to give this aspect of traffic flow the same consideration as they had to planning other areas of the institution.

Some traffic and space guidelines are available, such as:

- Early in the planning stages, educators and architects should attempt to locate academic classrooms, including language laboratories, the library, and study carrels, so they will be both close to one another and separated as much as possible from noisy areas.
- Planners also should consider placing noise producing activities, such as wood and metal shops, automotive mechanics, choral and band rooms, in as isolated a portion of the building or campus as is practically feasible. Traffic flow patterns will ordinarily justify such segregation, as the number of students involved is relatively small.
- A central location is advisable for the administrative areas and the library, since their use involves all students, and for the lunchroom and auditorium, which accommodate large numbers of students and require approaches via large central traffic areas.
- Since Sputnik, emphasis has been placed upon the physical science programs, and the trend in secondary education has swung toward a subject-centered curriculum. The location of science laboratories is thereby given new emphasis because of the increasing numbers of students involved. The usual problems still prevail — the delivery of science material and equipment, the discharge of odors, and the requirement for serviceable material that will not complicate the maintenance program in future years. Compromises must be reached with regard to the desirability of locating such facilities to be both near the receiving room for delivery of materials and adjacent to the balance of the academic classrooms.

While a central location is desirable for the cafeteria, it also must be readily accessible for deliveries and should be recognized as a source of noise and odors.

The true adequacy of the plant planning process can only be determined as the facility is occupied and utilized. Everyone in education,

"That's a great one-hander, Ralph!"

including the student, is all too familiar with class sessions disrupted during rehearsals of the band, and with food odors just before lunch-time, as well as the interruption of class activities by noise from a nearby shop. Everyone knows the noise created by the physical education classes on their way to the locker room or the gymnasium, and few can forget the stale odors of the dressing rooms or the sounds of garbage cans being emptied into trucks.

The problems of building traffic and spatial relationships are not easy to solve. However, the joint coordination and continuous efforts of the persons who will design, operate, and maintain the building can achieve a satisfactory solution. The student of today will be the taxpayer of tomorrow who will either praise it or grudgingly pay his taxes to keep the building in a safe, sanitary operating condition. Simple, direct, adequate, carefully thought-out circulation patterns must be given greater consideration in the architectural treatment of the building than, too often, they have in the past.

The building must be safe from the standpoint of emergency mass evacuation as well as day-to-day movement. It must provide the best possible circulation patterns within the building and between existing units, and permit contemplated future expansion as well.

If properly planned, the building will keep to a minimum any disturbance to classes at work, permit ease of supervision for all involved, minimize traffic congestion and interference, and promote a desirable relationship between the institution and the general public.

8. Public Access Areas

Public areas, sometimes referred to as non-instructional areas, can usually be provided without duplicating facilities needed to carry out the planned instructional program.

Normally, the public needs facilities for:

1. *Group meetings:* These would include the parent-teacher organization (such as the PTA), citizen groups, study groups, and occasionally, on a rental basis, outside organizations.
2. *Formal programs:* These usually involve use of the auditorium, but may include special or multi-purpose rooms.
3. *Athletic contests or events:* These usually include competitive basketball, football, baseball, or swimming competitions and may include use of athletic facilities by community recreational groups.
4. *Community service functions:* Examples of these would be clinical health programs and library services.

Public areas should be planned without sacrificing the needs of students. This usually involves establishing enforceable rules limiting public traffic to building areas in use and not permitting the "run of the building" to all who enter.

Considerable problems can develop in connection with public areas if plans do not include the necessary related facilities, readily available to these areas. Restrooms, drinking fountains, and other comfort facilities must be close at hand. With public areas so frequently used beyond normal school hours, it is best to provide telephone communications for the safety and convenience of people using the area. A pay telephone will suffice for the public; other telephones should be made available to personnel as necessary for them to carry out their duties.

Space and facility allocations should be made for concessions and coat checking if these are part of the planned program. Many events held in the public areas involve ticket sales, so ticket windows should be in a convenient location. A convenient, well-lighted parking area, one that will serve safely and adequately for both day and night use, also should be provided.

Present trends — not the least being considerations of cost — indicate an ever-increasing use of facilities for community as well as educational uses; thus, the importance of proper planning for these activities takes on added significance.

Mechanical Facilities

When major public areas are to be occupied beyond normal daytime, weekday hours, it is desirable to have separate controls for heating, cooling, and ventilating. Chapter 4, "Mechanical Facilities," advances several suggestions related to area controls.

Sound transmission from mechanical equipment must be controlled to avoid distracting and needless disturbances. This control is equal in importance to the interior acoustical environment or provisions to control other types of sound transmissions.

The selection of heavy-duty, durable, low-maintenance plumbing fixtures and other equipment is almost mandatory, since public access areas are heavily used, often without close supervision.

Considerable expense and much inconvenience results when mechanical services are not included in such areas as concession stands. Power outlets are required for popcorn machines, hot plates. and other electrical devices. Modern drink bars usually need water and waste connections, and health regulations often require handwashing facilities. Careful planning of the concession is necessary if fast service and economical operations are to result.

Housekeeping

The heavy use and/or abuse that public areas receive make the provision of durable, easily cleaned finishes especially important. Chapter 5, "Building Exterior," and Chapter 6, "Building Interior," give considerable coverage to this problem.

Stair treads should be non-slip and durable, and should require little maintenance. Some softer-type materials, such as vinyl or rubber treads, are effective in reducing noise and usually create a neat appearance. However, they require regular inspection to assure their serviceability. Large schools with heavy traffic may find these treads expensive to maintain.

Traffic patterns in public areas should be carefully planned to protect special finishes, such as the hardwood floor in the gymnasium. Ideally, an effort should be made to keep public traffic away from the gymnasium floor, but this is not always possible.

Rubber mats or similar devices have been employed to protect gymnasium floors from pedestrian traffic, with varying degrees of effectiveness.

At one high school, the main parking lot is located adjacent to the gymnasium for the convenience of spectator activities. A major portion of the student body and faculty members driving automobiles

"Practice called on account of traffic, boys."

to the school pass back and forth through the gymnasium in walking from the parking lot to the main school areas. The resulting problem of wear and tear on the floor has been partially solved by laying a rubber mat across one end. However, traffic through this area is not an ideal situation, distracting the programs being held as well as increasing the floor maintenance costs.

If housekeeping provisions are not included in the public-use areas, housekeeping personnel must pass to and from unused building areas to perform routine tasks. This situation usually means a less effective housekeeping program.

Concession stands present special problems. If such areas are planned, special attention should be given to food or beverage control and their use should be limited to areas where food is normally served, such as the cafeteria. Maintenance costs for gymnasium floors, auditorium floors and seats, and the building in general increase drastically if food or beverages are permitted there. Danger to the health and welfare of occupants also can result when spilled food attracts vermin and insects and when broken bottles are strewn about.

There should be sufficient receptacles for waste paper and other refuse disposal in the public-use areas if a high standard of cleanliness and safety is to be maintained. Planners also should not overlook the simple but burdensome task of sweeping and the necessity for reducing the amount of soil brought into buildings by people entering from the outside. Building entrance mats or other means reduce this problem.

Careful design for safety and utility may dictate the installation of ramps in lieu of stairways. Ramps serve normal traffic and provide a greater safety margin than stairs in the event of panic or emergency evacuation of a building. Normally the slope will not exceed one foot for every ten feet, and the same can be finished with a non-slip surface. Folding chairs or other movable equipment thus can be moved by wheeled carts rather than by the more expensive and time-consuming method of being carried. Major public areas should also have some easy means of access for people confined to wheel chairs.

The sweeping of steps can be simplified by having the abrasive nosing or other treatment stop about 3 to 4 inches from the end of the step tread; trash can then be brought down step to step with a minimum of difficulty.

Safety

Handrails, especially important in all stairways, should be available for both descending and ascending traffic. Safety measures, through use of a variety of materials, will prevent children from falling between widely spaced banisters. A secure and workmanlike installation is of prime importance, since rails are subject to extreme usage and weight. Despite all the codes and safety rules, steps are still sometimes constructed without handrails, a serious safety hazard, especially to infirm or older persons.

Fire extinguishers and other fire fighting equipment must be readily available to public areas when other areas of the building are closed.

Other safety problems can occur when sharp projections are found in building areas or on columns that support covered shelter. Accidental contact with these hazards can cause considerable discomfort or even serious injury.

Columns in open areas, such as sheltered play areas and covered walks, should be well rounded and free from sharp corners or projections. These columns are particularly dangerous, since students usually walk at a fast pace or are engaged in games. Sharp exposed supports have caused many serious injuries. Even with close supervision, injuries will result unless this problem is recognized and taken into account during the planning and designing of the building.

Careful consideration should be given to all glass areas. A safety-type glass should be provided when glass is to be in lower wall areas where people can make physical contact, or when specifications call for large sections from which pieces could fall and injure anyone below them.

A double accident occurred in a building when a student ran through a floor-to-ceiling plate-glass panel adjacent to a plate-glass door. A police officer who happened to be present at the school, upon hearing the crash, charged out to investigate and ran through an adjacent panel without realizing that it also was an area enclosed by glass.

Failure to provide protected rails or grids to guard glass areas can result in this kind of accident. Special care should be exercised in permitting glass to be installed directly behind panic hardware (inside push bars on outside doors). In one situation a child was running for a bus, looked back at a classmate, and missed the panic bar. The force of his moving body caused his right hand and arm to break the glass, causing severe lacerations.

Plans for the separation of public areas should specify that all required exits be clear and unobstructed. Exit lights, fire alarms, and other safety equipment must be functioning for safe occupancy.

Another hazard particularly evident in buildings involves objects dropped through open cores of stairwells. This action, usually done as a harmless prank, can cause serious injury.

The unguarded glass area phenomenon at work.

Chapter 1, "Site," and Chapter 7, "Traffic," cover in detail the problems of on-site traffic and parking requirements.

Consideration also should be given to vandal-proof light fixtures in unsupervised areas, especially on the exterior of a building. Without these, unlighted interior or exterior areas will pose a hazard to building use.

The Movement of People, Material, and Equipment

Careful study should be given to movement of people, material, and equipment in public areas. Door sizes, steps, and other building features can present obstacles, especially when moving heavy items such as pianos from service drives into building and stage areas.

It is usually desirable to limit public traffic to certain required areas without opening other portions of the building to traffic. When the building is in operation, it is best to separate public traffic as much as possible from regular educational activities. Doors, folding gates, and other provisions have been used for this purpose. If folding gates are to be effective, they must be installed securely and extend from floor to ceiling to prevent people from climbing over the top.

It often proves practical to have direct outside entrances to public-use areas, such as health clinics and libraries, as well as for the larger more commonly used areas.

When tickets are sold for admission, people should not need passes to reach restrooms and concession areas. Some administrators have found it practical to place ticket sales booths where they can sell tickets directly to either the outside or, as in inclement weather, the inside of a building. This permits sales prior to opening the building.

Equipment

The furnishings and equipment of public areas follow the pattern of planning for the whole facility: to serve the program of education of children and youth with secondary usage by the public. The real problem is to select high quality, long-life furnishings and equipment that will harmonize with the surroundings, and that have the lowest reasonable maintenance and initial cost. The items selected must be able to serve for normal use, as well as for anticipated use by the public.

For example, such details as chair size for adult seating, particularly in elementary and junior high schools, should be considered when purchases are made.

In all cases, a complete study of needs will help insure that first quality, durable equipment and furnishings are specified and obtained.

Emphasis should be on standard or stock items with interchangeable replacement parts.

No product is any better or more serviceable than the quality of service available to install and maintain it. If an item cannot be easily and economically installed or maintained, then it is of doubtful economy in the first place.

The finest automobile at dealer's cost is no bargain if replacement parts and service are not conveniently available. The same is true of any equipment, building materials, or other components which go into the construction of an educational facility.

Summary

To gain maximum harmony between community use and educational activities, and to provide for reasonable public use without jeopardizing the educational program, the following should be considered:

1. Adequate facilities, with the proper related areas for community or public-area activities.
2. Provisions to limit these activities to specific areas to avoid traffic through unused portions of the building.
3. Separate thermal control for areas frequently used during other than regular building hours.
4. Adequate provisions for housekeeping, including provisions for waste paper and refuse disposal.
5. Careful safety provisions to protect the building and its occupants.
6. Detailed planning of the movement of people, materials, and equipment to provide quick and effective means to handle materials.
7. Heavy-duty equipment for which service and replacement parts are readily available.

These are but a few of the many considerations that should be given to planning public areas for effective maintenance and operation. With the trend toward greater utilization of buildings by the community, the planning of public areas grows in importance. Accurate predictions of the extent of activities that will be taking place in public-use areas are impossible, but planners and builders can benefit from past experience and try to maintain some flexibility or adaptability to accommodate these changing activities.

9. General Instructional Areas

Every educational building devotes more space to general instructional areas than to any other facility. Yet, schools and colleges are being constructed with little attention given to the composition of these spaces, in terms both of educational needs and maintenance and operation. Perhaps classroom requirements seem so simple that they are brushed off and other areas of concern are sought. Students and staff are usually ignored as potential sources of good suggestions.

Nevertheless, educational space is the *raison d'etre* for any facility and full attention must be given to instructional areas to make sure they are designed for maximum long-term effectiveness.

Doors

The entranceways to corridors are a good starting point for consideration. In the lifetime of a building, a classroom door will be opened and closed as many as a million times. Is it any wonder that many doors and their hardware start to deteriorate long before the useful lifespan of the building has expired?

In view of this heavy traffic, it is essential to select carefully the door to be used and the quality of hardware to operate the door. All doors should be of the heaviest, strongest construction, and the hardware should be of the highest quality. There is no agreement on whether classroom doors should have a varnished or a painted finish. Varnished finishes are generally easy to maintain, and dirty smudges can be removed easily by a damp cloth. Painted surfaces are also easily maintained, if a good quality paint is used.

Hardware should require minimum maintenance. Some of the hardware used in the past was made from brass and required constant polishing to keep it shiny and clean. Most new buildings are now equipped with stainless steel, brushed chrome, brushed aluminum, or satin-finished bronze hardware which does not require special polishing. While these materials may cost more originally than plain brass, they pay for themselves in the long run in ease of maintenance.

When possible, classroom doors should be recessed from the corridor to prevent students from bumping into them and putting undue strain on door closers and holders. When recessing is not feasible, doors should have automatic closers installed to keep them from restricting the flow of traffic in the corridors. In many situations, there is a desire to leave doors in the open position. The door should then be swung out of traffic, and have a positive-type door holder.

Floor Materials

Within the instructional space itself, floor finishes are important. In the last 15 to 20 years, new structures usually have had some kind of composition tile installed on classroom floors. Asphalt tile was the most popular material, probably because it proved the least expensive to install.

However, new products, such as vinyl asbestos and pure vinyl tile, have been developed and have widely replaced asphalt tile. Both types cost more initially than asphalt tile, but vinyl asbestos is close enough in cost to be competitive when long-range maintenance costs are considered.

Recently, carpeting has been gaining in popularity. Carpeting has excellent qualities for creating a quiet, pleasant study atmosphere and, surprisingly, it is easy to maintain. Carpet manufacturers claim that the cost of carpet is more than balanced by the savings involved in cleaning. More educational buildings are being equipped with carpeting each year, and with good results.

Perhaps the most important asset of carpeting is its sound-conditioning quality. The installation of carpeting has almost eliminated the need for interior wall partitions between teaching areas in many situations. For years, educational planners have talked about achieving true flexibility, and the use of carpeting may go a long way toward making this possible.

Wall Materials and Finishes

Wall materials and finishes are of more than passing importance since the almost constant use of instructional areas causes heavy wear on wall finishes. Therefore, in selecting wall materials, it is important to choose the most durable and the easiest to maintain.

Very few educational buildings today are constructed with wet plaster walls because of the high costs involved. Plaster, however, has been a satisfactory wall finish for many years. It is strong and easy to repair if damage occurs.

In the last 15 years, aggregate block walls of various types have become popular. Their cost is much less than wet plaster and they are extremely resistant to the rigors of student use and abuse. Drywall construction has been tried in some areas, but it has not proven to be as durable.

Some architects specify a wainscot of structural tile block, vinyl wall covering, or sprayed glazing compounds to help eliminate painting and cleaning problems. One alternative is to provide classrooms with a semi-gloss enamel wainscot to a height of about four to seven feet. Such a finish resists abrasion effectively, is easy to wash, and eliminates unpleasant glare.

Water-base paints have also become popular in recent years. These paints are easily applied and withstand washing better than flat, oil-base paints.

Wall Structure

Operable dividing walls are being used today to achieve the flexibility demand by modern instructional methods. Selecting the proper materials for these walls is important, since not all types are suitable from a maintenance standpoint. Folding walls with fabric covering have not always held up well under the rigors of constant use. Generally, speaking, a heavier door, made of wood or steel panels, is preferable from a maintenance standpoint. Such doors also have the advantage of supplying a hard surface to which chalkboards or tackboards can be applied.

Movable walls have been used in business offices for many years, but are only recently appearing in educational buildings. Even though these walls are modular and relatively simple to move, to relocate them still requires work. Anyone using them should be aware that a degree of time, effort, and expense accompanies room layout revisions.

Today's classroom walls are designed to be reasonably effective sound barriers. Unfortunately, all walls have not measured up to expectations and distracting noises from adjoining areas continue to be a problem. As a partial solution, an acoustical ceiling is usually installed in the instructional room to help absorb sound, although this measure does not solve the problem completely. Some of the noise can be absorbed this way, but the major portion is retained in the room and must be dissipated by reverberation. Some of the reasons for poor acoustics are:

1. Dividing walls do not reach completely to the underside of the upper floor or roof deck on the erroneous assumption that a hung acoustic ceiling will prevent sound from traveling into the space over the ceiling and down into the adjacent room.
2. Walls are constructed of lightweight blocks only four inches thick.
3. Cracks where walls meet the ceiling or window are not adequately sealed against sound leaks, especially when continuous runs of windows are installed and a metal closure connects the masonry wall to a window mullion. Acoustical material is then needed between the two sides of the closure.

4. Electric outlets are laid out back-to-back and sound is transmitted through the connected boxes.
5. Heating lines are continuous from one room to the next without proper sealing against sound transmission.
6. Ventilating plenums or ducts are installed without any acoustic baffles to prevent sound from being carried to other areas served by the same lines.

Solutions to these problems are apparent from a discussion of their causes. In brief, dividing partitions should be constructed of materials thick enough and heavy enough to act as an effective sound barrier. All possible means of sound passing from one room to another must be eliminated.

Ceilings

Ceilings do not usually cause serious maintenance problems because they are high enough to escape much of the abuse suffered by walls and floors. Nevertheless, in selecting ceiling materials, certain factors should be kept in mind. For example, in multi-story buildings it is not advisable to use acoustic tiles fastened to the roof slab by paste. Any moisture which penetrates the roof slab is likely to loosen these tiles and cause them to fall. Replacement is simple, but, aside from the inconvenience and extra expense, the new tiles never quite match the old in color finish.

Sprayed acoustic ceilings are not recommended for places where the material might be touched or be subject to moisture or vibrations. Patching a sprayed acoustic ceiling is a delicate job requiring the services of an expert, and even then a conspicuous spot probably will be visible.

Unless carpeting is provided for the floor, all classrooms should have some acoustic treatment. A hung ceiling of some kind is best, since it is easy to repair or replace. Large panels which rest on a T-shaped grid section are especially easy to maintain. Any custodian can replace a damaged panel in a matter of minutes without any tools other than a ladder. In some cases, acoustic treatment may be more effective if placed on the walls.

Lighting Systems

The illumination system is especially important because poor lighting conditions result in a myriad related physical and emotional problems. Ideally, the best lighting system for instructional areas is probably a luminous ceiling where the entire ceiling becomes a lighting fixture. In such a system, maintenance is at a minimum. However, for reasons of economy, most classrooms are illuminated by fixtures hung from the ceiling. Such fixtures are subject to dust accumulation and to debris deposited by mischievous young minds.

Since all commercially available raw light sources are too bright to be looked at directly, lighting engineers have experimented with different means of covering the bulbs or tubes. Incandescent bulbs, once in wide use, are now being silvered on the bottom half; in some fixtures they are surrounded by concentric rings of metal, while in others they may be shielded by a glass or plastic diffuser. The concentric ring fixture provides lighting with low brightness levels and requires little maintenance.

However, recent increases in recommended lighting levels have made concentric ring, silver-bowl fixtures impractical because of the high amount of current consumed and the quantity of heat generated by the incandescent bulbs. Shields suspended below incandescent fixtures have always been a maintenance problem since they make excellent receptacles for paper balls, paper clips, erasers, pencils, and other small objects thrown there by students.

In the last ten years, fluorescent lighting has largely replaced the incandescent lamp in most new schools. While fluorescent systems are more costly to install, they produce roughly twice the amount of light for the same wattage consumed — and with less heat. Early fluorescent fixtures were troublesome because starters and ballasts were subject to failure. Fixtures now available do not require starters and have more reliable ballasts. In selecting a fluorescent fixture, the instant-start type is recommended and should be designed for easy replacement of ballasts by the custodian.

Early fluorescent fixtures were usually equipped with eggcrate shields to cut off view of the tube from an angle of less than 45 degrees. This system has been found to be very unsatisfactory in many respects and is no longer recommended. More recently, plastic diffusers have become commonplace, and eggcrate fixtures are being replaced. In selecting fixtures with plastic diffusers, a wrap-around type which completely encloses the tubes should be chosen. The result will be to lower maintenance costs because no foreign objects can reach the top of the diffuser. Any dust which gathers on the diffuser or fixture housing can be removed easily by dusting without removing any pieces. Plastic should be light, stable, and non-yellowing, and the diffuser should be hinged to facilitate replacement.

Recessed lighting fixtures are not generally recommended for instructional areas because they do not light the ceiling, resulting in a high contrast between fixture and ceiling. Very little maintenance of recessed lighting fixtures is required, however, since there is virtually no way for dust to collect on them.

Some architects and engineers are experimenting with cove lighting for classrooms. This design consists of a shielded strip of fluorescent lighting along the wall. The shield is designed so that a large portion of light is reflected up to the ceiling, while a smaller amount is reflected down to bathe the wall in light.

Theoretically, this is an excellent way to light an area. However, difficulties have been experienced in obtaining an even light distribution because of irregular room shapes and windows on the exterior wall. This drawback can be overcome by combining cove lighting and standard suspended fixtures in the same room. From a maintenance standpoint, cove lighting is excellent — tubes are easily accessible for replacement or cleaning and the vertical surfaces of the reflector shield do not collect dust readily.

Brightness balance and glare reduction are extremely important. Excellent for lighting design is the *American Standard Guide for School Lighting*, sponsored by the American Institute of Architects, the Council of Educational Facility Planners, and the Illuminating Engineering Society and published by IES (see page 223 for IES' address).

Natural Lighting Devices

As a supplement to artificial light, architects have experimented with ways to increase the amount of natural light. Two popular methods have been the provision of clerestory lighting on the wall opposite the windows and the installation of skylights in the ceiling.

Clerestory windows are not satisfactory when they create problems of heat gain or heat loss. They also can be a source of glare when they receive direct sunlight. Further, clerestory windows are not desirable from a maintenance standpoint because it is usually necessary to wash them from the roof. This type of window also requires shades, blinds, or draperies for use of audio-visual materials.

The two most common skylighting devices are glass block panels and plastic bubbles. Experience has shown that skylights can create more problems than they solve. Leaking can become a serious problem, and may result from two principal causes. In the skylight itself, leaks may develop because of a failure in the mortar which binds the glass blocks together or because of a crack in the plastic bubble. Similarly, leaks may develop in the framework or flashing around the curb on which the skylight is mounted. In either case, the ceiling material surrounding the skylight, as well as the furniture or flooring

"But Miss Witherspoon, it isn't an abstract, it just melted that way!"

directly under the skylight, can be damaged. Careful selection of skylighting devices coupled with proper installation can avoid many maintenance problems.

As with clerestory windows, skylights usually create problems of heat gain and heat loss, glare, and the need for room darkening devices unless steps are taken to solve these problems during the installation.

Much to the delight of maintenance personnel, the development of more efficient and higher quality fluorescent lighting systems has made it possible to achieve high levels of illumination without sacrificing the quality of the lighting environment. Thus, architects generally are abandoning the use of clerestory windows and limiting the use of skylights to certain areas of the school plant.

In one school's skylight-equipped art room, two main problems are excessive glare from the clear plastic dome and heat gain in spots where direct sunlight enters. The instructors who use this room complain that on a sunny day it is almost impossible to work there without pulling shades to close off the skylight. Furthermore, the shades installed do not satisfactorily darken the room for the use of audio-visual aids. Fortunately, the skylight has not leaked, but this is probably more an exception than the rule.

To prevent the problems usually associated with skylights, the following is recommended:

1. Specifications should call for a light-diffusing material to be used in either the bubble itself or in a panel mounted under the skylight at ceiling level.
2. All skylights in rooms where audio-visual materials are used should have suitable darkening blinds of a durable nature. These blinds should be metal or other heavy material and should fit tightly into an overlapping frame when closed.
3. Specifications should indicate clearly both the waterproofing required and design details.
4. Before ceilings are installed, skylights should be tested by spraying them with a high-pressure water line to make sure there are no leaks.

Windows

Windows in instructional areas are not given enough advance consideration. Often the architect selects a certain type of window because he thinks it best fits his design concept, without considering how the window meets the needs of the building occupants or the maintenance staff. Since windows comprise such a large percentage of the exterior facades of most educational buildings constructed in the last 15 years, they obviously deserve careful consideration before final selection.

Basically, there are three types of materials which can be used for window frames — wood, steel, and aluminum. Each material has its own advantages and disadvantages, depending on climate. A material to suit the particular climatic conditions should be selected.

Of equal importance is the actual design of the windows, how they will open, and what percentage of them will open. In general use are double-hung, hopper, awning, pivot, sliding, and casement windows.

Prior to 1950, most schools were designed with double-hung windows. During the 1950's, the use of hopper and awning windows became popular because they were less expensive and readily fit the architectural style of the day — long expanses of windows. Pivot, casement, and sliding windows never have been prominent in educational design, probably because they are never fully watertight or airtight and tend to bind and operate with difficulty as they age.

Hopper-type windows have several disadvantages which make them particularly unsuitable for classroom purposes. When open, they project into the room and create a safety hazard, with the possibility of students bumping into them. For this reason, unless each is placed in a recess it is not recommended that hopper-type windows be used for classrooms or other areas where individuals walk by.

If hopper windows are located only on the bottom section of a high window and all sections above it are fixed-sash, it is difficult to provide adequate ventilation in the warmer months. Without an opening near the ceiling, no natural circulation of air occurs and the hot air at the ceiling accumulates until the entire upper part of the room is stiflingly hot. Even an exhaust air duct located near the ceiling will not be enough to prevent the accumulation of hot air in rooms with large expanses of windows.

When hopper windows are located at the tops of a room's window sections, another problem results. It will be impossible to open the windows without first pulling the shades or blinds clear of the opening (although it is true that, if shades are used for light control, double shades will reduce this problem somewhat). With Venetian blinds, no light control at all is possible when the hoppers are open. Thus it is virtually impossible to darken the room for audio-visual purposes without first closing all hopper windows. If the windows are not closed, the shades, blinds, or drapes are damaged by rubbing against the edges of the hopper sash.

