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SCSD, a structurally coordinated school building components system, is a highly automated method of building new schools that creatively meet the needs of the ever changing educational environment through functional and flexible planning. Examples of why SCSD high schools are efficient, flexible, and spatially planned, are cited. Environmental requirements are given for--(1) heating/ventilation, (2) air conditioning, (3) lighting/ceiling, (4) storage and equipment, and (5) partitions. Photographs and diagrams demonstrate the interaction of the subsystem components. The evaluation concludes that society needs both higher quality and larger quantities of school buildings to meet the complex learning facility requirements of the present and future. (TG)

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SCSD: the Project and the Schools

a report from Educational Facilities Laboratories

Educational Facilities Laboratories

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*Resigned October 1966

School Districts Participating in Project

ABC Unified School District
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architects: Kistner, Wright & Wright

East Side Union High School District
Frank Fiscalini, *Superintendent*
architects: Allan M. Walter & Associates

Fullerton Union High School District
Leonard L. Murdy, *Superintendent*
architects: Wm. E. Blurock & Associates

Glendora Unified School District
Dr. J. M. Slezak, *Superintendent*
architects: Gogerty, Meston, Wilcox & Associates

Huntington Beach Union High School District
Dr. Max L. Forney, *Superintendent*
architects: Neptune & Thomas

La Puente Union High School District
Dr. Glen A. Wilson, *Superintendent*
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Placentia Unified School District
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architects: Daniel, Mann, Johnson & Mendenhall

Introduction

The School Construction Systems Development project (SCSD) is a practical test of a method of building better schools more rapidly and economically. In the project a group of California school districts built six schools and had five others in construction at the end of 1966, with two other projects scheduled to go to bid in 1967. Altogether the 11 schools built or under construction include about 1.4 million square feet of space and have an estimated cost of about $25 million.

The men most heavily burdened with responsibility for these schools, the school district superintendents, are enthusiastic. "The most creative approach to school building in 100 years," one has called the project. "When we look back on the problems we had to work out," said another, "we wonder if we would have tried it if we had known about them. But when we look at the product, we know it was worth all the trouble." A third says, "We are getting flexibility in these schools that we never dreamed of."

Another superintendent proudly declares that his new high school "will be one of the most famous in America, with people coming from all over the country to see it." What is this project that has called forth such praise? Basically it is a means of using the efficiency of modern industrial mass production to construct schools, while still avoiding standardized plans or monotonous repetition of either rooms or general appearance. It is also a way of introducing specific educational requirements into the manufacturer's part in the building process at an earlier stage than usual. And it is a mutually challenging relationship between school people and the building industry producing new creative thinking on both sides.

The SCSD staff, as technical advisors to 13 school districts grouped together as the First California Commission on School Construction Systems, analyzed the building needs posed by new secondary school programs. They then asked manufacturers to develop new products to meet a new type of specification. The specifications emphasized the need for compatibility of the various building components—in short the "systems" approach. The manufacturers bid competitively to the Commission for multimillion-dollar contracts to supply and install their products.

The individual school districts employed their own architects for the design of their schools. These architects used the new SCSD components, which comprise about half the cost of these schools, in much the same manner as they use standard building components. Local general contractors bid on each school, with the component manufacturers becoming their subcontractors to deliver and install the SCSD components.

As had been planned, the new schools vary extensively even though all are built with identical systems of steel structural components, ceiling and lighting components, air-conditioning units, interior partitions, cabinets, and lockers. The architect is not limited in plan layout and has a number of choices within the component ranges. Exterior walls are not a part of the system, and materials are selected for them at the discretion of individual architects.

Although the SCSD components were designed for buildings of one and two stories, one of the new schools is to have a three-story building—a two-story SCSD steel-frame building atop a reinforced concrete first story. Project sizes range from less than 30,000 square feet to more than 200,000. Exteriors include brick, precast concrete panels, plaster, wood, concrete block, and glass.

Architects and engineers are accustomed to picking many of their building components from catalogues. What SCSD has done is to give them a catalogue of new, ingenious, and economical components, all of which are designed from the outset to fit together. Some have felt chafed by being limited to the SCSD catalogue—but it is doubtful that SCSD seriously increases the restrictions on them. For in all building, and especially in building schools, there are already substantial and unavoidable restrictions.

First of all is the restriction of cost, and here SCSD has increased the architect's freedom rather than limiting it. To take one example, before SCSD no architect, even if he had diligently searched the great general catalogue of building components called "Sweet's," could find demountable partitions, that a California school could afford, with the quality and flexibility provided by the SCSD systems. Moreover, the general savings of using the SCSD systems quite evidently free an architect to have greater choice of the other elements of his project.

Finally, the SCSD systems were carefully specified to be capable of meeting the actual needs of schools, so that their limitations lie very largely outside the educational requirements. Thus, an architect will find that with the SCSD systems he cannot build a pitched roof. But this is not significant for school programs. On the other hand SCSD requirements called for long spans and a high degree of flexibility that are required by educational programs.

Educators have welcomed the project because it has made a long stride toward making possible the new type of building they know they need—a changeable building for today's rapidly changing education. The systems approach has not only provided for variety in original design; it has brought the cost of movable and demountable partitions within the reach of many districts that could not previously afford them, along with long spans of column-free interior space, and rearrangeable air conditioning.

"It will allow me to experiment with team teaching without being committed to it for 40 years," said one educator. Another commented that his teachers can now undertake to mix large-group and small-group instruction just as they choose, and to change the mixture from year to year. "The possibility, for the first time, of doing that is leading us to reconsider our whole instructional program," he remarked. "There are many ways to encourage teachers to improve our schools, and this is one of them. A building open to change is opening the eyes of our teachers."

School trustees and the voters who put them into office are also finding the project attractive. It seems to many to be an affirmative answer to the constant appeal for thrift in school construction—sometimes naively expressed as a desire for standard plans. School trustees welcome the idea of mass-produced components as proof that their staff is working for maximum economy, and approve expenditures that they formerly blocked.

"I think my board members have shown that they care what happens to their taxes," said one superintendent. "They will spend the money when they are convinced that they are getting as much as possible for every dollar. We will not spend less on our school because of SCSD, but we'll get a much better school for the money. That's the sort of thing that puts over bond issues."

First of the project's schools to go into actual construction was Fountain Valley for the Huntington Beach Union High School District, a 3,000-student school which opened in the fall of 1966.

Fountain Valley offers, as it happens, an unusual opportunity to compare an SCSD school with one of conventional construction. Only three years earlier the same architects, Neptune and Thomas of Pasadena, completed another secondary school of the same size and almost identical plan for the same fast-growing Los Angeles suburb. It is called Marina High School.

The general plan, of one-story buildings grouped around a large central court which contains an outdoor amphitheater, was obviously not at all influenced by SCSD construction methods, since it was first developed for the earlier school. But the differences in execution—some inherent in SCSD and some not inherent—are sufficiently noteworthy for discussion in some detail.

First of all, Fountain Valley has the built-in flexibility that the SCSD systems provide. Most interior partitions are demountable, so that classroom sizes and arrangements can be inexpensively altered, and the lighting and air-conditioning systems can be readily rearranged to conform. Cabinets are also easily rearranged, and their shelves, drawers, and doors are interchangeable.

Operable partitions, of which SCSD offers both folding-panel and accordion types, are also demountable. Fountain Valley makes an unusual use of the panel type in a group of four drama classrooms, each of which has one corner on a hydraulic lift, which elevates a stage 10 feet square. By folding walls back, teachers can combine these rooms into a single one with a central stage 20 feet square, or make other combinations, since each lift and each partition is independent. This is not provided for in the earlier high school.

As another SCSD feature, the air-conditioning system includes a five-year maintenance contract valued at about $52,000. Generally, maintenance of SCSD components is expected to be lower in cost than for conventional schools.

Fountain Valley has brick exterior walls, both more handsome—the school is a notably good-looking one over-all—and with better maintenance characteristics than Marina's tilt-slab concrete walls. Durability is an important requirement for Huntington Beach schools, since they are near the ocean and they must withstand the corrosive effects of salt air.

Lighting levels have been increased considerably throughout the school. Other improvements include tinting the concrete of the central courtyard to reduce glare, a snack bar terrace seating 800 to 1,000 students, a paved and fenced service yard, increase in size of one of the two swimming pools and the auditorium stage, separate buildings for student lockers away from the classrooms, additional electrical outlets in every classroom, and lighting for four tennis and four basketball courts.

Nevertheless Fountain Valley is being built only slightly more expensively than Marina, which has the traditional fixed interior partitions, and average spans of only 30 feet compared with Fountain Valley's average span of 70 feet. Marina's cost was 6 per cent under the maximum permitted by the California state authorities for a school built with state aid, and Fountain Valley's is 2.3 per cent under the maximum.

The Huntington Beach district does not, in

Although SCSD was established late in 1961, its beginnings go back to 1954 when architect Ezra Ehrenkrantz went to England as a Fulbright Fellow to work at the Building Research Station in Hertfordshire County. There a system of prefabricated building components had been developed by the Hertfordshire County Schools as early as 1946 and was in successful use to meet England's tremendous postwar need for new schools. While English conditions differ from those in the United States, Ehrenkrantz thought that the approach had great possibilities for United States schools, too.

After his return to America, he communicated with the newly established Educational Facilities Laboratories, Inc., a nonprofit corporation established by the Ford Foundation, and wrote a report for EFL in 1958 about the British work. EFL was interested, but judged that the time was not ripe to proceed to a trial.

By 1961, however, widespread interest had developed in finding ways to cut the costs of the huge United States school construction program, which in California alone, at the annual rate of about 15,000 classrooms, cost nearly $300 million.

As usual, there were numerous suggestions that simple standard plans should be developed, and, as usual, both architects and educators were answering that standard plans had proven inadequate to meet the varied conditions and needs—both physical and educational—of the nation's school districts. Nor had they ever produced any demonstrable economies. "But," as one educator noted, "when you tell school boards that you oppose standard plans, they ask what you have to suggest as an alternative."

The Architectural Forum and Educational Facilities Laboratories sponsored a national conference on the problem in September of 1961. [In attendance were Charles D. Gibson, chief of the Bureau of School Planning, State Department of Education, Sacramento, California; Anthony Part, Deputy Secretary, Ministry of Education, United Kingdom; Warren Schmidt, Assistant Commissioner, New York State Education Department; Rufus Putnam, Superintendent of Schools, Minneapolis, Minnesota; William Peña, partner, Caudill, Rowlett, Scott, architects, Houston, Texas; Ezra Ehrenkrantz; J. Stanley Sharp, partner, Ketchum & Sharp, architects, New York City; John Hinchliffe, Director, Commercial Products, Northrop Corp.; W. W. Dedon, Project Engineer, Northrop Corp.; George E. Martin, Director, Marketing Research & Distribution, Kawneer Co.; Dr. Harold B. Gores, President, EFL; Jonathan King, Secretary-Treasurer, EFL; Douglas Haskell, Editor, *Architectural Forum;* and Walter McQuade, Senior Editor, *Architectural Forum.*] At that meeting Ezra Ehrenkrantz, Harold Gores, and Jonathan King suggested that mass-produced components could meet the demand for standardization, while still providing the broad variety of solutions on which the architects and educators were insisting. Charles Gibson gave the idea immediate backing. And Harold Gores and Jonathan King agreed that, if school districts could be found that would actually make use of it, EFL should support the idea's development.

King and Ehrenkrantz, who was now practicing in San Francisco, enlisted the help of Dr. James D. MacConnell, Director of Stanford University's School Planning Laboratory, EFL's Western Regional Center. Together they went to Frank Fiscalini, Superintendent of the East Side Union High School District in San Jose, California. Fiscalini, a vigorous and imaginative educator, was and is facing school building needs of the most difficult kind. His district is in one of the nation's fastest-growing population centers in the booming Santa Clara valley, yet it contains little of the valley's flourishing aerospace industry or other manufacturing, and therefore is poor in its tax base. To add to its financial difficulties, the district has a large share of San Jose's Mexican-American population which needs expensive special educational attention to deal with language handicaps and cultural adjustment.

East Side was planning three new high schools, but they would have to be built within the strict budget limits that are imposed when the state and not the local district is paying most of the cost. Fiscalini believes strongly that the school building is important to the quality of education.

"This offered us a chance for the first time to buy quality schools at state aid prices," he has said, "so that we can really compete with districts that aren't receiving state aid. The building is part of a surrounding atmosphere that affects the learning process. It ought to be one that the youngsters want to come to, and not one that they are repelled by."

Fiscalini and his board, after extensive discussions with Ehrenkrantz, King, and MacConnell, agreed that if a prefabricated component system could be developed, they would use it.

On that basis Educational Facilities Laboratories granted $50,000 to Stanford University in December, 1961, to enable the School Planning Laboratory to do a full-dress feasibility study. School Construction Systems Development was organized. Ezra Ehrenkrantz was appointed project architect; he departed for England to review the latest developments there and write a report on the British experience to clarify its meaning for the American scene.

For EFL, which went on to invest more than $600,000 in the program, the situation was exactly the sort of opportunity that foundations usually seek—one where there appears to be a good chance that a "seed" investment will put into motion a development that will gather its own strength and finally become not only self-supporting but self-expanding. There seems to be every likelihood that this will be the case with the SCSD program.

On his return, Ehrenkrantz began to explore the problems involved with manufacturers, state officials, building trades unions, contractors, architects, and others. Quickly he discovered that East Side's three schools would not provide a big enough market to interest manufacturers, and with the help of Gibson and MacConnell he sought out more school districts in whose building programs the project might be helpful.

In March, 1962, the project got its second staff member when Dr. James D. Laurits, formerly principal of the Cubberley Senior High School in Palo Alto, joined the staff as project coordinator. He began the fundamental work of studying the actual building needs of contemporary schools, using previous studies sponsored by EFL and others, in close consultation with the school districts as they joined the project. Later Laurits accepted an appointment as Assistant School Superintendent in Newton, Massachusetts, and John R. Boice of the School Planning Laboratory of Stanford University replaced him as project coordinator.

Meantime an advisory committee had been formed in which a group of distinguished architects—Prof. C. Theodore Larson of the University of Michigan, Charles Lawrence of Caudill, Rowlett, Scott; Walter A. Netsch, Jr., of the Chicago office of Skidmore, Owings and Merrill; John Lyon Reid of Reid and Tarics—and education professor Cyril G. Sargent, then of Harvard University and now with the City University of New York, joined Fiscalini, Gibson, King, and MacConnell to watch over the developing work.

By July the feasibility study was finished, and its report was favorable. Five school districts, with building programs coming to about $11 million, were ready to participate, and there seemed to be no insuperable obstacle to enlisting more in order to attain the market of at least $30 million required by the manufacturers to justify the research and development expenditure.

Educational Facilities Laboratories approved additional grant funds, and the project was under way, to be administered by the Stanford University School Planning Laboratory. A small staff was recruited; first, architects Christopher W. Arnold, Vernon C. Bryant Jr., and Bert E. Ray, and later, architect Visscher Boyd, consulting engineer Charles M. Herd, and architectural assistant Peter Kastl. Paul Hoyenga of the State Department of Finance became a consultant to help with problems of state budgeting standards.

The group set to work to complete the educational analysis of the schools and to translate these educational specifications into the sort of specifications from which manufacturers could design components and bid them. Large schools —chiefly high schools were involved—are among the more complex of educational buildings. Besides simple classrooms, they are likely to include provisions for large assemblies, administration, counseling, physical education, industrial shop work, dramatics, and numerous other special uses. In addition, American education is in a period of profound and rapid change.

At the turn of the century the traditional California classroom, the staff found, had been 20 feet by 20 feet, because this was a convenient span for wood frame construction. Gradually the long dimension had been pushed up to from 30 to 32 feet, as classrooms of 750 to 960 square feet became the norm, by the use of premium lumber, light steel, and reinforced concrete. But schools are now facing the need of even larger spaces, school administrators told SCSD. "Why shouldn't a good lecturer be able to meet a class of 150 students, instead of having to repeat his lecture four times?" one asked. Yet at the same time the administrators were saying that social studies may soon be carried on largely in small groups of 10 to 20 students.

Counseling, traditionally done individually, may also be done with larger groups in future, the educators said. We are teaching more languages, so the new language laboratory where students work with tape recorders must make provision for small groups as well as large ones. Student art projects today "may be large, heavy, and dirty," suggested one educator, and so there should be outside space with good drainage available to the art department—but it should be roofed, to protect the work in bad weather.

From these discussions, the staff were able to reach basic conclusions about the construction system. They decided that a 60-foot span, or more, rather than the traditional 30-foot one, would be most useful, that many interior partitions should be demountable, and similar fundamental points. At last the staff began designing a hypothetical model high school—"Hypo High," for short—which should contain what the educators were asking. This allowed the staff to estimate how much of each sort of component, for instance, a movable wall, might go into it.

This analysis, the participants now believe, is one of the great strengths of the project. "Educators were in from the beginning," says Superintendent Frank Fiscalini. "And so the components we are getting are designed on the basis of educational needs, and are not makeshifts that were originally designed for another type of building."

Out of the educational specifications study grew the specifications for bidders. And they, too, were unusual, for instead of specifying the component in the usual way by dimensions, materials, and other quantitative aspects, they merely specified the problem to be solved and left the solution itself to the manufacturer. This, as one manufacturer commented, was "a reversal of the process by which industry's customs and practices had grown over the centuries." It is, however, analogous to approaches developed by the military for the aerospace industries.

And now, discussing the development of these "performance specifications" with prospective bidders, the SCSD staff began to find what Ehrenkrantz recalls as "an exciting reaction."

"They began to trump our cards," he says. "For instance, bids on air-conditioning systems have customarily been on first cost only. But the air-conditioning manufacturers pointed out to us that this forces them to provide only minimum durability, since the cost of improving durability would make their bid too high. 'Why not include five years of maintenance in the original bid?' they asked. That's both a better and cheaper way to buy durability than paying for repairs after the first year.

"Studying this, we found that some districts have paid as much as 40 per cent of first cost in a year for their maintenance of air conditioning, and that 10 to 20 per cent is not unusual. Similarly, we noted that with lighting systems it isn't enough to consider how much you are paying in first cost to provide a certain amount and quality of light; you also need to consider how much power you will have to buy every year to deliver the light." Educators say that schools really can't afford cheap buildings, because over their long lives the cost of maintenance will bring the total cost of the cheap building to much more than that of a building of higher first cost.

