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ABSTRACT

This publication is the result of a study authorized by the Washington State Legislature to identify and isolate factors that contribute to higher costs of building. The committee charged with this study combined existing research and information on the subject with its own suggestions. It developed recommendations to assist the school administrator, the architect, the legislator, and others to effect economies in school construction, thus promoting a more economical utilization of capital funds. (Author)

a study on economies in school construction

prepared at the request of the
1969 washington state legislature

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foreword

In the interest of combating rising construction costs, the Washington State Legislature, by resolution on April 10, 1969, authorized a study to be coordinated by the State Superintendent of Public Instruction to identify and isolate factors which contribute to higher building costs.

Consequently, a committee composed of architects, contractors, teachers, school administrators, structural, mechanical and electrical engineers and representatives of the State Legislature and the State Superintendent was established to conduct a critical examination and investigation into those elements which influence the costs of constructing school plant facilities.

This publication is the result of that study. The committee has combined existing research and information on the subject with its own suggestions to develop recommendations that should assist the school administrator, the architect, the legislator and others to effect economies in school construction, and thus promote a more economical utilization of capital funds.

Therefore, it is my hope that this document will prove useful to those responsible in the area of school plant construction, and that future school buildings constructed will reflect both quality and economy.

Louis Bruno
State Superintendent
of Public Instruction
1971

acknowledgments

The Office of the Superintendent of Public Instruction wishes to thank those individuals (listed this page) who contributed their time, knowledge, and energy to this committee.

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Finally, the Office of the Superintendent of Public Instruction would like to express its appreciation to Highline and Bellevue School Districts for the use of their administrative facilities and the many courtesies extended by their secretarial staffs.

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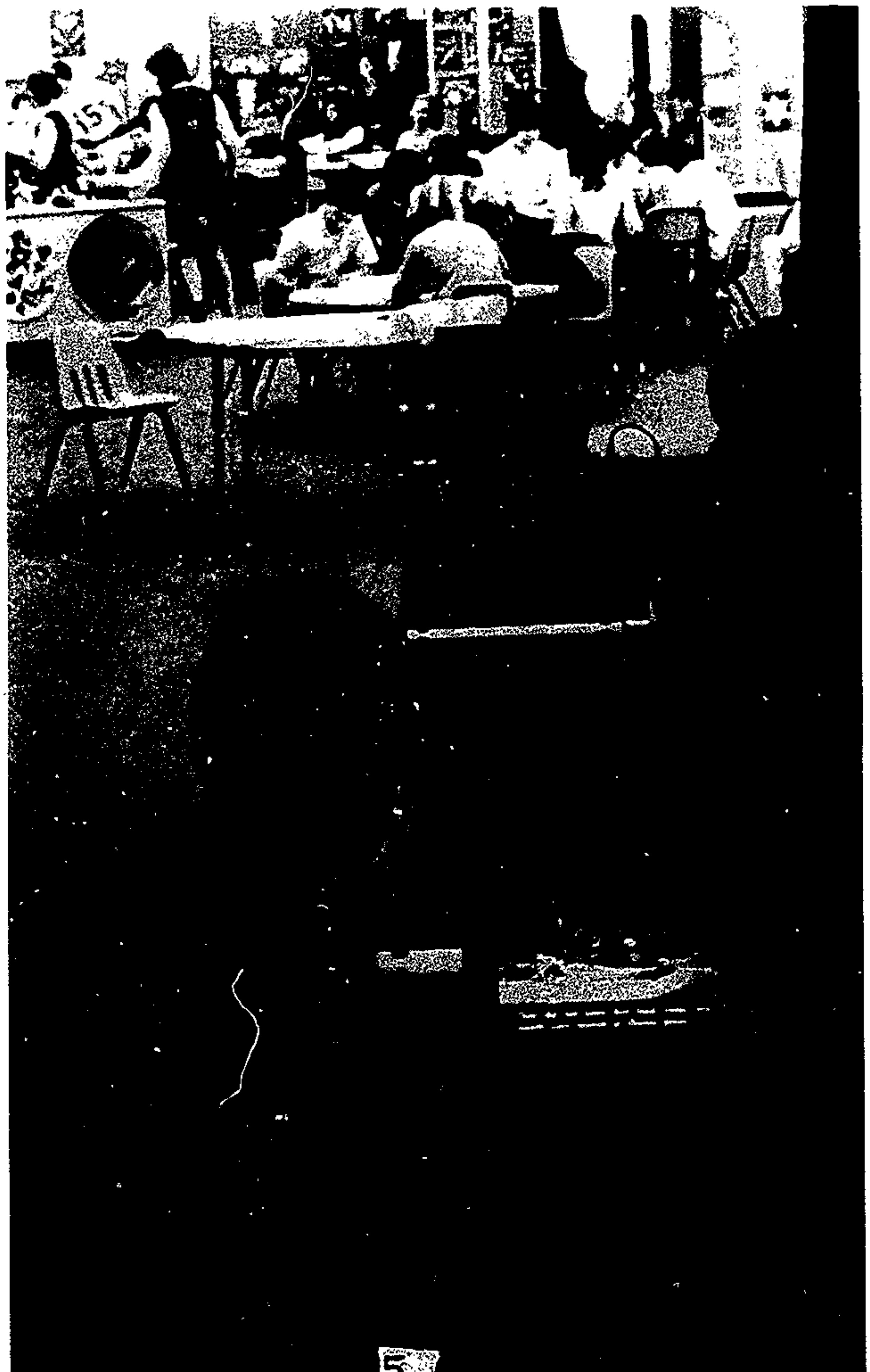

recommendations to school administrators concerning

architects, consulting engineers, and contractors

educational requirements

school sites

financing

maintenance

cost estimates

architects, consulting engineers and contractors

selection

Select an architect who is known by contractors, school administrators, and maintenance engineers to be extremely competent in planning economical schools. Ascertain how successful the architect has been in deleting unnecessary costs.