To summarize, in typical installations of hopper windows in a classroom, the edges of the sashes extend into the room past the window wall and create a safety hazard. There are also no opening sashes at the top of the windows, blocking natural circulation of air. In addition, all windows must be closed when audio-visual materials are shown. To avoid these problems, either awning or double-hung windows should be specified.

Awning windows are similar to hopper windows except that they project outward instead of inward. The same bumping hazard exists on the outside of the building that hopper windows create on the inside. Awning windows therefore should not be used where students might work or play close to the building.

One of the chief difficulties with awning windows is that they are sometimes difficult to operate if not properly designed. All high-awning windows should be operated either by a crank at sill height or by a window pole used from the floor. If this provision is not made, the top window usually will remain closed and a ventilation problem will result.

From a maintenance and operational standpoint, standard double-hung windows are desirable. Little can go wrong with the windows mechanically, especially since weights are no longer used to balance the window to keep it open. These windows do not interfere with any light-control devices and are excellent for natural ventilation in warmer months when normal mechanical ventilation is not adequate. Only jalousie-type windows are better for ventilation purposes.

The problem with double-hung windows is that their style does not fit the design concepts of many architects. Recently, however, it appears that architects are returning to double-hung windows.

Pivoting, casement, and sliding windows are not widely used in educational buildings for the reasons mentioned earlier. This situation is unlikely to change in the future. However, some of these windows are used in offices where they are not subject to the punishment they receive in classrooms.

An important factor affecting the design of windows in modern buildings is the growing use of air conditioning. Architects and engineers are designing air conditioned buildings with much less window area than in previous years. From an operational and maintenance standpoint, less window area does mean it is less expensive to keep the building clean and maintain a comfortable temperature.

Many educators still believe it is important to have windows so students will not have a closed-in feeling. If windows are installed, however, they should be operable. No mechanical ventilating system is fool-proof and it is advisable to provide at least some operable windows in the event of a breakdown in the air conditioning system.

Light-Control Devices

No discussion of instructional area design would be complete without mentioning window coverings. There are two basic purposes for the control of direct sunlight in learning spaces. One is to create more comfortable seeing conditions in the room. The other is to close out all natural light to permit the use of various types of audio-visual equipment.

Direct sunlight and glare can be eliminated from the outside of a building by using deep overhangs or sunscreens, by tinted window glass to reduce the light which enters a room, or by placing some kind of mechanical device on the inside of a window. Sunscreens and overhangs are effective in the southern United States, but have not been practical in the northern areas because of the low angle of the sun in winter months. The use of tinted glass has become popular, but unfortunately it does not completely reduce heat gain through the windows. The application of a glare-reducing film to standard window glass has not proven effective, since the material tends to expand and contract at a rate different from the glass itself. Unsightly cracking results and the material must then be removed at a considerable expenditure of time and money.

It has been customary to install either shades, Venetian blinds, or draperies to control sunlight and glare in instructional areas. Draperies are the least popular because they are not durable and do not allow as much flexibility as shades or Venetian blinds. Drapery material which is thin enough to be partially transparent is not heavy enough to withstand the abuse of everyday use, and heavier materials do not permit vision to the exterior.

Shades have served for many years and are widely preferred by administrators and teachers. In buying shades, it is important to specify the best material and to make certain it is washable. In addition, the shades should be reversible in order to increase their usable life.

Venetian blinds have enjoyed less favor than shades because they are difficult to keep clean without costly dusting or vacuuming. Their use is practical only when a reasonable degree of cleanliness can be maintained.

Even under ideal conditions, Venetian blinds have to be washed occasionally. The easiest way is to wash them in a long narrow tank containing water and a mild detergent, then rinse, and hang to dry. With this procedure in mind, it is important, when buying Venetian blinds, to specify slats, tapes, cords, and operating mechanisms which will withstand moisture.

A common difficulty with Venetian blinds involves the replacing of cords and tapes. While this is not a difficult task, it is time consuming. Nylon cords are durable and last for several years. Plastic and fabric tapes have equal merit. Regardless of which tape is selected, the heaviest quality available should be specified.

Venetian blinds have a big advantage in being effective in controlling glare and also as room darkening devices for audio-visual materials. Special blinds are usually needed for the latter purpose, but the extra cost is low and the results high. When even more darkness than usual is required, the blinds can be placed in channels which keep out practically all light.

Window Glass

One of the most costly maintenance tasks in schools and colleges is the replacement of wilfully broken window panes. Several methods have been tried to reduce such vandalism. The most common have been to place guards or shields of various types on the outside of the windows, to design the building with fewer windows and smaller glass panes (easier and less costly to replace) than the usual structure has, or to locate windows so that they face interior courts.

Recent developments have brought about the use of breakage-resistant plastic window materials. The initial cost of the plastic material is more than even the most expensive glass. However, the net result can be a saving in replacement costs which may outweigh the higher initial cost. Many large cities are now using such plastic for replacement purposes as well as for all windows in new buildings. Careful check of code requirements should be made before utilizing plastic glazing materials. Special window designs may be required to suit the material's thickness and expansion properties. Lack of visual acuity may limit its use in some areas.

Heating, Ventilating, and Air Conditioning Systems

A variety of heating and ventilating systems are available for educational buildings. Each system has its own peculiar problems and advantages, and these are reviewed in detail in Chapter 4, "Mechanical Facilities." In this chapter, the discussion is limited to the operation and maintenance of these systems as they relate to the educational program.

Generally, steam and hot water systems have replaced hot air systems as the prime source of heat in instructional areas, with no serious maintenance problem ensuing. Hot water heat is considered most effective because it is easy to control and distribute. Problems usually related to steam heat are defective traps and occasional banging of pipes caused by expansion when the system is turned on. While such drawbacks are minor, they are not common to hot water systems.

Unit ventilators are widely used in classrooms today. Central ventilating systems are rarely installed, except when central air conditioning is involved. Two problems related to unit ventilator operation deserve mention. First, some unit ventilators create so much noise they interfere with the instructional program. To eliminate this, it is necessary to specify units which have slow-speed fans designed for quiet operation. The units should also be acoustically lined to deaden fan noises.

The other problem with unit ventilators is the difficulty of cleaning and replacing filters. Both permanent washable and replaceable filters are available. Permanent filters are excellent if the custodian has time to remove, wash, treat, and replace them periodically. A good idea is to have extra filters on hand so clean ones can be inserted as the dirty ones are removed. This supply saves time and allows the custodians to wash and treat larger numbers of filters at one time. If the custodians do not have time to wash and treat permanent filters, the throw-away kind should be used. However, it is better to pay a few pennies more for replaceable filters and know they will be changed on schedule.

The great increase in the number of schools and colleges installing air conditioning systems can be attributed to two main factors. First, air conditioning has become so common in homes, offices, automobiles, restaurants, and other public facilities that people no longer look upon it as a luxury. Second, many schools and colleges are developing year-round programs and their success depends to a large degree on whether or not students and teachers can work and study with reasonable comfort during the warmer months.

Even if air conditioning cannot be included at the outset of a new building project, the building itself and the heating and ventilating system should be designed to facilitate future installation.

In one school, a summer instructional program necessitated the installation of air conditioning equipment in classrooms not originally designed for it. The units in question are large ones located in the rooms themselves. As a result, instructors who use the rooms are dissatisfied because they must shout to be heard above the noise of the units.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Planners can make advance provision for air conditioning in at least some of the following ways:

1. Window areas, where necessary, can be reduced to cut solar heat gain and make a smaller, quieter unit possible.
2. Adequate insulation in the exterior wall and roof can be provided.
3. Plans should specify that all unit ventilators and other heating and ventilating devices be constructed so air conditioning can be easily added at any time.
4. Provision for future in-wall installation of air conditioning units should be made and a unit should be selected which will be suited to the needs of the instructional area.

Chalkboards and Display Boards

Chalkboards and tackboards are a vital part of every learning area. So many different kinds of chalkboards are on the market today that it is difficult to generalize. The more prominent types are natural slate, steel with various types of backing sheets, cement-asbestos composition, and fiberboard or plywood composition boards.

Glass chalkboards, used extensively in the decade prior to 1960, have lost somewhat in popularity because of experiences with breakage. Chalkboards of fiberboard or plywood are not recommended for heavy use areas because they do not hold up well under repeated washings. Natural slate boards are returning to popularity after a period of decline during the 1950's. Steel chalkboards are useful because they lend themselves to the use of magnetic teaching devices. Cement-asbestos boards increasingly are being specified because they not only have many of the qualities of slate boards but are also available in different colors.

Regardless of the type of chalkboard used, a daily cleaning routine is important. Many custodians and teachers believe that chalkboards cannot be cleaned unless they are washed with water. This is not only false, it is also injurious to the boards. Water deposits clay particles from the chalk into pores on the writing surface, causing a graying of the board which cuts down contrast.

The proper way to clean a chalkboard is to wipe the surface thoroughly with a felt eraser and then rub it with a dry chamois. If necessary, a lightly dampened cloth may be used to pick up any chalk dust still remaining. Before new chalkboard is used, it should be chalked in thoroughly by rubbing it with the flat side of a pure chalk stick and then dry cleaning it as mentioned above. This will eliminate "ghosts" in later writing on the board.

Tackboards come in two main types — corkboard on a mounting sheet, or a vinyl-covered composition board. Cork is known for durability and satisfactory results. Smudges can be removed by a light washing and more difficult soiling can be taken off by rubbing lightly with fine sandpaper. Unfortunately, the shortage of cork has made it costly, and many schools are using vinyl-covered composition boards. These are available in many different colors and blend well with room color schemes. Recovery from tack holes is not quite so good as for cork, but it is still acceptable. Cleaning is not difficult because the vinyl surface can be washed with any of the usual detergents.

A pressing problem in many buildings, both new and old, is the lack of adequate bulletin board space. As a consequence, instructors are apt to use gummed tape, masking tape, and other methods to display objects around the classroom. This results in unsightly marks on painted walls, requiring frequent washing and sooner-than-normal repainting.

To overcome this problem, plans should specify the maximum amount of tackboard space in all rooms, except those where display needs are not great. In some areas, especially art rooms and elementary classrooms, an entire wall from floor to ceiling might be covered with a tackable surface of wood or a composition material. Such a material acts as both the wall covering and the tackable surface. Steel wall panels can be used for display purposes, but the magnets required are fairly expensive items, easily lost or stolen and generally not so satisfactory as tacks.

Classrooms also should be provided some way to hang heavy flat or three dimensional objects. This can be met by providing spring clips and map hooks along the tops of all chalkboard and tackboard sections and by installing pegboards at an appropriate location.

Built-in display cases are quite popular in elementary classrooms and in some special classrooms at the secondary school and college level. Proper lighting of such cases is a must.

Coat and General Storage Facilities

In the elementary school coat storage facilities are usually in the classroom itself for at least the lower grade levels. Such facilities usually consist of a built-in wardrobe with folding or sliding doors provided along the rear or side of the classroom. When this kind of installation is provided, planners should make certain that the doors are extremely durable and hung with the best operating hardware available. If care is not exercised, one can expect constant repair calls to keep the doors in operating order.

A second type of facility is the portable coat storage unit on casters. This unit can be rolled about the room and used either as a divider or as part of a teaching center by virtue of a tackboard or chalkboard surface on the rear side. The portable units are particularly useful in schools where a great deal of flexibility is desired for team teaching and similar purposes. Maintenance is minimal on such cabinets because there are no moving parts.

A third storage unit, used especially in college classrooms, is the wall-mounted coat and book rack. Such racks are not usually recessed and are not closed off from view. Therefore, they tend to be rather unsightly and their use is recommended only under the most extreme budgetary conditions or in a situation where students move from building to building each period.

Beside coat storage facilities, most elementary and secondary classrooms need general storage for the supplies and equipment of the instructional program and the teacher's outer garments and personal items, as well as a file cabinet or two for storing special instructional materials. These storage cabinets and files can be either movable or built into a wall recess. If movable cabinets are selected, units should be chosen which are sturdily constructed and have large-wheeled casters that will not damage the floor covering.

10. Laboratory and Related Areas

Few areas of the curriculum have undergone such dramatic changes during the last decade as have the sciences. The rapidity of change brings with it new concepts, new materials, new equipment, and inevitably more complex problems. Included in the proliferation of curricula and courses are earth sciences, space sciences, BSCS in blue, green, and yellow, CHEM study, SCI Study, PSSC, and other combinations of letters to increase the alphabet of science.* The nomenclature matters little; what does matter is the fact that the sciences have exploded like the mushroom cloud that shook the world in 1945.

Painfully evident is the fact that this state of organized change is replete with new questions and problems, and with a great need for careful planning. Investigation must be thorough if costly obsolescence of facilities is to be avoided — even before new plants are completed. Science is here to stay, but technological developments do not permit it to stand still.

The explosion of knowledge is nowhere more evident than in the realm of research. It may even be that the science curriculum will soon outdistance the ability to provide adequate services and facilities.

Add to this hopperful of problems the rapid development of audio-visual materials and techniques; mix in a 25-year veteran who still insists on instructing "real bread-and-butter sciences, none of this alphabet soup stuff"; sprinkle in some furniture and equipment designed for the turn of the century; add just a touch of architect who is confused by it all and whose sole objective is to keep the rain off your head; and garnish profusely with those who cherish the almighty dollar more than they do the almighty future. The result: a heaping big kettleful of trouble.

Planning for the sciences of today and tomorrow requires all the help available. Staff, students, educational consultants and specialists, architects, the progressive manufacturers of quality furniture and equipment, multi-media experts, and representatives from business and industry can make a real contribution.

Science is no longer a discipline where the all-knowing instructor dispenses a seemingly endless list of facts, where recitation and repetition of 20-year-old experiments are in vogue. Science has grown up to the realities of student investigation and experimentation.

*BSCS is the Biological Sciences Curriculum Study. CHEM Study is the CHemical Education Materials Study. SCI Study is the Science Curriculum Improvement Study, and PSSC stands for the Physical Sciences Study Committee.

Students need space where they can sit and listen to lectures; they need space where they can perform short-term experiments; they need space where they can carry out long-term project investigations; and they need space where materials and supplies are readily at hand. No longer are students spectators but active participants in this drama of life, in the quest for knowledge.

The challenges of change are many; new ideas and their ever-present problems are never ending. Out of change come some errors, some success, so that the search for the right answers must go on.

Perhaps this search for answers, the pointing out of some common errors, is best described by a passage from the first Telstar program which said: "The dogmas of the quiet past are inadequate to the stormy present; as our case is new, we must think anew and act anew."

A Place to Hang His Hat

The science instructor seems to have been forgotten in the mad dash to develop the latest in science facilities. The demands on space by the expanding requirements of the new sciences often leave little working space for the instructor. Indeed, many of the new facilities leave the viewer asking, "Where does he hang his hat?"

Science facilities are still being built with the laboratory serving as office, conference room, preparation room, and storage room. Yet, oddly enough, this space was basically designed as a laboratory. Any other activities and the instructor are just stuffed in because there is no other place for them.

As a result, the typical instructor has no place where he can meet conveniently and privately with people; where he can duplicate instructional material; where he can sit for a moment, to relax, to contemplate, to plan, or just to have a cup of coffee. Sadly lacking is a common source of science reference materials easily accessible to both teachers and students.

The questions raised pertain to more than space. They include the matter of safe, efficient housekeeping, an almost impossible task in overcrowded conditions.

Perhaps our planning of science spaces should include visits to the laboratories of industry. The price industry pays for comfortable and adequate working conditions is considered a wise investment for a good return in productive time. Industry rarely requires a research scientist to perform the routine duties of a stock clerk or perpetual housekeeper. Perhaps we can never fully emulate industry — but we certainly can improve our effectiveness by providing adequate and

proper facilities. No other failure in the design and operation of facilities when corrected will give greater returns than in the area of science. And if all else fails, at least give the instructor a place to hang his hat.

Science Furniture — Uncreative, Oversold?

Whirlwind changes are evident in all phases of the sciences — except in the development of furniture and equipment. The bulk of science furniture being produced has failed to keep pace with the startling advances in curriculum. To be sure, the newest of today's equipment is shinier and more colorful, but very little else has changed. The units are still fixed, they have some drawers, cabinet space (with a new development of adjustable shelves), they have tops which contain sinks, and utility turrets, and holes for poles, and sometimes there is even room left for special projects.

Other than the development of a handful of new concepts, there is an alarming lack of new furniture that copes creatively with the changing needs of science today. Therefore, the furnishing of a laboratory becomes a major problem and concern since so little of it has kept up with the times.

Perhaps one day we will see science rooms equipped with utility cores in the floor or along the wall: where a lab station/desk unit can be moved into position and "plugged" in; where a student can easily move his lab station into position for a lecture, slide out a writing surface at the appropriate level and take notes, or connect a recorder; where he could use this lab station/desk to spend an entire period doing work on a research paper; where the unit could provide a student with a place for viewing a filmstrip or TV, for using and storing a microscope; or for writing notes on the pullout shelf while watching the progress of an experiment on top of the unit.

None of these ideas is far fetched — but they do require imagination, study, and, most of all, people willing to encourage and support the manufacturer who keeps abreast of scientific needs and developments in this area.

What about the danger of overbuying or being oversold? One of the poorest buying practices today occurs with unreachable wall storage cabinets which require either the questionable safety of a stepladder or the arms of a Gargantua in order to reach higher than the bottom shelf. Dead storage on the upper shelves becomes terribly expensive. Equally bad are the deep storage areas contained in the base cabinets, where most of the space is unreachable and wasted.

Storage is critical, particularly in view of the many items to be stored and the final cost of storage. How often the low cost of a building on a per-square-foot basis is quoted with pride. How easily is forgotten the cost of the equipment which has to sit upon that square foot of space — and if that equipment isn't doing its job, the real cost per square foot rises astronomically.

If a planner considers for a moment how much floor space a base- or tall-storage cabinet takes up and then computes what it costs for every square foot taken up, he will readily see that storage is not only a major concern but a costly one. Storage therefore must be viewed with a critical eye, in the science room as well as other areas of a building. Poor facilities for storage result in poor housekeeping and lost time, make routine maintenance difficult, and can be dangerous.

Unfortunately, more often than not, educational planners pay little attention to the specifics of storage, so they end up just buying "cabinets" with doors, drawers, or both. Perhaps there should be more concern with flexible storage units that can change with need. Perhaps there should be concern with adaptability wherein a basic unit can be used for a variety of areas and needs; perhaps there should be concern with efficient utilization of space within a cabinet so that storage costs can be reduced.

It would be a useful exercise to examine the insides of a storage unit before deciding what to buy. Planners should not be surprised if only 50 percent of the space is usable — storage can be costly.

Poor planning and buying can result in paying for a lot of unreachable and expensive storage space. Perhaps an actual mock-up of sample units exactly as they are to be furnished should be set up and tried for size and reactions by students and instructors who will use them. All this should be done *before* specifications are written.

The Big Cover-Up In Science

One of the errors most repeated in developing science facilities occurs in planning simple and adequate window covering installations. All too often the architect forgets to allow for them.

Problems occur with large expanses of glass, with high narrow windows, or where fastenings are difficult to anchor so that coverings can be safely installed. Perhaps this may seem to be an insignificant point unless those using the facility are to work on color experiments requiring total blackout. Even slight light leakage can negate the laboratory experience for such experiments.

In some cases the expanse and shape of glass makes the cost of window covering almost prohibitive; similarly, the problem of maintaining these coverings is also formidable. They get splattered, torn, and even jammed to a point where the user becomes frustrated and avoids working them altogether.

The question then arises: "Why install windows in the first place in some of the laboratories where these special experiments take place?" Are large expanses of glass in laboratories necessary at all, except to fulfill building code requirements?

If the premise is accepted that windows in varying amounts are required by code, what can be done about proper covering? One logical step would be to limit the amount of windows, including those at entrances from the corridor and between interior spaces, since glass in interior walls and entrances also allows light spillage from adjoining spaces.

What about the various coverings available on the market for these special areas? Are there other materials or ways of doing the job that have been overlooked? Can folding wood or metal panels be used, or roll-up type overhead shutters, or sliding panels which are contained in pockets at either side of the window. Such items are durable, require little maintenance, and could provide positive light seals when properly installed. Though higher in initial cost, they would be less expensive in projected cost and, most importantly, they could function without getting in the way of the teacher or the student.

The problem is mainly the need for positive darkening of windows for the special requisites of science, but the discomfort of glare from windows is also a factor. Countless installations of tinted reflective glass have proved to be an excellent solution to this problem. One word of caution, however, regarding tinted glass. Contractors should be extremely cautious in trying to do the job with surface-applied materials. This solution is apt to create more problems than it solves — streaks, peeling, cracking of glass, and difficulty in cleaning.

Window coverings for the science area can be an expensive headache. Administrators must be certain that the architect is fully aware of specific problems and needs; they must plan for the big cover-up before it's too late.

Chalkboard and Tackboard

The problem of how to provide adequate writing and display surfaces in laboratories changes almost as rapidly as the program. Needs change with instructors, with program, and with development of specially designed units containing graphs and tables.

Newly assigned instructors invariably request either all chalkboards, all tackboards, or a combination of both. Immediately a


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problem is created, and something must be done. The problem is complicated by, and often results from, the installation of fixed units in the original construction.

Fortunately, few of the newer display or writing surfaces are "built-up" over rough wall surfaces. For the most part, newer units are applied to the surfaces of finished walls. However, they continue to be rigidly fastened or cemented onto the walls in large 4-foot-by-8-foot sizes, with the inevitable full-length chalk tray.

Though not of earth-shattering consequence, the problem of rearranging tackboards and chalkboard installations to suit individual requirements can be a repetitious and costly annoyance. Maintenance people have to make repairs and time-consuming changes each time these boards have to be rearranged, and the custodian has one more item to clean when he encounters the chalk tray.

During the planning and purchasing stage, the use of completely interchangeable modular units should be considered. Modular equipment permits any combination of units by merely removing a few fasteners. Units are available with a neat, narrow, metal trim which allows an almost continuous writing surface when chalkboards are mounted side by side.

How about the function and cost of full-length chalk trays? Are they really necessary? Few trays catch all of the chalk dust, and a large amount falls to the floor anyway. Why not let the rest of it fall to the floor, which is swept or dry mopped in any case?

The interchangeable unit is a solution to the problem of installing boards with graphs or charts imprinted on the surface. These units come in various colors and designs and can be easily changed to fit requirements.

It is true that the chalkboard and tackboard problem is one that can be lived with, usually for years. But a little advance planning can eliminate the problem and make for happier instructors, custodians, and, on occasion, happier administrators.

The Thermal Environment

Though the problems of thermal environment apply to all situations, several are especially significant in science labs. These include air exhaust systems, types of heating units selected, location of thermal equipment, means of neutralizing cold surfaces, humidity and temperature control in special areas, and cooling.

When the aroma of some acrid chemical wafts its way through a building, lights flash and bells ring with a strong and clear message:

the air exhaust system in the science rooms should be independent of all others. This is a cardinal rule to be observed at all times, particularly if conventional classrooms are to be converted into science spaces. Planners should never forget to isolate the air handling system.

The location of heating units can be a vexing problem, particularly when every inch of floor space is vital. Often the problem is solved by hanging the heat on the walls. Then comes the real headache when a wall full of science benches is placed in front of these convectors. First, an asbestos panel must be placed behind the cabinets to protect them from the heat. Then cut-outs and grilles must be placed at the top and bottom of the cabinets so air can circulate. Should the occasion arise, it is virtually impossible to repair a leak in the line behind this massive fortification.

Perhaps one answer is the ceiling. Some consideration should be given to placing the heating system there; at least it would be out of the way, and would even be accessible for repairs. Great strides have been made in the development of heating systems designed for ceiling installations; they may be part of the solution to many of the problems discussed above. Planners are well-advised to examine this alternative while debating other plans presented by heating specialists. They also should consider the use of mobile furniture which will not interfere with conventional-style heating units.

Thermal control in special areas such as greenhouses and animal rooms requires extra attention. What happens in the animal room when facilities are closed down and heat is kept at minimum? Can necessary heat be provided in this space or are the animals to be moved elsewhere? Perhaps a simple electric radiant panel, thermostatically controlled, would provide a solution. It's worth considering.

Rather than permit plants to freeze and wither in cold weather, the considerate planner might think about adding a radiant panel in the plant room, too. In either case, such panels can be the primary source of heat or an auxiliary source to be used during shutdown periods. A word of caution about the animal room: if at all possible, the air exhaust system of that room should be isolated from all others. The little critters don't smell exactly like roses.

Other than in tropical climates, a building is rarely designed without facilities for heat, simply because buildings would otherwise become too cold for occupancy. On the other hand, far less attention is paid to making our buildings comfortable by cooling them in hot weather.

Control of the thermal environment should include the avoidance of extremes — hot or cold. Planners and administrators should devote attention to this problem if educational facilities are to be efficiently used at all times.

Thermal environment is something everyone lives in, and lives with, for a long time. It really should be given extra time during the planning stage.

Safety

Science laboratories are among the most hazardous instructional areas. Special attention must be given to planning, not only to reduce the occurrence of accidents, but to establish procedures for handling emergencies.

Piping for laboratories where gas and, or acid waste are involved presents special hazards. Acid-resisting waste lines, whether metallic or glass, may be needed to reduce maintenance problems and to minimize the danger of acid waste leaking into other building areas. These wastes are not only dangerous to individuals, their corrosive effects can cause considerable damage to building, furnishings, or items in storage.

Where gas piping is installed, special care must be exercised to avoid the possibility of gas accumulating under floor slabs, in wall cavities, or in other unventilated areas. With the large number of manual gas openings usually provided, a master control valve is desirable for emergency use or when the laboratory is closed.

Floors for laboratories present special problems. The floor should be both easy to maintain and resistant to acids or other chemicals. In some cases conductive floors are desirable to reduce the accumulations of static electricity that could set off an explosion. In any event, the floor covering should not contribute an appreciable amount of fuel or toxic fumes in the event of emergency conditions.

Most laboratories need a special type of fire extinguisher and other fire safety equipment not generally provided in other areas of the building. There is also need for an emergency eye shower, and for special first aid supplies and equipment. A check with safety experts and industrial laboratories will quickly reveal most of these safety requirements.

An operational analysis of the proposed facility, particularly while it is in the design stage, will highlight many problems of safety which can be avoided. Safe and efficient facilities don't just happen; they must be planned.

11. The Instructional Materials Center

As educators learn about learning, and as technology develops new tools for learning at an almost frightening pace, the library of yesterday and today is in a constant state of flux in its battle against obsolescence. The advent of electronic hardware has expanded the function of libraries far beyond the role as "keeper of the books" and the "guardians of silence" in tomblike centers. Even the name has been changed from library to instructional materials center or resource center, an indication that educators have embraced, however reluctantly, the invasion of audio-visual and electronic devices as an effective means of collecting and disseminating information.

The twin explosions of population and information force recognition of the inevitable necessity of using modern technology to extend opportunities for inquiry.