As the analysis proceeded, the SCSD staff settled on a plan to ask bids on four initial subsystems, which the performance specifications would require to fit together. This meant that structural designers, ceiling and lighting manufacturers, the air-conditioning companies, and partition makers now had to work together to be sure their products could be used together—a simple idea, to be sure, but one that had been little tried before on projects the size of schools.

Exterior walls, it was decided, would not be included because the market SCSD was offering was not big enough to enable manufacturers to develop the variety needed. The SCSD staff analysis showed that at least 14 different exterior materials would be needed to satisfy the requirements of the project. Neither economy nor the desires of the superintendents and project architects would have been served by including exterior walls in the system.

One of the most important aspects of the performance specifications was that the structure, lighting-ceiling, and mechanical subsystems all had to be contained in a 36-inch space between the roof deck and the ceiling. This came to be known as the "service sandwich." Here wiring, lighting, TV conduits, air ducts, and plumbing were interlaced, rather than each being allowed a separate layer of space.

Most of all, to meet the changing needs of the schools, the new specifications emphasized the ability to change. The structural system was required to offer a variety of clear spans from 30 to 75 feet in the academic areas, on a basic five-foot planning grid or "module." Spans of 90 and 110 feet were to be provided for gyms. These have later been used for academic buildings as well. The structure in the academic spans was to be not more than 36" deep, the structure in gymnasium spans, not more than 60" deep.

Within these spaces the interior partitions were to be demountable so far as possible. Bids would also be received on operable walls of two types: accordion partitions, and rigid folding-panel sliding partitions. This gave architects maximum flexibility in providing for future changes in school needs and for unforeseeable developments in school program.

But there is not much use in being able to change partitions around if one cannot also change the lighting arrangements, as well as the air-conditioning system and its controls. So these were required to be equally adaptable. As finally designed, the air-conditioning outlets, with flexible ducts, may be moved to almost any line on the five-foot grid, and independent controls may be provided for up to eight spaces in each module of 3,600 square feet. Lights—of several varieties—are interchangeable with ceiling panels.

Later, to these four basic subsystems were added cabinets and laboratory tables specially designed to fit the modular dimensions. The cabinets were required to be interchangeable, so that drawers of various sizes can be swapped here for shelving there, and a door moved from one cabinet to another. Finally, lockers required to be designed to fit the objects normally stored in them and to operate quietly were also bid. Some educators said that the typical locker was designed to break books, not to store them.

Meantime numerous other problems were being worked out, such as the legal procedure for the combination of 13 school systems in seven different counties to satisfy all seven county attorneys that the legally required bidding competition really was occurring. Ultimately the 13 districts established the First California Commission on School Construction Systems, and were able to conduct the bidding as that entity. No new legislation was required.

The Commission is composed of five California school district superintendents. Ferd J. Kiesel of the San Juan district is President; Glen A. Wilson of La Puente, Secretary; Fiscalini, Treasurer; and Max L. Forney of Huntington Beach and David H. Paynter of Simi Valley, the other members. Ernest G. Lake of Fullerton was the secretary until he resigned in the fall of 1966 to join the staff at California State College.

More than a hundred manufacturing firms throughout the country responded when the Commission called a pre-bidding conference at Stanford in July, 1963. This was a special effort to produce compatibility of systems, for the staff knew they could just mail the specifications, but they feared that the makers of various components would fail to get in touch with each other. "It was an attempt to arrange some marriages," says staff member Vernon C. Bryant, Jr.

On January 3, 1964, the six manufacturers who were to provide the components were nominated by the Commission on the recommendation of SCSD. And promptly the legal propriety of performance specification as a method of bidding was tested by a disappointed bidder, against whom the Commission successfully defended a lawsuit.

As a condition of bidding, the Commission required that a trial building enclosing 3,600 square feet—the area served by a single air-conditioning unit—should be erected by the winners on the Stanford campus. The building, designed by Ehrenkrantz and the SCSD staff, is walled entirely with glass, and it immediately began to attract numerous visitors interested in SCSD.

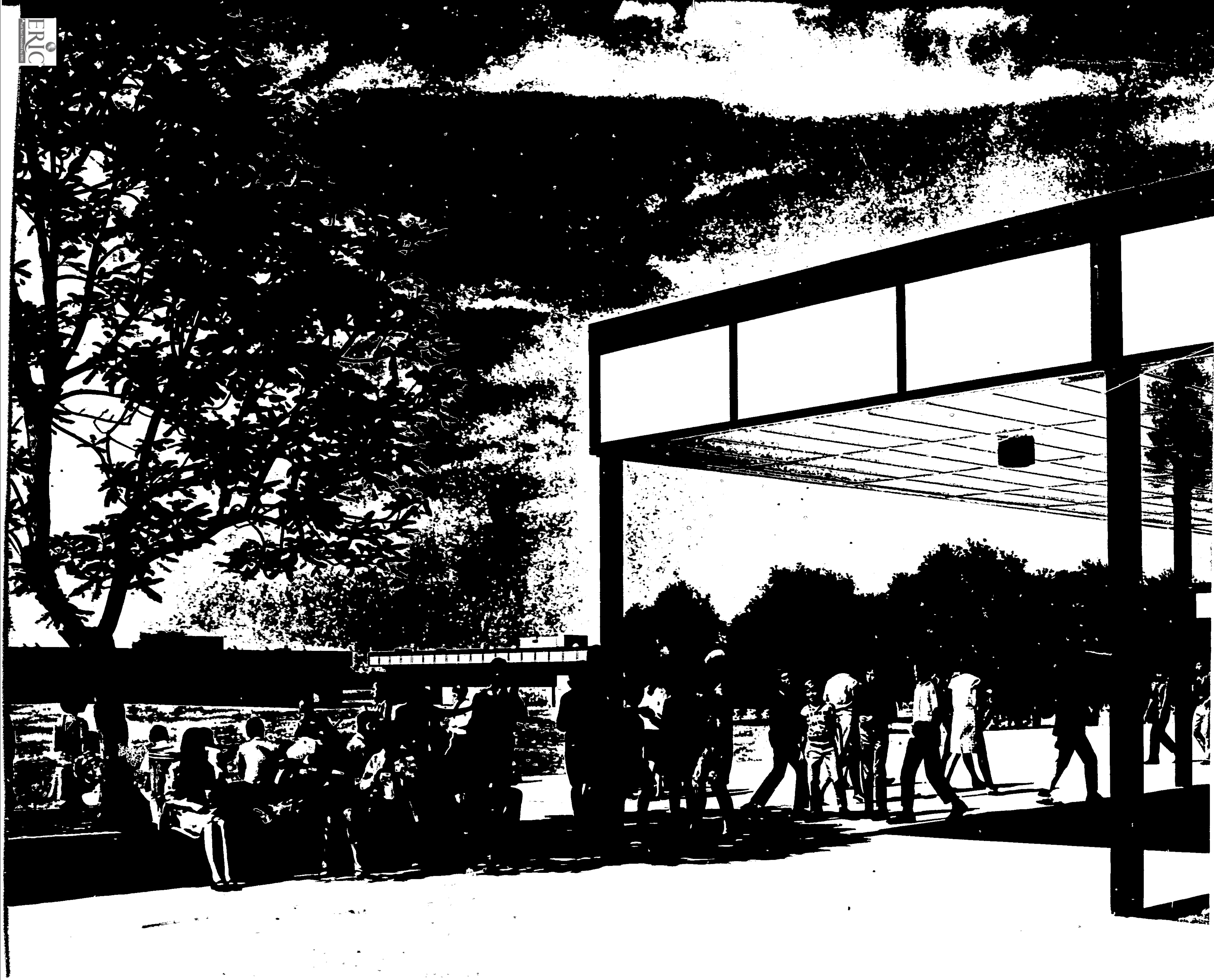
Soon after its completion in November, 1964, the building provided a dramatic demonstration of the flexibility for which its components were designed. Overnight, between two days of a meeting of the Board of Educational Facilities Laboratories in the building, a new room was produced by removing 120 feet of interior partition, installing 25 feet, and changing the surface of 80 feet of partition. The lighting was rearranged by moving 300 square feet of ceiling panels, seven air-conditioning zones were reduced to five, two thermostats were removed and one changed in position, and the building was tidied up in time for the next morning's meeting. Only 59 man-hours of work were required.

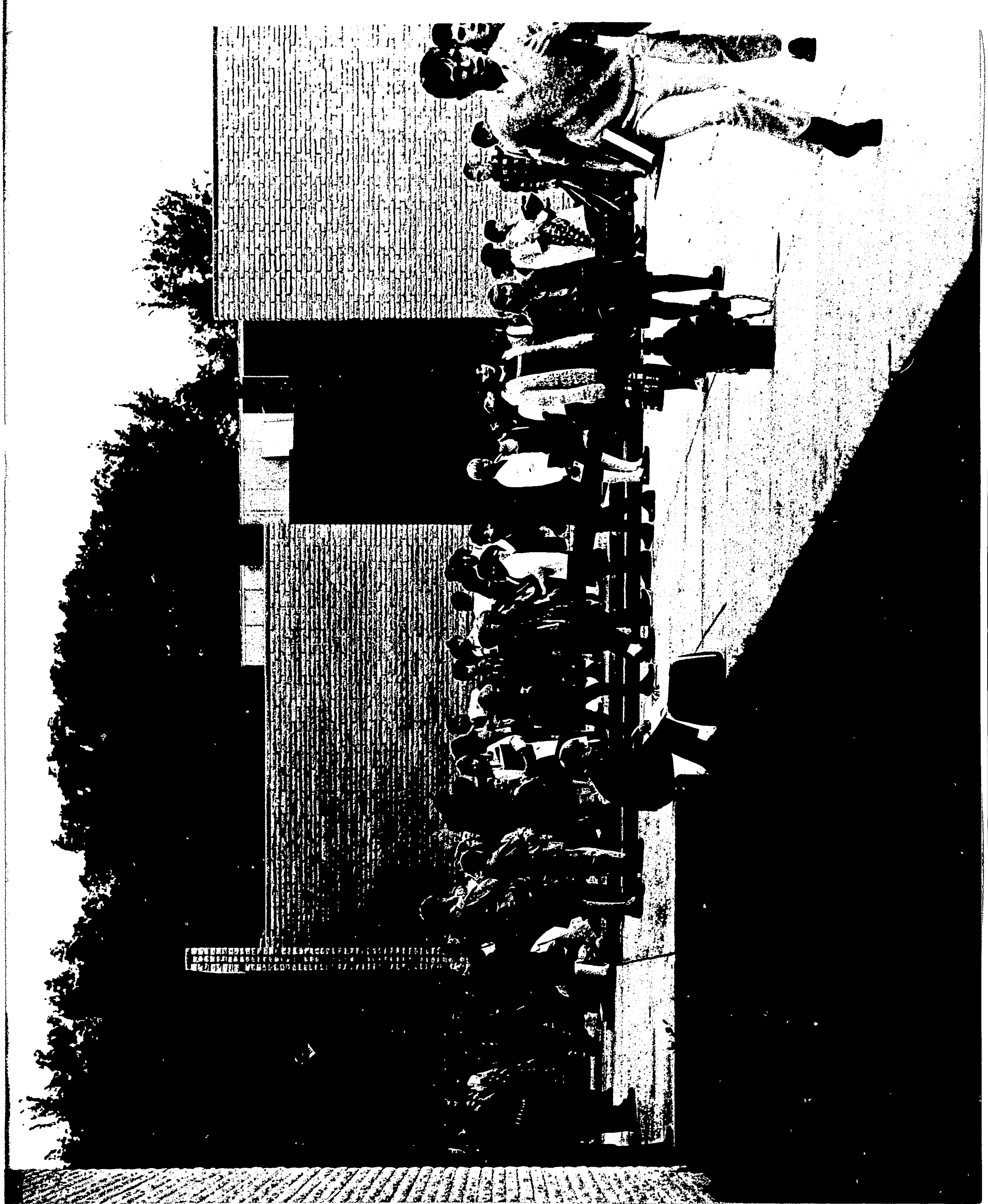
The self-expanding nature of the SCSD idea now began promptly to assert itself. Construction began on the first "systems" school, for the Clark County, Nevada, school district, utilizing the structural system designed not by the winning bidders but by the Butler Manufacturing Company, which had been runner-up in the structural bidding to Inland Steel Products Company. Butler joined its structure with the ceiling and lighting system designed by the Hauserman Company, which won the SCSD bidding for fixed and demountable partitions, but lost to Inland on the ceiling. The SCSD-winning air-conditioning system of Lennox Industries also joined in. And together they erected an elementary school in Las Vegas, Nevada.

Soon Inland Steel Products had a project under way using its system in Barrington, Illinois, for a school which was completed early in 1966. And soon afterward Inland undertook to use its SCSD-winning structural and lighting system to erect a new engineering building for the Lockheed Company in Marietta, Georgia, an unusual transfer of schoolbuilding methods to industrial use. The Marietta project provided a convincing demonstration of the speed in erection which prefabrication provides, for the first section of the building—some 180,000 square feet—was begun on October 19, 1965, and completed on February 1, 1966.

Inland's concentration of its production on this latter project caused some delays and conflicts with the California schools. But they did get under way—and now inquiries about the project began to come in from many parts of the country and even from overseas. Bellevue, Washington, and a St. Louis, Missouri, suburb decided to build "systems" schools. And schoolmen in Metropolitan Toronto, Pennsylvania, Massachusetts, and Florida began talking about the possibility of forming development groups like the First California Commission, working out their own specifications, and developing new systems of their own. Such projects were in progress in Toronto and Florida at the end of 1966.

Numerous problems and difficulties had been overcome to get the SCSD schools under construction and more problems and difficulties lay ahead. Like any other project that calls for fundamental change in the customary ways of doing things, the SCSD undertaking experienced fully the operation of "Murphy's law" as it was defined by the rocket experts of Cape Kennedy: "If anything can possibly go wrong, it will." But what had been only an idea was beginning to assume reality.





The total of 13 projects—built, building, and projected—that made up the SCSD program at the end of 1966 was a sharp reduction from the program of 22 schools for 13 different districts that had been contemplated when the First California Commission was formed. However, the Commission had foreseen the possibility of changes, knowing that population trends in fast-growing suburban districts are not wholly predictable.

Thus, for instance, the San Juan School District outside Sacramento cut back its building program when a large aerospace manufacturer in the area cut back employment and the suburb's growth rate dropped sharply. The Simi Valley Unified School District in Southern California also cut back because of declining growth, and the East Side Union High School District at San Jose, California, delayed construction of a previously scheduled high school for the same reason.

One of the Commission's school districts even vanished, when the state program for inducing districts to combine into larger units resulted in the unification of the Excelsior Union High School District, a Commission member, into the ABC Unified School District, southeast of Los Angeles. The new unified district revised the building program that Excelsior had planned.

But the Commission had allowed for an adequate number of such dropouts, and its remaining volume of construction was still sufficient to carry through the program and to make it possible to estimate if it had made progress toward building schools better, faster, and more economically.

The question to be asked is not, it should be emphasized, whether all the schools show remarkable architectural excellence, although some of them appear to be excellent schools indeed. Rather, the important question for SCSD is whether its systems have given architects high-quality economical components, freedom of architectural treatment, scope for the employment of individual creativity, and sufficient choice in plans to meet the differing needs of school systems. Not all architects and engineers will produce brilliant results with such freedom, any more than all produce brilliant results with conventional methods.

The SCSD schools certainly differ very widely. For example, in contrast to the Fountain Valley High School already described, which consists of separate buildings placed around a large central open area, the new Sonora High School of the Fullerton Union High School District, by architects William E. Blurock and Associates, is one single building—the somewhat controversial "loft plan." Here the instructional and other rooms surround a central "great court" which is roofed, like the mall of an eastern shopping center.

Yet this plan, so different from Fountain Valley's, has been carried out with equal facility using the SCSD system. A problem of the "loft plan" school has been noise in the central area when many students are out of classes. To help combat this, the Fullerton architects raised the court's ceiling from the 10-foot height elsewhere in the school to 20 feet—a possibility for which the SCSD system had provided. (In contrast, when a 12-foot ceiling was wanted in parts of Fountain Valley High School, its architects lowered the floor slab two feet to save expense and to avoid breaking the roof line.)

In another illustration of the system's range, architects Leefe and Ehrenkrantz designed an "expandable" elementary school with it for the Santa Cruz School District, even though SCSD was primarily aimed at high school construction. The De Laveaga Elementary School at Santa Cruz has 11 teaching stations to begin with—"One more than we thought we could squeeze out of our budget," comments Superintendent Denny Morrissey—and encloses unfinished space for 12 more classrooms. To meet the school district's educational specifications, the space is arranged so that "clusters" of three classrooms each can be added in the future as they are needed.

In exterior treatment, the range of the schools is equally great. Fountain Valley expresses its structure clearly; ceramic tile covering each structural column marks its occurrence in the brick outer wall, and a boldly contrasting fascia of black and white enameled aluminum panels draws attention to the structural system's deep roof-ceiling "sandwich." In complete contrast, most of the El Dorado high school buildings entirely conceal both these structural features behind a painted stucco wall. And the little trial building at Stanford has all its columns standing free five feet outside its grey glass walls.

Just as SCSD can only allow, but not guarantee, architectural excellence, it cannot guarantee favorable prices for a whole school, since the SCSD components normally account for about half the total cost of the building.