The consulting engineers should undergo the same scrutiny as the architect.

Great effort should be made in their selection. A New York State Department of Education study reported that a competent design team can save as much as 5 percent of the total cost of the building.

architect's contract

The architect's contract should be clear and definite regarding services to be rendered and fees to be paid.

definition

The specific responsibilities of the school administration and the architect must be made clear at the outset. A great amount of time and money can be saved by knowing who is responsible for final decisions.

The scope, budget and program objectives for the job must be carefully developed and candidly defined for the architect and consulting engineers.

adequate time

The architect and consulting engineers must be given adequate time for programming, planning, preparing contract documents and securing necessary approvals by state and local regulatory agencies. Hasty preparation frequently results in costly errors.

payment of contractor

Compliance with statutory and regulatory procedures is necessary to assure prompt payment of contractors. A school administrator's reputation in this matter should be considered as contractors may not bid on subsequent schools and the school district will suffer from the costs of reduced competition.

educational requirements

educational specification committee

A committee composed of the principal, teachers, educational facility planner, district program director. building coordinator, students, patrons, and architect should be formed to develop educational requirements. By bringing their various backgrounds, attitudes and data together in discussion and debate, facility requirements would be more thoroughly evaluated. This would hopefully reduce the chances of programming unused space and equipment.

educational facility planner

Consider the possibilities of employing an educational facility planner. He is a specialist in improving the educational efficiency of the school facilities.

cooperative planning

Reduce duplication of facilities by coordinating school planning with civic planning. City parks can be developed in conjunction with school playgrounds, city recreation centers with gymnasiums, etc.

Consider interdistrict cooperation of facilities planning, construction and usage.

accuracy

Determine accurately the quality and quantity of equipment and space needed for each specific purpose so as to avoid overbuying or obtaining equipment not suited to the purpose.

Consider the use of computer technology for development of requirements. Benefit/cost analyses and pre-performance testing (simulation) may provide a more accurate method of resolving space and equipment priorities.

school sites

acquisition

In regions with high land appreciation, sites should be acquired well in advance of actual building need.

Acquisition of future sites should be coordinated with overall community development—projected residential areas, population trends, transportation links, utilities and recreation areas. This coordination will protect the district against overbuying and/or buying sites which will, in the future, dictate excessive transportation and utility costs.

land types

Consider the cost advantages of undeveloped land. Once land has been subdivided by a developer, cost will increase.

In highly dense urban areas, the use of air-rights above highways, railroad tracks and other urban elements should be considered in selecting school sites.

consultants

Valuable assistance in cost predictions can be obtained from architects, soil analysts, landscape architects and engineers.

Regional and urban planners would provide help in projecting population trends, future residential areas, transportation links, utilities and recreation areas.

site development costs

Investigate surface and subsoil conditions as they may increase foundation and drainage costs.

Review site topography as it may require costly site preparation.

The amount of natural vegetation should be considered as landscaping and planting increases costs.

The cost of providing the necessary utilities, access roads, and walkways should be estimated.

Examine building restrictions imposed by the deed as they may restrict an economical building solution.

financing

financial plan

Development of a debt service schedule and organized plan for current and future capital expenditures should be carefully considered. An accurate, complete financial plan will usually result in higher bond ratings, which in turn, result in lower interest rates.

consultants

Consider the cost advantages in retaining reputable consultants, bond dealers, investment bankers and bond attorneys. Their awareness of essential marketing and legal data will help secure the best buyers at the lowest interest rates. Plus, by securing these buyers, the district's bond rating will be improved, which will give the district better interest rates in the future.

advertise

Consider developing a financial prospectus to let the investment field know about the background of your school district. Documented data concerning community, social and economic factors, school and civic government fiscal data, and probable future growth will help to convince the potential buyer that your community is a safe place to invest.

bond ratings

Bond ratings by nationally recognized firms such as Standard and Poor's, Incorporated, and Moody's Investors Service, Incorporated, should be considered, as rated bonds will usually secure a more favorable interest rate than nonrated bonds. Moody's will rate bonds free of charge for issuers if the outstanding debt is over $600,000 and the district provides the required information with respect to community economic conditions, credit history, debt pattern and other necessary financial determinants.

maintenance

education

Educate teachers each year on the proper adjustment and use of classroom-controlled heating systems. Also, advise them where to report maintenance needs when breakdowns occur.

Whenever mechanical and electrical equipment is used which is not familiar to the maintenance crew, necessary training for efficient maintenance and operation should be provided. Normally, the supplier of the equipment will provide this service.

recommendations to architects concerning

general planning

materials and equipment

construction

maintenance and operation

general planning

educational requirements

Prior to the planning and design phase, obtain from the district or client, concise and clearly expressed educational requirements. If these requirements are made clear at the outset, consequent changes, misunderstandings and costly delays will be reduced.

orientation of buildings

Consider orienting the buildings on the site so that the sun, prevailing winds and other natural factors may be used to supplement heating, cooling, ventilating and lighting requirements. Proper orientation will also reduce maintenance due to prevailing weather on unprotected facades.

building compactness

Design the school facility to obtain a maximum usable floor area with a minimum cubage. Minimize ceiling heights and exterior perimeter wall length.

heating plant location

By locating the heating plant in the center of the area it serves, duct and pipe sizes and length of runs can be reduced.

expandibility

Determine with school administration the extent of expandibility required.

If building additions seem imminent, the initial site layout should be planned to provide areas for economical expansion.

Location and layout of future heating, plumbing and electrical system by sizing main elements to take later additions should be considered. Stub-outs should be provided for future connections.

Develop the building floor plan to accept additions without relocating existing doors, windows, hallways, classrooms, etc.

Consider a structural system that will allow expansion without replacing or remodeling the existing structure.

general planning
continued

flexibility

Determine with the school administration the exact extent of flexibility required.

Consider the savings in future remodeling costs either by initially roughing in pipes, ducts and conduit, for future equipment or providing easily accessible mechanical and electrical space so that these elements could be added later.