This same technology, which opens new horizons, also opens, for the planner of educational facilities, problems of:

1. Housing a wide range of equipment and materials in an attractive facility conducive to independent and group study.
2. Organizing an abundance of appropriate material — printed and non-printed — in a way which will permit the user, whether student or teacher, to find a significant body of information quickly and use it easily.
3. Making a wider variety of equipment readily accessible for use by an individual *without concern about complicated machinery or entangling administrative procedure.*

What does this all mean when related to the process of planning? What are the things of which to be aware if this facility is to function successfully? Perhaps the following will point up some of the major concerns in planning.

Location

Location of and accessibility to the instructional materials center is of vital concern, both during school hours and during the "off-hour" period, including weekends. If the instructional materials center is truly to be the "heart and nerve center" of the school, then it must be so situated that it can be made easily accessible and available for use at all times.

Too often facilities are closed to students because "they can wander all over the building; we have no control." Therefore, the usual solution is not to permit after-hours use; the solution could have more readily been found in the initial planning of the area's location.

There can be little justification for the instructional materials center to be closed and unavailable to students and community alike during the evening or on weekends. There is even less justification if planning does not project and provide for this kind of use, now or in the future.

Most important are the recognition and consideration of the different requirements of accessibility for both day and off-hours use. The latter can cause serious control problems if location is determined solely on the basis of day use. It must be kept in mind that during the day a good instructional materials center extends itself *out to the pupils* by means of electronic and visual hardware, whereas during off hours the students move to the center.

Perhaps a significant exercise would be for one to do a traffic pattern study and "walk through" the plans to reach the instructional materials center. The imaginative planner should try to look through the eves of the user as he wends his way the distance of a football field through a maze of corridors to reach the center. Though it may not all be bad, he might then ask himself, "Does it have to be?"

Lighting — It Can Be Good

Lighting of the instructional materials center is a particularly trying problem, what with the number of different activities which take place and their varying demands for proper task illumination. Added to this is the oft-heard request to create a non-institutional space; when translated, this often means individualized lighting within the confines of a large mass. The universal plea is invariably for "lots of good lighting with no glare," yet seldom does this answer certain pressing problems. Here are four:

Carrel units, particularly those with shelves and high sides, are seldom properly lighted from overhead and are often plagued with problems of shadows, reflections, or both. Does one need a high degree of illumination to listen to a tape or to view television? Does one need to light all carrels whether they are in use or not? Perhaps one should seriously consider individual lighting for each carrel unit so that a user could select low lighting or no lighting for listening and high, shadow-free lighting for reading and writing.

"Up a blind alley" was probably coined by someone frustrated by the many inadequate solutions to lighting book stacks and book alcoves. Perhaps a wash of light on the face of the stacks, or the proper location of fixtures, would help remedy the problem. In any

case, the educator must make his concerns known to the architect. He must spell out his furniture and layout requirements so the architect doesn't end up in a blind alley too.

The reading and lounge area often lends itself to the non-institutionalized look and should be treated accordingly. Planners should avoid the high-level overhead illumination which blankets an area and consider the use of floor lamps, table lamps, and adjustable ceiling planes which combine lighting and acoustics.

Accessibility of fixtures for cleaning and repair is a most important consideration during the planning stage. Planners should insist on examining samples of the proposed fixtures to determine the ease with which louvers, ballasts, and bulbs can be serviced. No fixture is a bargain, regardless of cost, if simple maintenance becomes a major operation. The custodian will have enough obstacles maneuvering around carrels, bookcases, tables, and chairs without adding to his woes overhead.

Overhead lighting need not suffer the monotony of a factory atmosphere if some thought and attention is given to controlling areas of light, for example, by creating pools of different intensities. In fact, combined with "individualized" treatment, lighting itself can be both creative and exciting.

Climbing the Walls

Walls, and sometimes the absence of walls, bring into focus a series of problems apt to be overlooked in early planning, causing unsatisfactory compromises in the latter stages.

The architect is often instructed to provide "an open airy feeling;" "space for lots of books, but stacks must be low and out of the way for easy supervision;" "lots of space for kids;" and "plenty of display space." Meanwhile, back at the walls, the architect has also to satisfy the code requirement on windows and somehow to find a place to locate the heating units.

The multitude of requirements affecting what happens at the exterior walls means that one must set priorities in seeking efficient solutions.

Excessive windows (often dictated by code) with inherent problems of maintenance, glare, and need for covering often can consume large amounts of valuable wall space and add appreciably to the cost of installing and operating heating and cooling equipment.

Capacity requirements for books may be impossible to meet without using large amounts of exterior walls; otherwise, square footage, costly to build and maintain, must be added to meet requirements of low, free-standing book units.

Heating units, particularly in colder climates, are required to produce a blanket of warm air to offset the chilling effect of exterior walls and windows.

The use of conventional wall-hung units of various types, though effective in function, often cause more problems than they solve. For example, valuable wall space usually must be kept clear so the units can be repaired and serviced. Planners *can* place bookcases, with their top and bottom grilles for circulation of air, in front of the heating elements and pray the latter will run forever without requiring service. In doing so, those same planners will probably ignore the loss and cost of square footage required if the cases are set even six inches away from the wall; no one would see that anyway.

Therefore, the capacity requirements and the function of this space should be reviewed carefully with the architect. If there are exterior walls, the planner should be ready to limit the amount of window area desired on the number of books to be housed, or else to spend the dollars to provide both. Additionally, the planner should ask the architect to seek a really satisfactory solution to the problem of heating exterior walls without sacrificing stack space or ease of maintenance; it can be done.

Exterior walls in the instructional materials center can be a many-splendored thing, if their use is thoroughly planned.

Planning for the Unknown

Until recently, planning a library was fairly simple, since the only real concern necessary was with books, tables, and a few children. It was almost like child's play. Unfortunately, some still play at it like children, ending up with facilities circa 1930 in vintage.

The trouble began when someone decided to look at a film strip in the library. Then along came television, followed by information retrieval, so that educators soon found themselves wrapped up in such terms as coaxial cable, microwave transmission, jacks, amplifiers, xerography, and other strange innovations. Suddenly the library, as it used to be, was no longer, because schoolmen learned that children could gather meaningful information from sources other than books.

Then "Mr. Audio-visual" grew up and was wedded to the library; the couple was sprinkled with a confetti of electronics, and now its family has grown to become the instructional materials center.


LIBRAR
film
MISS LANE
VISUAL COMMUNICATION GRAMMAR
COAXIAL CABLE
MICROWAVE TRANSMISSION
STRIP FILM
FULL FRAME
STOP MOTION
HORIZONTAL JITTER
SINGLE SERVO LOOP
MATCH DISSOLVE
MICRO MINIE
8 MM./16MM./35 MM.
FRAME COUNT
AUDIO VIDEO
24 FRAMES PER SECOND
CHART 17

Many of the present troubles in planning and maintenance have come about because this couple has been blessed with a number of "way-out" relatives who keep showering gifts of contemporary hardware and software incompatible with traditional "cubby-hole" architecture.

The developments of new technology and new techniques are moving at such a rapid pace that one cannot know what tomorrow will bring, yet he must plan for that tomorrow. Unfortunately, the problem is compounded by building materials and techniques which are archaic when compared with developments in tools for learning.

In the not-so-distant future, computer power and outlets will be as convenient and as inexpensive as electricity is today; multi-discipline carrels will plug in almost anywhere; environmental simulation will be convenient for use; transmission of power will be wireless. Planning, therefore, must allow accessibility in or on ceilings, sub-floors, tunnels, service cores, and even walls for that which is to come.

As electronics is the magic word of industry, so must *accessibility* be the guiding theme for the planner, the designer, and the builder. Short-sightedness can prove costly and unsightly with makeshift arrangements. This is an area which must be investigated thoroughly and planned carefully, an area where knowledgeable consultants can save future headaches and dollars.

Static Is Status

Today, the "in" thing to talk about at lunch is how big a jolt you get from the static electricity in the carpeted instructional materials center. Carpeting, in this area at least, has reached an aura of acceptable respectability and is deemed a necessity, rather than a luxury. Therein lies a problem.

Many a custodian no doubt often feels like a farmer spraying crops because of the periodic need to spray an anti-static material onto the carpet to reduce the static charge. Yet, at best, this is a temporary solution, costly in time and materials — and complaints will continue to plague the school's administrator.

Prior to purchasing carpeting, school officials should thoroughly discuss the problem with the architect and the manufacturers. If they offer a solution other than grounding of the carpet, the next steps should be to inspect an installation, ask questions of those who "live with it," and ask for a guaranteed shock-free installation.

Whatever the solution, school officials should be certain it works, and be willing to pay a slight additional charge for positive results — it will rank among their wisest investments.

Built-In Distractions

Distractions, particularly those related to sound, tend to amplify beyond proportion when they occur in a relatively quiet area. Instructional materials centers are still in the category of quiet zones even with today's more permissive atmosphere.

Therefore, sound, which changes to noise when it distracts, must be carefully controlled during early planning or afterwards the maintenance staff will be "run ragged" to correct the nearly uncorrectable.

In these days of conditioned environment and high level lighting, one must look carefully at design factors of air handling equipment, equipment mounts, and lighting ballasts as a potential source of trouble.

The high whine of a ballast or the rush of air passing through a diffuser can have the torturous effects of dripping water. School officials need to be concerned enough to relate this concern to their architect. They need not spell it out in technical terms, but they can readily make clear that these units must operate reasonably free of distracting noises.

Further, they should find out what the architect means by decible ratings and how noisy a rating may be, then insist the requirements be written into the specification and strictly adhered to by the contractor. In other words, if school officials make a little sound now, they should not hear any noise later. In addition, one rarely goes about replacing a ceilingful of ballasts or fan units — even when they distract.

This chapter has touched upon only a few of the problems which often slip by unnoticed because planners take them for granted and rarely tend to do anything about them. If the instructional materials center is to function as the nerve center of the educational facility, then it deserves full attention and the best planning it can get.

12. Spaces for the Performing Arts

Each space in an educational facility is special unto itself. Each area must be carefully planned and designed to support and enable the learning process to take place under as near ideal conditions as possible. It is not enough to take space, cut it into modular or non-modular chunks, and then describe the areas as classrooms or special spaces.

Each spatial designation must be able to house a necessary range of equipment and material without getting in the way of the student, the instructor, or the learning process. Each must be designed to accommodate educational programs of today — and tomorrow as well.

How simple an educator's job would be if these well-worn phrases were enough to help attain the Utopia of educational facilities planning. But the path has many pitfalls and is ever-changing, as the process of learning and directions of education also change.

Specialized spaces are particularly vulnerable to poor planning. Problems often arise from a lack of sufficient planning time, lack of involvement of people, and a lack of adequate information and guidance. All too often, they also arise from misguided economy. Time after time, it is into these special areas that are stuffed, sausage-like, a multitude of activities to which are affixed exotic names. Too late the administrator realizes that a giant-sized headache has been created which unfortunately will linger for years.

These special areas are where, too often, well-meaning architects run rampant because the problems hadn't been clearly defined for them in the first place.

The creative and imaginative architect will not work in a vacuum. He will insist on adequate educational specifications. Yet, there are administrators who still believe in Santa Claus, who still believe they can get "something for nothing." They engage an architect who promises that he can work magic without educational specifications (and save money). But when the act is over and the illusions of magic are gone, reality forces the harsh comprehension that there really isn't a Santa Claus.

And what about the involvement of people in planning? Students, custodians, staff, and specialists must be actively involved in planning facilities. All the answers are not necessarily held by a select group of wise administrators; therefore, broad representation in the planning process helps in the development of effective facilities with a long, useful life. Involvement of people has many problems and does require a great deal of time. But time is also the true measure of a

" . . . testing, testing, one . . . two . . . three."

building. The involvement of people in planning will help assure a building that will pass the test of time.

There is no panacea for planning. Rather the warning flag can be raised on some oft-repeated errors which must be avoided to keep bad planning from getting in the way of good learning. Attention will focus here on the general nature of several recurring problems rather than on the technical detail of specifics.

The Auditorium and Its Acoustical Climate

The term "acoustics" can stir up more controversy than almost any other aspect of construction. Good acoustical qualities become a very personal thing, as do good food, good art, good design, or good anything. Acoustics can be related to conditioning — that is, to the understanding of acoustics or lack of understanding, and one's tolerance of noise as related to his nervous temperament.

One merely needs to consider the problems of the famed Philharmonic Hall in New York's Lincoln Center. The hall is almost as well known for its initial acoustical problem as for its beauty. The hall's problem stemmed from seeking the best in acoustical climate for the great orchestras and performing artists of the world. Educators' problems come from seeking a pleasantly balanced space in which to teach and learn. One may not be seeking Philharmonic Hall's epitome of acoustical climate, but neither can he accept the nerve-shattering echo chambers too often found in today's educational edifices.

The term "acoustical climate" encompasses a wide range of conditions which must receive consideration in planning an auditorium. To neglect any one of these conditions is to court disaster (or possibly to reduce a space to almost complete uselessness). It is impossible to isolate the interrelated problems of excess reverberation, sound transmission, balance of sound, relationship of spaces, effects of mechanical equipment on sound, selection of furniture, and use of special materials.

Excess reverberation in an auditorium is caused by sound bouncing off too many hard surfaces — windows, walls, floors, ceilings, and furniture. Reverberation also has the quality of growing and swelling in intensity; its effects are all too apparent. Therefore, it is necessary to soften surfaces, to absorb the shock of sound and, in effect, to take some of the bounce out of sound.

This can be accomplished by using a variety of softening or porous materials which absorb sound. These include carpeting, upholstered furniture, acoustical ceiling materials, acoustical baffles, and draperies. Equally important is the use of creative structural design, whether it be offset ceiling planes, sawtooth walls, non-parallel surfaces, or other devices to control reverberation effectively.

Transmission of sound presents one of the most serious problems encountered in auditorium design, particularly if the auditorium is designed as a multi-use space. The problem is to stop sound from being transmitted from space to space within this area, or at least to minimize the sound transmission.

In today's desire to provide flexibility in auditorium spaces, operable partitions are often used. Unless properly constructed, these can be most inadequate for containing sound. Sound leakage also takes place through small openings around doors, partitions, fixtures, electrical outlets, ducts, and other openings. As water under pressure gushes through a pinhole in a pipe, so sound can escape through even the smallest opening in a wall or door.

Many items of construction can be checked to help minimize leakage of sound. Glass, where used, should be double glazing; gaskets should be provided around doors; air ducts should be acoustically lined, and when possible, the duct system should be designed independently from the duct systems of other areas; electrical outlets should be spaced alternately and not put back to back; and insulated partitions should be built from floor to floor rather than from floor to ceiling, particularly where ceilings are suspended. Open suspended ceiling areas can become bothersome transmission chambers, easily offsetting all other precautionary measures.

An unfortunate paradox of sound control is that porous materials, which are good sound absorbers, are not good containers of noise. An example of this is the widespread use in construction of the porous-type block wall which absorbs sound energy but allows the transmission of noise from room to room. Because of this, wider use is being made of solid block in areas where sound containment is essential.

The balance of sound has to be achieved by an optimum balance in combining hard and soft materials in relation to the size of the auditorium and activities conducted within it. Acoustical materials should be chosen for the specific function of absorbing, containing, or correcting existing problems related to sound. A word of caution in striving for balanced sound: Surfaces should not be over-softened nor reverberations dampened to the point of creating an acoustically dead area.

If a little acoustical treatment is good, however, it doesn't necessarily follow that a lot of acoustical treatment is better. With few exceptions, most auditoriums require some degree of sound liveliness in order properly to project desirable vocal and instrumental sounds. Perhaps the most significant problem in this area is the need to reach a compromise between the balance of sound required for the day-to-day use of the auditorium as an instructional space and the balance of sound required for periodic productions when the facility is filled to capacity. Because of this compromise, serious consideration must be given to the use of sound-reflecting baffles and properly designed sound systems.

The location and relation of the auditorium to adjoining spaces can greatly affect the acoustical climate. Too often, there is insistence on locating everything adjacent to the auditorium, which creates serious, but avoidable, problems. How often has the whine of a power saw or the tooting of a trumpet driven amateur thespians and their coaches to distraction? When possible, the use of dressing rooms, scenery storage areas, and offices as sound buffers will help reduce the noise problem.

Types and locations of mechanical equipment require careful consideration for their total effect on the climate of sound in an auditorium. Poor planning often means that an air supply system has to be shut down because it interferes with hearing a speaker. Similarly, it is not uncommon to have sound transmitted to the auditorium from adjoining spaces through an air exhaust system.

The proper selection of furniture for an auditorium makes an enormous difference wherever acoustics are concerned. Upholstered seating helps to absorb noise and is particularly useful in achieving acoustical balance, even if the auditorium is half-filled with people. If wooden seats are selected, it becomes necessary to compensate for the introduction of a hard surface; this should not be kept a secret from the architect. Even though not related directly to the acoustical climate, the mechanical features of seating should be carefully inspected. The purchase of seating with built-in squeaks should be avoided.

These are typical recurring noise problems which disturb the concentration of a learner. Similar problems are numerous, yet they can be avoided. A first step is to insist that the architect and engineers be constantly alert to the need for sound control. The educational planner should review their plans and arm himself with several basic questions concerning levels and transmission of sound. The headache he saves may well be his own.

The problems involved in attaining a proper acoustical climate are many, but perhaps the greatest underlying cause of acoustical failure


ACT 3
EGYPTIAN HALL
Scene 2
18TH CENTURY
STAINED GLASS WINDOW
PROP DEPT STALL 2

in auditoriums today is that little more than lip service is given to sound control problems. The educator is concerned with the need for housing students, with costs, function, aesthetics and, on occasion, with acoustics. Too often he relies on the architect to wave his magic wand to make all work well. And so the architect also concerns himself with housing students, with costs, function, and aesthetics, and only on occasion with acoustics, even though the last-named is one area which requires all the expert attention it can get.

Space for Scenery Construction and Storage

Scenery construction and storage space is vital to the successful use of an auditorium, yet too often it is treated as the stepchild of planning. The moment that the fight for space is on, it is the storage area which has to give up "just a few feet of space."

Storage space requires serious attention and detailed planning if it is to function at all. Adequate open area for the construction and storage of flats and props must be provided; suitable work benches and tool panels will be needed, along with adequate utilities. Because of the nature of the activity, a highly fire-resistant space, complete with fire detection and fire control devices, is essential. Shelving, racks, and other storage facilities are a necessity.

While the inadequacy of space is one of the most serious problems encountered in this area, attention must also be given to adequate openings for movement of flats and props, the direct flow of traffic between the prop room and stage, and the avoidance of stairs that will impede the movement of heavy objects (including pianos).

Administrators should not assign leftover basement space for storage, for with a little planning and a few modifications first-class storage facilities can be created. These spaces should be planned just as carefully as any other space in the building.

Very few scenery construction or storage areas are eligible for good housekeeping awards, but a well-planned space will facilitate the school's daily cleaning program.

Windows in the Auditorium

Countless facilities have been built with large window areas in auditoriums, yet only in a very few cases, where auditoriums are designed as multi-use spaces, can this practice be justified.

For years, a well known eastern school was plagued with problems because of such windows. The windows were so large and high that cleaning and occasional glass replacement became a major problem.

Draperies were required to cover the windows, causing high initial and high upkeep expense. Since the draperies had to be kept closed almost constantly, they deteriorated rapidly from sun and dust. During daytime performances the slightest opening in the draperies allowed an almost blinding shaft of sunlight to pierce the darkened auditorium.

Aesthetically the windows were in pleasing proportion to the exterior character of the building, but functionally they were a nightmare. The problem, which never should have existed, was recently solved by blocking in the windows — about twenty years and thousands of dollars too late. For the economy-minded, painting the windows has been the answer, but the factory-like treatment may not be fully appreciated by those with a critical eye. In this case, functional use as well as aesthetics should have been a criterion for design.

The inclusion of any kind of window in an auditorium should be seriously questioned during the planning stages from the viewpoint of economy (e.g., upkeep, heat loss, window covering) and, more importantly, in terms of how they will affect the function of this space.

Even in so-called multi-use space, which is commonly any combination of gymnasium, cafeteria, and auditorium, it is difficult to justify the use of windows. In fact, the problem may be compounded because protective window coverings must be added to keep glass from being shattered by basketballs.

Windows do serve a useful purpose, but not in an auditorium, and only on rare occasions in a multi-use space.

The Choral-Band Room and Permanent Risers

A random sampling of opinions from a large group of music instructors brought forth a nearly unanimous objection to the use of permanent-type risers in a choral-band room. The reasons they gave for their objections were numerous. However, two main thoughts prevailed.

Their primary concern was over the inflexibility of this arrangement, which made it difficult to arrange people in anything but a football stadium effect. Their secondary concern was over the "final commitment" of such seating, precluding changes in the use of space.

The concerns expressed were real, yet the problems occur time and again. In a climate of changing educational concepts, flexibility of space and use is essential. Few institutions can afford the luxury of the finality of a fixed commitment of space.

Every administrator must regard permanent riser-type seating in a choral-band facility with serious reservations and questions. The installation of permanent risers often looks promising as a means of eliminating the need for purchasing and storing riser platforms. Whether fixed or movable, risers must be paid for, therefore only elimination of the storage problem seemingly weighs in favor of using permanent units. Is this advantage worth the high price of inflexibility in use of space, now and in the future? Will cleaning and maintenance of permanent risers be difficult? Are permanent units the only answer?

It can be noticed that permanent risers bear a striking similarity to the roll-away bleachers often used in gymnasiums. However, the similarity changes abruptly in that bleachers can be telescoped into a comparatively small space to form a "wood wall" whereas permanent risers are just what the name implies — permanent.

In essence, gym bleachers are nothing more than a series of narrow risers with a seat, therefore it is entirely possible to "flatten" the dimensions in order to develop functional roll-away risers suitable for any band-choral room.

Another consideration is to look at this same facility furnished with "fat" bleachers. The problem of storing risers no longer exists. Maintenance is the same as for any wood floor. Most important is the flexibility of space now available, with a bonus in that these units can be moved to another area if future programs so dictate.

It behooves the administrator to plan well. Change does take place. It should be anticipated through planning.

Pianos, Doors, and Saddles

This title may seem proper for a folk song, a western novel, or a rock-and-roll record, but none would capture the true anguish of the music center where door openings are too small to permit the movement of a piano. Though this problem is in the category of the "boat in the cellar," nevertheless it is a real problem in planning music facilities.

The music area is one place where school officials can splurge on width of doors, because the extra width comes at comparatively small extra cost. And who knows, they may inherit something larger than a spinet-sized piano to put in the room.

Next to small door openings, the greatest enemies of pianos are outmoded door saddles. Moving a piano over some of these saddles is like pushing the piano up the face of Mount Everest alone. One has to experience the wrath of the musician whose prize possession has been knocked out of tune by moving in order to realize that the problem is serious.

"Would you settle for an accordian?"

For an encore, a return to the wide doors is in order; these are just three more details to keep in mind to avoid the risk of oversight. First, if the doors are to be glazed, administrators should insist on double glazing set in a proper compound or putty. Second, installation of the doors should include rubber or vinyl gasketing all around. Neither single panes of glass nor openings around poorly fitted doors do a very effective job of containing sound. The third detail refers to a hardware item which should have disappeared from the scene long ago, but occasionally reappears, particularly in remodeling work. Locks which require a bit, or skeleton-type, key should not be used in the music area. That little keyhole in the door lets in an unbelievable amount of sound, as well as anyone who cares to pick up a skeleton key at the local hardware store.

Highlights of Safety and Function

Floors. Most auditoriums have sloping floors to provide better sight lines toward the stage area. As the distance from the performing area and the slope of the floor become greater, the need for non-slip floor covering in aisles becomes increasingly critical. In selecting a floor covering for these areas, consideration must be given to housekeeping, maintenance, and impact noises at the floor level.

Heating. Heating and cooling systems for auditoriums must have quick response to sudden changes in occupancy. This has proven to be a problem in several cases where radiant floor coils were used as the principal heating source for assembly areas. In one typical school, for example, when the area was vacant, the floor slab temperature necessary to maintain room temperature was much higher than when occupied. When a large group entered the room, the residual heat in the floor slab caused overheating. With the heat-holding characteristics of the concrete slab, it required two to four hours for temperature adjustment to occur, usually right after a performance had been completed.

Public Use. Public and after-hours use of auditoriums and other assembly areas is becoming more the rule and less the exception. It is desirable that these areas be planned so that they can be used with complete toilet and miscellaneous facilities without opening the remainder of the building. Also involved is the need for separate controls for heating these areas.

Stage and Special Equipment. A stage for performing arts involves a variety of special equipment and requires the skills of a highly experienced individual to plan and coordinate. Lighting, rigging, sound system, floors, and curtains are some of the major items that must be considered.

In planning stage lighting systems, provision must be made for flexibility and expansion. Plug-in type overhead battens are a means of varying an arrangement and increasing the number of special lighting instruments that can be used. Floor pockets are a source of electric power for portable lighting equipment or stage props. Even if dimmers cannot be installed initially, provisions for future addition of this equipment to handle the stage and at least a part of the house lighting can save considerable expense. Lighting controls should be located so that the operator has visual contact with the production. Where the adjustment or operation of lighting equipment requires a person to enter above ceiling or other high areas, securely anchored and properly designed catwalks and ladders are a necessity for audience safety, as well as for the people entering these areas.

The rigging of a stage, whether a loft is utilized or not, requires a structural grid system at or near the ceiling so that cycloramas, lighting equipment, scenery, and curtains can be installed and relocated to suit individual performances.

In addition to being compatible with the "acoustical climate" as previously mentioned, the sound system should have provisions for recordings and special effects to be introduced directly as required for productions.

Stage floors for theatrical productions are usually made of soft wood so that scenery and other items can be attached with a minimum of effort and delay. The use of concrete and hardwood floors has created a number of real problems for theatrical productions.

Curtains and lighting must be closely coordinated if acceptable lighting effects are to be achieved. There have been cases where curtains were installed in front of lighting instruments in such a manner as to make the latter useless.

Flame resistance is especially important in the selection of curtains, cycloramas, and other items of stage equipment. An investment in a permanently flame-resistant material may save later inconvenience and costs involved in periodic treatment. One word of caution in selecting curtains: Some of the permanent flame-resistant materials are subject to abrasion and have a relatively short life expectancy.

Spaces for the performing arts can bring countless hours of enjoyment to those who use the facilities — participants and viewers alike. But the art of performing also includes the art of planning — which therefore should be included in every educational designer's script.

13. Health and Physical Education Facilities

The health and physical education center is a highly specialized area requiring careful long-range planning embodied in educational specifications prepared by the instructional and administrative staffs. The specifications should explain the total educational program and fully describe facility utilization including safety, operation, and maintenance considerations.

Proper preparation of educational specifications, the foundation of good planning, requires extensive study, research, and coordination. For planning efforts to be successful, the services of a competent planning coordinator are essential, and he must be thoroughly familiar with all programs to be served by the building. If a planning coordinator is selected from the instructional staff, adjustment should be made in his assignments to provide him time for the research, staff consultations, and other coordinating functions.

Failure to appoint a planning coordinator may result in excessive construction deficiencies in the new building. Failure to pre-plan adequately may encourage the architect, when he arrives, to develop the educational specifications; this should be avoided. Preparation of educational specifications is the responsibility of the educator — not the architect.