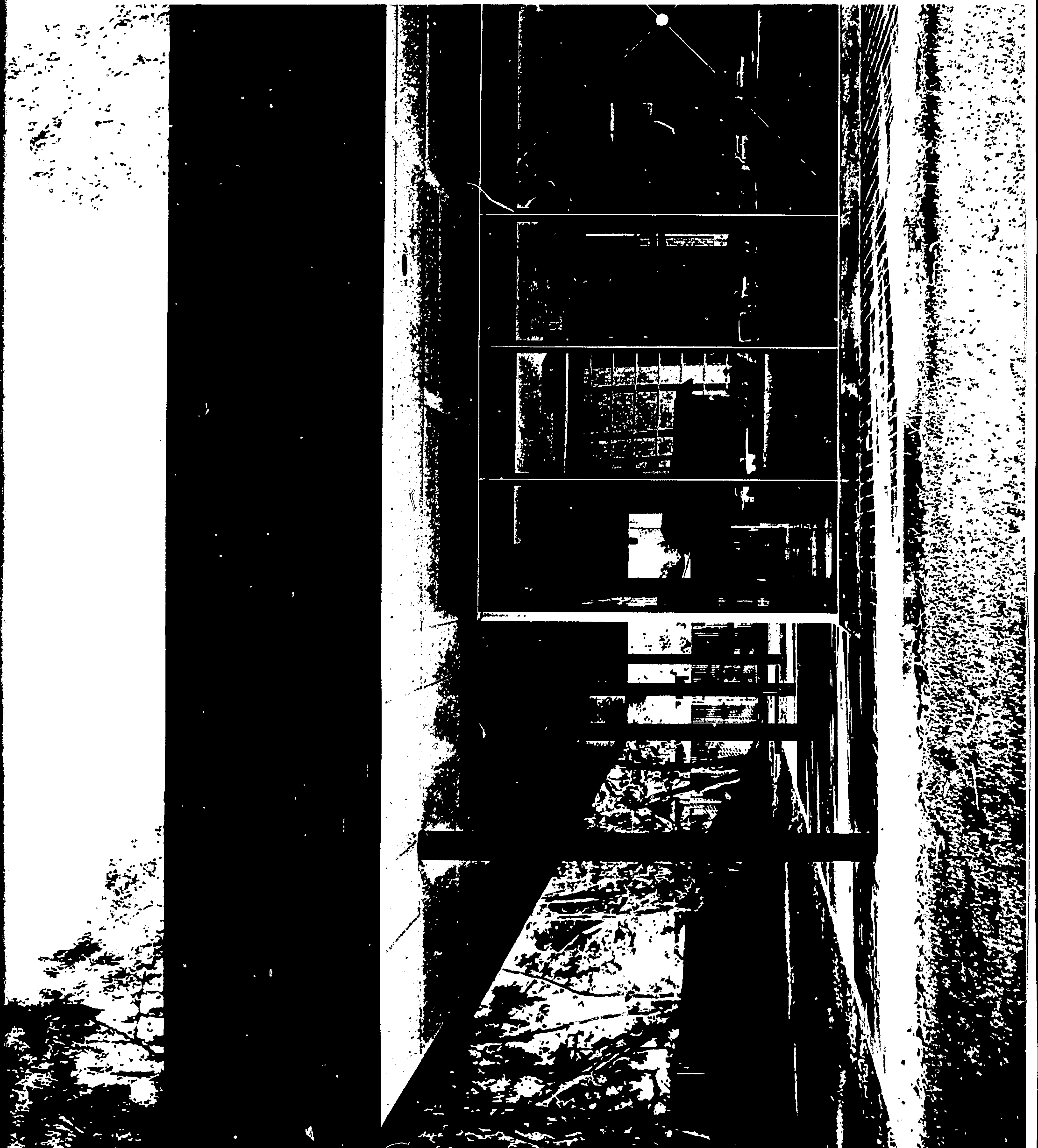
Even in the use of the components, moreover, SCSD's very flexibility permits variation in cost. If a school district should require an unusually high proportion of operable walls, above the usual needs of schools, that will obviously add to cost. Certain structural spans are more expensive than others, and there are other cost variations as well.

A principal factor which influences the final bidding results is that, knowing that the SCSD components will provide their part of the school very economically, schoolmen and architects ordinarily utilize this saving to provide other things in the schools that they believe are needed but which they could not previously afford. As some of the superintendents involved in SCSD have commented, "You don't spend less, but you get more for what you spend."

Hence it is to be expected that bids for some of the SCSD schools have come in above proposed budgets, reflecting individual variations in planning, estimating, and in bidding conditions. The costs of the SCSD components, however, having been fixed in the original bidding, have been held to expected levels in the final bids. There can be no question that this has been an economy for the schools concerned, particularly in view of recent trends in construction costs.

Speed of construction has also met expectations, although actual schedules were sometimes delayed by tardy deliveries of the structural components. One example will suffice: The entire steel structure for Casa Roble High School, designed by architect N. A. Tomich for the San Juan Unified School District near Sacramento, was erected in approximately 12 working days by five men and one crane. Although welding and reinforcement remained for completion, an engineer on the job commented that such speed alone "will make this structure a hot product."

Better schools are being built faster and more economically by using SCSD products.



Challenged to respond to the needs of a good-sized group of schools whose leaders had plainly stated their wishes, some manufacturing companies showed the effective ingenuity which the SCSD organizers had hoped for.

In each bidding area they developed new products which the schoolmen judged to be superior for educational purposes to those previously available, as well as generally cheaper.

Inland Steel Products Company won the contract for the basic structure with a framing system designed by architect Robertson Ward and The Engineers Collaborative. It is composed of cruciform columns, joined by trusses which act as the primary beams, between which the space is spanned by "truss-deck" units of a unique design. The truss-decks are unusual in having no top chord as such; instead, the decking itself serves as the top member of the truss, with a resultant saving both in steel and in weight, and consequently in money. This was the first use of orthotropic trusses for conventional building, although the technique had been used for bridges.

For economical shipping, the trusses fold neatly under the deck plates, and the units can be stacked. At the building site, the unit is lifted by a crane, allowing the trusses to swing down into their preset cambered position. After the unit is lifted into place and joined to the primary trusses, its upper deckplate unfolds to double width, so that a unit 5 feet wide in transit spans 10 feet in width when it is in place. Finally, the deck plates are welded.

Columns are of uniform exterior dimensions, but are provided in various thicknesses of steel to accommodate various loading conditions. The system provides at 5 foot intervals for spans from 30 to 75 feet with trusses 33 inches deep, and for 90 to 110 feet—"gym size"—with trusses 57 inches deep. Seismic or wind bracing was excluded from the bidding and is designed according to the judgment of the individual school district's architect and structural engineer.

The low bidder for the ceiling-lighting system was also Inland Steel Products, again with a design by Robertson Ward. It consists of a five-foot-by-five-foot horizontal metal grid suspended from the structure, flat panels to fill in the ceiling, and lighting coffers that replace the flat ceiling panels wherever they are needed. The coffers are furnished with any of three types of lighting—direct, semi-indirect, or luminous ceiling. These ceiling-lighting elements normally supply 70 foot-candles of illumination for academic areas while fixture brightness remains very low to meet SCSD specifications. Both ceiling panels and coffers are of prefinished steel, matte white, with mineral wool backing for fireproofing which, when the panels are perforated, does double duty and serves to absorb sound.

The air-conditioning contract was won by Lennox Industries, Inc., with a rooftop unit which normally serves up to eight separate areas of 450 square feet each through 8 individual mixing boxes. It can be ordered with 12 mixing boxes to serve 12 zones, or more if necessary. A combination of fixed and flexible fiberglass ducts carries the warmed or cooled air to strip diffusers which fit neatly into the Inland ceiling system, as part of the compatibility that was sought throughout. The return air simply comes back to the unit through the plenum space between roof and ceiling. The heat-exchanger is ordinarily gas-fired (although electricity and hot water can be used as alternate systems), and each unit has a fan to provide exhaust from the building so that the system can be fed entirely by outside air if necessary.

Partitions were divided by SCSD into four groups—fixed partitions that conventionally make up most school interiors, demountable partitions which should be movable with minimum trouble and expense, and two types of partitions which can be operated by a teacher—folding-panel style and accordion style.

The successful bidder for fixed and demountable interior partitions was The E. F. Hauserman Company with a single product, a wall which is fixed only when something else makes it that way, such as a plumbing line running through it. The ingenious "Hauserman Double Wall" is mounted on steel studs which fit at 40-inch intervals into a steel track on the floor and ceiling. It consists of steel-covered gypsum panels which snap into the studs along their full length. The wall's total thickness is three inches, and each panel is separately changeable.

The wall is provided in flat paint, with a choice of field-applied colors, or with a surface that will take chalk, or with glass panels of various sizes. The total floor-to-ceiling chalk surface is an innovation that appeals to teachers who have used it. Near the top of the wall is a special molding from which may be suspended hangers for cabinets, bookshelves, conventional chalkboard, tackboard, or maps and charts. Magnets enable the steel surface to be used as a tackboard, thus making all partitions educationally useful.

The operable partitions were required to be independently supported on their own trusses and columns, to make them really relocatable within the school. Low bidder for the panel type was Western Sky Industries, which furnished panels that move in groups of twos and threes on an overhead track, and may be folded neatly partially open so that any desired section of the partition remains in place. To meet SCSD's standards for sound attenuation the folding wall has an expansion device to provide a snug fit against the floor and ceiling.

Hough Manufacturing Corporation's accordion partition is a standard product modified to meet SCSD requirements. For acoustical seal the partition has a sweep strip at the bottom, but a mechanical lift frees the partition support frame when necessary, so it can easily be operated by a student or a 93-pound teacher in stiletto heels.

Low bidder for cabinets and laboratory stations was Educators Manufacturing Company, which is furnishing a wide range of floor and hutch cabinets ranging in height from 30 to 84 inches, as well as both wall and island laboratory components. Their most remarkable feature is that the drawers, doors, and adjustable shelves are freely interchangeable, in cabinets of the same width, using only a Phillips screwdriver. Drawers are 10, 20, 40, and 60 inches wide and 3, 6, 9, and 12 inches deep. Dividers permit, for example, the subdivision of a 60-inch-wide cabinet into three 20-inch sections, two of which might be given doors and interior shelving, and the third a rack of drawers in any combination that filled its height. The wooden cabinets may have wood, acid-resistant synthetic stone, or stainless steel tops, or melamine plastic tops in a choice of four colors. The door surfaces and drawer fronts are a melamine plastic available in four colors or a simulated wood grain.

The student locker system was given new dimensions by SCSD to conform more closely than traditional lockers to the habits of the modern California student, who doesn't bring to school heavy winter garments to hang up. The specifications also sought to eliminate the traditional clanging racket associated with lockers. This contract was won by Worley & Co., which is supplying lockers 15 inches high, 15 inches deep, and either 15 or 20 inches wide—unlike the usual tall and narrow lockers. There was a considerable saving in cost, making it possible to obtain a galvanized locker for the price of conventional painted but not galvanized ones. Maintenance costs for conventional lockers in many schools are very high, since painting is required every two to three years to keep rust in check, especially near the coast or where lockers are placed outdoors under overhangs, as they frequently are in California.

Naturally, with such broad ranges of products, the final price lists are elaborate. They may be summed up by a calculation made by the SCSD staff after the bids are accepted. A comparison was made between the costs of the major components for the SCSD schools and similar costs for a group of recently bid California secondary schools being built in the traditional way. For the conventional schools, structure, ceiling and lighting, heating and ventilating, and interior partitions came to about $8.39 a square foot. The comparable SCSD component cost would have been $6.85 per square foot.

Such comparisons can tell only part of the story. For instance, previously, high quality air conditioning of all academic and administrative areas had been regarded as uneconomical, or impossible within the California state aid provisions. Cooling systems of the necessary flexibility were estimated at about $4 a square foot, compared with an average price of about $1.70 paid by California schools for heating and ventilating. But the new SCSD system was bid at $2.24 a square foot by Lennox, including a five-year maintenance contract, the value of which was approximately $.30 per square foot. Where can one insert into this comparison a dollar-and-cents figure for the benefits of air conditioning?

Similarly, it tells only part of the story to say that the SCSD structure was bid at $1.81 a square foot compared with an average conventional cost of $3.24. What is the dollar-and-cents figure for the value of SCSD's long spans? SCSD's lighting system was bid at $1.31 a square foot compared with an average cost of $1.67 for the conventional schools' ceiling and lighting, but what is the added value of its glare-free lighting, its visual attractiveness, and its readiness for inexpensive change?

Altogether the SCSD way is more economical. But it is impossible to say how much more economical it is unless you can say how much more you would have been willing to pay for a school that doesn't get in the way of the educational program, and add that into the savings.

The component bidding and subsequent construction have also produced the sort of response from other manufacturers that was hoped for, so that there are indications that competition will continue to keep prices down and to reduce such problems as late deliveries of certain components. For example, a new firm called Compatible Design Systems, established by former Inland employees, bid successfully in 1966 on the Silver Creek High School to be built by the East Side district, one of the original SCSD districts, which is thus continuing its use of the systems approach. The structural system of the new company is composed of steel components but they are bolted together rather than welded, as in the Inland system, and they are producible by local industry rather than at a single plant.

In addition to the Butler Manufacturing Company (which has built schools in Las Vegas, Nevada, one in Rhode Island, and one in Indiana), another competitor in structure is called Interpace Precast Concrete Products—using a system similar to one designed by T. Y. Lin and developed by Wailes Precast Concrete Corporation. Interpace built an elementary school for the ABC Unified School District in Hawaiian Gardens, California, southeast of Los Angeles, but so far its price does not appear to be competitive with the steel systems for one-story construction.

Another manufacturer who has indicated interest in the structural system is Macomber, which, with Armstrong furnishing the lighting-ceiling system, has erected a Junior High School in Birmingham, Michigan.

Competitors for the Lennox air-conditioning system, which has proved highly successful in commercial building, have already come forward.

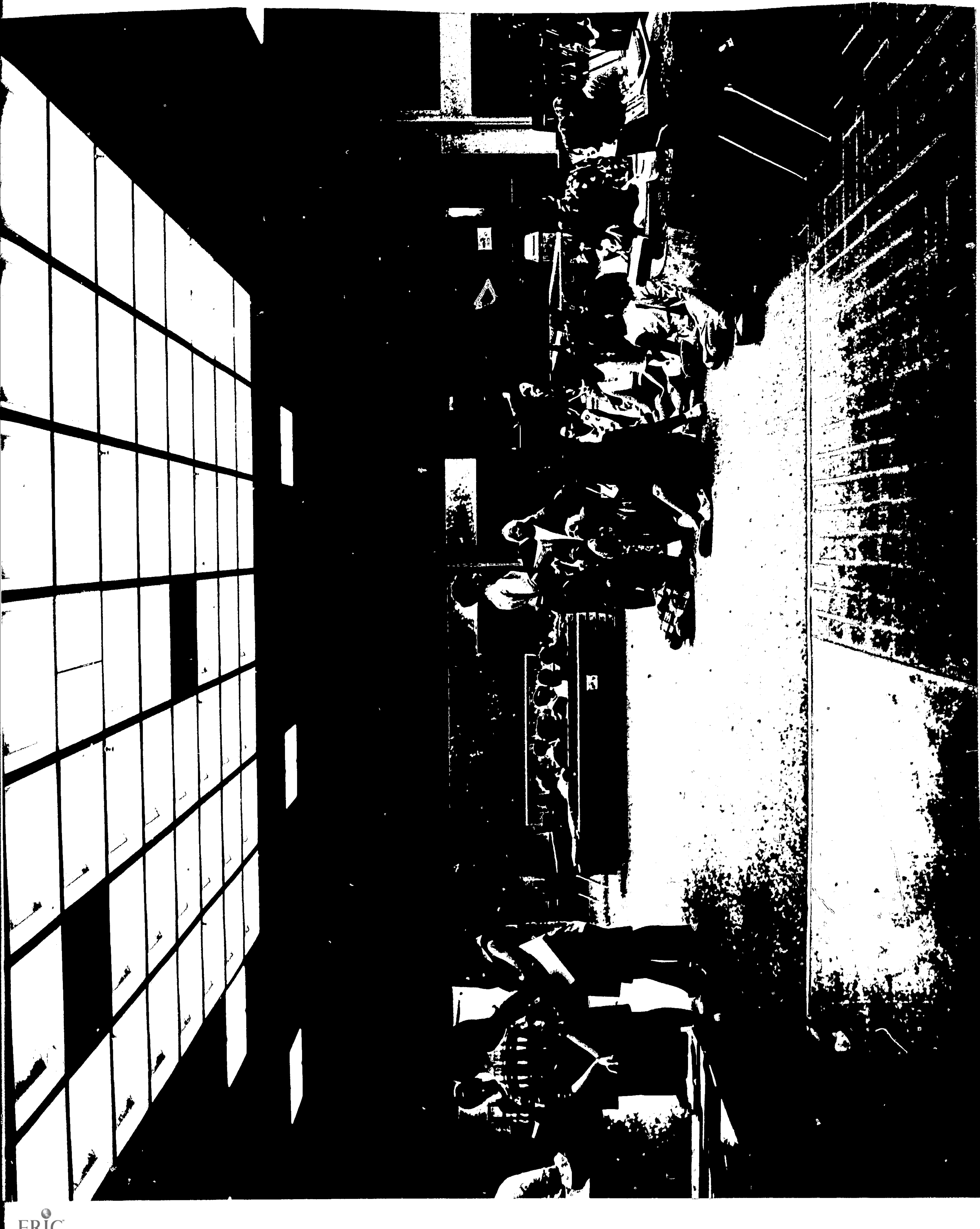
Inland's lighting and ceiling system is beginning to have competition from Hauserman, whose product was used in the Nevada schools with the Butler structure, as well as from Armstrong, Luminous Ceilings, Inc., and Lok Products.

Donn Products, Hough, and Weber offer competition to Hauserman's demountable partitions. Hauserman and Newcastle Products (Modernfold) challenge Hough's operable partition systems. (Western Sky's operable partition, in the meantime, has been acquired by Hough.)

As was also hoped, the impact of the new products has set off secondary reverberations in the building industry, leading to development of new products not contemplated by SCSD. One notable example was development by the Fastex Company of a line of fasteners for service lines in the SCSD roof-ceiling-lighting "sandwich," far less expensive than the conventional fasteners with which the air-conditioning ducts, electrical conduit, and other components are attached to the structural trusses.

Another interesting development occurred at Fullerton, where the school administrators decided to free their teachers from close dependence on a particular classroom by giving them departmental offices. In the office each teacher is to have a compactly arranged cubicle with a desk, closet, drawers, and bookshelves. Educators Manufacturing, which supplied the school's SCSD cabinets, promptly undertook to develop such cubicles compatibly with its other furniture.

Thus SCSD innovations are spreading beyond the original systems.



Although School Construction Systems Development is currently completing its original program, having arranged for bidding and construction of a group of schools on a systems basis, clearly its ultimate objective has not yet been reached. That must be to bring about a situation in which any individual school project may obtain genuinely competitive bidding of system against system without the necessarily clumsy administrative arrangements required by the original development program.

As matters stand today, the available systems are too few, and their prices and production too uncertain, for assurance that they will compete for a single school. Although competition appears to be developing, would it be desirable to organize a second round of specification development, product design, and mass market bidding?

Some of the superintendents who participated in the first round, including the five who made up the Commission, are cautiously favorable. "I think we'll be at it again in another couple of years," says Ferd J. Kiesel of the San Juan district. He and the others point to numerous school components that SCSD didn't attempt to deal with—hardware, plumbing, toilet partitions, shower rooms, electrical wiring, and carpeting are among those mentioned. Moreover, they note, technology continues to develop, and the components that this year reflect advanced thinking may be obsolete only 5 or 10 years from now.