Flexibility in the interior arrangement of space is most economically achieved by providing non-load-bearing partitions and locating electrical wiring, water pipes and heating ducts in the building's permanent elements—exterior walls, columns, floors and ceilings.

multi-use of spaces

Consider reduction of school size through greater utilization of space. For example, corridors can be designed to function both as corridors and educational areas.

acoustics

Carefully consider the amount and placement of acoustical materials. Costly repetition of acoustical materials would be reduced by consolidation and/or isolation of noisy areas.

plumbing concentration

By locating similar plumbing fixtures back to back or by stacking them vertically, duplication of waste, water and vent pipes would be reduced.

materials and equipment

multi-use of materials

Consider using single materials that serve more than one purpose. For example, there are roof decks that are structural, acoustical, insulating and which form the finished ceiling.

overdesign of systems

The minimum code requirements for mechanical ventilation and the number of plumbing fixtures should be observed except where special conditions require additional equipment.

Avoid overdesign of the heating plant to meet a rarely occurring minimum outside temperature.

Avoid extravagant control centers that provide data the operator cannot use.

Avoid lighting systems that provide higher light intensities than the code or school district requires.

Avoid overstructuring of foundations, columns, bearing walls, and roof and floor systems. Overdesign of foundations might be avoided by retaining a soils analyst. His analysis of the exact bearing capacity of the soil would provide greater design accuracy which, in turn, would reduce the need for overdesign.

painting and finish work

Omit painting and finish work in storage areas, boiler rooms and custodial spaces.

quantity purchase

Repetition of units such as structural columns and beams, roof deck panels, windows and doors would allow quantity purchase with resulting savings.

Consider the advantages and disadvantages of providing a heating oil storage space large enough to permit buying at lower prices in full tank-truck quantities.

plumbing connections

Reduce the number of plumbing connections by using gang showers, multifaucet trough-type lavatories and trough-type urinals.

materials and equipment
continued

gutters and leaders

Consider the elimination of gutters and leaders on sloping roofs where eaves extend beyond the building walls. This should be analyzed in conjunction with the overall storm sewage requirements of the site.

stock products

Standard or stock shapes and sizes of doors, windows, millwork, trim, and structural, mechanical, and electrical systems cost less than custom-made products.

wasteful cutting

Wasteful cutting can be avoided by using standard widths, lengths and thicknesses of materials.

overlapping of materials

Where fire regulations will allow, avoid unnecessary overlapping of materials such as plastering and painting behind chalkboards and tackboards.

availability of materials

Consider using local materials and locally manufactured equipment. In many instances, because of savings in transportation charges, costs will be less.

construction

repetitive connections

Consider using repetitive connection details between materials. A procedure for joining materials that can be repeatedly used allows the workmen to become familiar with the task and consequently perform it more rapidly.

modular coordination

Because of the decreased time spent in measuring, cutting and fitting of modular units, modular coordination should be employed whenever possible.

tools and methods

Erection time can usually be reduced by using such methods as the tilt-up slab and lift slab methods and tools such as the power nailer.

Consider specifying tools and methods that are familiar to local labor and tools that are available locally. If specially skilled labor and tools must be imported, construction costs will usually increase.

prefabrication

Replace the infinite number of small, different pieces of material with larger prefabricated units. Labor costs in a factory are usually less than in the field.

scheduling

Arrange schedules to permit as much of the job as possible to be under cover so that construction may continue during the winter, when manpower is most plentiful.

As the project increases in size and complexity, more precise time/task scheduling should be used as this will usually reduce construction delays. Two examples of scheduling methods are the C.P.M. (Critical Path Method) and P.E.R.T. (Program Evaluation Review Technique).

The length of time allowed for construction should be realistic. When the contractor must make special arrangements to reduce construction time, there is usually an increase in cost.

subcontractors

Reduce the number of trades required for construction. The more subcontractors involved, the more persons there are who must make a profit.

construction
continued

bidding procedures

Carefully select a time for the advertisement of bids that will assure maximum competitiveness on the part of the bidders. Normally, winter, early spring and late fall are best.

Advertise for a sufficient time to enable contractors to obtain dependable bids from subcontractors and suppliers. Bidding time should be governed by the size and complexity of the project rather than the date of the next school board meeting.

Avoid conflicts with other major projects for the same bid date.

Provide a "prebid" conference for bidders for clarification of contract documents.

Specify notification by bidders of errors, ambiguities, and worthwhile savings in the contract documents. Allow sufficient bidding time to make such bidder assistance possible.

bid contingencies

Provide clear and complete drawings and specifications as they aid the contractor in making accurate cost estimates and assure the contractor that he need not include a large contingency figure to his bid for protection against unforeseen costs.

Of particular interest to the contractor in his bidding calculations is the explanation of the lines of responsibility among the three prime contractors and payment conditions. If these are not spelled out in detail, contingencies will be added to cover potential delays.

Change orders, addenda and alternates must be kept to a minimum. If the contractor senses an indecisive and uncertain client or architect, he will add a contingency figure to his bids to cover subsequent risks.

proprietary specifications

Minimize the use of proprietary specifications. The possible advantages of interchangeability of parts and identical appearance of systems in building additions are not likely to outweigh the extra costs resulting from loss of competition.

performance specifications

Use caution in adopting performance specifications written by manufacturers. They may eliminate meaningful competition among suppliers.

maintenance and operation

equipment access

Provide easy access to mechanical and electrical equipment for repair and adjustment. Consider exposed, painted conduit, piping and duct work or hung "tee-bar" ceilings, which allow easy access through lay-in panels. An additional advantage to painting conduit and piping is that it can be color coded to provide more rapid identification for service.

special products

Specify materials and equipment that do not require special tools, parts, and/or personnel to maintain efficient operation.

cleanability and durability

Specify durable, washable products with a minimum number of corners, joints and irregularities in their surface.

consistency

Develop a consistency between the "life spans" of permanent building elements and replaceable building elements. For example, if the structural system's prooable life span is thirty years, there would be no need to specify a wall covering that would last one hundred years.

economic balance

Develop an economical balance between initial product cost and its future maintenance and operation cost. For example, fluorescent fixtures cost more initially than incandescent fixtures but are less costly to operate and maintain.

isolation for repair

Water, steam, and gas valves should be installed in mechanical systems so that parts can be isolated for repair without shutting down the entire system.

consultants

During initial planning, take advantage of the school plant manager and chief custodian's knowledge of maintenance and operation costs.

water consumption

Install timed valves on lavatories and showers to reduce water consumption.

maintenance and operation
continued

fuel consumption

Develop benefit/cost studies on the most economical heat energy source and building orientation.