The Gymnasium

Gymnasium utilization. A multiplicity of efficient utilization is the keynote to good gymnasium planning. Spectator sports should not overshadow or supersede the design requirements for effective instruction.

Because of its size and adaptability, the gymnasium frequently serves as the school's social center. As such a multipurpose facility, the gymnasium requires many planning considerations other than those of health and physical education.

Has thought been given to dispensing refreshments? Does the food service area have good refuse accommodations, suitable electric service, adequate storage, and good accessibility? What about the location of a bandstand and essential services such as electricity and a public address system? Will there be recessed wall hooks carefully located and spaced for decorating purposes? When such items are omitted, more time is required to prepare for social functions and hazardous ladder gymnastics result. Planning ahead for social functions is an essential aspect of good gymnasium planning.

Very seldom has too much storage space been provided for gymnasium equipment. More likely, there is insufficient storage and little possibility of correcting the situation. Each gymnasium teaching station should have access to a storage room that accommodates all necessary instructional equipment. The number of items to be stored, as well as their individual dimensions and weight, should be known, and space should be allowed for each so as to eliminate bumping or other physical contact that could damage equipment or injure personnel using the area.

Specifications should provide for an open aisle to permit moving a piece of equipment without disturbing other items. (How often has an instructor altered his teaching plans rather than wade through a storage "jungle" to reach the desired equipment?)

Undersized entrances and exits are equally frustrating. Ease of accessibility cannot be over-emphasized. To overlook this seemingly insignificant detail can produce serious problems. Damage to door jambs, doors, and equipment is likely to occur each time equipment is moved through such "bottlenecks." Poor access also can cause injuries to students and staff. Turn-space is an important aspect, as well; it should be sufficient so that a long object can be turned on its long axis when passing through a door into a corridor. Educators must plan early for all future logistic operations.

Since the gymnasium is an activity area, advance planning will help protect students from injury. Special attention must be given to safety lanes bounding all designated playing areas. Also the safety areas must be ample to prevent injuries. A playing court that requires wall mats for safety is too close to the wall or other structures. All playing courts should have a minimum six-foot space from the out-of-bounds line to the wall, or to the extended feet of spectators occupying front row seats.

Unprotected structural members, sharp edges of bleachers, door glazing, or wall-supported horizontal bars are hazards that invariably result in injury to participants or spectators. All activity areas must be carefully checked for surfaces requiring protection; such surfaces should be eliminated if possible. When protective mats are used, the installation of first-quality shock absorbing material should be specified.

During the selection or installation of gymnasium equipment, items best described as attractive nuisances should be avoided. One such piece of equipment frequently installed in gymnasiums today is the non-retractable basketball backboard. Although this type of backboard is less expensive at initial installation, related problems far exceed any original advantage. Non-retractable backboards should not be supported from a block wall if the wall has not been designed to support such equipment. Damage to loose backboard supports and walls adds to maintenance costs and contributes to substandard backboard performance. The lowest cost is best only when it is the final cost.

Gymnasium walls can be used for instructional purposes, in developing skill techniques, and for playing surfaces. If gymnasium wall areas are rendered nonplayable by capacity spectator seating, however, then the school's emphasis on spectator sports has been at the expense of the instructional program. Studies indicate bleacher use at approximately six percent of the operational time of the gymnasium. Such limited utilization must be evaluated by planners in terms of overall educational objectives.

Failure to coordinate the installation of bleachers with instructional use of walls greatly reduces the effectiveness of the gymnasium as an educational facility. Proper balance will satisfy the needs of athletics while meeting the basic requirements of the instructional program.

Considering the expense and upkeep of folding bleachers, it may be desirable to install sections of folding bleachers that can be moved about on hydraulic-lift dollies. Such sections can be relocated temporarily to other areas, so that all wall surfaces can be made available.

Maintenance of the gymnasium. In selecting a gymnasium floor, intensive research and study is required; the experienced planner does not permit selection to be left to chance. The choice should be a cooperative endeavor between the user and the architect; it should not be the sole responsibility of the architect or the basketball coach.

Factors to consider are location, use, moisture resistance, guarantee against warping, non-floating characteristics, holding power of floor plates, and floor strength. Floor plates should resist an upward minimum pull of 5,000 pounds. For adequate securing and holding power between the floor and concrete slab, concrete of 3,000 psi (pounds per square inch [strength capacity]) minimum is required; concrete testing at 4,000 psi is recommended. Top-quality floor finishes minimize maintenance and reduce moisture penetration from the playing surface.

One of the most expensive installations in a gymnasium is the power-operated folding partition. Low maintenance, minimum door sway, optimum soundproofing, and secure floor seals constitute basic criteria for the selection of folding partitions. Determining the type of partition to be installed should be a joint effort by the facility planner and architect. Both should review all technical data on acoustical qualities of the product and become thoroughly knowledgeable about the different door sealing devices. Poor seals produce constant adjustment problems, contribute to door sway, and appreciably reduce sound control.

A folding partition should be a usable surface for special types of skills. If it is to be used as an all-activity wall, a long-wearing surface should be selected. Failure to provide generous wall surface areas for instructional and recreational use is uneconomical and indefensible. In addition, administrators can obtain further protection of the investment by ensuring that factory-training maintenance help is available on call.

Another trouble spot is the floor track for the folding partition. Planners should be wary of doors requiring floor tracks; they are excellent receptacles for dirt, gum, candy wrappers, pencils, coins, and other items. The rough passage provided heavy gymnastic equipment introduces a related problem. Small wheels supporting such equipment have been lost as a result of impact with the floor track, and track damage has resulted as well. Many planners feel that folding partitions should be recessed into a wall pocket for participant safety and aesthetic qualities; such factors should at least be considered.

The wall finish is yet another maintenance item. The relatively inexpensive painted wall surface automatically limits wall activity games and skill instruction. Frequent cleaning and painting are necessary for painted walls, and costs are high in terms of labor, material, and operational down-time. Some painted surfaces require repainting every two years or less. Use of flat paint makes it virtually impossible to clean the surface. However, structural glazed tile or spray epoxy finishes lead to long-range economy and minimum interruption of the instructional program.

Each unit of the educational plant must receive special planning consideration to effect the most efficient utilization of maintenance equipment and custodial personnel. The gymnasium, because of its size and usually heavy schedule, requires extensive study to achieve a balanced preventive and corrective maintenance program. The good planner will consult with his custodial and maintenance staff; he may learn much from them.

Ideally, each gymnasium should have a well-equipped, conveniently located custodial service closet. When a custodian must walk 300 feet for custodial supplies, equipment, or water, the operational budget is needlessly taxed. Inefficient operation contributes to substandard housekeeping, poor sanitation, and increased labor costs.

Planners should always determine the quantities of supplies that should be stored nearby to service the physical education plant. They should ask: What instructional and non-instructional supplies and equipment are essential to efficient, productive functioning of the instructional complex?

Environmental conditions. One frequent planning fault associated with the gymnasium pertains to natural lighting. Natural light, if excessive and improperly located, creates annoying and offensive glare. If windows are part of the building design, they should be properly oriented with the sun. Tinted glass will reduce glare. If glass must be used, sun shades can be incorporated to minimize glare.

The aesthetic qualities of glass are not questioned. When improperly used, however, glass can produce conditions that render a facility unsuitable. An operating cost factor not to be overlooked is heat loss. Glass has been known to permit a 30-percent heat loss in areas where it is installed. Obviously, vast expanses of glass present major problems in heat loss, solar heat gain, daytime glare, and breakage possibilities. Planners should think twice before they approve such designs; even a small window opening can create acute glare problems if the window is in the wrong place.

Ventilation can be provided by modern, mechanical forced-air installations. Multiple service, for which a gymnasium is designed, presupposes that a thermostatically controlled heating and ventilating system will satisfy all activities. Many gymnasiums can be subdivided into two or more teaching stations, each with its own thermal environment. Suitable thermal controls provide areas with suitable thermal environments.

A rate of air exchange of from five to eight times an hour, removing stale air and introducing conditioned fresh air, contributes to a good thermal environment for the health and physical education plant.

The acoustic environment should be studied by an acoustics engineer working in conjunction with the architect. The planning coordinator conveys to the designers the characteristics of a suitable acoustical environment, outlining the type of activities to be conducted in various areas. Noise values associated with these activities, acoustic qualities of building materials, structural characteristics, and many other technical factors must be considered.

The Locker Room

With the emphasis on instructional needs, locker rooms and other service areas usually receive secondary consideration with regard to space allocation, traffic control, student supervision, maintenance, safety, and general accessibility.

The size of a locker room should be based on the total number of assigned students, peak loading, total number using the locker room in after-school activities, size of locker unit, and growth probability. As a rule of thumb, floor space of 14 to 15 square feet per student should be provided, with a 10 to 20 percent growth factor.

Also, lockers must be large enough for gym clothing storage and temporary storage of street clothes. Educational specifications should be utilized as the basis for planning locker needs.

Although not all factors can be treated here, several pertinent aspects relating to locker room design are posed for consideration. Are the aisles wide enough? Are dressing benches placed in the center of the aisle? If so, traffic problems will be increased and maintenance efficiency decreased. Are locker rows and aisles butted against a wall? Problems of locker room supervision and inaccessibility to other service areas are permanently built-in problems, hence the need for thoughtful planning.

While many people regard the locker room as a place to change clothing, it really should accommodate other services. Noisy, crowded, humid locker rooms inevitably produce personal discomfort, which is inexcusable and totally inconsistent with generally accepted educational concepts.

Good ventilation with adequate air exchange in both locker rooms and lockers contributes to a hygienic environment, low humidity, and good drying conditions. Careful planning includes locker ventilation. One of the least expensive items is a locker that provides for visibility and ventilation of locker contents. Each locker front has openings spaced to permit visibility and provide greater ventilation than provided by the louvered locker door. For maximum ventilation, the back panel should also be perforated, thus making full use of the forced-air ventilating system. As air is forced into the locker room, it passes through the locker panels and exhausts stale air while drying locker contents.

One time-consuming obstacle the physical education instructor faces is the removable padlock; a fixed-combination type lock is suggested for consideration. Regardless of the type of lock used, a master key system should be incorporated to expedite emergency entry into a locker if a combination has been forgotten or a lock malfunctions. Sawing or cutting locks will thereby be relegated to the past. Also, when planning a lock system, it should be remembered that class time is for instruction and learning. Too many hours are required each year for the issuance, collection, and storage of keys, and search for lost locks or keys.

In turning to locker room safety, planners must strive to incorporate safety and eliminate hazard in every aspect of design. Entrances and exists should facilitate peak load traffic flow with good traffic control during all hours of operation. To avoid congestion, "in" and "out" doors should be designed.

The general locker area can be equipped with control gates to separate it from visiting team lockers. Competition frequently produces heated contests and irresponsible conduct may result if locker rooms are not separate. Restriction of visiting groups to a limited area of the locker room complex after the game may prevent property damage, bodily injury, and social problems.

One common safety hazard in the locker area is the floor surface. A slippery floor is extremely dangerous, and injuries can easily result in lawsuits. Students have been known to run about recklessly in the locker room, even under ideal supervisory conditions. Recognizing that aesthetic qualities are important, aesthetics nonetheless must never supplant safety in order of priority. Terrazzo and ceramic tile floors are beautiful, but they can be dangerous when wet if the surface is not slip resistant. Concrete floors, on the other hand, may provide breeding surfaces for fungi and germicidal growth. The requirement of quarry tile for a thick grout constitutes another possible sanitation problem.

One of the most serviceable surfaces is the seamless floor; it has aesthetic appeal, non-slip safety features, essential hygienic features, and is easily maintained at reasonable cost. Shoe cleats, used in athletic programs, may preclude the use of seamless floors in some areas. All these should be considered when specifying floor material.

Recessed ceiling light fixtures help reduce vandalism, especially if they are out of reach even to persons standing on a bench. Recessed lights should have hinged, shatter-proof, heat-resistant diffusers.

Maintenance that continues through the life of the building can be minimized by careful design and selection of structural materials. Locker room walls should be constructed of low maintenance, glazed structural tile block, ceramic tile, or concrete block with a hard, durable, impervious surface. Sufficient floor drains and wall-mounted, keyed water spigots permit convenient washing and hosing of floors. Abrasives from mud, cinders, and dirt cut and scratch floor surfaces, rendering them both dirty and unattractive. Specifications should include a plan for a "mud patio" where sneakers and various cleated field shoes can be removed and cleaned before being carried into the locker room.

Floor conditioning is a constant maintenance requirement. In any area where electrically operated cleaning equipment must be used, planners should be certain to specify outlets for 110-volt or heavier voltage, adequately spaced for complete overlapping coverage. The electrical engineer should be given complete electrical specifications of cleaning equipment to be used; he will need it for the design of the electric power distribution system.

Two planning oversights that encourage students to be litter-bugs, thereby increasing maintenance cost, are:

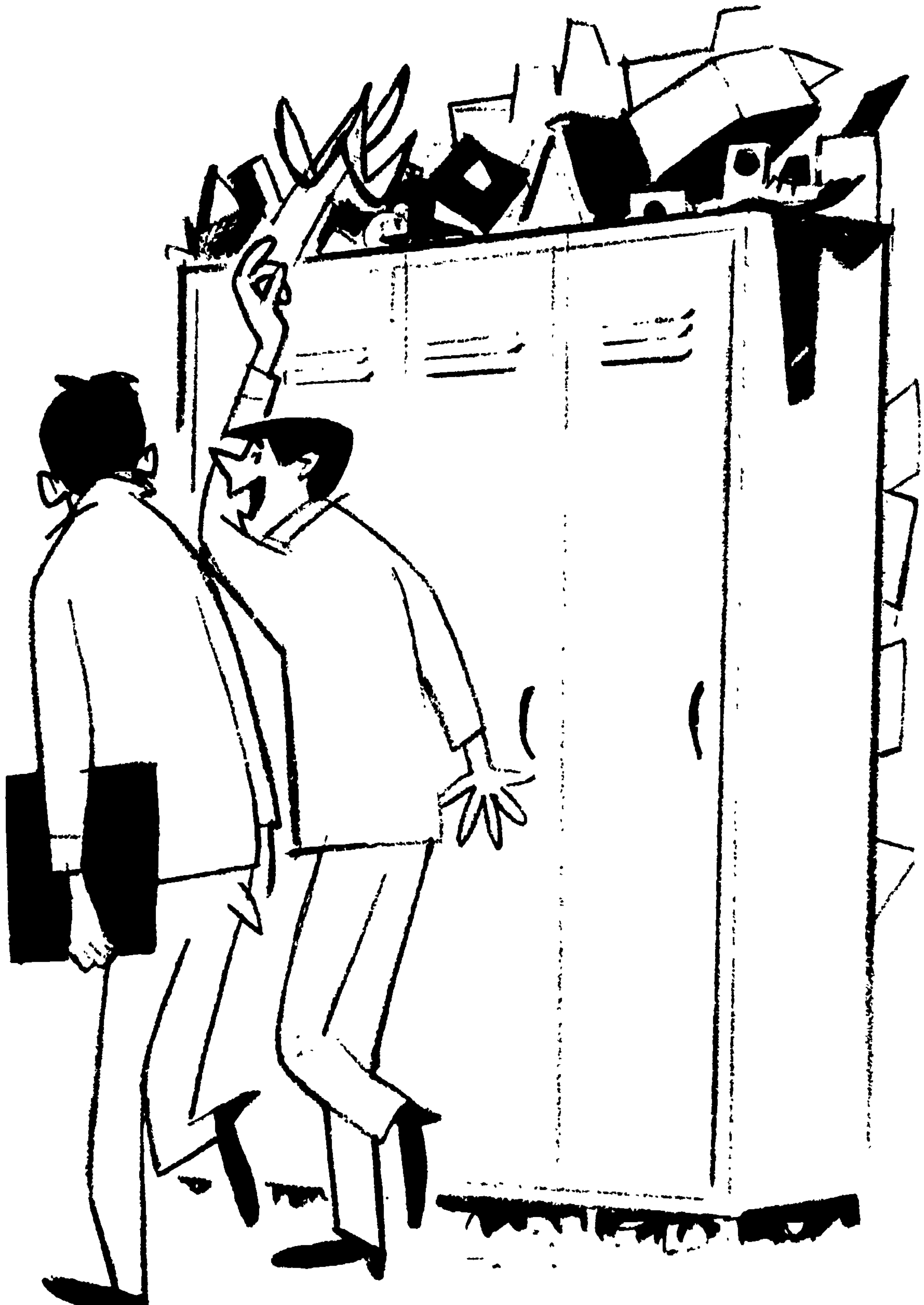
1. The installation of flat-top lockers — excellent areas for depositing waste paper and other refuse.
2. Failure to install lockers on enclosed bases. Open areas under lockers are vermin pockets, convenient trash receptacles, and very difficult to keep clean.

The Shower/Body-Drying Room

The shower room should be immediately adjacent to the locker room complex and the natatorium. Functional design facilitates movement of students from locker room, to showers, and to pool. On return from the showers, traffic should pass the towel-issuing service on its way into the body-drying room. If properly located, the body-drying room permits ease of supervision, traffic control, economical maintenance of the locker room, and takes full advantage of heating and ventilating conditions.

The following deficiencies are frequently found in shower rooms of educational buildings:

1. *Perimeter drains.* A sharp drop-off ledge can easily cause an ankle or foot injury or a serious fall. It can also increase maintenance problems because most mechanical scrubbing equipment cannot fit into the drain channel. In addition, perimeter drainage channels increase construction costs.
2. *Inadequate water run-off.* Shower room drainage must be able to handle the water from all shower heads fully open, without creating "pooling."
3. *Absence of curb.* All entrances and exits to the shower/body-drying complex should have bullnosed curbs. Four-inch-high curbing prevents the flow of shower water into other areas with minimum trip hazard.
4. *Insufficient shower heads.* Too few shower heads indicate failure to compute anticipated loading properly. Elementary and junior high shower rooms should be designed with four students per shower head, high schools with five students per



"Out of sight, out of mind, eh, Joe?"

shower head. In both cases at least nine square feet of floor area per shower head should be allowed. The number of shower heads should be based on peak loading. Planners should not limit their schools to the bare minimum, however; they should provide for at least ten percent above the anticipated full load. In addition, standards of modesty in some communities may make advisable private shower stalls for girls.

5. *Water waste.* Conservation of water is vital. The planner mindful of this will determine the rate of flow and total output of water from shower heads. Each shower head should produce a flow of about three gallons per minute at 40 pounds pressure. A "sure-fire" method of controlling water use is to specify timed shower controls. Timing set for 40 seconds will conserve water and provide for effective showering.
6. *Absence of soap system.* A liquid or powdered soap system is recommended. Use of cake soap is wasteful, causes maintenance problems, and leads to hazardous footing. Gravity-feed liquid dispenser systems or powdered soap systems are practical, clean, and easy to maintain, and minimize hazard.
7. *Inappropriate hardware.* All shower room hardware should be tamperproof. Mixing valve controls should be located where students cannot tamper with them. All controls, plumbing or electrical, should be restricted to supervisory control areas.

Body-drying rooms are often omitted because of economy — usually false economy. Where there is no body-drying room, students will track water about the locker room, creating a wet floor and an uncomfortable environment. A wet floor is also unsanitary, dirty, hazardous, and requires extensive maintenance. Such false economy and operating handicaps are rarely corrected. Once a building has been completed without a body-drying room, it is highly improbable that such a room will be added later.

It is recommended that the body-drying room be at least half the size of the shower room to facilitate the safe, smooth, and direct flow of traffic from the shower area. Temperatures of both areas should be compatible. The towel-issuing window should be located on one wall of the body-drying room.

The body-drying room for girls should be equipped with clothes hooks. Some girls, for personal reasons, wear underclothes to the shower room. To accommodate the ladies, clothes hooks or a clothing bar should be provided in the body-drying room and also at the entrance of each private shower cubicle.

The Laundry Room

When properly planned and operated, a self-contained laundry room can be a wise investment. Commercial athletic cleaning services can be expensive ar . have been known to reduce the wearing life of towels, uniforms, and other launderables. Caution is suggested.

A laundry room can be operated from fees collected for towel service and funds otherwise expended for commercial service. Immediate service, proper and more frequent washing of practice and game gear, and relative independence are important advantages of the self-contained laundry room. Uniforms can be purchased with guarantees against shrinkage, excessive wear and tear, and running dyes.

Athletic Team Rooms with Equipment Service Rooms

Today's broad co-curricular athletic programs require careful planning of specialized rooms in the health and physical education center. General locker areas for interscholastic athletics usually leave much to be desired in terms of instruction and athletics.

A well-designed athletic team room can serve a number of purposes and is regarded by many people as highly desirable. The following checklist may be helpful in planning team rooms:

1. Is there enough room for each participant to dress and undress comfortably? More space is needed by a football player than a basketball player because of equipment used.
2. Are locker room benches provided and suitably placed?
3. Can "skull" sessions and halftime lectures be conducted?
4. Has proper security been provided?
5. Are the lockers adapted to the activities, fully ventilated, ruggedly constructed, vandalproof, and designed to accommodate helmets, shoes, and other specialized equipment?
6. Have seasonal peak loads been determined to compute team room requirements?
7. Have equipment-drying rooms been provided? A good forced-air ventilating system will remove all odors and excess humidity. If such provisions have been successfully incorporated in the team room, it may not be necessary to construct a special equipment-drying room.
8. Are athletic team rooms accessible to the shower/body-drying complex? Good design precludes the need for separate shower facilities for athletic teams.
9. Will the location of the team rooms afford effective supervision by the coaching staff?

10. Can team rooms function without conflict with visiting team rooms during competition?

Planning mistakes common to visiting team rooms are:

1. Use of metal lockers rather than adequate clothes hooks; use of wall-supported shelves, wall-supported benches, and materials or equipment that can be damaged easily.
2. Insufficient area to enable coach or trainer to treat athletic injuries.
3. Absence of chalkboard and recessed wall clock.
4. Failure to provide a repository for valuables.
5. Misuse of facilities designed for other purposes, i.e., use of girls locker room as visiting football team room.

The Swimming Pool

Many schools are including swimming facilities in their health and physical education center. Recent studies tend to justify the inclusion of the swimming pool by showing it to be one of the most widely used school facilities in the community. Factors to be considered are:

1. *Accessibility.* All swimmers entering and leaving the immediate swimming area must pass through the shower room complex. Such design greatly helps to enforce the required showers for swimmers before entering and after leaving the pool. Spectator accessibility to the pool or pool deck is to be avoided; herein lies the importance of careful design.
2. *Air-water temperature* at excessive variance will cause discomfort to swimmers. A steady, controlled flow of heat devoid of drafts contributes to the maintenance of proper balance between air and water temperature. Air temperature should range between 78 and 83 degrees Fahrenheit; water temperature should be automatically controlled between 76 and 82 degrees Fahrenheit unless special conditions can be justified.
3. *Relative humidity* is a major factor in successful pool operation. Great care must be given to environmental design in terms of heat, ventilation, and humidity controls.
4. *Official performance standards.* Are pool dimensions proper? Do they satisfy official standards? If the pool is even one-half inch short, it can never be the site of an official championship meet nor can official records be established. The length of the pool should exceed the officially specified length by one full inch. Caution: Planners must be certain to allow for the thickness of the tile placed on the concrete.

5. *Poor acoustics* create difficult teaching conditions. Acoustical properties of the walls, supplemented by the acoustical treatment of the ceiling, contribute to an acoustically suitable environment. To be avoided acoustic materials that absorb moisture, are difficult to clean, or that flake off.

6. *Adequate, safe lighting*. Splashed water has been known to strike the heated glass surface of lights, shatter the glass, and cause it to fall into the pool, creating a hazardous condition. Pools can be suitably lighted from the perimeter area with lamps that will provide comfortable illumination of all points of the water surface.

7. *Contestant seating* is an important pool requirement. Built-in, radiantly heated seating provides warmth and comfort for contestants while presenting a clean, attractive, low-maintenance facility, a feature that is much appreciated by building service personnel.

8. *Radiantly heated pool decks* give warmth and comfort to the swimmer, reduce humidity, and provide a safe, dry instructional or traffic area.

9. *Pool safety* is a first consideration. Planners should check the following provisions:

   a. Are there enough elevated lifeguard stands?

   b. Does the deck have a non-skid tile surface?

   c. Are all electrical outlets high above the deck and properly grounded?

   d. Can all depth markings be readily seen?

   e. Have provisions been made for the installation of safety barriers?

   f. Is water safety and rescue equipment properly located about the pool?

   g. Are all overhead lighting fixtures shatterproof?

10. *Pool sanitation* is usually regulated by local and/or state health departments. The wise planner will double check with the architect to see that all requirements have been incorporated into the construction of the pool and filtration system.

11. *Pool storage* with enough space for all equipment is too often forgotten during planning. Pool personnel should be consulted to determine the quantity, type, and size of all equipment to be used. Only then should the total storage area required be computed.

12. *Handicapped-person lifts* are a relatively new convenience for pool areas. Such a lift can be used to introduce and remove a handicapped person from the water. Most pools do not have such a lift, but if a pool is to serve the total community, either a lift or a ramp should be provided for handicapped persons. The lift can be removed when not required.
13. *Washdown spigots* should be located in the pool area for washing and hosing pool decks.

Some Specific Problems

The high cost of the gymnasium floor and the fact that, once purchased and installed, it is there for a long time dictate that every precaution be taken before installation. Gym floor problems usually are not easily or quickly remedied.

Major problems or failures are inexcusable and no degree of rationalization can justify the cost and inconvenience of correction or repair. Many times the "doctoring" produces little more than a second-rate facility with second-rate service.

Gymnasium floor warping. One school in the United States has a gymnasium floor of heavy-duty, flat grain, first grade, 1¼-inch-thick-by-1¾-inch-wide northern hard maple. All wood was treated to resist swelling, shrinking, grain raising, warping, termite damage, and moisture absorption. Boards were joined together by steel splines and secured by a mastic applied on one-inch cork board. The cork board was seated in mastic over a damp-proof membrane spread on the concrete floor slab. All materials met specifications, and installation was accepted as satisfactory. The project was accepted on final inspection.

Less than one year following installation, a drinking fountain water line failed and water flowed over the floor, remaining there for an extended period. The gymnasium floor warped and pulled away from the mastic binder, causing a wave-like disfiguration. The excessive exposure to moisture broke the adhesive bond of the mastic, which had a holding power of 20 pounds per square foot.

Any of the following could damage a gymnasium floor:

1. Allowing moisture-laden materials to be placed on the floor.
2. Failure to schedule periodic examination of the effectiveness of the floor seal.
3. Failure to maintain a good circulation of air throughout the entire gymnasium during humid weather.
4. Windows left open during a driving rain.

"Too bad this isn't a real horse, Coach."

5. A plumbing mishap.
6. Lack of protective floor pads under drinking fountains.

In the case cited the floor has not yet been corrected; neither the flooring company nor the contractor has been successful in resolving the problem. After several weeks, many areas remain loose and move under foot. Even were the floor completely replaced, what would prevent a new floor from reacting in the same manner under similar conditions?