Changes in school programs, too, are still evolving, with greater use of teaching machines, computers, and other special equipment, new sorts of student scheduling, greater use of teacher aides and volunteer assistants for whom existing schools provide no facilities—and an increased understanding by many school boards and the public that specialized school programs may meet real needs and not be merely "frills."

SCSD confined itself to a group of more or less homogeneous districts in fast-growing suburban areas—where most new schools are being built. But might it not stimulate new creative thinking if some big-city schools were in the package, perhaps multistory buildings to be built on small and restricted sites? The Toronto and Pennsylvania projects will offer this challenge.

And isn't the prospective market offered by a sizable group of schools absolutely necessary to evoke real interest and new development from manufacturers? Isn't the big market of a new group still advantageous to obtain the best possible prices?

Superintendent Fiscalini, the first to join the SCSD group, argues strongly that the existing team should be held together and new work started soon, making use of its unique experience. He thinks participating districts get more out of the project than a new school, because "this teaches you more about school building than you could learn in any other way."

Presumably a second round, given the advantage of following after the pioneer work, would not cost as much as the first. It might be financed by the districts themselves if they were to contribute ½ to 1 per cent of their expected building costs as an SCSD fee.

The way for future rounds—by this group, or others—has been left wide open. Early in its development the organizers assigned ownership of SCSD to the trustees of Stanford University, with the understanding that they would make its findings freely available, only forbidding unauthorized use of the name SCSD itself.

"SCSD is an approach to work, but not a way for a group in California to develop an empire," Ehrenkrantz has remarked. But in spite of the indications of enthusiasm, there can be no certainty about what a second development round might accomplish.

It has often been asserted that the social structure of the building industry strangles most efforts toward its technological modernization. What might the cost of an automobile be, it has been asked, if the powerful combination of state and local building and safety codes, 19 trade unions, 5 powerful mechanical associations, and a long historical tradition required that part of the car be built on the spot by hand and all of it assembled there by an elaborately specialized staff, using nonstandardized parts from a wide variety of industrial manufacturers?

If SCSD found this situation less hopeless than many others have, the reason may be that it didn't try to force its way through the obstacles, but instead attempted to consider the viewpoint of everyone concerned. "We did our best to work with contractors, unions, architects, engineers, and code enforcement agencies, and to gain their confidence and win their willing consent," says Ehrenkrantz. He describes what occurred as "a game of musical chairs, but without taking anyone's chair away." Most people, he believes, are willing to make changes if everyone else must make changes, too, for a desirable goal—in this case, better schools. Hence it was made plain that everyone was giving something—manufacturers had to spend on new development, unions to accept more prefabricated parts than before, architects to work from a novel catalogue, and so on down the line. "In order to make progress with these problems," says Ehrenkrantz, "I think you must find a way to spread the burden, so that it doesn't fall on any single group alone."

Not all of the problems the schoolmen would like to tackle lend themselves to such solutions today, he believes. Despite this caution, he concedes that further progress probably can and should be made. If it can be carried far enough, there is much to be gained. One remarkable possibility that SCSD holds forth to both builders and users of buildings is the realization of really changeable space.

Architects have long considered a fundamental of their art to be the enclosing and shaping of space. Especially in the modern period great attention has been paid to just how people use their architectural spaces, so that they might be molded in the most desirable—or, some have said, the most "functional"—way that technology makes possible.

But up to now little attention has been paid, except in major office buildings, to the fact that the way the spaces are used—for example, the way a family uses its home—is a continual process of change. Children grow, and then leave home, individual interests change unpredictably, the surrounding society changes and compels the family to change, and life is full of unexpected circumstances. Should not the home, or the school, or any building, also be capable of change?

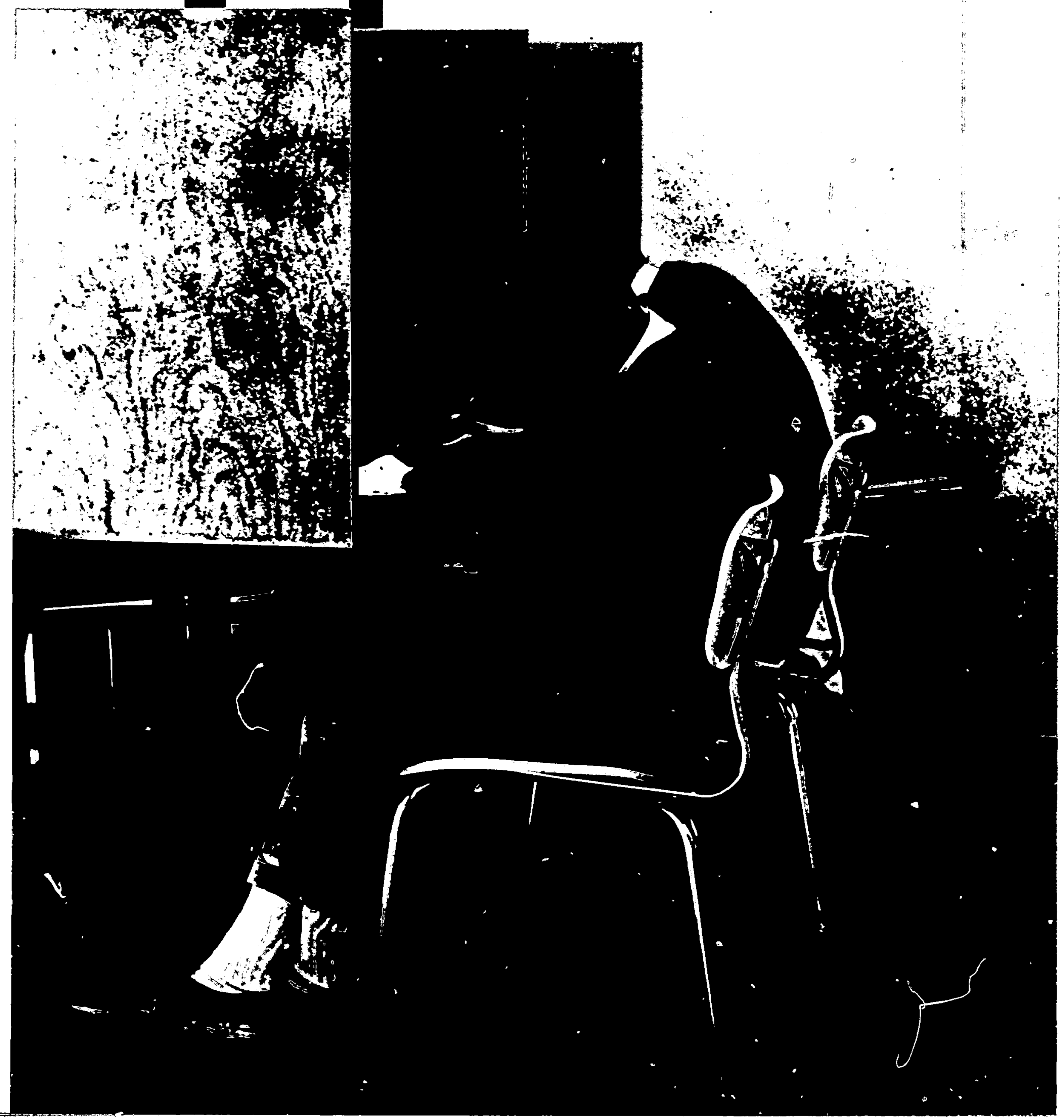
SCSD architect Christopher Arnold suggests that the problem was well solved in middle-class Victorian homes by the provision of all sorts and shapes of rooms, with lots of extra space, so that almost any activity could somehow be accommodated by a little shifting around. But today space has become more expensive and limited.

It may be, then, that a major contribution of SCSD will prove in the long run to be the new thinking it has brought to building flexibility, useful not only for the schools that elicited it but for many other sorts of building as well. In these SCSD schools the educational task will continue to determine the space – rather than the space determine the task as is so often the case today.

But SCSD's principal contribution, naturally, will be in the systems approach to building, if that can be carried to full development for the schools and other buildings. Ehrenkrantz speaks of what systems can offer an architect as a "keyboard" or a "palette" rather than as any sort of restriction. And artists and musicians have not found that absolutely unlimited palettes or keyboards are needed to produce splendid effects.

Further development should open up the prospect that numerous systems compatible with each other may be created. As Ehrenkrantz points out, the technological opportunities in the United States are far greater than in England, so that there is an opportunity for a multiple system "in which few things are fixed, but everything is related." That opens a dazzling prospect, and not only for the schools, but for all types of buildings as well.

SCSD is a first step, radical in many ways, timid in others, which suggests a new and vital way for the building industry to work toward the satisfaction of society's needs—needs for both larger quantities and, more importantly, for higher qualities in buildings to answer the more complex requirements of the present and the future. It points to buildings more responsive to the ultimate users in a society increasingly dominated by rapid change.



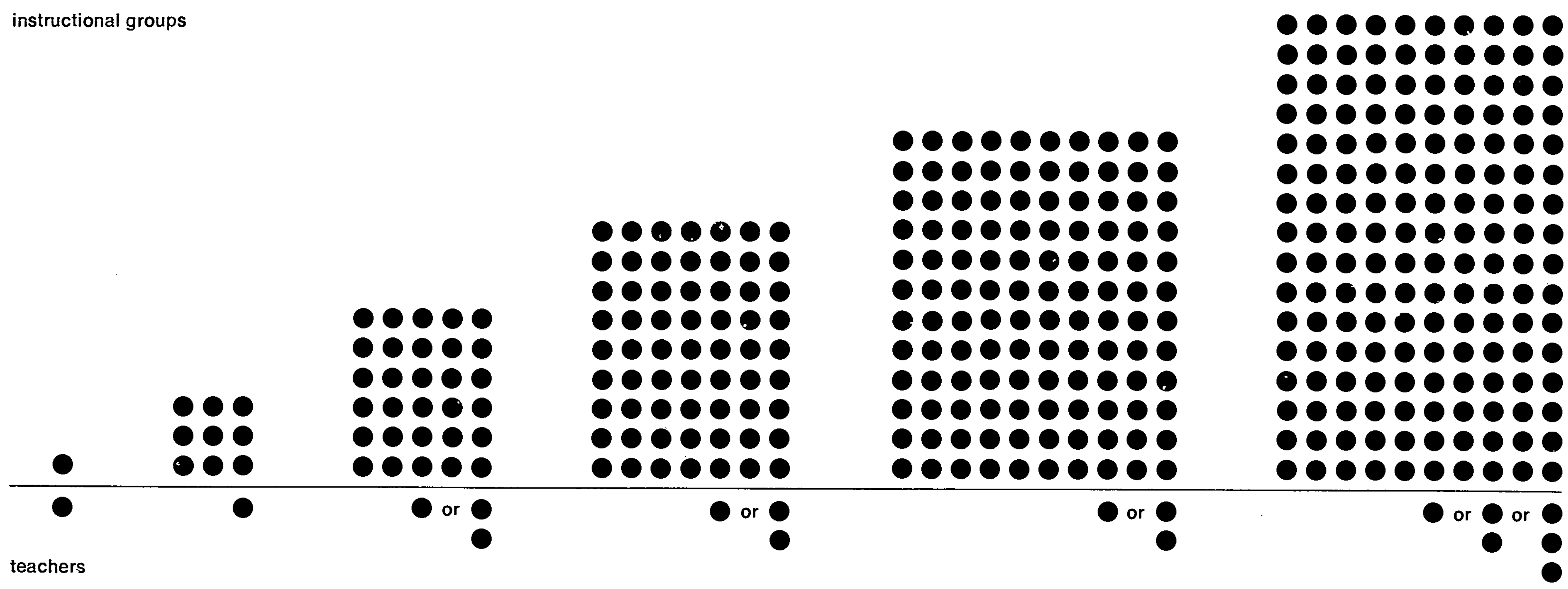
Educational Requirements

The educational requirements as they were developed by the various districts and by the SCSD staff covered the following topics: instructional groupings, flexibility, school organization, and general environmental requirements.

Instructional groupings

In studying the requirements of the participating districts, SCSD identified a variety of possible instructional groups, all of which were taken into account in the developmental work which followed.

activity:	students:	teachers:
individual work	1	0 or 1
small group	3 to 15	0 or 1
conventional class	15 to 40	1 or 2
medium group	40 to 80	1 or 2
large group	80 to 150	1 or 2
assembly	150 and up	1 or more



Flexibility

The school districts' requirements for various types of flexibility were clear, but the definitions were not precise enough to guide component fabricators. One of the tasks of the SCSD staff was to relate educational flexibility to precise requirements for the building system. The SCSD staff saw the educators' demands as taking four basic forms, each of which had import for the system. These are:

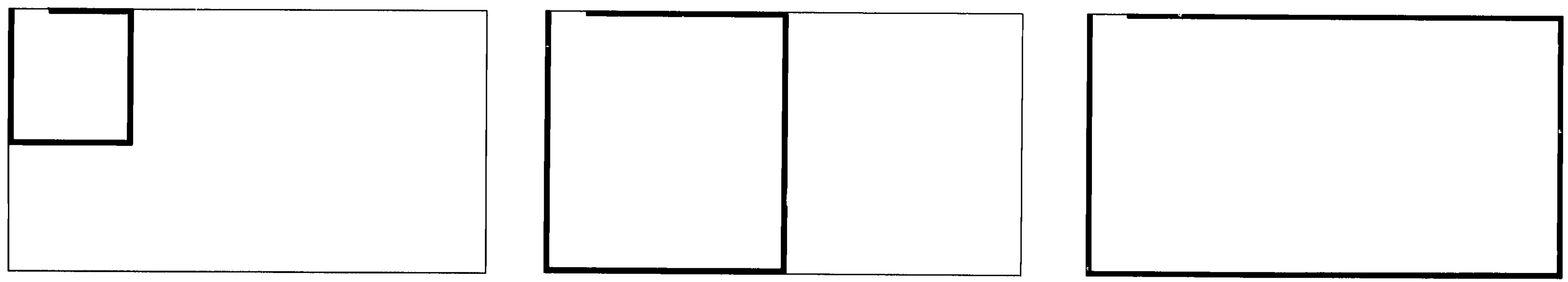
Spatial Variety

The instructional groupings cited above call for a variety of space sizes and functional capabilities. In a large school, a variety of spaces, combined with effective scheduling, can provide options in the use of the facility which are a mode of flexibility. Some of these spaces may be quite specialized: music rooms, physical education facilities, vocational laboratories, and science laboratories. Other spaces provide for varying degrees of multi-use capability.

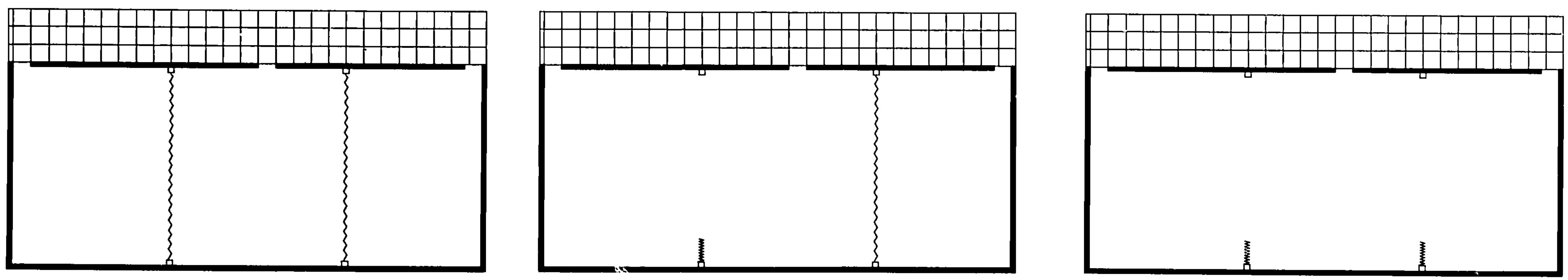
Immediate Change

In the day-to-day operation of the school, it should be possible to convert certain spaces immediately with an absolute minimum of time and effort. Such changes are apt to be necessary during the school day, and generally take the form of temporarily reducing or expanding spaces in order to separate or bring together groups or activities. Such flexibility accomplished primarily by operable walls, readily moved by teacher or student, but movable furniture and space dividers may also be used.

spatial variety



immediate change



Long-range Changeability

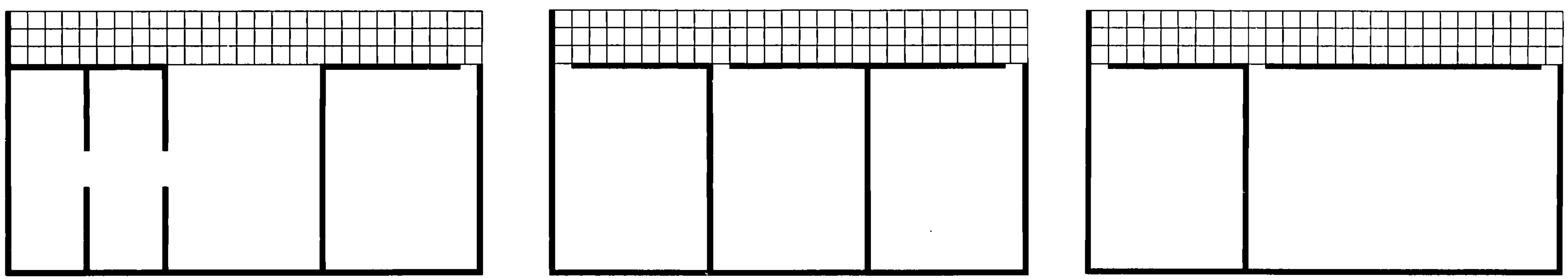
The design of the building should permit rearrangement of interior partitions in order to facilitate changes in the teaching program and the resulting redistribution of students, teachers, and equipment. The SCSD staff recognized that movement of partitions alone does not answer this requirement fully and that the implications of moving partitions on other subsystems may govern the degree of flexibility absolutely. Among the functions involved are the relocation of: supply and return air diffusers; ductwork; thermostats; control lines; electric outlets; conduits; switches; and lighting fixtures. Also involved are the effect on flooring materials and wall-mounted furniture.
Such changes are a form of remodeling; but to be realistically useful to the schools they must involve a minimum of expense and, where possible, should require only regular school personnel or minimal outside building labor to complete.