Consider zone heating so that independent units or segments of the building such as the auditorium, offices and gym may be used without heating the entire building.

Suitable thermal insulation and a minimum exterior surface area will reduce heat loss.

Consider using two small boilers rather than one large boiler for steam or hot water plants. A boiler with one-half the total capacity to heat the building will accommodate the load during most of the year; the second boiler wou!-' he needed only during the coldest weather or when .'here is a breakdown in the first boiler. The cost of duplicate power plants versus a special control on single units should be carefully analyzed.

vandalism

Exposed aggregate or impervious wall surfaces will help prevent defacing of materials.

Use of acrylic or plexiglass windows and/or placement of windows on interior courts will help reduce breakage.

Adequate exterior lighting tends to discourage vandalism.

grading and landscaping

Grading and landscaping should be developed to facilitate lawn mowing and snow removal.

Hard surface walkways, playgrounds and parking areas cost more initially but greatly reduce school ground maintenance costs.

insurance

Consult with the Washington Survey and Rating Bureau, Seattle, during the early stages of design to determine the possible insurance cost advantages inherent in different types of construction.

recommendations to legislators concerning

state building code

re-use of school plans

sales tax

school site

"systems" approach to school construction state building code

recommendations

1. **Support the development and le.islative adoption of a statewide building code.**

2. **Appointment of a broadly representative code committee (including representation from the State Office of Public Instruction) to recommend necessary updating of code.**

3. **Updating of code biennially, or as necessary.**

supporting data

The degree of influence of design and construction codes on school construction is a matter of concern to all parties connected with the industry. The building industry is interested in simplification of current code requirements as a factor in reducing construction costs. The governmental policing agencies are interested in health, safety and public welfare aspects of code problems. The state and local school officials and their design agents are interested in achieving a reasonable cost to benefit ratio with respect to code requirements, in addition to uniformity and a rationalization of code standards and their enforcement.

In a survey conducted by the committee, covering $33,650,000 of school construction, three major factors were apparent:

1 Direct building costs for only interpretive code requirements ran 1.82 percent of the sample. For example, on a $2 million project this would involve an additional expenditure of $36,400. These costs tend to be accumulative and intermingled with periodic code revisions. These costs can be viewed as minimum periodic increases on an arithmetic basis. The cost-benefit ratio can be argued from many subjective points of view.
2 Of all design consultant's time, 3.1 percent was spent, over and above a normal allocation on other types of projects, for school code involvement. All of this time represents principal's or project manager's design time at key decision points in project design development. This factor is crippling to both school districts and their agents.
3 The total costs, due to building requirements and direct delay costs, was a minimum of 1.908 percent.

The long-range solution will require uniformity of standards and enforcement throughout the state with a system of cost-benefit evaluation. This is a problem involving at least state level direction of local levels of government, if not direct state level involvement.

re-use of school plans

recommendations

Legislation requiring the use of stock plans should be discouraged.

School districts should continue to be encouraged to re-use plans when programs, site conditions, capacity and other factors indicate the feasibility of their use.

supporting data

During many sessions of the legislature, during most school building conferences and during many planning sessions for new school plants, a question that is invariably raised is whether the design and use of stock plans will result in savings in construction costs. The American Association of School Administrators recently outlined the conditions under which stock plans will work. "If the educational program never changed; if the culture were static and scientists had ceased groping into the unknown; if inventors had gone on a long holiday and discoveries and innovations were at a standstill; if population mobility had ceased and the birth rate had become a constant factor; if community life always remained the same; if towns and cities were all alike; if there were no differences in school sites; if no new jobs were being created; if no new educational needs were emerging and if the specific purposes of the school were rigidly defined; if the researchers had concluded that all of the answers of teaching and learning had been found; if there were no more content to be added to the curriculum; if the producers of instructional materials and equipment had ceased to experiment and had settled down to producing a standard product; if people were entirely content with present accomplishments; if the dynamic forces of society had all been securely grounded and had ceased to function, then school building planning would be a simple matter. Stock plans and standard classrooms would be the answer to the school district's needs for building space. But such is not the case, nor is it likely to be."

The North Carolina Association of County Commissioners recently made a detailed analysis of stock plans and concluded "... that (1) the savings on architectural fees are much smaller than expected because of the necessary cost of modifying plans for use at a particular site and because of the necessity for architectural or engineering inspection of construction; (2) the use of stock plans at particular sites may increase construction costs over plans developed specifically for the site; (3) there is no proof that total costs of stock buildings are lower than total costs of individually designed buildings; (4) standardized buildings may have some educational disadvantages; and (5) only one state, in the last five years, has developed a full range of stock plans and these have not been used enough, as yet, to justify the cost of preparation."[1]

Much evidence has been compiled to show that architectural costs savings are nonexistent in stock plans. The State of New York[2] found that the cost to design a minimum number of stock plans, sufficient to meet the needs of a multiplicity of school buildings in that state cost over $800,000 in architectural and engineering fees. The first plant built from a set of these plans cost an additional 5% of the cost of the plan to design it below the floor line and to set it on the site, to redesign the plans to house the desired program, to make use of materials made available since the original plan was drawn and to meet the community needs of the district. This cost was exclusive of supervision of construction which is normally provided by the architect and his engineers at a cost of from 1½% to 2% of the bid.