Planners wishing to follow recommended preventive measures should:

1. Thoroughly investigate all types of gymnasium floors on the market.
2. Consult with representatives of each manufacturer.
3. Evaluate material, engineering, and performance specifications.
4. Know the various floating characteristics and potential lifting action of each floor.
5. Investigate effects of water and dampness on adhesive qualities of the mastic proposed for use.
6. Determine the floor's resistance to cable tension.
7. Know the resistance-to-pull specifications of floor plates.
8. Determine whether the floating floor will bend or shear floor plates that penetrate the concrete slab.
9. Evaluate floor seals and floor finishes for maximum resistance to moisture and water penetration.
10. Investigate treatment of underside of floor material.

Inadequate storage. Two gymnasiums recently completed and placed in operation in a new junior high school were found to be grossly lacking in storage space for gymnasium equipment.

The girls' gymnasium has no storage area for equipment. All equipment is stored in a corner and along one wall of the gymnasium. The boys' gymnasium is provided with one room too small to store a set of parallel bars. The door is too narrow to permit the passage of a mat truck.

Inadequate gymnasium storage space inevitably creates many problems for teachers and maintenance personnel alike. Equipment stored on the gymnasium floor occupies space designed for activity, resulting in misuse of space. The danger of body contact and student injury noticeably restricts activity. Expensive gymnastic equipment can become a serious liability when left available for unsupervised student use. In addition, equipment stored in the gymnasium creates a maintenance problem. Such an area becomes a catch-all for litterbugs and is difficult to clean.

The school, although it is new, has a built-in problem which may very well remain for the life of the building. In the case cited, there appears to be no feasible solution, since there are no areas available for conversion to gym storage.

Unfortunately, the physical education staff was excluded from review of the plans. Although gymnasium storage was requested in the educational specifications, the architect obviously failed to interpret that need properly. If economy or structural problems necessitate modifications affecting educational specifications, the architect should consult with the educator before changes are made.

Recommendations for gymnasium storage are based on several factors. Each gymnasium teaching station must have access to storage which can adequately house its movable equipment. The quantity and size of all items to be stored and necessary access aisles determine the total area required. Storage of large pieces of movable equipment must be safe and quick with easy accessibility. Aisle locations must permit maneuverability. Adequate storage space eliminates damage, minimizes maintenance problems, and aids effective utilization. Entrance doors to the storage room should be a minimum of six feet wide and eight feet high.

The book storage problem. Plant personnel have a direct responsibility to protect structural components, fixed equipment, material and supplies from damage; consequently, a large measure of protection should be built into all areas. Design failures can interfere seriously with supervision and contribute to costly repairs and excessive operating costs. An item of particular concern is book storage in the locker room complex.

In one particular situation, the locker room design called for an arrangement of one dressing locker to nine storage lockers. Lockers, arranged in double-faced rows, were butted against the wall, thus providing very limited traffic flow. A student assembly area was nonexistent; that is, there was no area for class dismissal, for reading notices, posters, performance records, schedules, or for issuing locks and lockers. Of equal importance was the absence of book storage facilities.

If students in secondary schools are not permitted to visit their hall lockers between classes, they are required to carry their books to each class. When they fail to find proper storage facilities in the locker room, students may place them on the bench, or drop them on the floor. Under such conditions, book damage is inevitable and lost books are a daily occurrence. The resultant book loss and supervisory problems are reflected in unnecessary costs to parents and taxpayers. An adequately designed street locker usually will provide space for books.

Studies reveal that it is less costly to provide book storage than to continuously repair and replace books.

Poor locker room design. In analyzing problems resulting from the omission of bullnose curbing at the shower room entrance, the absence of a body-drying area, congested traffic, and hazardous, unsanitary floors, one soon realizes that a chain reaction has been created with far-reaching effects on supervision, safety, maintenance and operating costs. The shower room, drying room, and locker room are so closely related that coordinated planning is absolutely essential.

The common entrance/exit to the shower room in a third school faced the main locker room. There was no curb to retain water within the shower room. Ordinarily, one would expect to find a low curb at the base of the doorway.

Inasmuch as a body-drying room had not been provided, body drying was done in the locker room. To further complicate the problem, there were no floor drains in the locker room. Thus, unsanitary and hazardous pools of water collected on the locker room floor. In addition, there were no foot benches.

Students entering and leaving the shower room at the same point congested traffic. Frequently, deliberate body contact caused students to fall on the hard floor, producing painful injuries. Even with care on the part of students, heavy student traffic on a slippery, wet floor constitutes an extremely hazardous condition.

With the absence of shower room curbing, any excess water in the shower room immediately produced flooding of the locker room. It was observed that a combination of heavy shower use and a partial blockage of the floor drain by the feet of students in the shower room frequently caused flooding of the locker room.

Since there were no footrests for foot drying, students walked through pools of water to benches to dry their feet while others stood with wet feet on the benches, again creating an unsanitary and hazardous condition. Water and dirt were tracked all over the locker room, students wore wet socks the rest of the day, foot infection was widespread. The wet, humid environment produced great personal discomfort, dissatisfaction and poor student morale coupled with greatly increased maintenance. It was a rather miserable situation by any standards.

Planners wishing to avoid such problems should specify that, as recommended, builders should:

1. Install four-inch bullnose curbing at the base of the doorway.
2. Reduce the number of lockers to provide a drying area.
3. Install floor drains in the drying area.
4. Install a foot rack to facilitate foot drying.
5. Establish a towel-issuing station between the shower room and the drying area.
6. Establish a towel-deposit station at the locker room exit.

Investigation of the above-cited situation showed that there was no planning coordinator, nor were educational specifications submitted to the architect. Were conditions a result of administrative neglect, lack of know-how, inadequate budget, or just gross ignorance of program requirements? The experience, whatever the cause, was unfortunate, unnecessary, and wasteful.

Omission of exterior mud cleaning patio. Probably no other school area is subjected to more abuse than physical education facilities. Therefore, physical education personnel in particular should be aware of the tremendous maintenance requirements of the physical education plant. It is a wise planner who discusses the maintenance problems of each area with the custodial supervisor, becomes familiar with his special problems, invites his suggestions, and works with him to increase plant efficiency.

The planning coordinator should know the type of shoes worn from outdoor facilities. There are times when fields are dusty, wet, or muddy. Cleated shoes can carry seemingly tons of dirt indoors if care is not exercised.

Where there has been no provision for the removal of sneakers, street shoes, and cleated or spiked shoes before entering a building, the practice is to wear them, dirt-laden, into the locker rooms and gymnasium, compounding an already difficult cleaning problem. At one school where this all-too-common situation prevails, no area was or is provided for students to remove field shoes before entering the building. Missing is the mud patio, a smooth, hard-surface deck, protected from the weather and located near the entrance to the locker room. Also missing are foot benches and cleaning brushes.

When a physical education class or an athletic team leaves the field, and a mud patio is not available, it is inevitable that large quantities of dirt are unnecessarily carried indoors. Most of the dirt seems to collect at the locker room entrance or at the student lockers.

If there is no drying room, or if students are permitted to dry themselves at their lockers, enough water mixes with dirt deposits to create a gritty, grimy mess.

Generally, the following conditions result:

1. Wet, dirty, slippery floor with deposits of dirt, cinders, and mud.
2. Unsanitary dressing conditions.
3. Badly soiled clothing.
4. Heavily soiled towels used as floor mats.
5. Widespread foot infection.
6. Staggering cleaning job.
7. Excessive floor wear.
8. Poor student conduct.
9. Nonreceptive student attitude toward health and physical education.
10. Low custodial morale.

The school, unfortunately, has adopted neither preventive nor corrective measures. Complacency best describes the general attitude of teachers and administrators alike. Although they apparently have decided to live with it, their acceptance of conditions is incredulous. Suitable mud patios could be provided as additions to the building as a joint project by educator, architect, and educational facility planner.

14. Food Service Areas

As with any special area, many factors influence the design of an efficient food service facility. Careful planning will help keep the capital fund outlay to a minimum. The initial capital required is determined by the amount and type of equipment and the space required by the food service operation. Operating funds, on the other hand, are dependent upon how well the installation functions and how much maintenance the equipment requires. Care is the watchword in both equipment selection and final design of the food service operation.

There are three main concerns in planning food service areas: the kitchen, the dining area, and the food storage area. Before tackling the special problems peculiar to each, the educational planner should consider a number of general aspects common to all.

The extent of a food service operation, like any other phase of the educational program, is determined largely by the philosophy of the school district or college. If, for example, a feeding program is considered to be a "frill" or a "necessary evil," then gaining approval of a complete or elaborate food service facility is almost impossible.

If a new facility being planned is part of a central kitchen operation which handles food preparation for distribution to several areas, only dispensing and dining areas will be required.

Projected enrollment has a direct bearing on the size of facility needed. Whether the community or campus is stable or still growing will be a determining factor for future expansion provisions.

The type of menu to be served and the expected percentage of student participation in the food program affect both the size and type of facility needed. An extremely limited menu calls for a less elaborate facility than if an extensive menu is to be served. If the percentage of student participation is expected to be small, there will be no need for a huge facility, and vice versa.

Important is the availability of qualified personnel to staff the kitchen and to insure proper equipment maintenance. Even when there are enough chiefs, cooks, and bottle washers, little can be done if the equipment does not operate properly.

Sometimes a contract arrangement is to be made for the food service operation. If this is the plan. then by all means a representative from the food service contractor should be included in planning the new facility.

"Hey, Joe. Tell Mrs. Dunworthy to change the menu from fried to scrambled."

Perhaps the plan is to dispense both hot and cold lunches by vending machines. Usually, the vending operation is provided by contract. The district or college, however, may choose to purchase and operate its own vending machines. If all or part of the food service is to be via vending machines, then space and equipment needs will be quite different from those associated with a kitchen-served program. Also, if it is anticipated that vending may be considered later, provisions for such a change should be reflected in the original installation. A decision about vending should be reached before space planning begins.

The project may involve alteration of an existing food service facility. This presents a different problem. In such cases it is necessary to evaluate the condition of all existing equipment and areas as a prerequisite to alteration planning. Such data are the basis for determining how much replacement and/or additional equipment will be required as well as the additional area that may be required.

Floor Elevations

A word of caution about the specification that the whole food service area be located on one floor might seem unnecessary, yet it needs special emphasis to avoid a critical situation.

It is recommended that the elevation of all areas where food is stored, prepared, or served, be carefully checked to eliminate as many changes in floor level as possible. Where structural modifications are necessary, they should be attended to as needed during the design stage of the building. Avoiding even one mistake will make the effort well worthwhile.

The Kitchen Area

The kitchen is a highly specialized, complex, and expensive facility, and great care should be exercised in its design. It is recommended that the services of a kitchen or food service consultant be sought to assist in the preparation of kitchen plans and specifications. His participation should greatly enhance the design of the kitchen, and nothing reduces future food service operating costs more than proper design. The starting point is a thorough understanding of the school's needs. As previously mentioned, this will involve an analysis of enrollments, types of menus to be served, and how the service is to be provided.

If time permits, planners should visit other food service installations to look for methods of operations that will improve the utilization of the new facility when completed. In fact, planners should take the time to visit other installations — much can be learned from such observation.

Key food service personnel should be included in planning the new kitchen. They should be encouraged to contribute; their experience will be of benefit during the planning. A little extra effort at this point to keep the food people involved may yield untold operational benefits in the years ahead.

The importance of developing a proper food processing flow in the kitchen cannot be over-stressed. Each step of the food process must be analyzed to determine its proper location and relationship to other operations. This phase of planning is absolutely essential to good floor plans and equipment specifications. The food service director and his staff will be able to give valuable help here.

One school found that in its proposed kitchen it had an unused area created by the location of walk-in freezers. To avoid having an unused, and, therefore, non-functional area, the pot-and-pan-washer was located in the empty corner. The dishwashing operation is at the opposite corner of the kitchen, even though there are obvious advantages to having the two functions together. The location of the pan-washing area causes workers to travel through other areas to carry dirty pans to the washing areas or to obtain clean pans.

The kitchen operation depends on the equipment. If equipment is properly selected and of good quality, food preparation becomes an easier and more economical process. From the standpoints of operating costs and employee morale, both equipment size and quality assume considerable importance.

Size and quality are not the only factors to consider in selecting equipment. The following is a sampling of the questions that should be answered before the equipment specifications are completed: Does each item meet sanitation and safety code requirements? Does it carry a UL (Underwriter's Laboratories), ASME (The American Society of Mechanical Engineers), or NSF (National Sanitation Foundation) label, or some other recognized seal of approval? Does the equipment permit standardization? Is it mobile or fixed? Is it easily cleaned or does it have cracks and crevices where soil can collect? (If soil can collect there, it will.) Can it be readily serviced?

Have the potential suppliers provided satisfactory services in the past? Do they recommend a definitive preventive maintenance program? Do they offer a continuing contract for maintenance after the warranty period? Are they willing to help train employees in the operation and maintenance of the equipment? Who will operate the equipment — men or women? Will competent maintenance personnel be available? If not, what happens in case of trouble?

What service will be used: china, plastic, paper plates, etc.? Will a mechanical dishwasher be needed? Is the new facility to be a central kitchen or a unit kitchen? Is there provision for future expansion? How much automation is needed? How much is desired? Is the equipment properly sized for the job?

Extremely important is the need to check and double check the electrical, steam, hot water, cold water, waste, and other required services. Are the necessary services available in the required quantities or capacities? It is not uncommon, particularly where remodeling is involved, to have equipment purchased and delivered only to discover that the necessary services are non-existent. A check before specifying equipment would preclude such mistakes.

The selection of kitchen equipment is one of the most important phases in the design of a food service facility. A competent food service consultant who understands the particular needs and is willing to involve everyone who is interested and able to contribute should be engaged. Planners also should work with reputable equipment suppliers known to provide good service. Above all, planners should insist on good, tight specifications that will eliminate all unnecessary loopholes. They should follow up and insist that the equipment be installed according to plans and specifications.

Proper equipment operation depends on the quality of maintenance. The initial planning should provide for regular servicing both during and after the warranty period. The effort expended in setting up a preventive maintenance program will reduce operating costs.

While the selection and placement of equipment are important, there is much more to the kitchen than equipment. Specifications of floors, walls, and ceiling constitute another important aspect of kitchen planning. The aggregate cost of these items can easily exceed the cost of the equipment they house. Because of high initial cost and the important part that floors, walls, and ceilings play in the cost of operation, it is well to spend time on their selection.

Flooring, of course, should have good wearing qualities to obviate the necessity of replacement during the life of the building. Planners, in selecting a durable floor, should consider the traffic it must bear. For example, if heavy carts are used to transport food during processing, the flooring must successfully withstand heavy cart traffic.

Along with wearing quality, appearance should be considered. Flooring materials with a wide range of finishes are available. One with both suitable wearing qualities and an attractive appearance should be selected.

Cleanliness is said to be next to Godliness. In the kitchen this is certainly true. The flooring selected should permit ease of cleaning to reduce maintenance costs.

Properly located floor drains are part of floor care. Poorly located or too few floor drains will increase the floor maintenance cost and decrease the standard of sanitation. It is virtually impossible to maintain acceptable sanitation standards on floors lacking drains. Once installed, a drain is difficult and expensive to relocate.

Finish materials for walls and partitions should be selected with an eye to economical cleaning and high level sanitation standards. There are many materials available with good cleaning and sanitation characteristics. All available information should be consulted to ascertain the best type of wall material for kitchens.

A secondary, but by no means minor, wall consideration is appearance. Many colors are available, making possible a real opportunity to have an attractive kitchen. A pleasing appearance encourages both good performance and good maintenance.

The kitchen ceiling is apt to be completely forgotten in the search for good construction materials. Yet the ceiling is an important part of the kitchen, and its finish material merits careful selection. The ceiling usually is not so often cleaned as the walls or floor, but the necessity for periodic cleaning should be taken into account. The finished ceiling should present a surface free of unnecessary broken lines, cracks, or crevices where soil can collect. The appropriate ceiling material eliminates potential sanitation trouble spots, often at no additional expense to the school.

The lighting provided in a kitchen has a significant impact on employee morale, which in turn will reflect itself in lower operating costs. Fixtures should be located to insure safety. Also, fixtures should be selected that are easily cleaned and serviced. There is a wide variety of lighting sources from which to select, so planners should insist on lighting that will enhance the kitchen's operation.

The ventilating system is another area of the kitchen which, all too frequently, receives insufficient attention. Nothing contributes more directly to employee morale and efficiency than a well-ventilated, comfortable kitchen. Likewise, nothing is more appreciated than a system which prevents kitchen odors from permeating the rest of the school.

A case in point is a new grade school where the kitchen and storeroom ventilation system, as planned and installed, was wholly inadequate. The only exhaust originally provided was a 3-by-3-foot exhaust pickup over the stoves. The food service director reported that it was difficult to retain personnel long enough to train them. The reason most gave for their resignations was that the kitchen heat and odors were unbearable. Finally, the system was redesigned and a 3-by-6-foot exhaust pickup was added. The revised system is a great improvement over the initial installation, but it still leaves something to be desired from the air handling standpoint.

Space does not permit a detailed discussion of the problems of ventilating a kitchen. However, school officials are urged to insist that the architect, engineer, and consultants be encouraged to cooperate to insure adequate ventilation for the new kitchen.

The Dining Area

Planning the dining area requires the same care and attention as are recommended for the kitchen. While the kitchen serves one highly specialized role — the preparation of food, the dining area may be utilized for a variety of services besides dining. The area may see service as a classroom, laboratory, meeting room, banquet hall, or recreation space. The wide range of uses poses many questions which must be answered before the dining unit can be designed.

Planning sessions should include all individuals who will use the area after it is completed. If the area is to be used only for dining, planning becomes a relatively simple matter because concern for its operation will then be vested in the food service department. However, if the area is to be a multi-purpose room, its design must reflect the needs of each activity.

What is desirable for one activity may prove unsatisfactory for another; the solution is to develop compromises reasonably satisfactory to all. Opportunity should be provided during the preliminary planning sessions for each interest group to make its needs known. Enough time should be allotted for complete discussion of all requirements and the resolving of conflicts.

The planner must understand the type of food service to be provided. Will the service be cafeteria style or table service? Will there be one large dining area or several smaller dining rooms? Will service be via serving stations or vending machines? What type of menu will be served and how extensive will it be? What kind of service — e.g., china, paper, plastics — will be used? How much time will be allowed for feeding each group? How large will each group be? Will it be necessary to serve all students at one time?

In multi-purpose areas, how much time after the lunch period will be allowed for clean-up? Who will take care of setting up the room for other uses? What type of furniture will be used and how will it be stored? Will the area be equipped with sliding or movable partitions to divide it into smaller areas?

Where will the dining facility be located? Will it be centrally located or will it be set up as decentralized units? What is the pattern of student traffic? Will serving lines interfere with the incoming and outgoing flow of traffic? Will the student bus his own dishes? If so, where and how will this be accomplished?

What does the administration expect from the lunch program? Is it to be nutritional only, or is it to provide a social experience also? The questions raised during the planning phase should stimulate the thinking that produces better buildings.

Student traffic flow — incoming, outgoing, and within the dining area — must be carefully plotted. The design should help minimize the conflict between normal traffic and traffic created by the food service operation. Provisions should be made for areas which can accommodate all lines to avoid interference with normal corridor traffic. Finally, when possible, planners should specify ways to avoid cross-traffic which will pass through the lines. Prevention of serious traffic conflicts is essential to a good lunch program.

For example, the first unit of an elementary school was constructed in a rapidly developing neighborhood. Additional units were to be added as growth demanded. The first unit contained a gymnasium-stage-dining area and a kitchen to handle food preparation for itself and all proposed future additions.

The traffic problem soon became all too apparent. The conflict occurred when students returning to their classrooms passed through the line of students who had just been served lunch. This problem could have been avoided if greater attention had been given to student traffic flow patterns.

The location of the dining area within the total complex is also important. Its location will determine how far a student must travel to and from the dining area, and thus how much time must be allowed for the lunch period. Balanced against student travel time is the need to situate the dining area so that it can be properly serviced by the kitchen.

If the kitchen is adjacent to the dining areas, meal service is no concern. However, when the kitchen is in a remote part of the building, meal delivery can pose a difficult problem. A final note: Planners should consider accessibility for evening use by the public. The dining room should be neither hidden nor difficult to find.

The equipment and furniture for the dining area varies according to contemplated use. If the space is planned for multi-use (as a gymnasium, perhaps), the furniture will have to be stored out of the way. The answer to this problem may be tables and benches that fold into the wall. However, this kind of specialization, while satisfactory from the sports activity standpoint, can be a detriment to food service and other activities requiring arrangements of tables and benches.

When tables and benches that fold into the wall are selected, planners should consider detachable units that can be rearranged for variation in use. These units are also available in multiple depth so that more units can be provided along a limited wall area. If folding tables and folding or stack chairs are to be used with separate storage provided, storage carts should be provided to facilitate quick and easy movement.

Regardless of the plan ultimately followed in equipping the dining area, equipment should be selected that will have a long life, free from excessive maintenance. Time devoted to the selection of the proper furniture will be reflected in reduced operation and maintenance costs in future years.

The choice of floor, wall, and ceiling materials for the dining area also is based on the usage planned for the area. If food service is the only function, the flooring and walls can be entirely different from those selected for a gymnasium. Any material selected should be durable and easily cleaned to keep maintenance costs within reason.

Acoustical treatment for the dining room ceiling is necessary. When the room serves other purposes, the durability of the acoustical treatment becomes an important factor. There is always a need for adequate acoustical control to help combat the noises of a dining room, and the educational planner must see to it that this factor is not overlooked.

Lighting also plays an important role. The quality and level of light desired, the functions of the area, the moods and accents to be stressed all must be considered when the lighting scheme is devised.

Finally, planners should consider the finishes and colors to be applied to floors and walls. A wide variety of both are ready and waiting to be selected to make the new or remodeled dining a place of beauty as well as function.

The Food Storage Area

The food storage area is as important as the food preparation and serving facilities. The success of the kitchen or dining room could well depend on the efficiency of the storage area.

Good storage design requires a complete understanding of the whole food service operation. Much can be learned about the operation from the local food service staff. The food service director and the purchasing agent can be especially helpful in providing key information. In fact, all persons who can provide useful information should be encouraged to participate in preliminary planning sessions.

Questions that need to be answered include: How many meals per day will the storage area support? How varied will the menu be? Will the storage area be supporting a single kitchen or will it serve as central stores for several kitchens? Will it supply a central kitchen where all or most of the meals for the entire district will be prepared?

What is the purchasing policy? Is quantity discount buying anticipated and, if so, will the facility have to store large quantities of food? Will it be necessary to store government surplus foods? Are suitable suppliers readily available? If so, is vendor storage a possibility? What is the distance from the storage area to the local suppliers? Will it be necessary to store large quantities of food because suppliers are not readily available?

Are unloading facilities, such as a loading dock, available? Have areas been provided for receiving and checking shipments? How far is the receiving area from the storeroom? What areas must the food pass through in moving from the dock to the storeroom? How much temporary storage space is available for checking deliveries?

Will cold storage be required? If so, how will it be allocated — e.g., for vegetables, dairy products, produce, and meat? What capacity will be required for each? Where should the cold storage be located and how shall it be organized?

What storeroom arrangement will best suit the food service operation? Has proper space been allocated for each kind of food? Have proper aisle widths been provided to accommodate carts or hand trucks? Are the doorways wide enough? Is the ceiling height sufficient? Can the room be easily cleaned? Has a floor drain been provided? Is the room properly ventilated? What type of shelving is contemplated, and is it to be movable or fixed? Is the lighting adequate for reading labels, etc.? Can the area be secured to prevent theft?

Is the supply room suitably close and available to the kitchen? If the building has a freight elevator, is it accessible from the storeroom?

Proper location of the storage area does more than minimize employee travel time when getting supplies for the kitchen. A well-located storeroom helps keep operating costs low and employee morale

high, and such a facility is easy to control. That the storage room should be located in the logical path of supplies from the receiving dock to the kitchen is axiomatic.

The interior of the storeroom should be arranged for ready access to each item as it is needed. Providing enough space is only half the job; proper allocation of areas to avoid confusion and inconvenience is equally important. Inventory control should be considered and provided. The food service director, the food service consultant, and the purchasing agent can be helpful in determining the correct location and amount of space needed for each item.

For example, in a recently completed new elementary school, all necessary food service functions were performed satisfactorily, but the food storeroom was on the small side. As the number of students increased, the food service operation had to keep pace. Soon it outgrew the storage facilities. Adequate storage no longer exists. Today, in this relatively new building, the storeroom must be replenished daily because it can hold no more than one day's supplies.

Since the storeroom will undergo periodic cleaning, racks and shelving should be designed to help, not hinder, the cleaning operation. There should be a minimum of cracks, crevices, and hard-to-get-at places where dirt is trapped and difficult to remove.

Flexibility is another vital concern of the planner. The shelving and storage racks selected should, whenever possible, be adjustable for different carton and container sizes as well as to accommodate changes in future requirements.

A review of this topic would be incomplete without special attention given to the storeroom ventilating system. Improper ventilation of food storage areas is one of the most common design failures encountered. All too often no provision whatsoever is made for ventilation, even though sanitary requirements dictate adequate ventilation. Planners should insist that the architect indicate storeroom ventilation in the plans and specifications.

Summary

The design factors for a food service are essentially the same whether planning a kitchen, dining area, or storage facility. Only on the fine points of detail is there any degree of difference. The main points of the planning process can be summarized as follows:

1. The services of a competent food service consultant should be obtained. Planners should not assume that the architect has the necessary background for food service facility planning.

The long-term investment is great enough to merit the specialist's attention.

2. Planners should ascertain the administrative philosophy toward the feeding program and reflect it in their facility design.
3. Planners and others involved should arrive at a complete understanding of food service needs. The advice and counsel of all persons who have special knowledge and skills in food service should be sought. Also, the assistance of the school's own staff, i.e., food service director, purchasing agent, chef, dining room supervisor, and others should be obtained. They can contribute much to effective planning.
4. Flexibility and possible expansion should be foremost in thought while planning the facility. Changing patterns for feeding and new types of equipment make this imperative.
5. Operation and maintenance costs should be kept uppermost in the deliberations so that a design may be developed that will keep them reasonable. Careful attention should be given to the processing of food and the selection of equipment.

It is recommended that not only should each function of the food service area be given individual attention, but the total interrelationship of all functions should be carefully studied to avoid unnecessary conflict.

15. Planning the Data Processing Area

During this past decade the acceptance of data processing as an aid to the administration and operation of schools and colleges has been phenomenal. Not only has data processing been recognized and accepted by increasing numbers of administrators but, also, the variety of applications has increased at an equally rapid rate.

The planning of a data processing area should be no less carefully considered than the planning of any other special facility. There are as many problems in this area as in other specialized areas of the physical plant. A data processing area that is poorly designed cannot function properly.

Many space and environment problems have been created and compounded by the growing use of data processing facilities. In some instances, growth has been so rapid that data processing areas, entirely satisfactory at the time of their design, became outmoded in a few short months. Recognition of problems such as this should alert school and college planners to the importance of carefully considering how to avoid them in early stages of planning.