Expansion

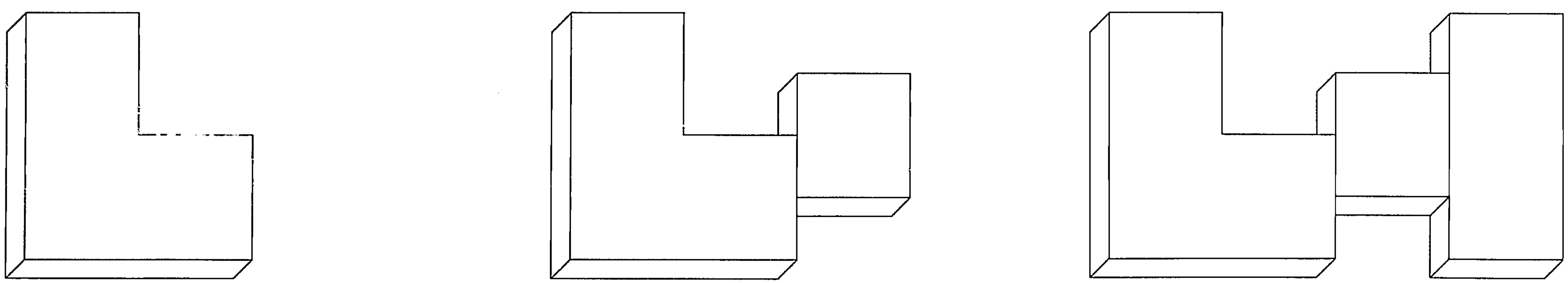
The school building should be planned in such a way that increases in enrollment may be accommodated by an orderly expansion of facilities. By orderly we mean the campus must accommodate growth with a minimum of demolitions, interruptions, and cost, and also that the school must be a successful architectural and educational entity at each stage of development.
Expansion is largely a matter of plan arrangement of the school by its architect and programing by the school district. However, the characteristic pattern of expansion of California schools (several SCSD schools were planned for expansion within the two-year building period of the project itself) tended to favor a unitized heating-ventilating-air-conditioning system as a solution to the growth of the mechanical system.

These four modes of flexibility directly influenced the specifications in a variety of substantial ways. Their influence is particularly strong on the range of structural spans and ceiling heights.

long-range changeability



expansion



School organization

The design of the school building can either enhance or limit the administrator's freedom in planning the way in which the occupants and activities of the school will be organized. After consultations with the school districts, SCSD defined the following as organizational patterns that should be possible within the use of the system products:

1. Arrangements based on curricular divisions; i.e. schools organized around departmental or divisional groupings such as science, social studies, languages, business education, etc.

2. Arrangements based on functional divisions: i.e. lecture rooms, standard classrooms, seminar rooms, offices, vocational subjects, etc.

3. Subschool (school-within-a-school) arrangements; organization of the student body and faculty in units larger than the class or department but smaller than the school.

In general, these organizational types are independent of building size and space configurations as expressed by a building structure. Organizations tend to affect the disposition of buildings, in a campus plan, or the disposition of spaces, in a loft plan. These are functions of the program and the architect's design. General parameters for building structures in SCSD tended to be largely a function of codes, which limit size of buildings in relation to a fire protection classification, and of general design consideration. For instance, the fact that all SCSD schools were on suburban sites with reasonably ample acreage determined the typology of the SCSD structure as predominantly one-story. The loft plan type of building embracing several departments derives from the desire to keep very large schools of 2-3,000 students from becoming dispersed.

General environmental requirements

The SCSD environmental specifications aim to provide conditions in which the activities of the school are carried on in comfortable surroundings.
Precise requirements for lighting, thermal environment, and acoustics are by no means universally agreed upon. SCSD was not in a position to institute basic research in all these areas. But the SCSD staff studied all available data from research on educational, industrial, and office environments. The performance standards were related to the economic context in which California schools are built. In addition, current accepted standards for California schools were an important consideration. The specifications were written so that development work would be necessary to raise the environmental standards within the economic context and thus to raise the general level of environment in these schools to as close to the optimum as possible. Specific problems to which attention was directed were:

1. Lighting

The specifications were oriented to the work of the California Bureau of School Planning in demanding fairly high over-all illumination levels combined with brightness limitations to avoid glare. The requirements aimed to recognize the variety of visual tasks which occur in schools and the varying eyesight capabilities of the students and staff.

2. Thermal Environment

A high degree of comfort was considered necessary, particularly in view of the tendency toward increasing use of schools during the summer months. The requirements also recognized the differences in thermal needs among people. This suggested a specification with refined zoning and control capabilities.

3. Acoustics

The problem of sound transmission between spaces, particularly where demountable and operable walls are to be used, was basic. This resulted in close attention in the specifications to compatibility of acoustic standards between different partition types and the ceiling. Information obtained from EFL's Reid-Fitzroy report* resulted in setting a relatively low acoustic criterion but requiring that it be met in field tests of the system rather than relying on laboratory tests of the various components considered singly.

**Acoustical Environment of School Buildings* by Dariel Fitzroy and John Lyon Reid, 1963, Educational Facilities Laboratories, Inc.

SCSD System Performance Specifications

Introduction

The performance specifications, published in two sections by SCSD in July of 1963 and July of 1964, were of a technical nature and covered each subsystem in great detail. The specification clauses that had the most effect on the design of the components and established the necessary type and degree of compatibility between subsystems are included in abridged form here. In addition, some comment is added to indicate the derivation of specific requirements. Basic guidelines for the specifications were derived from eight main considerations. These were:

1. Direct Educational Requirements

There were two primary requirements to be met: one was the need for flexibility which permeated the whole concept of the SCSD system and the specifications which brought it into being; the other was the establishment of various special factors which related directly to the dimensional choice for the structural system. Flexibility and spatial requirements considered in combination resulted in the general concept of a wide span planar umbrella within which the main services are concentrated and below which the partitions move.

2. Codes and Regulations

The SCSD system was subject to all state (but not local) codes, and the requirements of the State Fire Marshal. The State Office of Architecture and Construction greatly influenced the system. This office does a thorough check of every school building designed for the state, particularly from the point of view of earthquake protection, and has wide authority over school building construction.

An example of the code influence on the system was the definition of building size in relation to fire classification. As a Type IV one-hour building system, SCSD structures would be, by code, limited to a maximum of 43,500 square feet with separation between units required if the total school exceeded this size. Fire requirements strongly influenced the ceiling and heating-ventilating-cooling specifications. The permission to use an unsubdivided return plenum for the air distribution system made significant economies possible.

3. Requirements Intrinsic to the Nature of the System

Systems have certain requirements which may be of significance only to that system. For example, the 5 foot ceiling module resulted primarily from two causes —the economy of using standard 4 foot fluorescent tubes and the fact that the use of two such tubes per 25 square feet was apparently an economical way to achieve the level of 70 foot-candles while respecting the desired brightness ratio limitations. This requirement of the lighting system was the primary influence in determining the whole horizontal structural module.

4. Compatibility Requirements between Subsystems

The need for subsystems to be designed compatibly from their inception led to the mandatory compatible bidding arrangement whereby structure, heating-ventilating-cooling, and lighting-ceiling systems had to be cross-referenced to be acceptable. The "sandwich" depth of 36 inches for academic spaces was arrived at through consideration of duct requirements, the need for approximately 18 inches of depth for the indirect lighting system, and the capability of structures for academic areas to span up to 75 feet economically.

5. Labor and Contractor Influence

Concern about potential jurisdictional disputes contributed to the decision not to develop a plumbing subsystem, even though technical studies had shown the feasibility of considerable cost-saving. Similarly, it was felt advisable to leave power wiring to the general contract work and restrict wiring to that from the lighting fixtures to a junction box.

6. Predicted Industry Capability

The specified criteria were aimed to be just out of reach of catalogue components within the price context of state-aided schools. Uncertainty of industry capability within the project cost context resulted in the decision not to call for a light switching system to match the flexibility of the lighting system itself. Similar caution resulted in the decision to restrict heating-ventilating-air-conditioning control zones to 450 square feet whereas 225 would have been more desirable (for administration areas, for example). These decisions were based primarily on talks with manufacturers during the writing of the specifications and also on cost studies of existing schools.

7. Design Requirements/Project Architects' Influence

Examples of these were the decisions to omit exterior walls from the system, to provide three lighting systems for academic areas, and to attempt to provide structural components which would give architects a varied enough vocabulary with which to express themselves. Such options stopped short at the decision to permit only flat roofs, because the system would have become too unwieldy if a range of pitched roof forms had been introduced.

8. Design Requirements/SCSD Influence

The specifications inevitably reflected some of the predilections of the SCSD team members who wrote them. A strong attempt was made to keep these influences minor, but at the same time such influence forms an important aesthetic control on the system as a whole.

System description

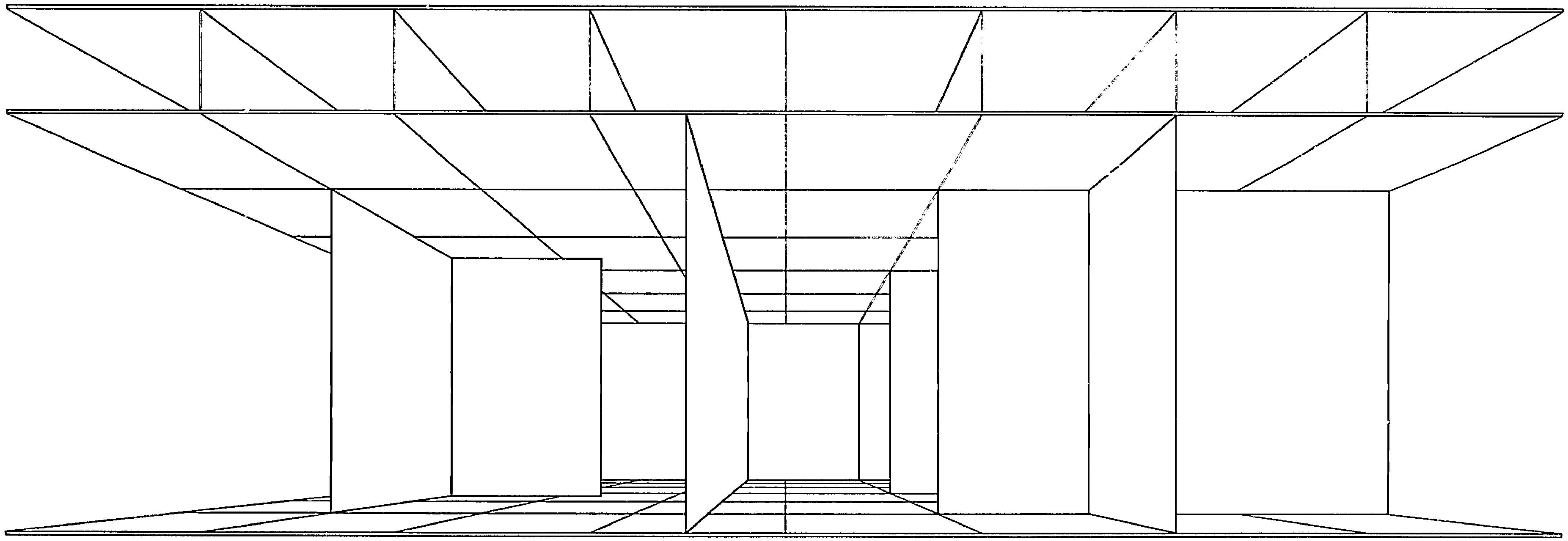
The SCSD system is comprised of six integrated subsystems:

- structure and roof
- heating / ventilating / air conditioning
- lighting/ceiling
- partitions (fixed, movable, and operable)
- cabinets and fixed laboratory furniture
- lockers

Planning module

The structural subsystem must allow the various district architects freedom to plan the structure of the individual schools on a 5 foot by 5 foot horizontal and a 2 foot vertical module or multiples of these modules.
All subsystems have to relate to these modules. As indicated above, the 5 foot horizontal grid derived largely from the development of the SCSD approach to the lighting-ceiling subsystem. The 2 foot vertical module was felt to be in scale with teaching space requirements and promised to be economical for structure and partitions (i.e., since teaching spaces are large, a more refined vertical module was not felt to be necessary).
All subsystems must acknowledge requirements that will permit the district architects to plan the design of interior spaces on a horizontal 4 inch by 4 inch module. This module is called the partition planning module.
This 4 inch by 4 inch module derived from need to allow architects to adjust areas more tightly than the 5 by 5 foot structural module allowed and thus meet state aid building area and cost requirements more precisely. The 5 by 5 module forms an area increment of 25 square feet or 150 square feet for a 30 foot wide room. This is too coarse a grid for economy. Also, the 4 inch grid allows thick walls (e.g., for plumbing) to be accommodated within the modular system.

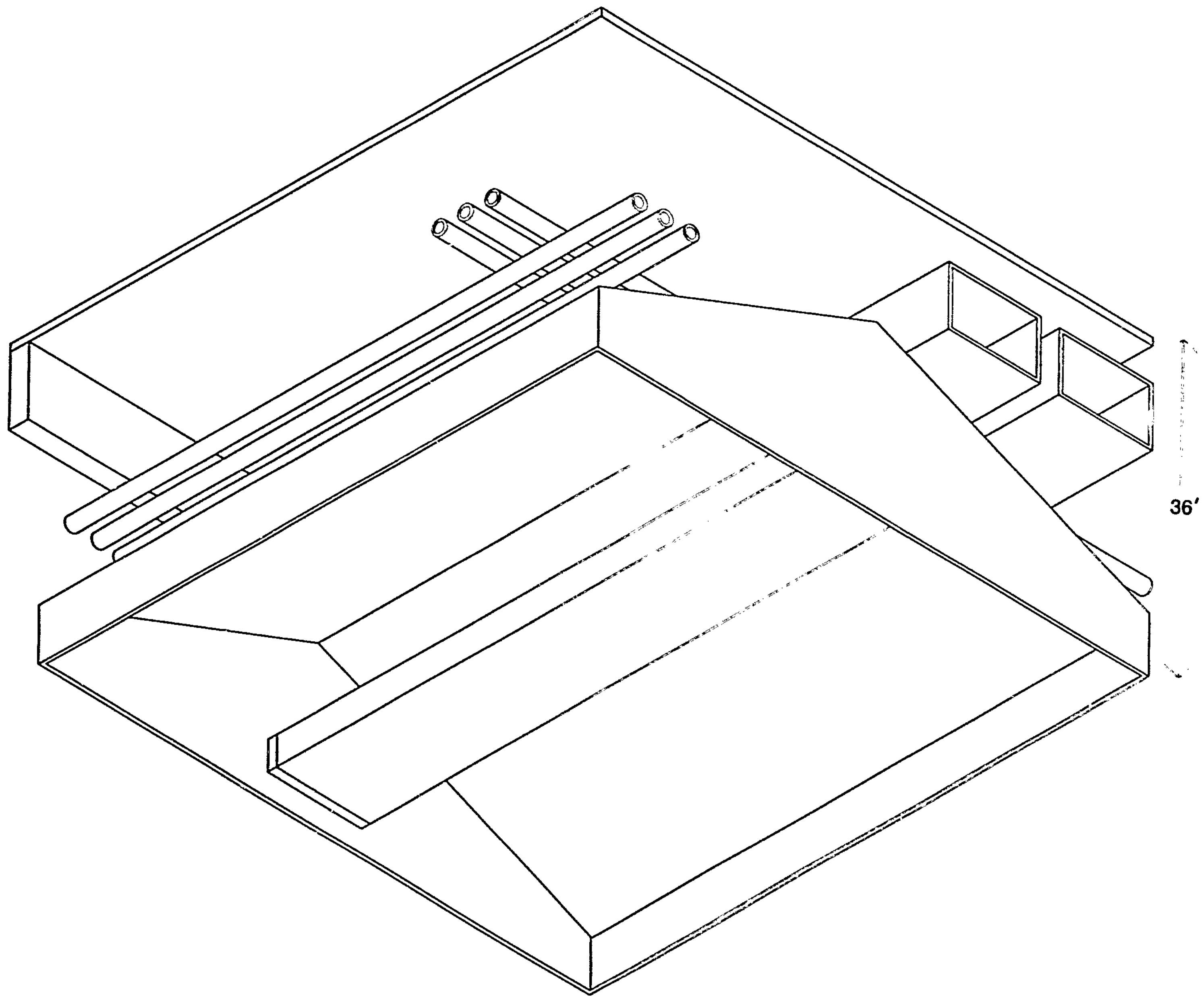
Structural planning is on a 5 foot by 5 foot horizontal and 2 foot vertical module.



Partitions may be located anywhere on the 4 inch by 4 inch planning module.

Integrated "sandwich"

The structure is defined as a horizontal "sandwich" supported by columns with no load-bearing walls. This "sandwich" is to meet the requirements of an integrated structural, mechanical, and lighting-ceiling subsystem the depth of which is not to exceed 36 inches for academic areas or 60 inches for gymnasium spans.



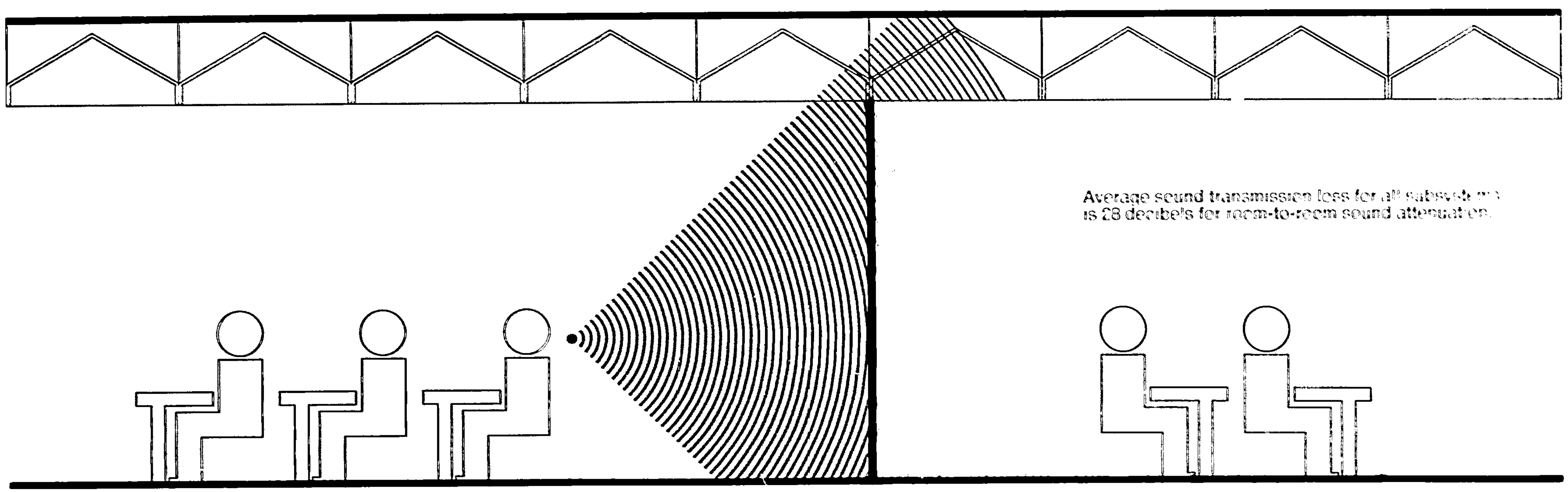
The structural, mechanical, and lighting-ceiling "sandwich."