Much evidence has also been compiled to show that savings in construction costs are nonexistent. The supporters of stock plans maintain that the use or re-use of a stock plan lowers the total cost through better bidding, easier construction and lower construction expenses. If structural faults develop, whose responsibility is it? Is it the responsibility of the architects and engineers who drew the stock plan or is it the responsibility of the architect and engineer who designed the footings and other supports below the floor line? If the contractor is to submit a reasonable bid, he must know where the responsibility rests.

An additional construction cost that must be considered in using a stock plan is that of orienting the building on the site. No two sites are alike; therefore even stock plans require architectural design below the floor level in every case. The direction a building faces will determine heating and insulation needs, window glare, lighting and other requirements. The stock plan must be redesigned for climatic differences, utilities, underground writing, sewers and drain fields. A school building designed for the rains of western Washington must be different from the low temperatures and heavy snows of eastern

[1] Guthrie, Paul N., Jr. "Can Stock Plans Reduce School Construction Costs?" North Carolina Association of County Commissioners, p. 1.

[2] Letter from New York State Department of Education on file in the Office of State Superintendent of Public Instruction.

re-use of school plans
continued

Washington. A building designed for seismic zone number one in Anatone would not be safe for children in Seattle where zone number three requirements must be met.

School facilities are built for boys and girls—one of the vehicles for their education. Too often, when we try to stereotype schools we neglect to consider their educational suitability as the "stock plan" takes shape. A school should be designed to house an educational program. Unless we want to insist on "stock" programs in all schools, stock facilities should not be tolerated if we want public school programs flexible and dynamic enough to meet the needs of our changing times.

The North Carolina Association of County Commissioners, in its report on stock plans further reported ". . . Aside from the obvious difficulties in construction and site adaption, a further problem with the use of stock plans is their lack of education suitability. Educationally, stock plans present a problem in that in their initial design they require a firm and uniform decision as to what type of building should be constructed. With the rapidly growing school population, there have come many new ideas as to the proper alignment of grades and classes. In proposing a stock plan concept there must be a decision on how many grades and class divisions will be allowed. Also, individual school needs as to size, type of facility, type of heating plants, and utilities must be determined. For instance, in some areas shop will have a major emphasis, while in other areas agricultural courses may be in more demand. One school may be science and college preparatory oriented, others may be business and technically directed.

"With these many variables, it is difficult to determine on a uniform basis what type of facility should be built so as to provide the educational program best suited to the local community. And when uniform decisions are made, they immediately cause great concern among local people who fear that the stock school planners want to eliminate the liberty of local school districts to determine what to build in their own schools. Further, it is argued, by necessity a standard plan is a compromise, and therefore, it freezes in all structures a minimum achievement that does not fit the facility either to the students or to the curriculum.

"To many people, school planning is educational development in action and the design stage incorporates educational development into a final testing center. This school of thought maintains that it is necessary to build each school independently so that new innovations may be incorporated into new plans. They feel that the independent method of design and construction achieves the maximum return in the educational planning process.

"Again, as in other instances, analysis of the pros and cons is difficult. The position that current planning is more likely to follow current practices is well taken. And the cost of constantly revising stock plans so that they are current would probably be fairly high.

"Building a small, simple stock house on an average lot requires only a few adjustments to please a single family and the site. To build a school on a convenient location may require many more carefully prepared plan changes, not only to please a community, but also to satisfy the educational requirements of a rapidly changing profession."

sales tax

recommendations

School districts should be exempt from the state sales tax (4½%) as well as any county or city sales tax on any contract for new school construction or modernization.

supporting data

Approximately $150,000,000 in school construction funds will be expended during the current biennium ending June 30, 1971. Of this sum at least 4½% (disregarding any local sales tax), or $6,750,000 reverts to the state general funds from imposition of the sales tax. Since state matching funds to school districts—averaging 50 percent—are involved, the collection of the state sales tax represents partly an indirect transfer from our state fund, the common school construction account, to another, the state general fund.

If the sales tax were not charged, housing for about 2,700 additional pupils could be provided with the funds returned to the state in the sales tax.

school sites

recommendations

Introduce legislation which will provide a revolving fund from which funds may be borrowed by school districts for the purchase of future school sites. The school districts shall reimburse the state for the advance of funds within eight years; otherwise, the sites shall be sold by the state and all funds received, except local funds advanced, shall revert to the revolving fund.

supporting data

The school site is more than a building location. It is an integral part of the education plan and one of the basic tools in the educational process. A portion of the school's planned educational experiences and the community's functions may be enhanced or curtailed by the degree of adequacy contained in the school site. School site location, selection, acquisition, development and utilization is an educational and technical problem requiring a synergetic approach to its solution.

Today, there are still all-too-frequent reports of instances where inadequate forecasting of needs and preliminary investigation of suitable sites has resulted in the location, acquisition and development of unsuitable parcels of land at inflated prices.

Where are the potential economies in school site selection? It is fairly obvious to those districts experiencing rapid growth (8 percent or more per annum) that this "wait and see" planning has resulted in early obsolescence of educational facilities, in increased costs to taxpayers and in serious curtailment of the educational programs.

School sites should be acquired well in advance of need. Each district whose forecasted growth is deemed to be above normal expectations should be selecting and acquiring sites at least ten years in advance of need for in ten years site cost may double or triple as a result of land appreciation. This is especially true in the 10 to 25 mile radius of expanding metropolitan areas.

Plans for site acquisition should be made concurrently with perceived changes in economical, sociological, cultural, ecological and environmental conditions affecting educational programs.

School organization has strong implications for appropriate site location and acquisition programs.

Changing educational programs designed to meet changing societal and environmental needs should be reflected in the statement of educational requirements for new schools and/or major additions and renovations. Physical site analyses and preliminary site development plans and alternatives should also be made concurrently with educational programming. The school architect, landscape architect and related local and state planning agencies concerned with environmental health, land use and zoning, utilities connections and transportation should be involved concurrently with the educational programming to ensure a viable site acquisition program.