The initial design generally determines the future capacities of a data processing operation. The greatest care should be exercised to insure that this planning is complete and sound. Data processing operations usually have modest beginnings, and all too often administrators have failed to consider future requirements, when the program becomes developed fully. The result has been that the operations have slowly strangled themselves. A prime consideration therefore, when planning a data processing area, is to provide space for anticipated expansion. The mere provision of floor space is not enough.

Room for Expansion Necessary

In the installation of any new facility a common failure is insufficient space for specific functions. Planners seem to be particularly vulnerable when it comes to data processing operations. With all the attention devoted to describing the capabilities of data processing equipment, it would seem that planners would specify enough space to take care of immediate and projected space requirements, plus a factor for unexpected growth.

One reason for this failure to allow for expansion lies in the fact that data processing equipment is often sold in increments, with other increments added later. Certainly, no one can criticize a salesman for taking this approach to selling a product or service to a customer. It

"Just put it anywhere, boys."

is not suggested that failure to advise the prospective owner of future requirements is deliberate. Nor is it implied that it is the salesman's responsibility to provide for expansion. However, he should advise the educator of all aspects of a long-range program. The educator must then determine the best course of action based on the information made available to him.

Here is an example of what can happen when future expansion is not anticipated. An established school district installed a data processing system to satisfy registration needs according to certain specific patterns and to report grades. After the school administration had become acquainted with the equipment, it desired to expand the operation to accommodate a number of other administrative and business functions.

Unfortunately, very little space had been provided for the installation of the additional equipment that would have been required. The situation is the same today; should the school officials decide to expand the service now, it will be necessary, after only a few years of operation, to find a new location for the data processing center.

There are other factors which determine suitability to house a data processing operation. The designated area must have a temperature and humidity control system. If there are no provisions to control the humidity in a room known to have a moisture problem, that room should not be used for the data processing operation. Particularly is this true of a system which utilizes key-punch cards or paper tape, both susceptible to damage from high humidity.

Temperature and humidity equipment for the data processing area should be both automatically controlled and capable of functioning 24 hours every day. Mechanical cooling with separate controls is often necessary even when such cooling is not required in other building areas. This situation may require separation from temperature control equipment in other parts of the building to avoid the excessive cost of operating heavy equipment requiring special personnel.

The machine room should be located as near as possible to the stock storage area. Stock will include cards, tapes, and various printed forms. The storage area, like the machine room, should have provisions for temperature and humidity control so that both areas will have the same environmental climate.

Storage Space

A common problem is the failure to provide sufficient storage space for tapes, forms, and card stocks. In one situation, barely enough room was provided to accommodate equipment. A small closet

"Thanks a lot! The next guy with a batch of cards gets folded, stapled, and mutilated right in the IBM!"

was marked to store the card decks and the bulk card stock maintained in inventory. The lilliputian closet soon filled to capacity, so that it became necessary to store the card stock in the main equipment room where it remains today. As a result, machines cannot be operated at capacity and system operations are severely restricted by an inadequate punch card inventory.

The designation of an area for data processing should take into account the ease of moving supplies and printed material to and from the machine and storage rooms. Such factors as availability of elevators, delivery docks, and the locations of stairs will then take on considerable importance.

Planners should never overlook the size and weight of equipment that must be moved in and out of the data processing area. Even with the newer transistorized equipment, small door openings and stairs become formidable obstacles.

If not initially, then eventually, consideration must be given to two or three personnel shifts to take advantage of machine capacity and to garner maximum benefits from the capital investment in equipment. This indicates a 24-hour need for telephones, restrooms, vending machines, and snack areas, and convenient and well-lighted access to the building from parking areas and public transportation stations.

The power supplied to the machine room is also a special consideration. Power services should be able to handle not only present needs but also any anticipated expansion. If additional power will be a future requirement, the power supply capability at the time of the initial installation should well exceed the amount actually needed at that installation.

The voltage regulation also must be good. The sizing of conductors should take into account the length of run, the present system load, and the data processing system load. Recognition of these factors can materially reduce future equipment difficulty. Planners should check and double check to make sure that the correct phasing and voltage will be supplied.

Sometimes, in a desire to develop the best possible facility, common, but important, design problems are overlooked. For example, in arranging for the key punch machine or computers, items such as good lighting can be forgotten. Most of the work done in a data processing center is detailed in nature and, as such, necessitates a high level of lighting. Careful study must be given to selecting the proper fixture and to securing the needed level of illumination. Planners should not make the mistake of cutting corners in lighting design.

Acoustical treatment is also important, although not always regarded as such. Every effort should be made to insure effective control of the noise created by computers and related equipment. Considering sound control during the initial planning stages will avoid later corrective measures. No single item is more irritating to personnel working in a data processing center than unnecessary noise. Careful control can materially improve the morale of personnel.

In one installation, an old shower room was converted into a new data processing center. No attention was given at the time of conversion to sound control, and no acoustical treatment was provided. The room was placed in operation and, as time passed, additional equipment was brought in. With the addition of each new piece, the need for acoustical treatment increasingly became apparent. Finally, acoustical tiles were attached to all of the wall surfaces above the storage racks and machines. This solution, while only fairly satisfactory, has given much relief to the personnel who work in that area.

Unfortunately, in order to install the tile, the operation of the data processing center had to be curtailed, an unnecessary inconvenience. The installation could have been accomplished more cheaply and with less inconvenience had its need been recognized as important during the initial planning of the center.

Interior finishes can greatly influence the amount of service time involved in cleaning, redecorating, and restoring of finishes. Durable finishes are available on acoustical products for walls and ceilings. These can be vacuumed or wiped clean without interrupting an operation, whereas dust and trash from redecorating activities can be detrimental to the data processing equipment and supplies. Why risk a valuable investment by trying to reduce large initial capital outlay by the relatively small amount of the price difference between durable and non-durable finishes?

Even the simplest data processing operation will employ a number of machines interconnected by cables. Signals are fed through these cables from one piece of equipment to another. Unless provisions are made to keep the cables from lying on the floor, they will be in the way as stumbling hazards.

A common method of accommodating the cable runs from one machine to another is to install a raised floor and to string the cables beneath it. The necessity of running the cables across the working floor is thus avoided and unnecessary hazards are eliminated. There are other ways to accommodate the control cables. The raised floor is only one example. How the cables are concealed is not the main point of emphasis. What is important is to make provision for the distribution of control cables at the initial plant planning sessions.

As the data processing operation increases in scope, the value of the data and programming recorded in the center will increase at a surprising rate. If this material should be lost through fire, storm, flood, or vandalism, the restoring of programs could consume many valuable hours and dollars. A few extra dollars spent on a fire-resistive building, security from unauthorized entry, and fire protection devices could prove to be a very profitable investment.

All too often, a data processing center is developed to support either an academic program or a business operation, with little thought given to the need to expand it to accommodate both functions in the future. Recognizing that the initial capital investment is substantial, careful study should be devoted to every possible application of data processing to the total educational program.

Planners should recognize at the outset that the philosophy of the educational institution will largely determine the extent to which data processing facilities will be developed. If, for example, a school district or college fails to recognize the significant contribution that a computer can make to an educational program, or if it fails to appreciate the potential savings in applying the computer to the administration of the educational program, it is unlikely that a comprehensive or extensive data processing center will be developed. On the other hand, the administrators may recognize the importance of the computer to contemporary education and may also be aware of the administrative savings which could be realized. In this case, it may insist on an all-inclusive data processing program.

Whether data processing is to support a single program or the program of the entire system or university will be a factor in setting the amount of space for the center. For example, if the initial installation is to be a pilot program only, it would be advisable to provide considerable capacity for future expansion. Expansion will undoubtedly require more space and can be expected to add to the load of the utility systems serving the area. A little thought given to the possibility of future expansion during the initial planning of the program may result in substantial savings in the future.

The type and scope of the data processing program must also be considered. If extensive offerings are planned for the academic program, this should be reflected in the space provided and in the equipment selected. If, however, the course offerings are to be minimal, the area should be proportionate in size.

The predicted enrollment will have a direct bearing on the size of the data processing facility, particularly if it is to be used in support of the academic program. This is an important consideration in determining present as well as future needs.

The importance of delineating the type and extent of the program cannot be overemphasized. All too often, equipment salesmen are permitted to exercise undue influence in the selection of equipment. It is suggested that the proposed program be thoroughly checked by a computer expert, such as a professional consulting firm. This type of outside review should minimize serious mistakes that would hinder the program.

Whether the equipment for the data processing center is to be leased or purchased outright has little effect on the physical facilities needed to house it. Moreover, it is advisable to invite representatives of data processing equipment manufacturers to participate in all discussions concerning the facilities to be provided. Their assistance can be of real value.

The first planning requirement is, of course, a thorough understanding of needs. This phase involves enrollment analysis, the type of program to be provided, and the size of the school district or university to be served. Planners should visit a wide range of data processing installations to review the methods and procedures being used by others.

Discussion so far has assumed that the data processing installation is to be a new one, but this may not be the case. If an existing facility is to be expanded or relocated, a planner should take the same care to analyze all aspects of the problem as he would with a new installation in order to obtain the best results.

While a school's administrator may not make the actual selection, he should see to it that the following questions are answered in planning and developing a data processing center:

What functions will the data processing center support? Will it serve research projects? Is it to be incorporated in the academic program? Will it satisfy the needs of business operations? If it is to serve more than one school or college, what arrangements have been made to provide ready access to the equipment for all users?

Will the equipment accommodate both present and future requirements? Is the data processing equipment expandable by adding units to the basic components? How much space, initially and projected, will the equipment require?

What is the best arrangement of the various pieces of equipment? What provision has been made to accommodate the cables connecting the units? Is the facility adaptable to change?

Is adequate electrical power available? Can suitable voltage regulations be provided? Will the heating and ventilating system meet all requirements? Have provisions been made to control noise generated by the various pieces of equipment?

Has enough space been provided for card, tape, and form storage? Has humidity control been provided? Is the lighting system good? Are interior finishes durable and easily cleaned?

Have adequate provisions been made to protect the data processing unit from fire, storm, flood, and vandalism? Have satisfactory provisions been made for moving equipment in and out of the building area? Has sound control been taken care of?

Essential to the operation of data processing equipment is adequate maintenance, and a part of initial planning is the careful consideration of all maintenance matters. Particularly is this true of the equipment. School officials should make sure that the equipment supplier can provide regular and emergency service and maintenance both during and after the warranty period. Any effort expended to obtain an effective maintenance program reflects itself in reduced operating costs and in an efficient and reliable operation.

Summary

To achieve a compactly designed data processing area requires depth study of all factors included in the educational specifications. This chapter has touched on but a few of many important aspects of this rapidly growing service. Briefly repeated, the salient points of this chapter are that planners should:

1. Seek competent assistance to help develop their school's data processing service. They should not assume that the data processing sales engineer has their best interests at heart. They should confer with a consultant to insure that they get the facility they need.
2. Know the administration's attitude toward data processing before planning the facility.
3. Keep flexibility and future expansion foremost in all phases of planning.
4. After equipment needs have been determined, invite manufacturers' representatives to participate in the planning to help avoid costly and unnecessary mistakes.

16. Specialized Areas

Today, education is faced with the problem of providing facilities which meet the challenge of an increased emphasis on college preparatory work and on more specialized and technical education terminal below the college level. Adding to the problems is the explosion in all fields of knowledge. Every indication points to still greater emphasis on preparatory education and on technical training, nor can any let-up be expected in the growth rate of the body of knowledge to be learned. These considerations suggest that great care must be exercised in planning new facilities, to assure maximum flexibility for the following areas: Art, Home Economics, Business Education, Vocational Agriculture, Industrial Arts, and Industrial Trades.

The designing of a new facility requires architects, engineers, and consultants who are not only familiar with the materials and equipment in use today, but who are equally conversant with products and techniques currently under developme·ı.. Reflection on the changes experienced in materials, techniques, equipment, and furniture during the past decade will show them to be excellent indicators of the type of knowledge, skill, and imagination which need to be employed in designing and building a modern educational plant.

Specialized facilities should reflect the philosophy of the school as diligently as they do the specific technical requirements of the subject matter for which they are planned. This is more easily said than done.

Often specialized areas are designed by individuals who lack specific knowledge of the particular requirements or problems of those areas. As one result, they are frequently unable to view objectively both what a specialized area needs and how it can best fit into the total plant design. Such individuals should supplement their generalized expertise by consulting teachers or others who know in detail what a specialized area must have to be used most effectively.

In this chapter consideration will be given to the maintenance and operation factors involved in the planning and design of the special shops, laboratories, and studios necessary to support home economics, business education, vocational agriculture, industrial arts, industrial trades, and art programs. Before each of the areas are discussed individually, however, a number of general considerations common to all will be touched on briefly.

Of equal importance with purpose is the need to consider a school's predicted enrollment, for the size of the student body will have a direct bearing on the size of the initial installation and will affect provisions made to accommodate future expansion.

The desirability of future efficiency suggests that attention should be given to the matter of incorporating flexibility in the design — flexibility in terms of multi-purpose use and future updating of machines and equipment. It is not uncommon for a laboratory to be carefully designed for its initial equipment installation with insufficient thought given to the services and spaces necessary for the tools and machines required in the future. This is particularly true of electrical power, exhausts, and mechanical systems which have in-floor distribution.

Acoustical treatment should be considered for every special area. Each presents its own special problems for the designer. For example, the amount and kind of acoustical treatment needed in a business machine laboratory would be quite different from that required in an art studio. Few designers would question the desirability of keeping extraneous noises to a minimum to encourage student concentration. The purpose is to provide the best possible teaching-learning environment, and the control of sound in all areas must receive the planners' careful deliberation.

Just as there is no single type of acoustical treatment which will satisfy the needs of all areas, there is no one type of wall material which can be said to be best for all locations. Analyzing the operation of an area is essential in selecting the most suitable wall material. Suitability is determined by how well the material meets the requirements of a particular situation. A wall material and finish should facilitate cleaning and present an attractive appearance. Modern developments virtually assure an attractive colorful material suitable for every application. Drabness should not be equated with durability.

The problems encountered with floors have no universal answer. It will be necessary, in selecting the correct material, to determine the type of traffic to which the floor will be subjected. It would be unwise to select a resilient floor in a shop area where heavy farm machinery is found; similarly, it would be inappropriate to select for an automobile repair shop a flooring material which would deteriorate if exposed to gasoline, solvents, oils, or grease.

In the home economics laboratory, where the desire is to create a homelike atmosphere, plain concrete floors would be most undesirable. In this area, it would seem more appropriate to use carpeting, a decorative tile, or some other finished floor material normally associated with a home.

In any event, the selection of the floor must be individual and should take into account the appearance desired, the abuse it will direct bearing on the size of the initial installation and will affect provisions made to accommodate future expansion.

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In any event, the selection of the floor must be individual and should take into account the appearance desired, the abuse it will receive, and, most important, the ease with which it can be cleaned and maintained. A final thought on flooring: With so many new developments in floor patterns and colors, flooring materials should be specified which will brighten the shops, laboratories, and studios. Planners should let the flooring materials contribute their full share to a desirable educational environment.

Most shops, laboratories, and studios in their normal operation generate handiwork which, from time to time, should be placed on display. At the time a building is designed it is relatively simple to provide built-in showcases along the corridors for this purpose without entailing any substantial increase in building cost, whereas to add these cases at a later date can prove extremely difficult and expensive. Also, display cases considered at the time of the initial installation can be located and sized in proper relation to other fixtures.

Increasingly common is the necessity for providing year-round climate control. The educational administrator is constantly under pressure from the community to make greater use of plant facilities. The capital outlay for any educational building is substantial and if it is possible to utilize a building or portions of it during more months of the year than the usual school period it is generally considered advisable to do so. Extending building use into the evening hours for community service programs is becoming a widespread practice. All this suggests that air conditioning is desirable.

Shops and laboratories represent individual problems for an air conditioning system. In most instances they use exhaust hoods to remove dust, fumes, and objectionable odors. This requires special care in the matter of supplying adequate quantities of makeup air, thus affecting the capacity of the air conditioning system. The problem caused by exhausting air should by no means lessen the desirability of air conditioning shops or laboratories. It is mentioned as a specific condition which must be taken into account by the engineer designing the heating, ventilating, and air conditioning systems.

Waste lines are important because the operation of special areas is directly affected by how satisfactorily the waste system functions. For example, in a ceramics laboratory the waste lines should include properly installed and accessible mud traps to prevent ceramics materials from entering and clogging the drainage system. Waste lines also should be composed of appropriate material to withstand the corrosive action of acids, solvents, or similar materials used in the various areas.

Providing for future modification or expansion of the system is always advisable. All too frequently a waste line is installed as a one-time effort, as if it would never need to be changed. Easy accessibility is a must; otherwise, problems arise when it becomes necessary to replace or relocate equipment, or to provide additional equipment. Each eventuality is not only possible but quite probable; each should be acknowledged in the planning stage to minimize potential difficulties future changes may cause.

Water, gas, and air lines also should be installed so that they will be accessible. Future changes in these facilities are extremely likely because equipment and techniques are constantly being improved. The good administrator will try to keep abreast of these improvements.

The electrical service supplied to each studio, laboratory, or shop should be very carefully analyzed to insure that it meets the requirements of each specific area. No type of service will meet the needs of all special areas. Electrical service facilities both should be adequate for present needs and have a capability for expansion to meet future requirements. This criterion suggests that the building consultant be conversant with modern trends and potential future developments.

The selection of the equipment for the various shops, laboratories, and studios is not within the scope of this chapter. It is suggested, however, that equipment be selected which meets recognized safety standards such as the National Board of Fire Underwriters Code, and that all installations be in accordance with all applicable state and city building codes.

School officials who select equipment should consider the service available from the manufacturer or distributor. A little care in determining if a company or a supplier feels obligated to maintain his equipment, not only through the warranty period but after the warranty has expired, will help insure that each item of equipment selected will have a trouble-free life.

If it is a school's intention to provide its own maintenance in lieu of contracting with an item's supplier, the school's administrator should investigate and make certain that qualified personnel are available in the vicinity. A highly specialized piece of equipment is of little value if it cannot be kept in proper operating condition.

Administrative officials would do well to visit shops, laboratories and studios in other locales to seek ideas and innovations which could be incorporated in their own facility. They should look for others' mistakes with the idea of avoiding them in the new building.

Most schools welcome visitations for the purpose of inspecting their facilities. Generally speaking, they are quick to admit to oversights which should have been avoided. Finding the time to inspect other buildings may be difficult but avoiding just one serious mistake or adding one good feature can make the time well worthwhile.

The Art Areas

The complexity of art facilities varies considerably. A painting or drawing studio differs substantially from a ceramics laboratory. It is not possible in this chapter to analyze in detail each of the art areas. An attempt will be made to cover briefly several aspects which deserve recognition.

The location of the art area should receive careful study to insure ready access for the delivery of supplies and material and for a proper relationship with complementing areas. The location should not affect the general appearance of the balance of the building. It seems almost unnecessary to suggest that the ceramics laboratory, with all of its plaster and dust, should be placed where the dust will not be tracked through the balance of the building; yet, this mistake is not uncommon.

Storage for each studio and laboratory is important. Too often this is given insufficient consideration during planning, so that storage areas must be built into the studios and laboratories at a later time, a step that reduces the size of the art areas and impairs their effectiveness. Such a remedy also minimizes the amount of storage provided and places it in any available space rather than where it ought to be to support the art department.

Good lighting in an art studio or laboratory is important, but the *correct type* of lighting is even more so. For example, it is essential in a painting studio that lighting be selected which will render, as near as possible, true colors over the complete color spectrum. To achieve this, special work lights at key locations may be desirable.

Earlier in the chapter it was suggested that built-in display cases be planned to exhibit student art work. Such display areas should have convenience receptacles in them for effective lighting. This is a minor matter if considered early in the planning. It can be extremely troublesome at a later date.

The electrical service for each area should be carefully analyzed so that adequate receptacles will be provided in all areas where they are or will be needed. Special thought should be given to the location of convenience receptacles particularly in the jewelry laboratory where desk lamps may be needed at work stations.

Special heavy-duty services, such as those required by electric welders, electric kilns, and other special pieces of equipment, are something else to be considered during initial planning. The various operations should be placed to insure a correct relationship with other functions. Welding stations should have shields for the protection of eyes, and so that objectionable fumes can be readily exhausted.

Vapor and explosion-proof lights, switches, and receptacles should be provided in areas where there is possible danger from volatile fumes and vapors.

Where kilns are gas fired, proper attention must be given to installing appropriate safety devices. Local gas companies are good sources of help in determining these devices.

A paint spray booth should be provided regardless of the size of the art area. This will involve installing an exhaust system to remove any objectionable and hazardous vapors. Here, too, safety takes on substantial significance. Unless properly designed and protected, paint spraying areas introduce a definite hazard. State and local officials should serve as consultants in establishing desirable safety practices and devices.

A final point to consider in developing an art area is the appropriate sink for a particular operation. Whether island-type, wall-mounted, or recessed, the sink style should be determined by the program. The program should also determine the placement.

The installation of sinks serves as a reminder to select wastes and traps which will give long, trouble-free service. The effectiveness of an art program can easily be destroyed by the ineffectiveness of its waste system.

Home Economics

The design and construction of the home economics department should reflect the purposes of the courses offered. If the facility is intended primarily to teach homemaking arts, its design and construction should give the impression, as nearly as possible, of a home. On the other hand, if the purpose is to provide qualified personnel for community vocations, such as hospital dietitians and industrial personnel, both design and layout should reflect that primary interest.

The location of the home economics laboratories in the building should minimize such access problems as delivery of materials. Convenience of deliveries, however, is not the only criterion to be considered. The department should be situated where disturbances from other groups will be at a minimum.

Any hoods or venting required because of the use of gas should be considered in terms of both economy and long-term flexibility.

Lighting in the home economics section, particularly in the homemaking laboratory, affords an excellent opportunity for the imaginative architect and engineer to contribute, in a very real sense, to the type of atmosphere which should be created. In the home, lighting is individual and quite personal. By design, this concept should be incorporated into the laboratory so as to contribute its full share to enrich the total homemaking program.

The planner should not lose sight of the fact that change will be continual, both in style and in techniques. The home economics laboratory should accommodate as many of these changes as is possible without destroying its primary purpose. One way would be for the design to specify partitions that can be relocated in order to obtain different effects. When considered and implemented at the time of initial planning, this kind of flexibility will present little or no special problem later.

Adequate and properly located receptacles are a must in any home economics work area. Their locations should permit maximum flexibility in the arrangement of furniture and equipment. The special attention necessary to make certain that convenience receptacles are truly convenient for their function and not just for their designer will help minimize teacher and student discomfort.

Flooring in general was discussed earlier. It might be well, however, to suggest again that the purpose of a home economics laboratory is to generate a homelike atmosphere. The floors, as much as any other single feature, can help create this effect. There are many types of flooring, including carpeting, tiles, linoleum, and wood, which should be examined before the selection for the laboratory is made. Planners should try to select the correct flooring for their school's situation.

If gas-operated appliances are used in the laboratories, special precautions should be taken to operate them safely. Among these are safety pilots, controls, and fume exhausts. Gas actually is no more unsafe than electricity. Just as special grounding care is suggested for the electrical system, so special care and thought are recommended when installing gas systems.

Nothing enhances the appearance of home economics laboratories more than the proper selection of wall finishes or coverings. Whether the covering be paper, vinyl, paint, or paneling, if properly done it will present a most pleasing and attractive appearance. The range of products and materials available for wall covering is almost unlimited, and the selection ought not to be made until all appropriate materials have received due consideration.

The movability of partitions will have a direct bearing on the type of wall covering which can be used on them. Also affected will be the selection of the wall covering for the balance of the area. The two should complement each other for an overall pleasing effect. All possible partition arrangements should be studied. The mobility of walls should be considered a challenge, not a problem.

The installation of the waste system should take into account other facilities for waste removal. If waste removal is available on a periodic basis rather than continuously, this should be reflected in the system design. Under these circumstances it may be desirable to utilize garbage disposal units for as much waste disposal as possible.

If, for some reason, garbage disposal units are not advisable and if the refuse removal is on something other than a continuous basis, it will be necessary to store waste materials between pick-ups. The ideal system will make it necessary to store minimal amounts of kitchen and waste materials.

Equipment selection for the home economics area depends on many factors, such as local suppliers, the policy of local utilities companies, and the availability of service personnel. These considerations fall outside the scope of this planning guide. Nevertheless, it is suggested that careful attention be given to selecting equipment which meets safety standards, especially those criteria set by the various national standards groups.

Business Education

Business education facilities are most effective when they reflect the occupational needs of the local community. There will be circumstances, however, when a very small community may offer relatively limited job opportunities for students graduating from its schools and colleges. In that event it may be desirable to offer a broad business education to prepare a student for advanced education and to equip him for the greater community. Whether or not this concept is followed, depends, of course, on the local educational philosophy.

The location of the business education department is not especially critical if it operates as a unit by itself. The location does take on significance, however, if the educational program includes data processing or computer courses which require the use of a data-processing center. In these circumstances it may be advisable to locate the laboratories in the general proximity of the data processing center.

It is also possible that a joint use of machines may be desirable between the business office and the business education department. In this instance it would be desirable to locate the two divisions in the same area of the building. A third possibility is the common use of business calculators by the business education department and the mathematics and statistics units.

The above are a few factors which ought to be considered in locating the business education department. Individual circumstances may necessitate numerous other possibilities in determining the correct location for a specific building.

Lighting business laboratories presents very special problems. The work is detailed in nature and requires a high level of lighting. The architect and the engineers should be able to assist in planning the appropriate lighting for the business education laboratories.