Acoustic requirement

All subsystems are to meet requirements for an average sound transmission loss of 28 decibels, measured in place, for room-to-room sound attenuation.

Fire ratings

SCSD buildings are Type IV one-hour buildings. Hence, structure and lighting-ceiling assemblies are to meet requirements for one-hour fire-rated construction. Interior partition subsystem (excepting operable partitions) is to meet requirements for one-hour construction, with additional two-hour capability for partitions and columns. The resulting fire separations make it possible to increase the size of buildings so that large loft-type projects may be planned.



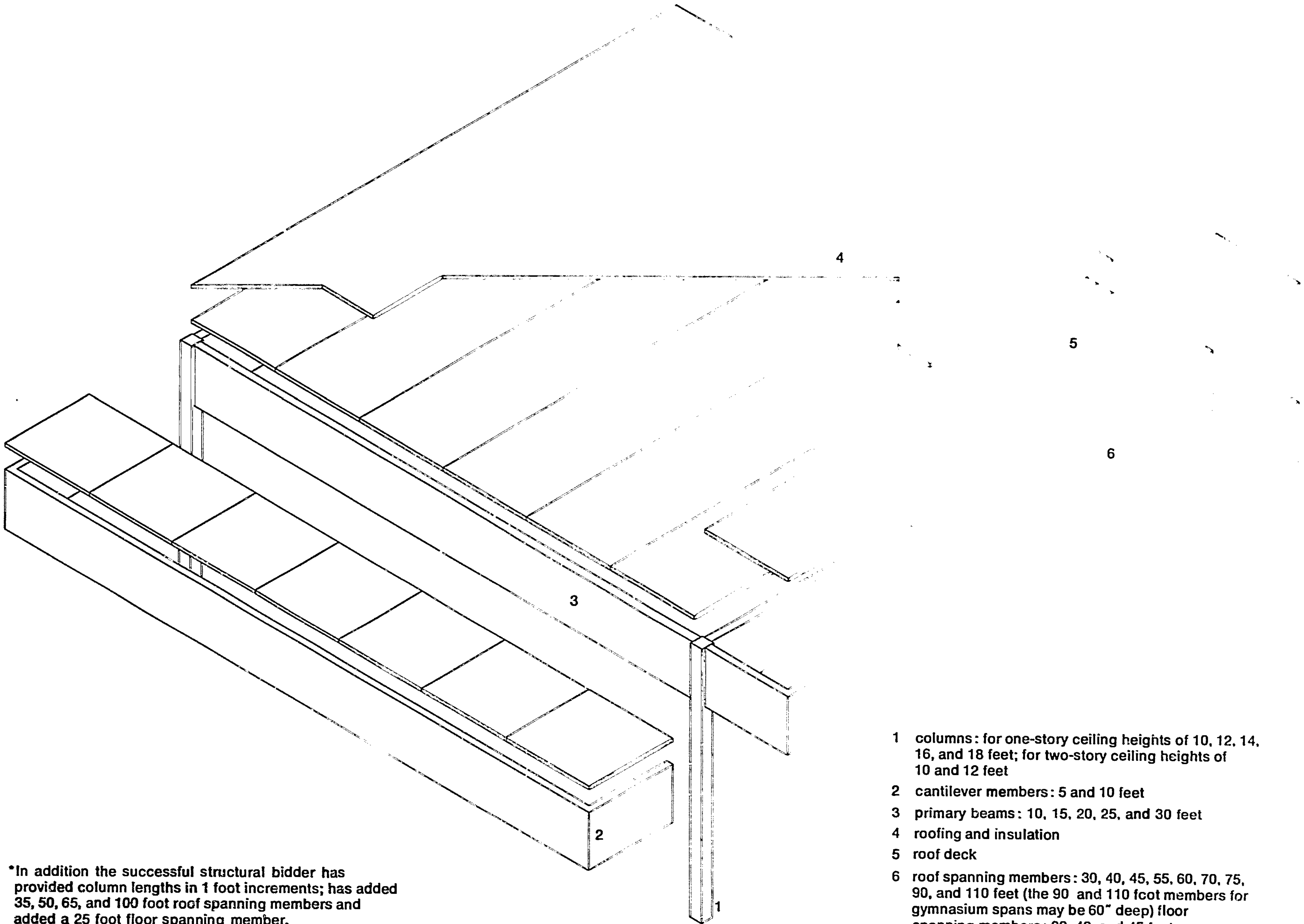
Subsystem components

Columns, primary beams, roof and floor spanning members, roofing, flashing and insulation.

Dimensional criteria

Structural components must make possible the construction of unobstructed areas up to 7,200 square feet.

To permit flexibility in planning, the sizes of members below are required.*



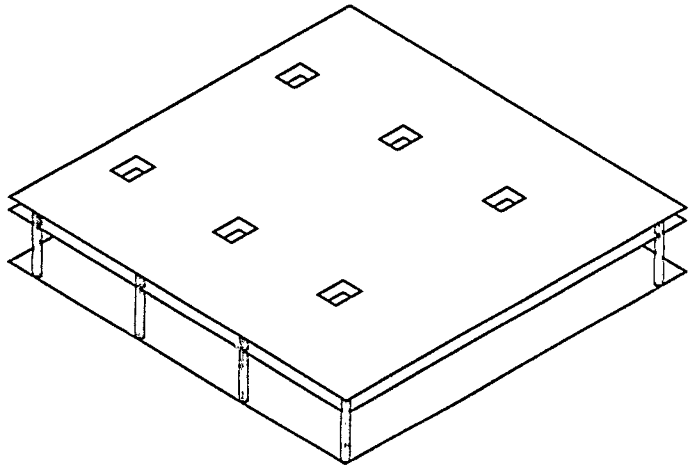
1 columns: for one-story ceiling heights of 10, 12, 14, 16, and 18 feet; for two-story ceiling heights of 10 and 12 feet
2 cantilever members: 5 and 10 feet
3 primary beams: 10, 15, 20, 25, and 30 feet
4 roofing and insulation
5 roof deck
6 roof spanning members: 30, 40, 45, 55, 60, 70, 75, 90, and 110 feet (the 90 and 110 foot members for gymnasium spans may be 60" deep) floor spanning members: 30, 40, and 45 feet

*In addition the successful structural bidder has provided column lengths in 1 foot increments; has added 35, 50, 65, and 100 foot roof spanning members and added a 25 foot floor spanning member.

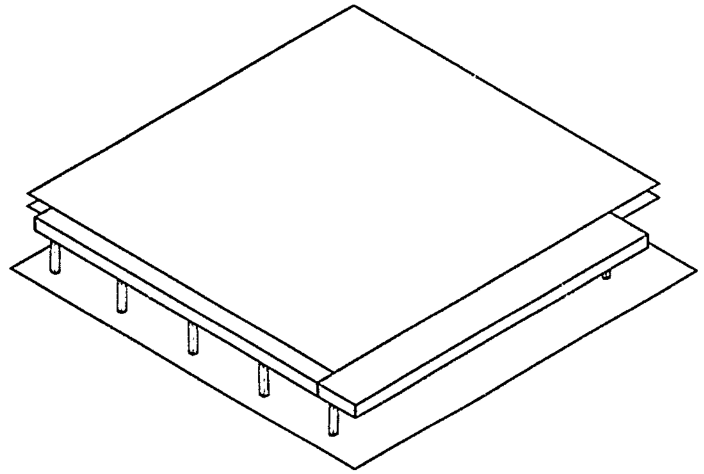
Building configurations

Structural components must accommodate any of, or combination of, the conditions below:

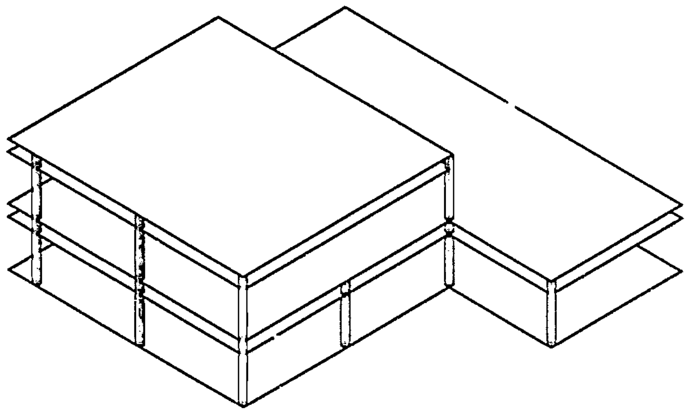
roof openings



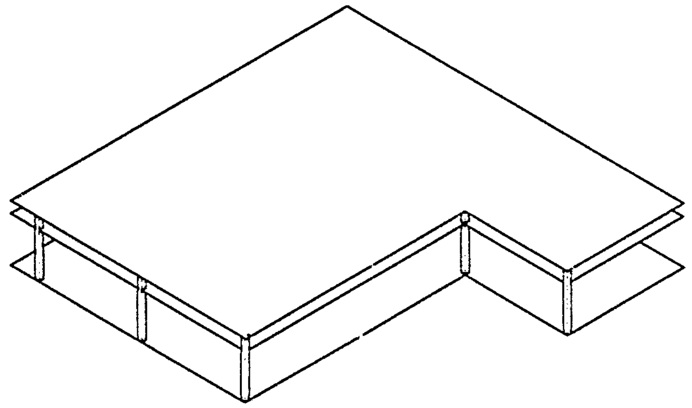
cantilever



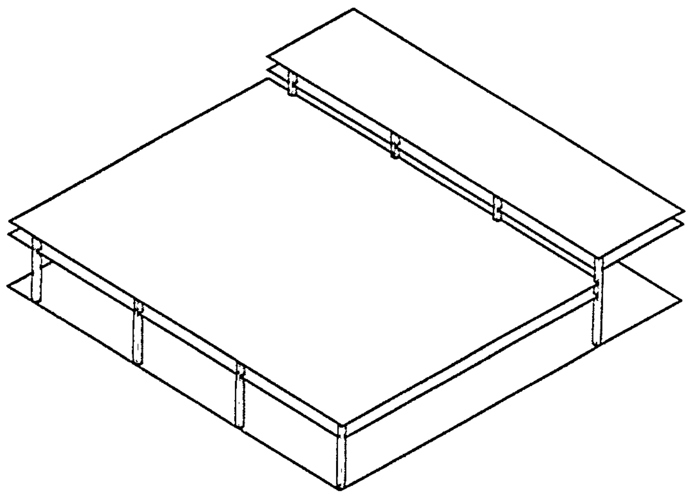
single-story and two-story buildings



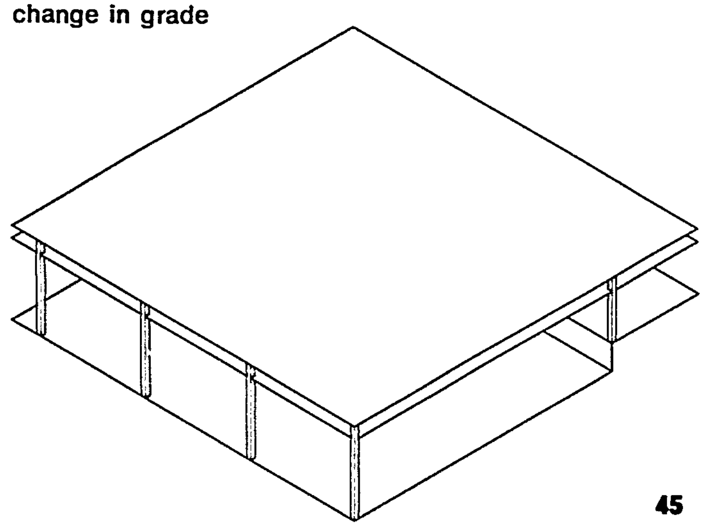
one and two-story buildings with inside corner



change in ceiling height



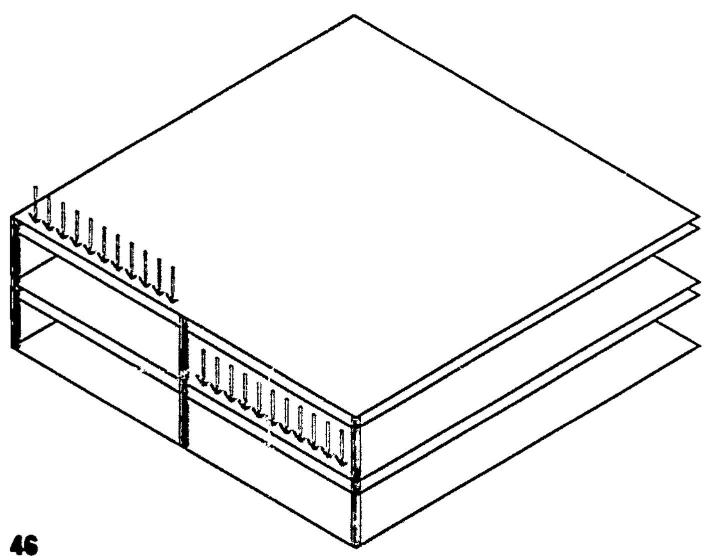
change in grade



Loading

Roof: live load 20 pounds per square foot; dead load 5 pounds per square foot plus structure, roofing, and insulation (California conditions did not require snow loads).

Floor: live load 50 pounds per square foot; dead load 26 pounds per square foot plus structure.



Dimensional tolerances

Structural members may not deflect below the horizontal under full live load.

Maximum variation allowed above the horizontal including camber and deflection will be 1/360 of the span except as follows: maximum variation for 70 and 75 foot spans will be 2 inches.

Exterior materials

The SCSD system does not include exterior finishes. Exterior walls are designed by the school district architect. To insure a reasonable amount of freedom of choice for the architect, the structural subsystem must provide a method of attachment at five foot intervals for exterior materials.

Roofing warranty

Roofing, insulation, flashing, and any other materials necessary to give a 20-year bonded type roof will be considered a part of the structural subsystem bid.

Note: Structural subsystem does not include lateral bracing or stairways. Lateral bracing requirements are largely a function of building configurations and consequently were left to the district's structural engineers. Stairways were uncommon enough within the project to make their inclusion uneconomic.

Heating/Ventilating/Air Conditioning

Subsystem components

Heating, ventilating, and cooling equipment plus any plumbing, controls, and wiring which services the equipment.

Performance criteria

Temperature: plus or minus 2 degrees

Outside air: minimum 8 cfm per person

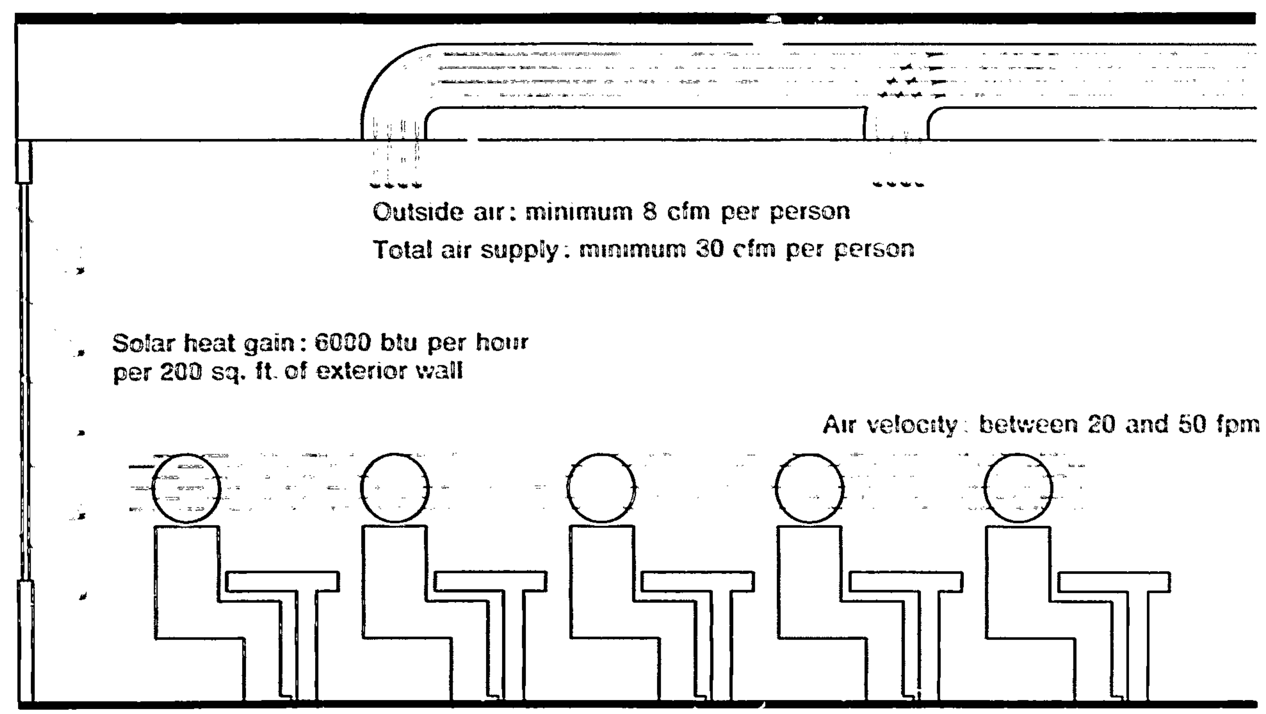
Total air supply: minimum 30 cfm per person

Air velocity: between 20 and 50 fpm

Solar heat gain: 6000 btu per hour per 200 sq. ft. of exterior wall

Outside temperature range (for design): 30 to 100 degrees*

*The successful bidder used an expanded range in designing subsystem components.