Long-range planning should be an obligation of the district with strong support from the state for ensuring the potential economy realizable from planning for and acquiring sites in advance of need. Unpredictable shifts in the economy and the resultant shifts in population can generally be compensated for by appropriate trade-offs of appreciated land. This cost/benefit approach can only result in aggregate savings to both the district and the state.

Past experience, in general, has been less than satisfactory with respect to planning our environment. In some situations things have been disturbing, as John Ormsbee Simonds observed in the early 1960's, ". . . our basic urban, suburban, and rural pattern is ill-conceived, disjointed, and askew. Our highway patterns bear little logical relationship to one another and to our topographical, climatological, physiological, and ecological patterns. We have grown, and often continue to grow, piecemeal, haphazardly, without logic. We are dissatisfied! We are puzzled. We are frustrated. Somewhere in the planning process we have failed."

This can be said of the period we are now entering. But a new optimism has begun to manifest itself. It has been a deeply held concern. Now it is an openly expressed one. A program of action has begun. A new awareness, a new dedication to educate and train more professionals in the environmental arts and design—men who can and will work closely and in direct communication with the synergetic group of educators, architects, planners, landscape architects, ecological—and the related humanists and scientists in the planning and provision of needed community facilities. Educational facilities comprise the largest segment of such facilities in our society. The school site must provide for a whole host of services and equipment to support the teaching-learning process and, hopefully, within easy access of the users.

In general, the school site should promote health and safety and the functions of teaching and learning. Educational adequacy of the site should be in keeping with the best traditions of economic feasibility. A properly located and utilized school should be an attractive place, enhanced by its natural and man-made setting, arranged to accommodate an optimal flow of pedestrian and vehicular traffic. The educational and community purposes to be achieved should influence to a great extent the size, shape, and location of land areas to be acquired and developed for educational facilities.

One of the greatest potential economies to be realized in any school district's site location, acquisition and development program, though somewhat intangible in the past, is becoming more tangible each day, and can be found in a paraphrase of the late President John F. Kennedy's inaugural address: "Ask not what you can do with your school's environment, but what the environment of the school can mean to you—and the generations which follow."

"systems" approach to school construction

recommendations

Introduce legislation which will fund a study of construction systems (as outlined in section five of the supporting data) to report to the 1973 Washington Legislature.

Authorize the Office of the State Superintendent of Public Instruction to make this study.

supporting data

section one—definitions and differences

Two terms, "Building Systems" and "Systems Building," have come into wide use in the last few years. Two quite different concepts are involved which are often, unfortunately, used interchangeably. The first, "building systems," refers to a physical entity, that of a number of building elements that can be put together to form buildings. The second, "systems building," or the "systems approach," refers to a broad methodology of decision making. The term "systems" has been so widely used of late as to make its meaning and value somewhat problematical. For this reason, other synonyms will be used for the most part. A few comments are in order concerning each of these.

Building Systems Usually a collection of components and subassemblies which can be put together to form various kinds of buildings. A good building system should permit many possible designs and many plans and alternatives. In England, where school building systems are quite successful, the usual terminology is a "kit of parts" which describes the situation best. As best used in England, a "building system" contains several elements, one of which is the physical "kit of parts." Equally important, or perhaps even more important, are the policy, management, procurement, and development functions that have been evolved to properly use the kit of parts.

Systems Building By this it is usually meant the systems approach tn decision making in the building industry. This does not imply any kinds of physical collection of parts, components, pieces, or subassemblies. This simply means the organized approach to the total process of building, the best possible coordination, the use, where applicable, of mechanization and technology, including computers wherever possible in organized and logical process for making decisions. Examples are the well-known PERT (Program Evaluation Review Technique) or CPM (Critical Path Method) computer methods for construction scheduling, etc.

In aircraft and aerospace, systems analysis has been used with major success. In fact, CPM and PERT were originated there. Its proper application is usually expensive to begin with and generally requires skills not found in the building industry. Every large building contractor and architect today will sincerely assure you that he is using the systems approach to building right now.

In other technologies, such as the aircraft industry and the communications industry, the "systems approach" is actually being applied. But these fields have certain advantages and certain implications which are not yet operative in the building industry. Each of these requires that the total performance of the system be measurable numerically, that there be a single measure for the total performance or well-being of the system. It implies that there are unique choices to be made and that there are unique decisions independent of the people who make them. This would apply, for instance, that for a given design problem of a school and five architects, that all five architects would come up with the same solution.

section two—building systems approach

The best historical examples of the use of building systems are seen in England. In the next section, some recent examples in the United States and Canada will be given. Approximately 40% of all schools now being built in England are built by one of the systems groups or consortium groups. The essential elements of the "building systems" approach are contained in: Building System, Policy, Management, Procurement, and Research and Development.

Building System Common to each of the consortium groups are certain management procedures which have helped in producing an orderly approach to school construction. One of them is a "handbook" which defines several construction types, and which defines standard components and some standard details. There are no standard designs of schools. Each handbook defines

"systems" approach to school construction
continued

either conventional, traditional construction with a limited range of applications and details or it defines standard components and construction elements and illustrates their use in a limited number of cases.

Most, but not all, of the consortia have established a building system (kit of parts) which incorporates components and still allows each architect to design each school individually for the local needs of the locality and the program developed by the local school board.

Policy is determined by the school board, or governing body of several school boards acting together for their joint benefit, called a "consortium." These consortium groups are often made up of representatives from each participating school board, often planners or chief architects. This group decides on the scope of the system, its technical development, the range of application, etc. The consortium policy group usually contains architects acting in an executive or "predesign" capacity who develop broad concepts of what the building system should accomplish, and they also evaluate its success and progress. Much of this is documented in the British literature.

Management of the use of the building system is conducted by a committee or delegated officials of the consortium who run its day-to-day business. Their legal powers would probably be defined by legislation.