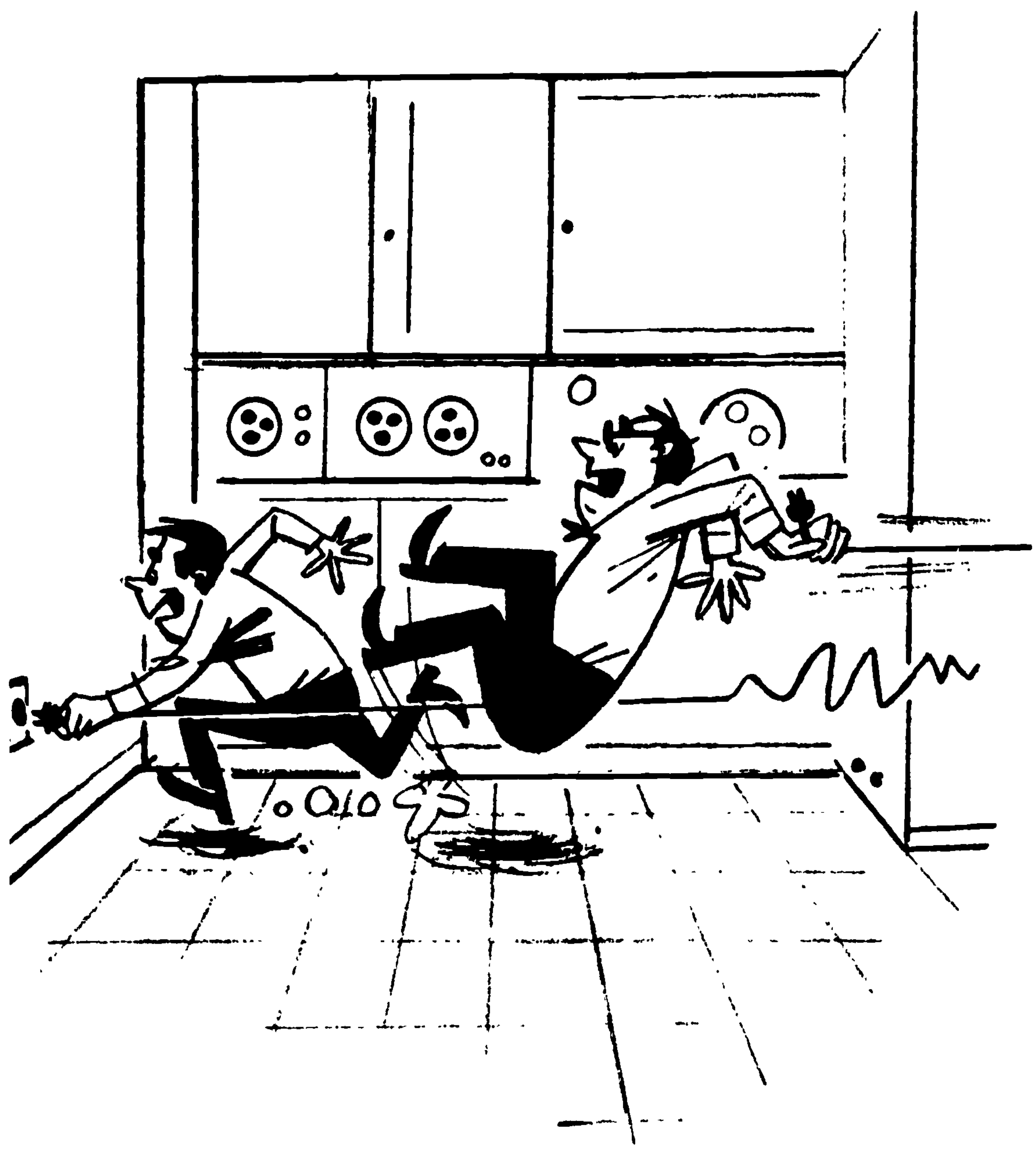
A problem often encountered in business laboratories is that the convenience receptacles are not properly located and that there are not enough of them. Machine and typing laboratories should have electrical receptacles available at each station. Unfortunately, because of the difficulty in getting a receptacle to an appropriate location without creating a stumbling hazard, the problem is too often ignored. There are a number of techniques for providing receptacles at all stations, and of avoiding tripping or stumbling hazards in the process. The architect or engineer should have no difficulty in resolving this problem while still protecting the flexibility of the area.

As with many other items of equipment, the types and styles of business machines are in a constant state of change. As a result, the electrical system should be such that any and all stations can be easily moved without upsetting the distribution system itself. School officials should use the system which will work best, but they should also see to it that as many future requirements as possible can be accepted by that system.

No particular recommendation is made regarding wall and floor covering except to suggest that business education laboratories need not be drab. There is a wide variety of types, colors, and patterns of both floor and wall coverings which can be used. The selection of attractive, complementary materials will enhance any room.

Business machines can generate a great deal of noise, objectionable to faculty and students alike. Control of this noise problem is not particularly difficult through the proper application of acoustical materials. The problem, however, is serious and merits the close and careful scrutiny of planners to insure that effective sound control measures are part of the initial design.

Storage of business education supplies is often slighted during the building planning sessions. This oversight or de-emphasis can seriously impair the effectiveness of any laboratory. It is suggested that the function of each laboratory be analyzed to determine the amount and kind of storage space required to support it. This analysis should be as much concerned with the appropriate location as it is with the



"Winner gets the use of the juice!"

amount of space provided. The storage requirements are easy to accommodate in the planning stage but can prove expensive and ineffective when done later. Generally, storage provided after the laboratory is completed must be remotely located or it will encroach upon the laboratory itself. Neither situation is tolerable.

The operation of business education laboratories makes it desirable to have hand washing facilities in the general vicinity. The extensive use of carbon, adhesive, stencils, labels, and the like, make this convenience extremely important. In developing the plans for the business education laboratory the planner also should check to see that wash fountains or sinks are not overlooked.

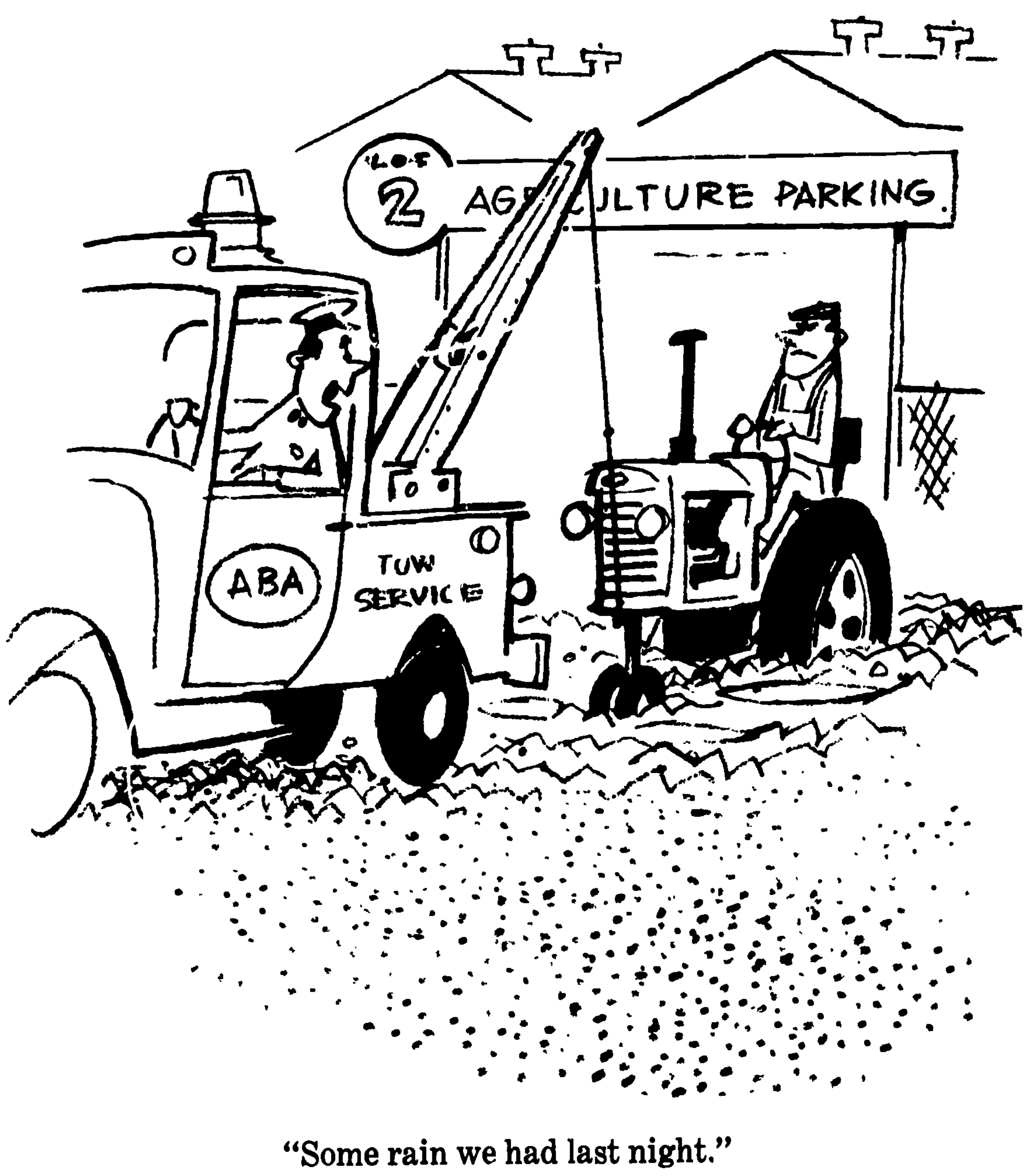
Vocational Agriculture

Vocational agriculture shops provide a wide range of services and deserve the planner's careful attention. Because of the nature of this area's specialization, it is advisable to engage a consultant to do the planning, or at least to review plans and specifications before they are put out for bid. The time and funds spent in hiring a vocational agriculture shop consultant can avoid a lot of unnecessary mistakes in the finished facility.

In addition to the regular classrooms for instructional purposes in vocational agricultural programs, several specifically specialized shops will be needed. These shops probably should be placed at a remote point in the building or even in a separate building. Generally, this would be done to keep shop noises, dust, and other disturbances from interfering with quieter academic activity. A shop should also be situated so that farm machinery can travel to and from it without undue interference with other traffic on the grounds.

A major aspect of vocational agricultural shop planning involves storing hand tools and supplies. The number of specialized tools and the amount of materials and supplies can be extensive, and provision should be made to accommodate them. Specifying enough space is not sufficient; the storage area should be located so that it will support the operation of each individual shop. The consultant should check the operation of each area of the shop to insure that the supplies and tools needed are stored in both the proper location and the proper quantity.

The electrical distribution system should permit complete flexibility. Vocational agricultural shops, as most special areas, experience continual change in the type of machinery and tools used. The electrical system thus should be designed to permit easy replacement of equipment. An overhead distribution system may insure the



"Some rain we had last night."

amount of flexibility needed. In-floor service should be studied very carefully before installation because of its inflexibility once installed.

The wall finish should be selected according to what is best for each shop situation. Materials should be able to withstand the attack of grease and solvents and at the same time present a pleasing appearance.

The flooring for each vocational agricultural shop should be able to withstand the load of farm machinery and resist damage from grease, solvents, gasoline, and oil.

In support of the vocational agricultural shop areas it may be expedient to provide a parking lot for storage of equipment. The lot should be hard surfaced and located where it will not detract from the appearance of the school.

Farm machinery must be moved freely in and out of the shop areas. This can be accomplished by the use of overhead and sliding doors. Access is critical to the operation of the shops, so the most appropriate door should be selected.

Special attention should be given to heating the shop areas. The large doors necessary for moving machinery into and out of the shop areas can seriously upset the heating system. Special provision should be made to ensure that the heating system will compensate for these sudden temperature changes.

A final consideration in planning a vocational agricultural shop is to provide dressing rooms for changing clothes, and shower facilities for cleaning up after class sessions. Planners and consultants should be certain this important need is not overlooked.

Industrial Arts

The industrial arts program is usually one of two different types: the comprehensive general shop or the unit shop. In the first shop, several areas, such as woodworking, metal work, and electricity, will be housed in a single area. In the later situation, each of the functions will have its own area. Either way, the planning should insure that each facility serves the purpose intended. Here again it is suggested that a consultant familiar with the operation of an industrial arts program be commissioned to prepare, or at least review, the plans and specifications for the projected equipment and facilities before the building is constructed.

The location of industrial arts shops and laboratories should be determined by how objectionable the noise, fumes, and access problems are to the balance of the school. For example, the noise associated with the motor mechanics shop would suggest that it be located a substantial distance from classrooms. Also, the garage doors for moving automobiles in and out of the shop may be detrimental to the appearance of the school. For this reason it may be desirable to locate them at the rear of the building. Each desirable and undesirable characteristic should be evaluated for the correct location of the industrial arts facilities.

Little need be said concerning the floors except to point out that each industrial arts area presents special problems to consider when selecting the flooring material.

The industrial arts shop has several very special utility system problems. For example, there is the problem of wood and sawdust removal, fume exhausts, electrical distribution, water, gas, and air distribution systems. Each of these should be designed to accommodate present needs, and changes dictated by future equipment design. School officials should consider installing all utilities so that they will be readily accessible for any changes demanded by the curriculum. Services should not be buried in walls, ceiling, or floors unless absolutely necessary. This will help avoid floor cutting and patching when future changes become necessary.

The type of wall material and its finish should receive attention. The materials selected should be able to resist the attack of oils, gasolines, solvents, and other materials found in an industrial arts shop. They should also be easy to clean and, most important, they should be attractive. There are many wall finishes on the market, and there is really no excuse for selecting one which will not meet the criteria of resistance to materials used, ease of cleaning, and a pleasing appearance.

In the industrial shop, as in the vocational agricultural shop, heating and ventilation can prove to be a problem. In both instances there will be fairly large openings to the outside for moving equipment and machinery into the shop areas. At such times a severe load is placed on heating and ventilating systems. The design must compensate for these sudden changes.

During the summer months, if industrial arts areas are air conditioned, it may be necessary to provide special mechanical ventilation to insure enough change of air for student and teacher comfort. If community emphasis is placed upon the industrial arts area, it may be desirable to air condition all areas so they can be used for longer hours and more months of the year. This is a local problem and is mentioned so that it will be considered.

The industrial arts area, perhaps more than any other special area, deserves careful study regarding the installation of safety measures. For example, there can be a number of operations — from paint spray booths to glue melting pots — which ought to have exhaust hoods. Some of these exhaust hoods may well be exhausting vapors and fumes which are explosive in nature, and the electrical switching, lights, and fan motors connected with these locations should be vapor- or explosive-proof. Planners must be certain that the proper safety devices are included.

In areas where operations require welding, soldering, and working with molten metals, exhaust systems should also be considered. Additionally, thought should be given to providing protection with curtains or vision shields in all areas where arc welding is done; otherwise, the possibility of injury to eyes will be very great.

Not to be overlooked is the need for locker and shower facilities. Students will be changing clothes before and after class, and in some cases will require showers to clean up. Both the size of the locker and shower facilities and their location should be studied to insure convenience to the department.

The selection of the shop equipment should be made with the help of the consultant. However, a word of caution. School officials should select quality equipment which will have a good follow-up support by its distributor and manufacturer. Slow delivery of replacement parts can keep a a piece of shop equipment out of service for months. The types and kinds of service the suppliers are able to provide should be well studied before equipment is selected.

Industrial Trades

The purpose of industrial trades education is to prepare trainees to make a living by applying the skills they learn in a given trade. It is common practice for high schools with vocational components to hold evening classes so that students who work for a living can avail themselves of this specialized training. This is particularly true in subjects having a high industrial orientation.

Because the courses taught in the vocational school provide a salable skill rather than just an exposure to a craft, the facilities need to be more complete than those required for the ordinary industrial arts shop. The character of such shops may also take on more of the atmosphere of the industrial plant. This suggests that the equipment used to train students should be up to date, because the student will work in industry on similar types of equipment. He will be more valuable because of the added familiarity with current industrial equipment.


SHOP
SHOP
SHOWER

In designing the service systems, it is extremely important for the industrial trade shop to be able to accommodate future alteration and changes. This adaptability is dictated by the fact that the industrial trades shop will be subject to many changes resulting from frequent up-dating of equipment and processes to meet changing industrial needs.

The planning and design of the industrial shop calls for the help of a consultant who is specialized in this type of program. The location of the shop, the arrangement of the equipment, the types of equipment selected, and the location of storage areas must be considered simultaneously, as they relate to the curriculum. The consultant should not only understand the function of the equipment, he should also be intimately familiar with the program's curriculum plan.

Summary

The design concern for each specialized area is essentially the same. Each has design problems of location, storage, utility services, building materials, and layout of the facility itself. In summary, to cover the high points of the planning process, school officials should:

1. Call upon the services of a competent consultant for each of the individual areas. They should not presume that the architect has the necessary background to do an adequate design for all the facilities. The long-term investment in both plant facilities and program is great enough to merit the attention of a qualified specialist.
2. Determine the educational philosophy toward the program of each of the specialized areas and design a facility which will reflect this attitude.
3. In each instance develop a complete understanding of the program's needs. To accomplish this they should seek the advice and counsel of all persons who have special knowledge and skills in the area under consideration. Most important, they should include the local staff and faculty in the early phases of the planning; both can contribute much to its effectiveness.
4. Keep flexibility and possible future changes foremost in the thinking while planning a facility. Changing curriculum needs and development of new types of equipment make this imperative.
5. Make sure that operation and maintenance costs are uppermost in thought as the special facilities are designed. Careful attention given to the types of materials selected and the systems installed can materially reduce these long-term operating costs.

17. Housing

With college enrollments at an alltime peak, student housing is a big enterprise in America. For comparison, consider that the cost of living facilities for one dormitory student is roughly equal to the cost of all instruction-related facilities for that same student.

To those charged with dormitory operation, the residence hall is considered the student's "home away from home." As such, his room must be comfortable, cheery, and functionally efficient. The institutionalized feeling must be overcome. By the same token, facilities must be durable enough to stand the rigors of hard use over a period of many years.

Wall Materials

The two most popular wall materials are hard white plaster and concrete aggregate blocks. Plaster walls are excellent from an appearance standpoint, but are subject to chipping and other damage caused by moving furniture. Concrete blocks are more durable than plastered surfaces, but do not create so pleasant an atmosphere. However, since they are generally less costly, they are often used in preference to plaster.

One big complaint from a maintenance standpoint is that dormitory residents are not careful about hanging objects from the walls. Students have been known to drive nails directly into walls to hang pictures and other decorative material. Gummed tape is used to hang all kinds of light paper items. As a result, the walls of dormitory rooms take on a battle-scarred appearance and must be repaired or painted more than normally necessary.

The only solution to this problem is to provide built-in devices for hanging and displaying various personal items. A kind of picture molding can be installed along all walls approximately seven feet above the floor. One type used with plastered walls is a metal groove imbedded in the wall and designed to receive picture hooks. Another type, used with concrete block walls, is an extruded aluminum map and picture railing, with a small strip of cork in the center and equipped with hooks for picture hanging. Such a device is durable and has both a tacking surface and hanging hooks for heavy objects.

Another alternative is a wooden molding high enough to be used for hanging or tacking. Such a molding is less expensive than other types, but it does not blend well with modern architecture and requires frequent finishing.

"Hey, man, what was the color of the walls in this pad?"

Besides the special moldings along the upper walls, it is advisable to have tackboard space at a lower level for miscellaneous notes, pictures, and reminders. Each student should have a tackboard, at least two feet by three feet, for his own personal use. In women's dormitories especially, good use often is made of individual pegboards of comparable size for displaying personal items.

When furniture is moved about in the dormitory room, much damage can be done to walls by sharp edges. To prevent this damage, furniture designed with rounded corners and edged with a vinyl or metal strip for resiliency should be selected. The edging strip should be difficult to pick loose. Another good idea is to have rubber bumpers installed at critical points on the backs of chests and desks. Chairs and bedframes should also have wall-saver legs to keep them from rubbing against the walls.

An even better way to keep wall damage to a minimum is to install built-in furniture. Colleges frequently install built-ins because they can then be included in the building cost for loan purposes, while movable furniture cannot. The principal disadvantages of built-in furniture are that students cannot make their own room arrangements and that the decor is apt to become institutionalized. The administrator must decide which is more important — ease of maintenance or flexible furniture arrangements.

Acoustic Problems

Students who live in dormitories seek a quiet atmosphere, free of distractions, for study. A recent survey indicates that most students prefer to study in solitude and not in groups. Since today's college libraries provide relatively few individual study carrels, dormitory students do most of their studying in their sleeping rooms. If noise from adjoining rooms penetrates into a student's room, he is apt to find the distractions greater than those faced while trying to study in a library with four to six persons at one table. Control of noise in the dormitory is thus of the utmost importance from a functional standpoint.

There are two sources of noise to consider — lateral and vertical. Lateral noises are those carried from adjacent rooms on the same floor level or from outside the building. Vertical noises come from rooms below or above an area. Lateral noises usually enter through walls which are too light in weight to absorb sound or which are not tightly sealed at wall or ceiling joints.

The smallest crack at such points permits sound to pass through, just as water under pressure will pass through a small crack in a pipe. School officials should see to it that all wall joints are sealed as tightly as possible. Planners should write specifications which require caulking of all joints which cannot be sealed in any other way; then the procedures outlined in Chapter 9, "General Instructional Areas," should be followed.

Of equal importance is that dividing walls between rooms have adequate sound absorbing qualities, so that noises will be retained within the areas where they originate. Since the best sound barrier is mass, the simplest way to achieve this is to specify walls made of at least six-inch concrete blocks. If really effective sound retention is desired, solid blocks are best. If plastered walls are specified, staggered joists can be used to create a double sound wall. This will cost more than a standard wall, but is worth the extra price in the long run.

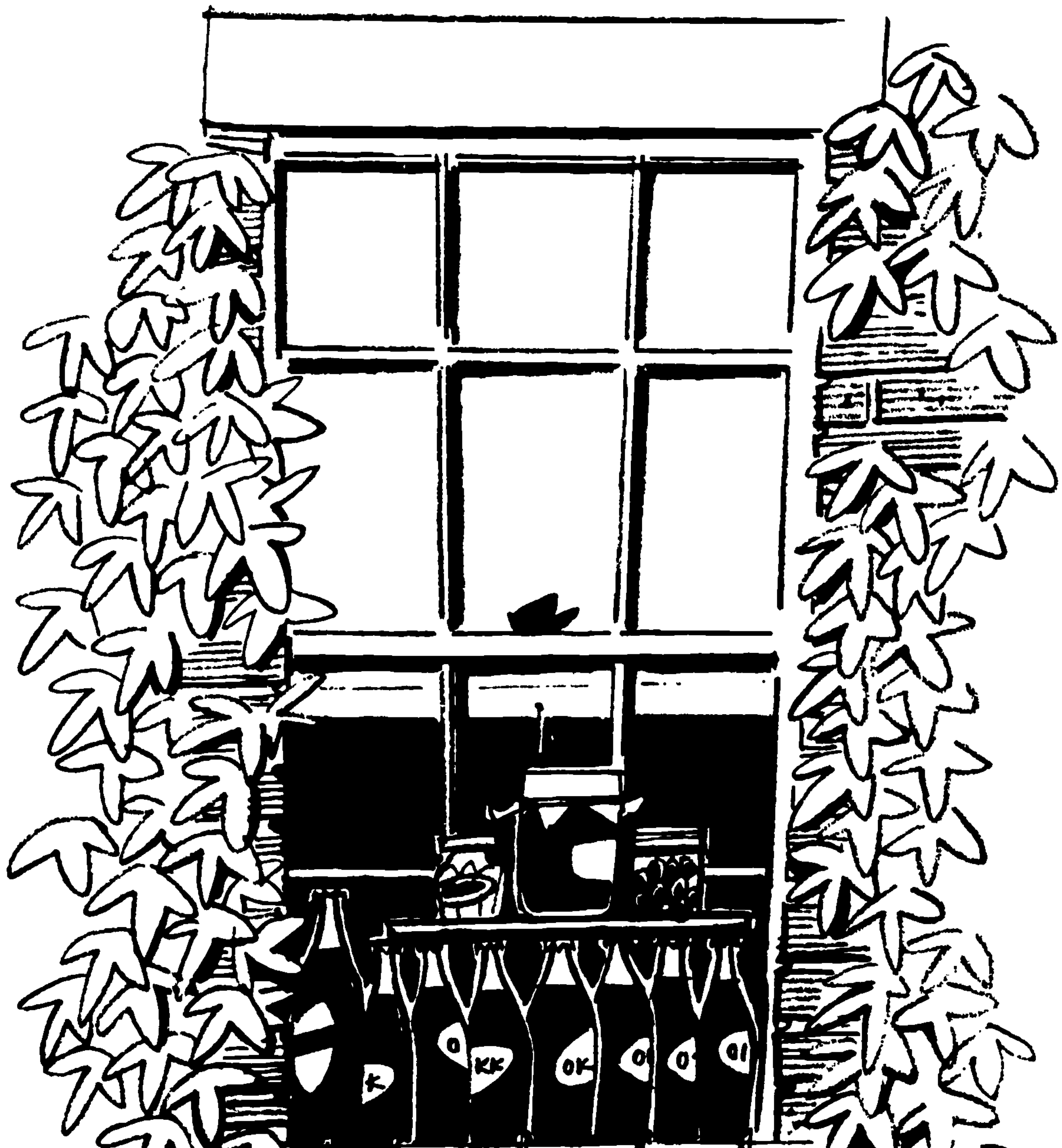
Much of the noise penetrating dormitory rooms can be blocked by doors with solid core construction. Hollow core doors cost less, but their acoustical qualities are not ideal; neither do they hold up well under the heavy use which dormitory rooms receive.

Serious consideration should be given to the installation of acoustical materials on the ceilings of both student rooms and corridors. This material is thought to be costly, but some planners find it is no more expensive to install an acoustical tile ceiling than to rub a concrete ceiling smooth and paint it. If bar joist construction is used, a suspended acoustical tile ceiling does not differ appreciably in cost from a plastered ceiling. The dividends reaped from an acoustical ceiling are certainly high for the dollars spent.

Many colleges are now installing carpeting in dormitory corridors or student rooms in a further effort to reduce noise transmission and to cut down maintenance costs. That carpeting is an excellent acoustical treatment is a well-established fact. Carpeting not only absorbs noises once created, it also prevents many noises from occurring, since any contact with the floor is practically inaudible. Another observation is that people, and especially young people, act in a quieter fashion when they enter a carpeted area. Today's prices make carpeting competitive with hard floor coverings such as vinyl asbestos and vinyl tile. Maintenance requires only regular vacuuming, spot cleaning as necessary, and on-the-site shampooing occasionally, depending upon the severity of use and how much outside dirt is carried into the carpeted area.

Window Selection

Do school officials or students ever stop to consider how many windows there are in a typical dormitory? There is at least one window for every two students in the building, and usually many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more than this. Thus, careful consideration is necessary to select a satisfactory window style for beauty, function, and easy maintenance. Just which one of these three factors deserves the most attention is debatable, and the answer depends upon whether one is speaking with the architect, the dormitory supervisor, or the maintenance engineer.

From a functional standpoint, windows in student rooms serve two main purposes. First, they make it possible for the resident to relate himself to his outdoor surroundings. They provide him with a homelike atmosphere which helps him relax and concentrate on his studies. Second, windows serve the very practical purpose of providing both natural light and a means of ventilating the room.

Natural light is an important asset for making the room pleasant and reduces the amount of artificial light necessary. Windows are perhaps more important for ventilation purposes, however, since mechanical ventilation is not normally provided in individual dormitory rooms. Therefore, it is vital to select windows with a suitable amount of operable sash.

For most effective ventilation, operable sash should be at both the top and bottom of the window unless jalousie windows are used. Either double-hung or awning type windows serve this purpose.

Since dormitory students are always looking for a way to display all kinds of objects, the windows can be designed so that there will be a large interior window stool. By the same token, planners should take care to guarantee that no items can be stored outside the windows by keeping exterior window sills to a minimum width and sloped enough to make it impossible to store anything on them. Safety reasons make this design mandatory.

There should be no need to use the window sill to cool food and drinks. Every dormitory should have at least one vending machine area where students may purchase snacks. Recommended also is that each living unit within a dormitory, usually a group of 50 or 100 students, have a small kitchenette area with a sink, refrigerator, and stove for storing and preparing light snacks.

Many new dormitories are multi-story units as high as 15 or 20 floors. Such buildings present entirely different maintenance problems from the customary two- or three-story dormitories. One difficult problem is how to keep windows clean on the outside.