Mechanical Service Module (MSM)

The heating, ventilating, air-conditioning subsystem must maintain thermal conditions outlined in performance criteria for a minimum area of 3,600 square feet of any configuration allowable using the partition planning module of 4 inches. The system must further permit individual control in zones as small as 450 square feet. A single mechanical service module may be comprised of from one to eight such control zones.*

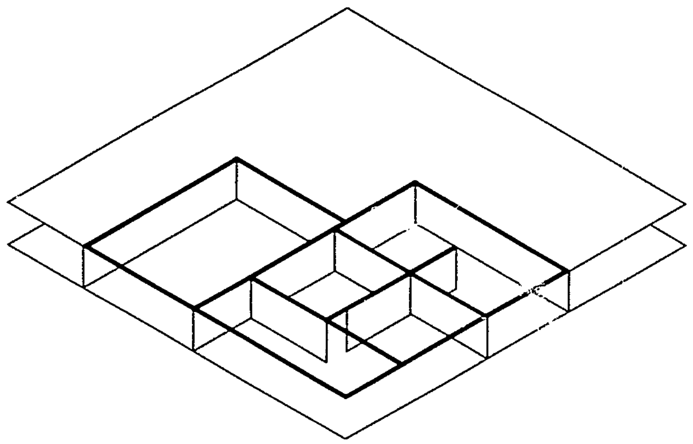
*The successful bidder has provided means to control up to 12 control zones with one unit.

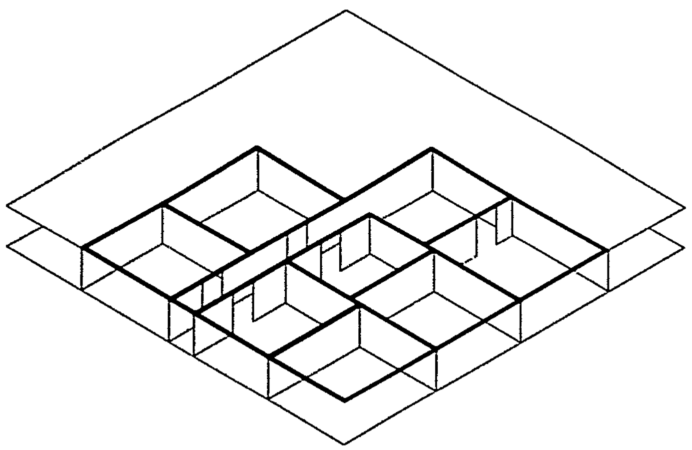
Flexibility

Anticipating rearrangement of the space divisions within the mechanical service module during the lifetime of the building, it was required that the heating, ventilating, and air-conditioning subsystem permit a great variety of rearrangements without modification of equipment, disturbance of other subsystems, or sacrifice of prescribed performance criteria.

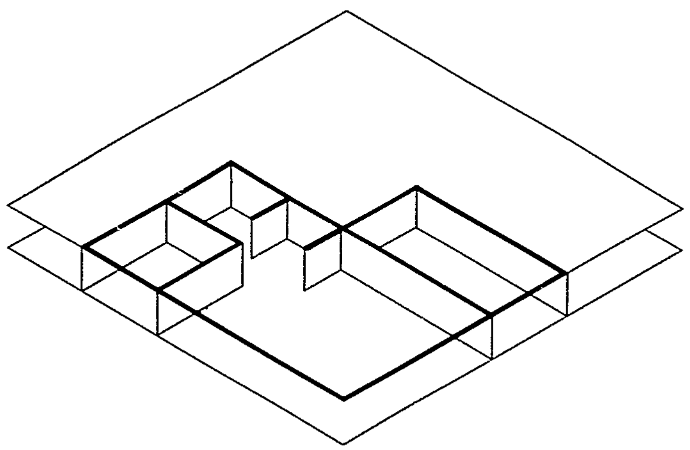
Maintenance contract

The manufacturer must furnish a long-term maintenance contract extendable to a total of 20 years, which is to include periodic inspection and replacement of parts on failure and as necessary on a preventative maintenance basis.





The 3,600 square foot MSM may have 1 to 8 control zones as small as 450 square feet each.



Subsystem must permit rearrangements of space divisions within MSM without loss in performance.

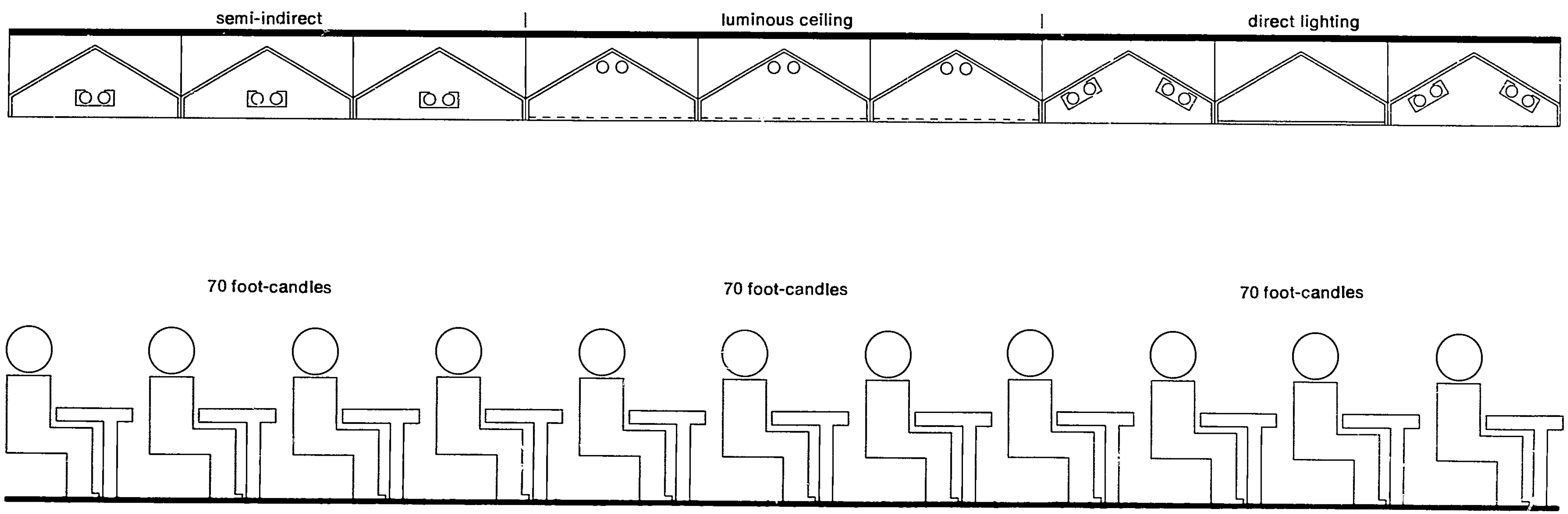
Subsystem components

This subsystem includes the total aggregate ceiling construction from wall to wall plus all lighting, acoustical, and ceiling members including flat opaque ceiling panels. It must also provide for introduction and return of air if not otherwise provided by the heating-ventilating-air-conditioning subsystem.

Academic area lighting

Subsystem is to include the following types of lighting-ceiling assemblies: luminous ceiling assembly; direct assembly; semi-indirect assembly.

Thus three visibly different lighting systems are provided for academic areas, each meeting the same lighting criteria. In addition, components for gymnasium lighting and subsidiary areas such as corridors are to be included.



Performance criteria for academic spaces

Average illumination at the work plane must be at least 70 foot-candles maintained.*

Illumination at the work plane at any point more than 4 feet from the walls must be not more than 25 per cent below or above average illumination level.

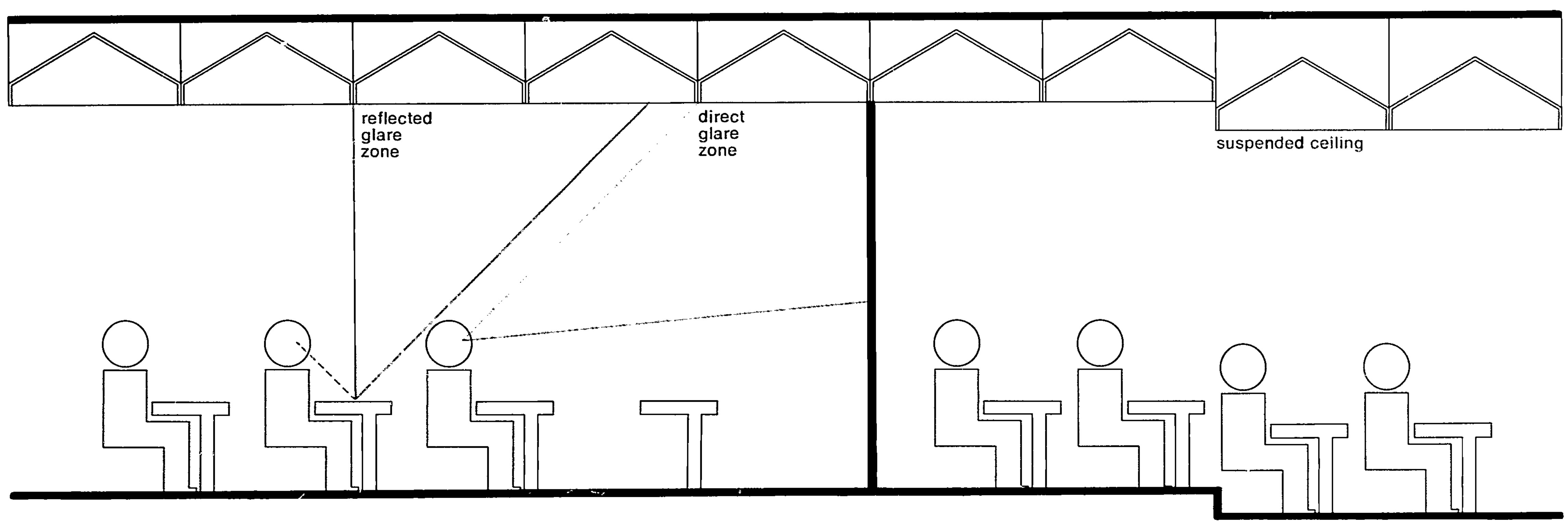
Maximum brightness of any area in the direct glare zone must not be more than 350 footlamberts.

Maximum brightness of any area in the reflected glare zone must not be more than 500 footlamberts.

The subsystem must be so designed that in certain areas ceiling may be suspended or attached 12 or 24 inches lower than the normal ceiling plane.

Note: These intensity and brightness criteria were difficult to meet using catalogue components except by using architecturally unacceptable fixtures which drop well below ceiling.

*Successful bidder provided for levels from 35 to 210 foot-candles.



Flexibility

The subsystem must provide for rearrangement of its components within the 5 foot structural module. The rearrangement characteristics must be such that the requirements of other subsystems may be accommodated.

Compatibility

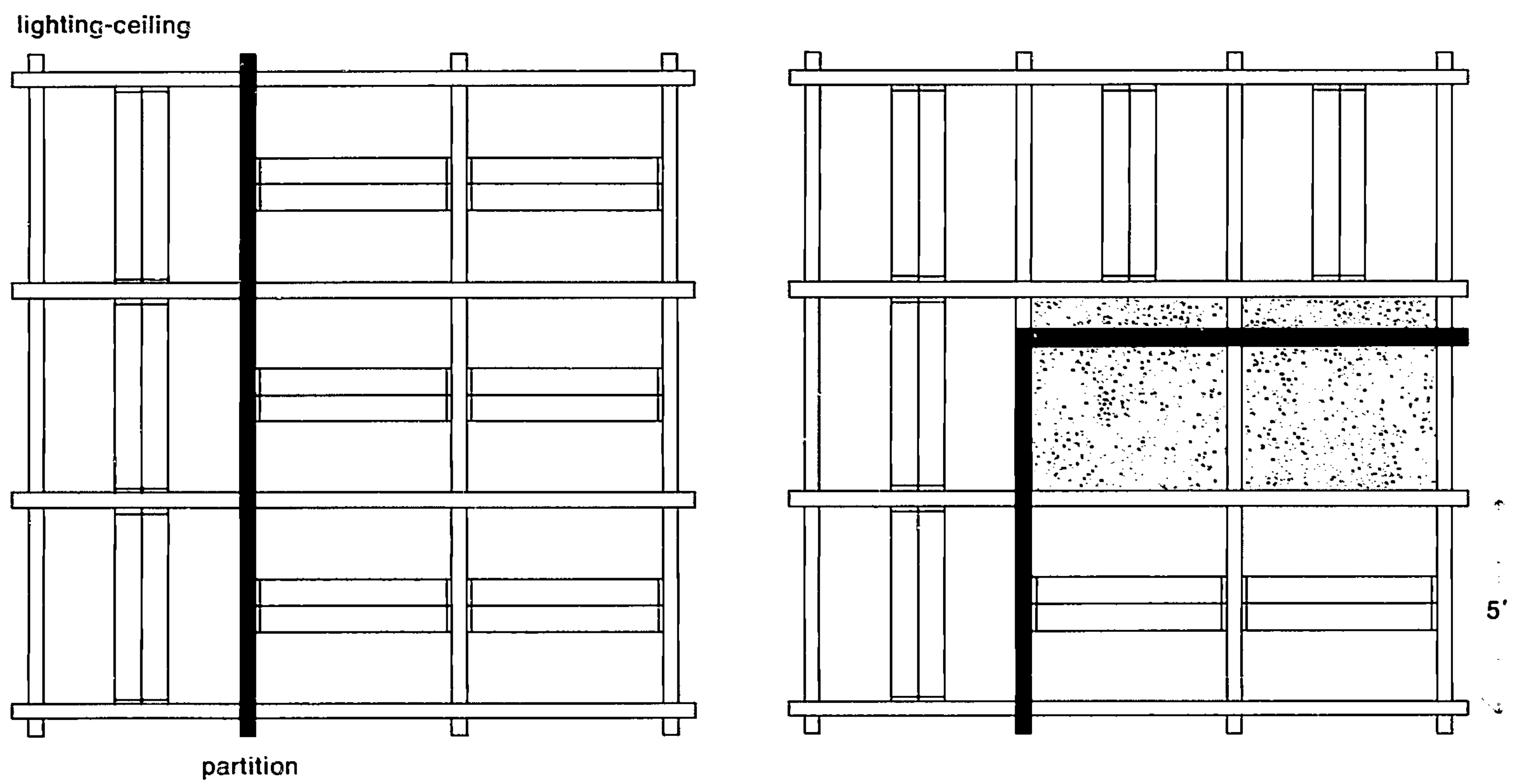
The lighting-ceiling subsystem must be so designed that the presence of an interior column will not necessitate the omission of lighting capability in more than one 5 foot module.*

The subsystem must be able to receive and provide necessary stability for interior partitions which may be located on any increment of the 4 inch partition planning module.

The subsystem must acknowledge the requirements imposed by the heating, ventilating, and air-conditioning subsystem and allow for any necessary devices required by it.**

*Successful structural bidder through design of cruciform columns made it possible not to eliminate lighting capability in any 5 foot module.

**Cooperation between two component fabricators was necessary to meet the problem of intersecting systems.



Subsystem must provide for rearrangement of its components within the 5 foot structural module

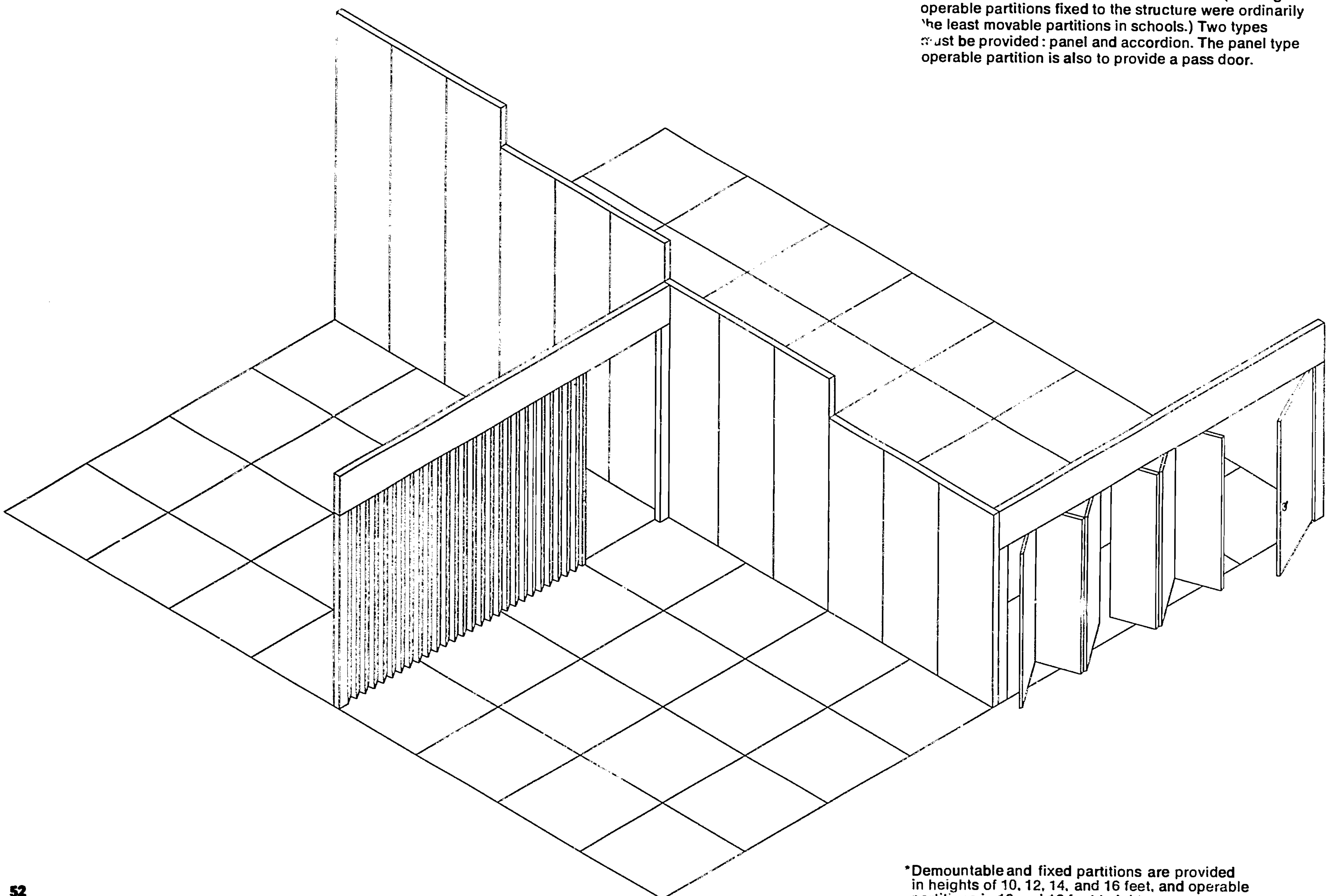
Subsystem components

The interior partition subsystem includes those elements which provide vertical separation of spaces from floor to ceiling inside the building. The following types of partitions are provided:

Fixed partitions: partitions which will be permanently set in place.