Procurement or bulk buying is one of the main items of business of the consortium. Invitations for bidding are published by the consortium to purchase all of the components of a given type for all schools to be built during a program of one or more years. For example, a single bid covers all structural steel skeletons (or roof deck, or windows) for, say, 240 school buildings to be built over a period of two years.

Obviously, this gives the consortium and its member school boards an excellent leverage in obtaining quantity prices. The bid conditions require a fixed unit price on components in the system or handbook for a period of two years with only minimal escalation provisions. This gives the school board a true minimization of risk. At the time a preliminary design is done, the actual price of that part of the school is fixed. Rates and dates of delivery are determined by the consortium, not the manufacturer.

The attraction to the manufacturer is the minimization of risk due to volume production and continuity of manufacture. He is then able to plan his purchases of material and equipment over a longer period of time.

It is now estimated in England that within ten years, 60-75% of all schools will be built by one of the consortium groups using a building systems approach.

Research and Development Several of the consortium groups impose a levy of ¼ to ½% of gross construction volume to all users to support a research and development program. This group covers the areas of computer usage, design methods, handbooks, evaluation of past programs, performance specifications, and development of new products. Although the cost is quite low by American standards and these departments are quite small (one to six people), they have been quite successful. They maintain a constant policy of upgrading quality, keeping abreast of development in related fields, and developing a new or improved system every five years or so.

section three—building systems approach: u.s.a. and canada

In the U.S.A. and Canada, several projects have used all or part of the building systems approach, and considerable success and advances have been achieved through it.

SCSD (School Construction Systems Development) In 1966-67, fifteen schools in California were built for approximately $25 million, all using common building components. These components were:

- The structural system and roof,
- The ceiling system which integrated lighting, heating distribution and electrical distribution,
- Demountable partitions,
- Cabinet work,
- Storage lockers.

In this system, the outside wall of the building was not part of the building system.

The bidding procedure outlined the performance requirements of each of the components, but did not specify the design of the individual parts or the materials. Each manufacturer responded with a proposed design and, if found acceptable, was then asked to submit a price for supplying his component for all fifteen school buildings. The architects then were instructed to use this kit of parts and design individual buildings for the individual needs of each school district and its building program.

Other programs listed below briefly describe other developments in the United States and Canada. Each of these follows the same procedure, using some variations.

SSP (Schoolhouse Systems Project) In Florida, the SSP has adapted the performance specifi-

"systems" approach to school construction
continued

cations developed in California by the SCSD program. Unlike California, Florida has gone on to make repeated program purchases of the same components designed to the same or slightly modified performance specifications. They have, therefore, provided continuity of design, construction, and manufacture which should produce a stability of prices which is unknown in the typical school construction program where each school is designed, bid, and built separately, using different construction methods and materials.

SEF (Study of Educational Facilities) This Toronto program is presently the most comprehensive approach to school building undertaken in the Western Hemisphere. It includes a structural system, the exterior envelope, atmospheric system, light-ceiling system, partition system, roofing system, carpeting, casework, seating, and office furniture. The first contracts for components only involve $36 million and will provide elements for thirty-one schools and one office building.

One set of contracts is negotiated with systems contractors for the manufacture and installation of individual components. A second series of contracts are essentially with general contractors for site work and coordination of all trades.

A second program of approximately the same size is being considered to follow this.

The first program resulted in economies of approximately 8% on the total cost, which is phenomenal for a new system in its first application. All components are being manufactured and supplied by Canadian firms, and a separate private group has been formed to supply essentially the same components to other school construction programs outside of Toronto. A second group is being formed to supply the same components for construction of schools in the United States.

A first prototype is now being finished. Component and subassembly manufacturers are now building and testing mock-ups and prototypes to insure compliance with the performance specifications for the rest of the program.

The Montreal Catholic School Commission is developing a system and components which will be used on twenty schools worth over $38 million. There is a second potential of an additional seventy-five schools in the Montreal region during the next ten years. System components include structural, ceiling-lighting, heating-ventilating, air conditioning, interior partitions, and electrical-electronic distribution. The exterior envelope is not included in this system. As in previous systems, a performance specification was prepared. In complying with local fire codes, a four-hour column protection rating was required. Basic structure consists of a precast concrete portal frame which supports precast slabs similar to the conventional double tee slabs used in the United States. HVAC distribution systems, and ceiling systems are similar in nature to SCSD.

URBS (University Residential Building Systems) This system was developed for the State of California for dormitory construction and was to have 4,500 dormitory units in the first phase. First bids accepted showed prices comparable and slightly below conventional construction with demountable walls, air conditioning, sound proofing prices fixed for two years at a time. It involved the use of performance specifications which described the function of each part of the building but did not give specific designs, nor did it specify materials. Manufacturers developed products to meet these requirements. Each building is to be designed by an individual architect selected by the individual campuses and will be designed to the requirements of that campus and its building program. The first building is now under construction in San Diego.

ABS (Academic Building Systems) The states of California and Indiana combined their requirements here to develop a building components system which could be applied to academic buildings in either state. The program is in the state of development now and bids have not yet been taken. The original program is about $300 million.

GHS (Greater High School System) This Pittsburgh program originally called for the design of one gigantic high school for the whole city which would be an answer to the integration problem. Because of this approach, one architect was chosen to develop a design program with the city; a second architect was chosen to design the physical building and its system. Because of its size and particular requirements, a different approach was taken and the architect originated the system in collaboration with various manufacturers.

Since the original scheme, the program has been changed to three schools, each one still a giant in its own right. Construction is supposed to begin on the first of these in the near future.

This system uses poured in place reinforced concrete for the main structure and uses a number of prefabricated components and subassemblies in conjunction with the structure. Particular attention has been given to the speed and economy of relocatable partition walls.

section four—comments

The experience in England, the United States, and Canada appears to be that standardized components and subsystems supplied on a standardized pricing basis provide a workable alternative to the stock plan approach. It allows enough freedom for each architect to design individual buildings for the building programs generated for the individual schools. Bulk buying and standardization allow economical advantages by guaranteeing fixed prices to the buyer, minimizing the number of components to be produced and thus guaranteeing the producers continuity of production, volume, and standardization so that they can effect economies on mass production. These systems have demonstrated over the last fifteen years that a very wide range of building can be designed and built through the use of building systems.