In a lower building, double-hung windows can be washed from the inside the way housewives do their home windows. Any window in a two- or three-story building can be washed from the exterior by using a ladder or with an extension device attached to a garden hose. Multi-story buildings rule out these cleaning possibilities.

There are several relatively simple ways to overcome the high-rise window cleaning problem provided that it is recognized before the building is completed. The best solution will undoubtedly be determined by the designer, but college officials should include a warning in the educational specifications about the need to solve this problem.

Some possible solutions are:

1. The installation of window washing bolts on the outside of each window. Before doing so, planners should check the legality of this arrangement in the local area.
2. The provision of a device to accommodate a moving scaffold suitable for washing windows quickly and safely from the outside of the building.
3. The installation of pivoting or jalousie windows which can be washed easily on both sides from inside the building.
4. The installation of sliding, double-hung, or other types of windows designed for easy removal of the window sash for washing outside of the frame.

Either of the last two methods is better than — and therefore takes precedence over — the first pair for two important reasons. First, these latter-described windows are much safer and can be washed by maintenance personnel for a lesser cost amount than contractors charge for this service. Secondly, and often overlooked in dormitories, is the provision for window screens. Lack of screens is inexcusable. When selecting windows, planners should keep in mind that insect screens are a necessity. Naturally, the screens should be accessible for cleaning purposes.

Window-Covering Devices

Every dormitory sleeping room needs some kind of window covering to provide privacy. Basic window coverings in use today are shades, Venetian blinds, and draperies. The use of shades is the least expensive way to achieve the desired privacy. However, shades are rather stark by themselves and are usually supplemented by draperies to give a room some warmth.

Planners should ask themselves, however: Why not use draperies in the first place? Some colleges provide shades as a bare minimum and then require students to provide their own draperies. While this is a cheap way to do the job, it puts a financial burden on the students and can result in an unattractive exterior façade unless all draperies are lined with the same material — a difficult aspect to control.

Venetian blinds are popular because they are simple to operate, look well, and, if properly designed, require a minimum of maintenance. Usually the periodic replacement of cords and tapes is all that is required to keep Venetian blinds in good shape for 10 to 20 years. However, as with shades, Venetian blinds tend to be cold in appearance and are not liked for this reason.

The recent development of vertical Venetian blinds has done much to improve the appearance of this kind of window treatment. The success of vertical blinds so far seems to indicate that their use will be more widespread in future buildings, including dormitories. One of their principal advantages is that they do not collect dust and are therefore easier to maintain than standard horizontal blinds.

Probably the most popular window treatment for dormitories is fabric draperies. Draperies present possibilities for an attractive decor for each room, and such possibilities are limited only by the imagination of the decorator. All colors of the rainbow and all manner of weaves and patterns of material are available or can be made to order at almost no extra expense. If desired, the draperies can be lined with the same shade of material to present a uniform appearance from the exterior of a building while still allowing an endless number of designs on the parts facing inside the building in its various rooms.

From a maintenance standpoint, an unlined drapery lasts longer without repairs, since it has fewer points of wear. In selecting fabrics for dormitory draperies, several factors should be kept in mind. The fabric must be pre-shrunk to the highest extent; it must be colorfast when subjected to direct sunlight; it must be heavy and durable in order to withstand repeated washings or dry cleanings; and it must be reasonably opaque in order to guarantee privacy.

The hanging track and component parts also must be heavyweight to prevent needless wear and assure smooth opening and closing of the drapery under the worst conditions. All working parts should be either nylon or solid bronze to prevent corrosion. Careful buying can give remarkably durable wear for any college administration willing to take the time to consider some of the factors mentioned above.

Heating and Control Systems

The heating system for a dormitory and the manner in which the temperature of each room will be controlled deserve careful study and design. Most dormitories have low ceilings and seldom is there a suspended ceiling to conceal overhead mechanical components. Exposed piping is not desirable in occupied areas.

Uncovered pipes are not permissible because of the danger of burns, and exposed covered pipes are subject to damage and need constant repairs. Architects and engineers must therefore determine some way to run heating pipes to the various rooms through tunnels and chases and to enclose them in radiation or convector covers within the room.

The type of temperature control to install is also a perplexing decision. Individual room thermostats are not usually used because they are expensive and subject to mistreatment or vandalism. Some dormitory administrators believe that zoned thermostatic controls are most satisfactory. In such systems all rooms on the same thermostat presumably receive the same amount of heat. It is thus important to assure that all rooms in one zone have the same exposure to the sun and are used similarly. If, for example, the thermostat happens to be located in the room of a student who likes a lot of fresh air, the thermostat could be calling for more heat to overcome cold air from an open window in that room, while other rooms with closed windows become unbearably hot. Zoned controls easily become a problem in dormitories if the zones and thermostat locations are not carefully selected.

Another method of control is to have each room's heating element manually controlled by the occupant. An example is the old-fashioned radiator valve which, by a turn of the wrist, allows more or less steam or hot water to pass through the heating element. These manual controls are excellent since they are sturdy and almost foolproof.

Another method permits the occupant to open or close shutters on the convector unit, thus reducing the flow of air over the heating elements, and controlling the temperature of the room. This method is not so satisfactory as the water or steam valve since it does not reduce the heat distributed by radiation. In addition, the devices used to manipulate the shutters are not quite so durable as a valve.

As with instructional rooms, air conditioning is becoming more prevalent in dormitories. Increasingly, colleges with either a large summer school enrollment or a 12-month program are air conditioning their dormitories. This trend involves increased maintenance and operating costs which must be reflected in higher room rates, but is proving to be an attraction for students who are interested in thermal comfort.

Lighting of Dormitory Rooms

Lighting for dormitory rooms has generally followed patterns established for home design. Ceiling-mounted lighting fixtures are gradually disappearing from designs of new dormitories in favor of desk and floor lamps. Some colleges prefer to have students provide their own lamps to help reduce the capital outlay and maintenance involved in college-owned lamps. This procedure is debatable since the college then has no control over the quality or the safety of the lamps used by students. Lamps with frayed wires can be a serious safety hazard in a dormitory, for example.

To overcome hazards, a college either should supply all lamps or regularly inspect all student-owned lamps. In each dormitory room, at least one electric wall outlet should be controlled by a switch located at the entrance door, so that students entering at night will be able to turn on a light without stumbling over furniture.

Selecting and specifying proper lamps to be purchased for dormitory rooms is important. The bases, columns, and shades of lamps should be of heavy and durable material.

A satisfactory lamp is one which is sturdily constructed and provides well-distributed light to the ceiling and on a working surface. The base and column are fabricated from heavy-gauge steel and painted with a baked enamel finish which resists chipping and scratching. Lamps also can be fabricated from stainless steel or with a brushed chrome finish, but this type of finish has a cold appearance.

A typical lamp shade is drum-shaped and can be made of a fiberglass material which permits some light to pass through but does not create a glare problem. The drum shape directs roughly half the light upward to light the ceiling and create a balanced lighting condition in the room. The base contains a heavy cast iron weight to prevent tipping, and a heavy-duty socket is provided to handle safely the largest wattage available in standard bulbs.

Switches should be one-way only. Three-way switches wear out quickly, and students are not prone to buy three-way bulbs because of their high cost.

For best lighting balance in a room, the type of desk lamp which reflects all of its light downward and thus creates excessive light on the working surface and very little light for the rest of the room should be avoided. Such a lamp causes a brightness contrast greater than it should be for the most comfortable seeing conditions.

When built-in furniture is specified, it is desirable to include built-in fluorescent desk lamps. These can be designed to provide a comfortable light for study and will result in economical, relatively maintenance-free operation. Additional lighting can be provided by a suitable floor lamp or a ceiling fixture.

Bath and Toilet Facilities

Two principal types of bath and toilet rooms are found in dormitories. One is the gang facility located off the corridor and serving from 25 to 50 residents. The other is the small individual bathroom usually situated in a suite of rooms and serving from four to eight students. The cost of installing a central gang bathroom normally is less than the individual type because utilities can be concentrated instead of being distributed throughout the building. However, students are notoriously rough in their treatment of gang facilities, so that maintenance costs usually are high.

On the other hand, when students are given a smaller bathroom which they can look upon as their own, they take better care of it and maintenance costs drop. Also, students in a suite usually are responsible for the daily cleaning of their bathroom, with a maid cleaning only weekly. This procedure cuts labor costs, since central bath facilities must be cleaned at least once daily by the cleaning staff. While the use of suite bathrooms has increased in recent years, the idea is not new. A recent visit to a small, private women's college revealed a design of this type in a dormitory which was obviously at least 40 or 50 years old.

When suite bathrooms are used, it is suggested that the bathroom contain adequate storage space for all of the cosmetics and toilet lotions required by students. Either large medicine cabinets should be installed over the lavatories or storage space for each student should be provided in a base cabinet under the sinks. Towel racks also are a necessity. If central bathroom facilities are provided, such storage needs must of necessity be met in the sleeping rooms.

Ventilation of suite bathrooms is a most important consideration. Two types of ventilating systems are commonly used. One is a centralized system with ductwork connected to one or more central fans located on the roof. The other is a system where each bathroom has its own fan located in the exterior wall or tied into an exhaust duct which runs to the roof. The central system may cost more initially but is recommended from a maintenance standpoint since there are fewer motors and electrical connections to cause trouble. Oiling the motors once or twice a year should be all that is required in the way of maintenance.

In central bath facilities, the ventilation systems are not a serious maintenance problem. The number of rooms involved is not great and the system is relatively simple. The bathrooms normally are stacked on top of each other, thus reducing the ductwork and the number of fans.

"Hey, Charlie, skip the isometrics. We're late for our interior design class."

Wardrobes

Storage space for student clothing and incidentals is a vital part of all sleeping room accommodations. Wardrobes should be designed with great care to assure proper functioning and a minimum of maintenance. Generally, there are two basic types of wardrobes — the portable wardrobe manufactured by furniture suppliers, and the fixed wardrobe built on the job. Each type has its own advantages, but both have the same problem to overcome — the design and installation of maintenance-free doors.

Several types of doors are in use — sliding wood doors, hinged doors, and folding fabric or wood slat doors. Some colleges leave the wardrobes without doors or provide only a pull curtain for the opening. This arrangement is unsightly and is not recommended except for instances where a maximum of economy is required regardless of appearance. If folding fabric or wood slat doors are used, they should be durable enough to take the heavy wear received in dormitories.

Sliding wood doors are satisfactory, provided that they are heavy and warp-proof. Maintenance problems can be overwhelming, however. Such a door, if not heavy and warp-proof, can constantly jump its track and catch on students' clothing.

Another important consideration is to make the wardrobes sufficiently deep to permit the doors to slide freely without catching or rubbing against clothing. A minimum depth of 24 inches, exclusive of the area devoted to the sliding doors, is recommended. The tracks for sliding doors should be heavy-duty and should have quiet, free-moving rollers. Bottom tracks are not recommended because they become dust catchers and make cleaning out the bottom of the wardrobe difficult.

The sturdiest maintenance-free door is the swinging door. Except for the hinges and latch, there is nothing which can cause trouble. However, unless these doors are wide enough to cover the entire opening of the wardrobe, which is usually not the case, it is difficult to reach articles stored at the ends. The bi-fold door helps to remedy this problem.

Chests, Desks, and Chairs

Every student needs his own chest or dresser of a size adequate to store enough personal clothing for living away from home. Drawers should be deep enough to store comfortably such items as bulky knit sweaters. By the same token, drawers must not be so deep as to cause fumbling and digging to retrieve clothing stored at the bottom. A depth of 5 to 6 inches is considered appropriate.

To conserve space. chests should be high and narrow. A chest approximately 42 inches high and 30 inches wide provides either five or six drawers of adequate size. To keep students from removing drawers and replacing them in the wrong opening, which causes drawers to fit improperly, it is suggested that each drawer be equipped with a device which makes it impossible to remove.

If a chest is constructed of wood, all corner posts should be made of densified lumber. A plastic laminated top is definitely recommended even when the chest is wood. Many colleges have switched to units which are entirely laminated plastic on all exposed surfaces and have found them to be most desirable with one exception. Exposed edges which are self-edged with laminated plastic are subject to chipping. To prevent this, a matching vinyl T-molding can be used on all exposed edges. These moldings must be carefully fitted to reduce the temptation to pick them loose.

All drawers should have dove-tailed corners, front and rear, and be of the best hardwood available. Drawer bottoms should be securely fastened with nails and glue blocks.

The construction of student study desks is comparable to that of the chests. Each desk should have at least one shallow pencil drawer, one file drawer, one or two box drawers, and a pull-out typewriter shelf. Some desks have a built-in bookcase on one end. If this shelving is not included, some separate means of storing books must be provided.

Built-in chests and desks are used in dormitories for a variety of reasons. From a maintenance standpoint they are most advantageous. However, they do restrict the furniture arrangement and decor of the room.

Many colleges prefer to purchase steel chests and desks. These units can be selected with laminated plastic tops and even with plastic side panels and drawer fronts. Steel units lend themselves readily to various color schemes and, in some cases, are less expensive. In selecting steel furniture, school officials should make sure that the metal used is of a suitable thickness and that drawer mechanisms are strongly constructed to insure a quiet, effortless, and foolproof operation.

Each student also needs a desk chair, with or without arms. This chair should blend well with the chest, desk, and wardrobe. It must be large enough to be comfortable and yet small enough to fit easily into the kneespace of the desk without necessary bumping against corners. Otherwise, both the desk and chair will soon have a battle-scarred look. The corners of wooden seats can be provided with rubber bumpers to minimize the damage to both the desk and the chair.

Unless the bed is suitable for lounging, at least one upholstered lounge chair should be supplied for each double room. This chair must be selected and designed for strength and durability. Under no circumstances should an upholstered arm be used. All arms should be either wood or steel with a wood or plastic surface attached.

There are two schools of thought as to whether lounge chairs should be designed with removable seats and backs or with permanently attached upholstery coverings. Removable seats and backs are easier to replace when damaged, but, being easily removed, they are also subject to more abuse. If a chair with permanent upholstery is used, it is vitally important to specify one with a seat and back independent of each other and which is designed for simple replacement of the covering material by a semi-skilled maintenance person.

The covering material should be either a supported vinyl plastic or a washable nylon fabric with a close, tight weave.

Communications Systems

When designing a new dormitory, a most important item to consider is the communications system to be installed. Unless the communications system is thought out carefully, those responsible for administering the dormitory and the students who live there will be saddled with endless problems. In some colleges, a private telephone is installed in each dormitory room. Usually this phone is connected to the college system so a student can make a call on campus or in the local dialing area without the services of an operator, going through the college switchboard only for long distance calls. Such a system relieves the dormitory supervisor of all responsibility for handling telephone calls or messages to students.

Another popular system is to have a two-way communications system between the dormitory office and each student room. Incoming telephone calls are received at a small switchboard in the office. The student is called on an intercom and told to pick up the house telephone located in the hall near his room. If the student is not in, a message can be taken and a switch thrown to activate a light in his room which serves to advise him that a message is waiting for him at the office. When this system is used, a public telephone must be provided at appropriate points for outgoing calls.

A similar system, but less expensive, requires the office supervisor to take all telephone calls and notify students by pushing a button which rings a bell in the room. The student in turn pushes a button to advise the office that he has heard the bell and will go to the telephone in the hall to take the message. If he is not in, a light stays on to advise him, when he returns, to contact the office for his message.

The important consideration in selecting the proper system for a particular situation is the amount of personnel time required to make the system function satisfactorily. The least expensive system may be the most expensive to maintain in the long run if too many people must be hired to keep it functioning.

Special Areas

All dormitories require special purpose areas besides the regular student sleeping rooms. Such areas usually are an office, apartments for supervisors, study rooms, laundry rooms, recreation rooms, lounges, and public toilet facilities. A word of caution seems advisable concerning the design of these spaces. A recreation room, for example, is a space which normally receives heavy wear and tear. All finishes in a recreation room should, therefore, be durable and maintenance-free. Floors should be covered with materials which can be wet mopped when necessary and still look good without constant buffing and waxing. The extra cost of terrazzo or vinyl tile floors could easily be justified in reduced maintenance cost for such an area. It is also advisable to install some type of durable and washable wall covering in a recreation room.

Lounges, on the other hand, tend to receive kinder treatment. Finishes, therefore, can be decorative and less durable. Carpeting for a lounge floor is strongly recommended to create an atmosphere conducive to orderly behavior. Furniture arrangements also remain in place better when carpeting is used. This saves a lot of time for the custodial personnel who must rearrange the furniture each day as they clean the room.

Wall finishes in a lounge should be different from any other area in the dormitory. Painted walls either should be plastered or have concrete blocks arranged in some special way for design effect. Use of stacked block is common. Other finishes, such as exposed brick and wood paneling, will give the room a feeling of warmth not possible to attain with painted walls.

Office areas should be laid out to function efficiently. Sufficient glass should be provided between the office and the lobby to enable the supervisor to oversee the coming and going of students and visitors without leaving his or her desk. Student mail boxes should be situated so they can be loaded from inside the office while mail is picked up by students from the lobby or corridor. The telephone and intercommunication system should also be located conveniently to the supervisor's normal working station.

The number, size, and type of supervisors' apartments in a dormitory vary from one college to another, and no definite pattern has been established. An important consideration is to have at least one apartment or sleeping room adjoining the office so that someone always can be on hand for emergencies as well as for routine supervisory duties.

Wherever possible, each supervisor's apartment should have its own private entrance, as well as an entrance from inside the dormitory. Finishes of walls, floors, and ceilings in the apartments should approximate those in a normal home or apartment to achieve a home-like atmosphere.

All special areas should be thermostatically controlled to achieve satisfactory temperature conditions. Lounges and recreation rooms should be thoroughly ventilated to keep them comfortable and to exhaust the inevitable smoke.

Summary

The dormitory may be the only home a student has for the biggest part of his college life. It is, therefore, incumbent upon dormitory planners to make this home away from home as pleasant and comfortable as possible within reasonable financial means. Furthermore, there is just as much need for a set of educational specifications for a dormitory as there is for a classroom or laboratory building.

Planners should give due consideration to the needs of students and maintenance staff and develop educational specifications which tell the architect what facilities are required and how they will be operated. Without these functional specifications, the architect will be unable to create a design to suit particular needs and problems.

18. Conclusion

People are the planners, designers, builders, and users of educational buildings. When people fail in their responsibilities to help create good educational facilities, the facilities, in turn, fail the people they were meant to serve.

The Council of Educational Facility Planners has presented, in these pages of *"What Went Wrong?,"* area-by-area discussions of the components of new educational buildings and the troubles that can occur once a building is in use. This guide has not attempted to pinpoint every danger point nor to detail every possible pitfall. However, it has emphasized throughout the responsibility of the educational facility planner to learn as much as he can about the buildings he controls and to recognize that he cannot carry out his plant planning activities wearing "blinders" of preconceived notions about structure, mechanical, or finish details, or hampered by a lack of information.

"What Went Wrong?" includes information that an educational facility planner needs; he has only to avail himself of its help. Since it is written for the layman, it is purposefully not technical. Its goal is to strengthen the bonds of communication among all the persons who deal with educational buildings, thus opening up avenues of information exchange hitherto too often blocked.

"What Went Wrong?" was designed to help lead the way toward successful buildings. Its chapters have been easily identified by title and scope, and each chapter has given an in-depth treatment of the particular areas being discussed, showing how to avoid future maintenance and operation trouble. This guide can be read in part or in whole, with help for specific phases of facilities planning, or for overall, comprehensive treatment.

The Council will feel that this book has been successful when its pages help to change such questions as "What went wrong?" into positive statements that say "Everything is as right as possible."

Good planning ahead!

Appendix A
Technologically-Oriented Organizations

This appendix lists the names and addresses of technologically-oriented organizations, most of which are mentioned in the text of *"What Went Wrong?"*

Acoustical Materials Association
335 East 45th Street, New York, New York 10017

American Carpet Institute, Inc.
350 Fifth Avenue, New York, New York 10001

American Concrete Institute
P.O. Box 4754, Redford Station, Detroit, Michigan 48219

American Institute of Architects (AIA)
1735 New York Avenue N.W., Washington, D.C. 20006

American Insurance Association
85 John Street, New York, New York 10038

American Society for Testing and Materials (ASTM)
1916 Race Street, Philadelphia, Pennsylvania 19103

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
345 East 47th Street, New York, New York 10017

American Society of Mechanical Engineers, The (ASME)
United Engineering Center
345 East 47th Street, New York, New York 10017

American Wood Preservers Institute
2600 Virginia Avenue N.W., Washington, D.C. 20037

Architectural Aluminum Manufacturers Association
35 East Wacker Drive, Chicago, Illinois 60601

Asphalt and Vinyl Asbestos Tile Institute
101 Park Avenue, New York, New York 10017

California Bureau of School Planning
State Department of Education
Sacramento, California 95814

Certified Ballast Manufacturers Association (CBM)
2120 Keith Building, Cleveland, Ohio 44115

Facing Tile Institute
333 North Michigan Avenue, Chicago, Illinois 60601

Hardwood Dimension Manufacturers Association, Inc.
3813 Hillsboro Road, Nashville, Tennessee 37215

Illuminating Engineering Society (IES)
345 East 47th Street, New York, New York 10017

National Board of Fire Underwriters Code
American Insurance Association
85 John Street, New York, New York 10038

National Fire Protection Association
60 Batterymarch Street
Boston, Massachusetts 02110

National Sanitation Foundation (NSF)
P.O. Box 1468, Ann Arbor, Michigan 48106

National Woodwork Manufacturers Association, Inc.
400 Madison Avenue, Chicago, Illinois 60606

Portland Cement Association
33 West Grand Avenue, Chicago, Illinois 60601

Steel Door Institute
Keith Building, Cleveland, Ohio 44115

Steel Window Institute
Keith Building, Cleveland, Ohio 44115

Structural Clay Products Institute
1750 Old Meadow Road, McLean, Virginia 22101

Tile Council of America, Inc.
800 Second Avenue, New York, New York 10017

Underwriters Laboratories, Inc. (UL)
207 East Ohio Street, Chicago, Illinois 60611

Appendix B
Selected Additional Sources

This appendix lists a number of organizations and publications that may be helpful as additional sources of information and assistance to educational facility planners. The list is by no means complete; further, the non-periodical publications cited usually are only a sampling of those available from their publishing organizations.

Except for the Council, the organizations and periodicals are listed alphabetically.

1. Council of Educational Facility Planners
   29 West Woodruff Avenue, Columbus, Ohio 43210

   Available publications include:

   CEFP Abstract Journal, Numbers 1-8, Abstract Service Series. Paperbound. 1968. $4.00. The Journal is published jointly by the Council and the University of Houston, Houston, Texas. It includes material abstracted from pertinent literature in the educational facilities planning field.

   Educational Facilities in Urban Settings. 64 pages, paperbound. 1968. $2.50. Major presentations made at the Council's 44th annual meeting in 1967.

   NCSC Guide for Planning School Plants. 156 pages, hard cover. 1964. $7.50. Covers spatial, economic, and other factors.

   Planning Facilities for Higher Education. 104 pages, paperbound. 1960. $1.50.

   Selected References for Planning Higher Education Facilities. 95 pages, paperbound. 1968. $2.50.

   Schools—Planned for the Community. 168 pages, paperbound. 1967. $2.50. Presentations made at the Council's 43rd annual meeting in 1966.

   Publications expected to appear late in 1968 or early in 1969 include:

   A Guide to Planning for Community Junior College Facilities

   A Guide to Planning for Secondary Level Vocational-Technical Educational Facilities

   (These two illustrated *Guides* are part of the reports in the Publications for Effective Planning [PEP] project funded by the Bureau of Research of the U.S. Office of Education.)

Facility Technology–Catalyst for Learning. Paperbound. 1969. Major presentations made at the Council's 45th annual meeting October 7-10, 1968, in Washington, D.C.

Secondary School Plant Planning Guide

Survey of State Practices of School Construction Final Report. Undertaken for the U.S. Department of the Army, the survey includes information about school construction practices in all 50 states, Guam, and Puerto Rico.

A CEFP-AIA publication on educational specifications, title to be determined.

2. American Association of Junior Colleges (AAJC)
   1315 Sixteenth Street, N.W., Washington, D.C. 20036
   Publishes *Junior College Journal* (10 issues per year).

3. American Association of School Administrators (AASA)
   1201 Sixteenth Street N.W., Washington, D.C. 20036
   Publications include *Schools for America.* 175 pages, illustrated. 1967. $7.00. Produced by the AASA Commission on School Buildings.

4. *American School and University*
   757 Third Avenue, New York, New York 10017
   Published monthly.

5. *American School Board Journal*
   400 North Broadway, Milwaukee, Wisconsin 53201
   Published monthly.

6. Association for Supervision and Curriculum Development (ASCD)
   1201 Sixteenth Street N.W., Washington, D.C. 20036
   Publishes many publications.

7. Association of School Business Officials of the United States and Canada (ASBO)
   2424 West Lawrence Avenue, Chicago, Illinois 60625

8. *College and University Business*
   1050 Merchandise Mart, Chicago, Illinois 60654
   Published monthly.

9. *College Management*
   22 West Putnam Avenue, Greenwich, Connecticut 06830
   Published monthly.

10. Department of Audio-Visual Instruction (DAVI)
National Education Association of the United States
1201 Sixteenth Street N.W., Washington, D.C. 20036
Publishes *Audiovisual Instruction* 10 times a year and *AV Communication Review* quarterly.

11. Educational Facilities Laboratories, Inc. (EFL)
477 Madison Avenue, New York, New York 10022

12. Educational Resources Information Center (ERIC)
Division of Information Technology and Dissemination, Bureau of Research,
U.S. Office of Education, Department of Health, Education, and Welfare, Washington, D.C. 20202
Publishes *Research In Education* quarterly; it includes information received from research projects funded by the U.S. Office of Education as well as other reports collected by the 18 clearinghouses that comprise the national ERIC network.

13. *Educational Technology*
P.O. Box 508, Saddle Brook, New Jersey 07662
Published semi-monthly.

14. *Nation's Schools*
1050 Merchandise Mart, Chicago, Illinois 60654
Published monthly.

15. National Education Association of the United States (NEA)
1201 Sixteenth Street N.W., Washington, D.C. 20036
Publications include the *NEA Journal*, which appears nine times yearly.

16. *School Management*
22 West Putnam Avenue, Greenwich, Connecticut 06830
Published monthly.

17. *School Progress*
481 University Avenue, Toronto 2, Ontario, Canada
Published monthly.

18. *Theory Into Practice*
    College of Education, The Ohio State University
    249 Arps Hall, 1945 North High Street, Columbus, Ohio 43210
    Published five times a year.

19. United States Office of Education, Department of Health, Education, and Welfare
    Washington, D.C. 20202
    Publishes many publications, including:

    College and University Facilities Survey, Parts 1-5.

    National Inventory of School Facilities and Personnel.

    School Plant Management Series (e.g., *School Building Maintenance Procedures,* 1964; *Extended Use of School Facilities,* 1967).

    All can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

20. The University Council for Educational Administration (UCEA)
    Center for the Advanced Study of Educational Administration
    University of Oregon, Eugene, Oregon 97403
    Publishes *Educational Administration Abstracts* three times a year.

"You'd think a little more light could have been shed on this subject!"

(Up a blind alley, page 123)

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