Contrary to normal views of innovation, the greatest innovation is required of the school board, not the architect. We have come to think of the architect as the "creative" element, as the innovator, because of the easily recognizable change in appearance from one building to another.

The major requirement is that the school board and the state change their standard methods of practice to allow new methods of operation. These have been described on preceding pages under organization, policy, management, and procurement.

section five—recommendations

It is recommended that the Legislature authorize a full study into the economies and opportunities for the use of building systems, bulk buying, and related legislation (if any is required) to enable school districts to utilize a building systems approach together with related procedures. It should be conducted by people with background and experience in this field. Subjects touched on should include:

1 Consortium organization and operation, including authorizations, management, and policies.
2 Standardized space allocation studies.
3 Standardized construction cost analysis and reporting methods.
4 Performance specifications.
5 Unified format for the summation of design program requirements,
6 Standardized components

and their combination into feasible building systems.

7 Implementation of the English "quantity surveyor" technique.
8 Standard pricing and production policies.
9 Bulk buying procedures and policies.
10 Design studies to show the possible range of building types that can be created with a "kit of parts" building system containing a limited number of parts.
11 Generate a suggested program of action to implement a school building system, together with schedules and budgets.

Additional information on building systems can be found in the periodical, *School Management* (August and September issues, 1969), and "A Report on Building Systems with Recommendations for a Washington Schoolhouse Project" prepared by Dr. Wesley Apker. Reprints of the study in *School Management* can be obtained by writing to: *School Management* CCM Professional Magazines, Inc., 23 Leroy Ave., Darien, Conn. 06820, ask for catalog No. 80891. Copies of Dr. Apker's report are available from the Office of Superintendent of Public Instruction, Facilities and Organization Section, P.O. Box 527, Olympia, Wn. 98501.

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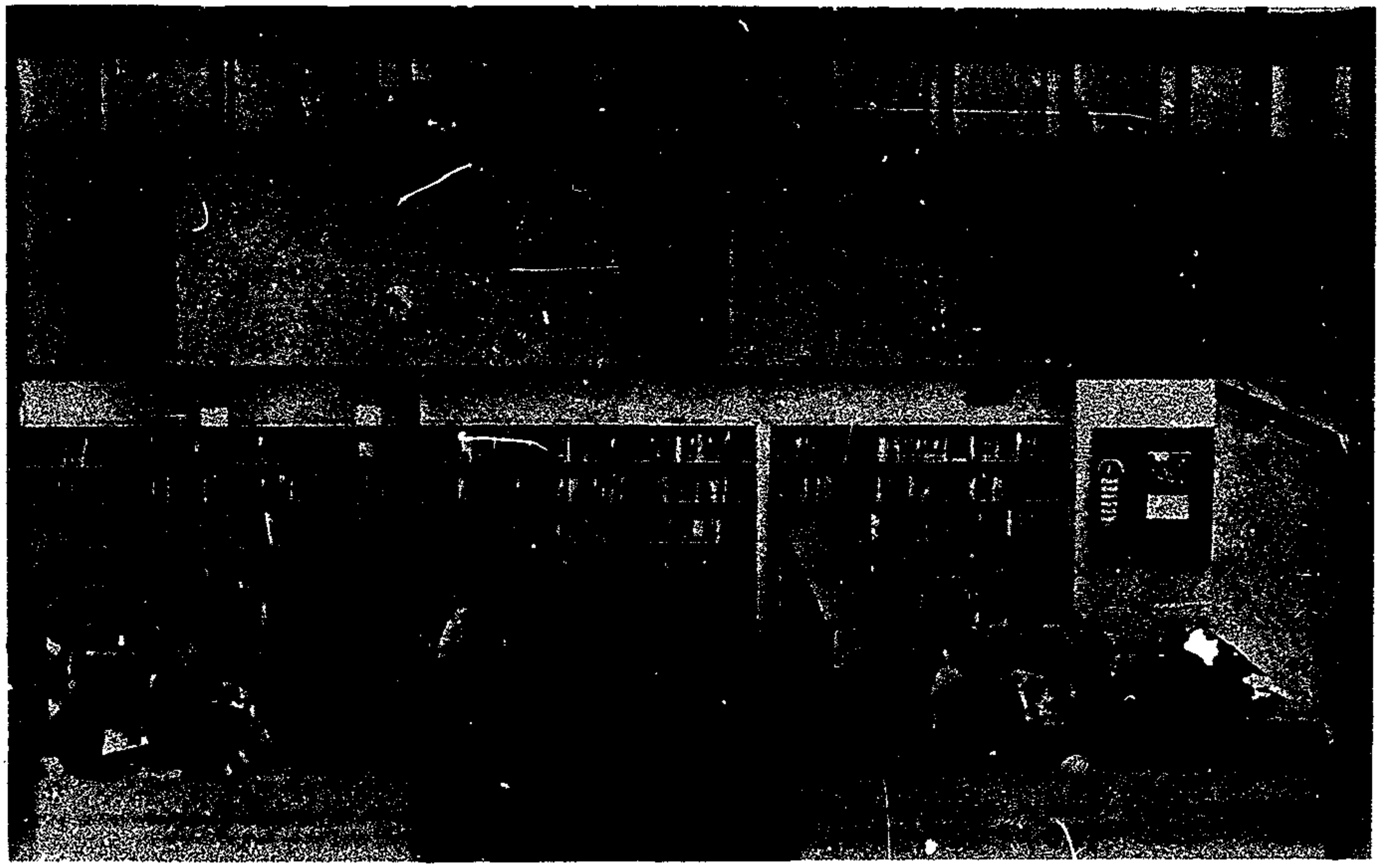

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