Demountable partitions: partitions which may be moved to a new location with minimal reworking of the partitions themselves or the components to which they are attached.

Demountable-Operable partitions: partitions which may be moved at will along their line of placement and in addition may be removed entirely independent of the building structure and relocated elsewhere. (Catalogue operable partitions fixed to the structure were ordinarily the least movable partitions in schools.) Two types must be provided: panel and accordion. The panel type operable partition is also to provide a pass door.



*Demountable and fixed partitions are provided in heights of 10, 12, 14, and 16 feet, and operable partitions in 10 and 12 foot heights.

Dimensional criteria

The partition planning module for thickness is to be 3 or 4 inches for fixed and demountable partitions.

The horizontal dimension of panels for fixed and demountable partitions must accommodate a 3 foot door and relate to the 5 foot structural module.

The vertical module for floor to ceiling heights is 2 feet from 10 to 16 feet. Fixed partitions provided for all modular heights. Demountable and operable partitions provided in 10 and 12 foot heights only.*

Doors are 7 feet high.

Performance criteria, fixed and demountable partitions

The partitions must be designed so that the facing on one side of a partition can be changed independently of the facing on the other side.

It must be possible for school district personnel to relocate demountable partitions, and to install and/or replace individual demountable partition panels.

Fixed and demountable partitions must permit both horizontal and vertical passage of services, a critical point for effective demountability.

Performance criteria, operable partitions

It must be possible to move an operable partition with a trained crew in not more than one week.**

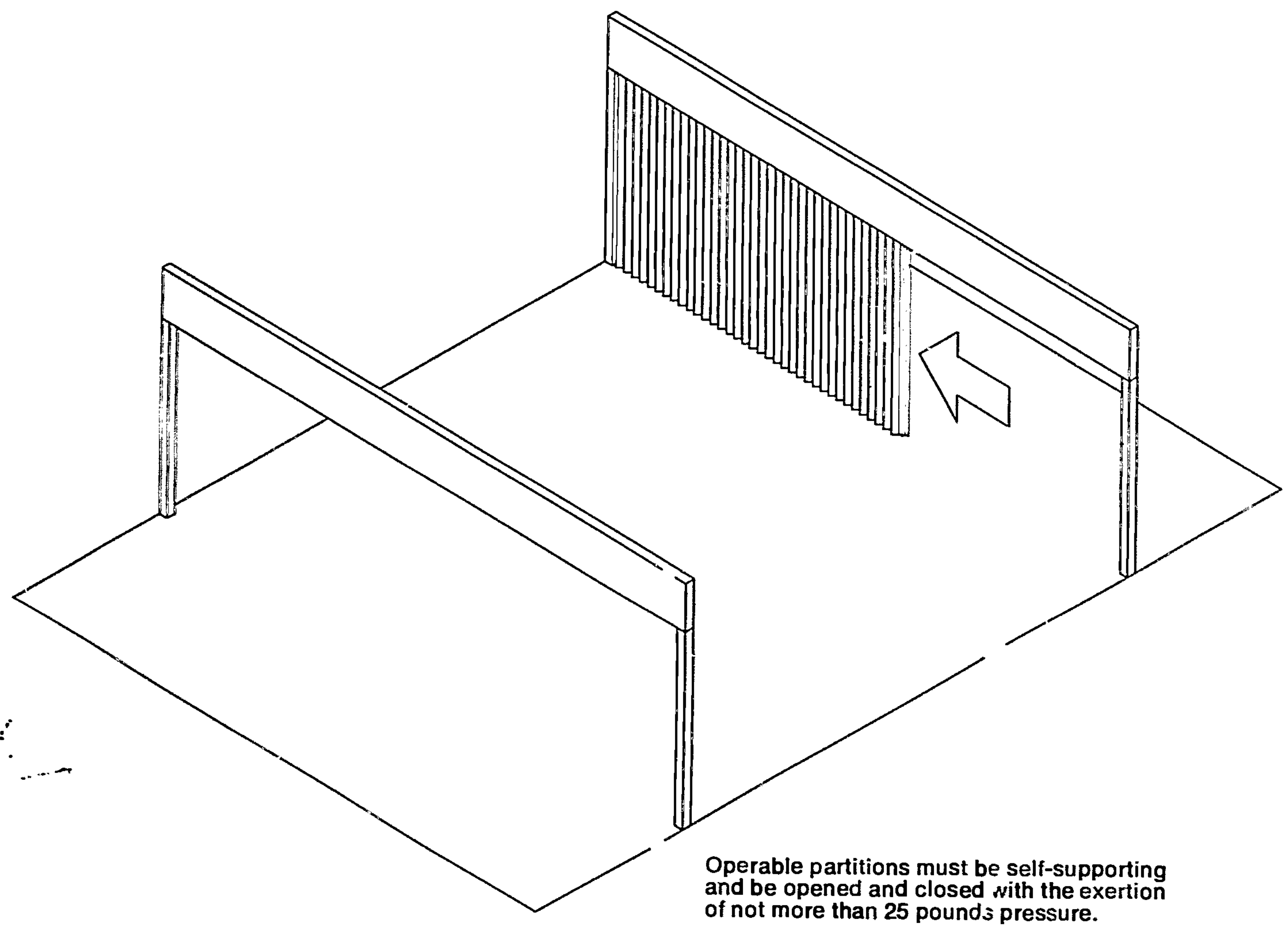
Operable partitions must be self-supporting, however they may be stayed laterally by attachment to a structural member.

Operable partitions must be designed so that they open or close with the exertion of not more than 25 pounds pressure.

**Successful bidder's partitions can be moved in 4-6 hours.

Fixed and demountable panel faces and finishes

Manufacturer provides the following panel faces and finishes: basic panel (durable but finished for chalk- or tackboard use), chalk panel, tack panel, glass panel, back-up panel (unfinished). Manufacturer is to supply basic panels in a range of 25 colors.



Operable partitions must be self-supporting and be opened and closed with the exertion of not more than 25 pounds pressure.

Subsystem description

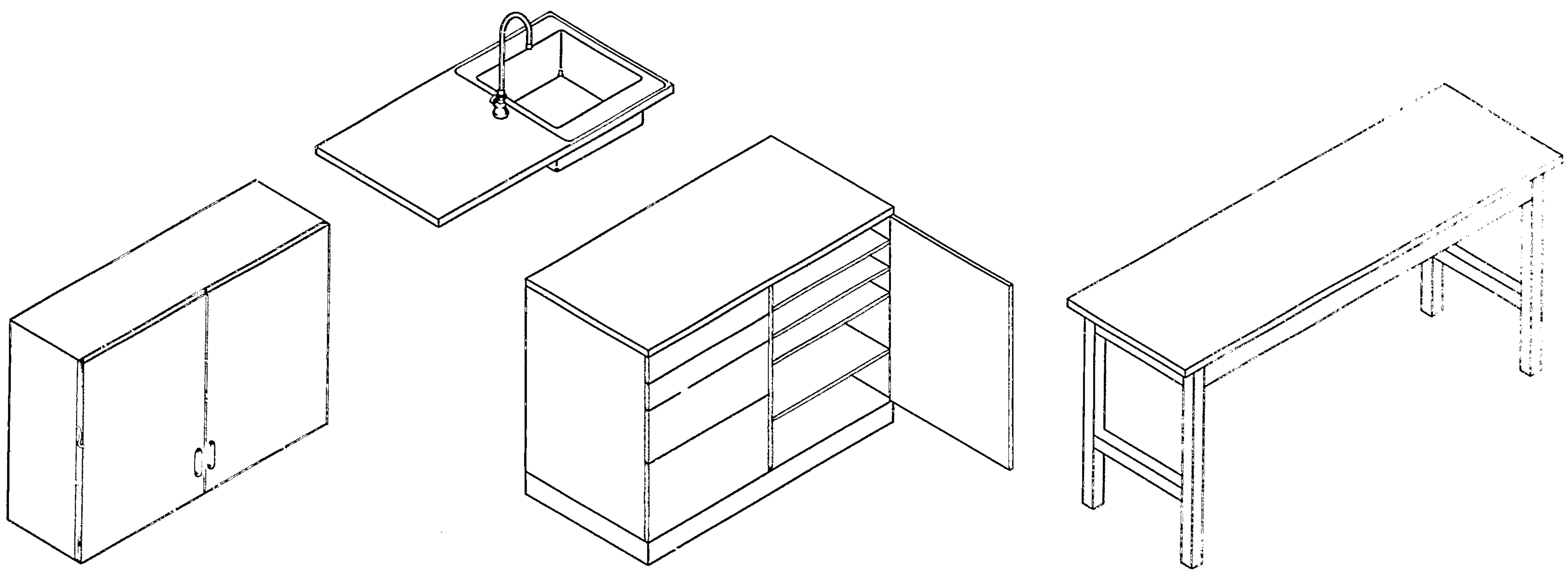
This subsystem encompasses two separate types of cabinets: science laboratory equipment and general cabinets for storage in other areas of the schools.

Subsystem components

Subsystem components include: tables, tops, cabinets, sinks and laboratory accessories, doors, drawers, and shelving.

Scope of work

Manufacturer provides in addition to components: installation of cabinets and casework; furnishing of all service fixtures such as gas, hot and cold water faucets, remote control valves, filter pumps, electrical switches, fixtures and receptacles, fume hoods and fume hood light fixtures, sinks, drain troughs, waste outlets where required; proper reinforcement and attachment devices necessary to enable ceilings and walls to support cabinets and casework, without screwing or bolting to partitions so as not to impede flexibility.



Flexibility

All cabinets, except those fixed by services, must be designed to be relocated without requiring any additional parts or new tops. It must be possible to remove and relocate a cabinet without having to replace any part of the building to which the cabinet was attached.

Dimensional criteria

The sizes of cabinets must relate to the partition planning module. Since the horizontal dimension of the interior partition panels is 40", cabinet dimensions must relate to a 40" partition joint.*

Cabinets will be provided in the following nominal (modular) sizes:

width: 60, 40, and 20 inches

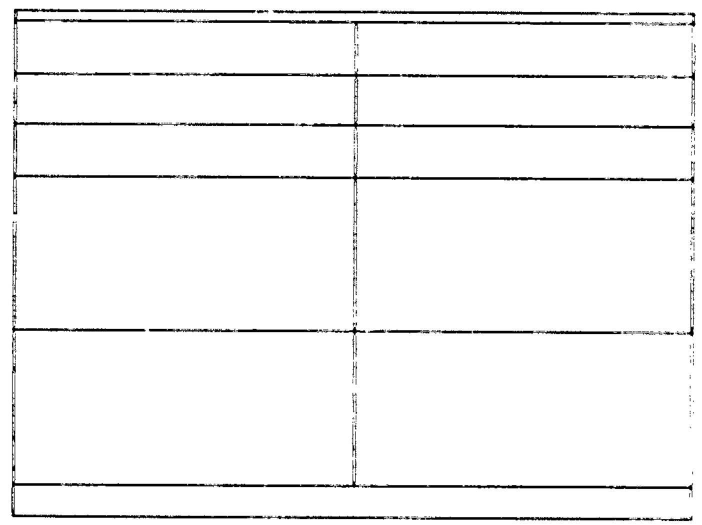
height: 84, 54, 36, and 30 inches

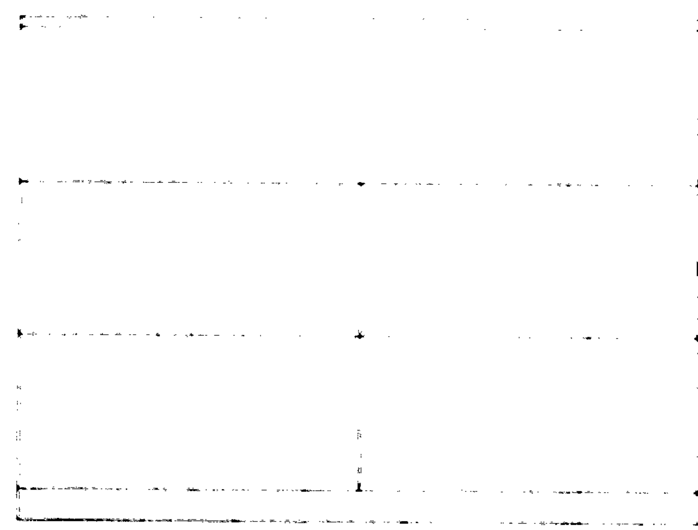
depth: 40, 30, 20, and 13 inches

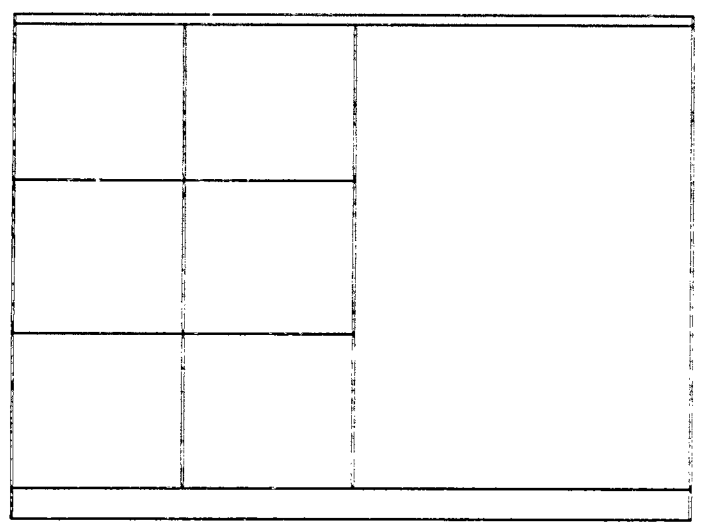
*Casework was bid later than primary components so that partition panel size was established when case work specifications were written.

Cabinet interior subdivisions

Cabinets must be designed to permit maximum freedom to modify interior spaces for varying mixes of drawer sizes or changes from drawers to cupboards as use requirements change.







Elevation of a base cabinet shows different arrangements of drawers and cupboards within the same basic carcass.

Subsystem description

This subsystem includes all student lockers, tops, finished ends, shelves, combination locks, number plates, and operating handles. Gymnasium type storage lockers are not included.

Scope of work

Manufacturer is to provide subsystem components described above including installation.

Dimensional criteria

Dimensions represented are nominal and represent maximum exterior dimensions. Door opening must allow for insertion of 13½ inch high-school ring binders.

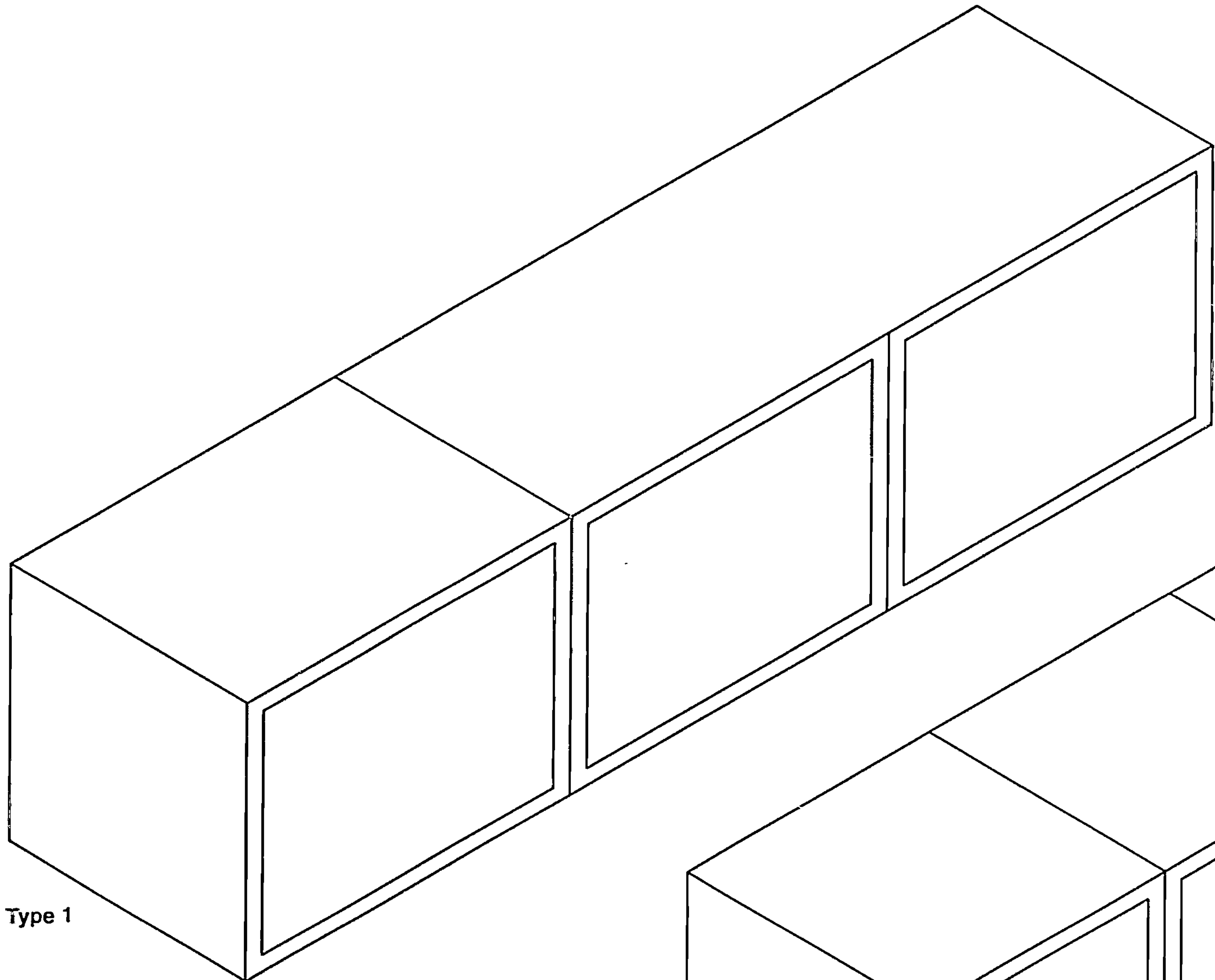
Type 1 : 20" wide, 15" deep, 15" high, four tiers

Type 2 : 15" wide, 15" deep, 15" high, four tiers

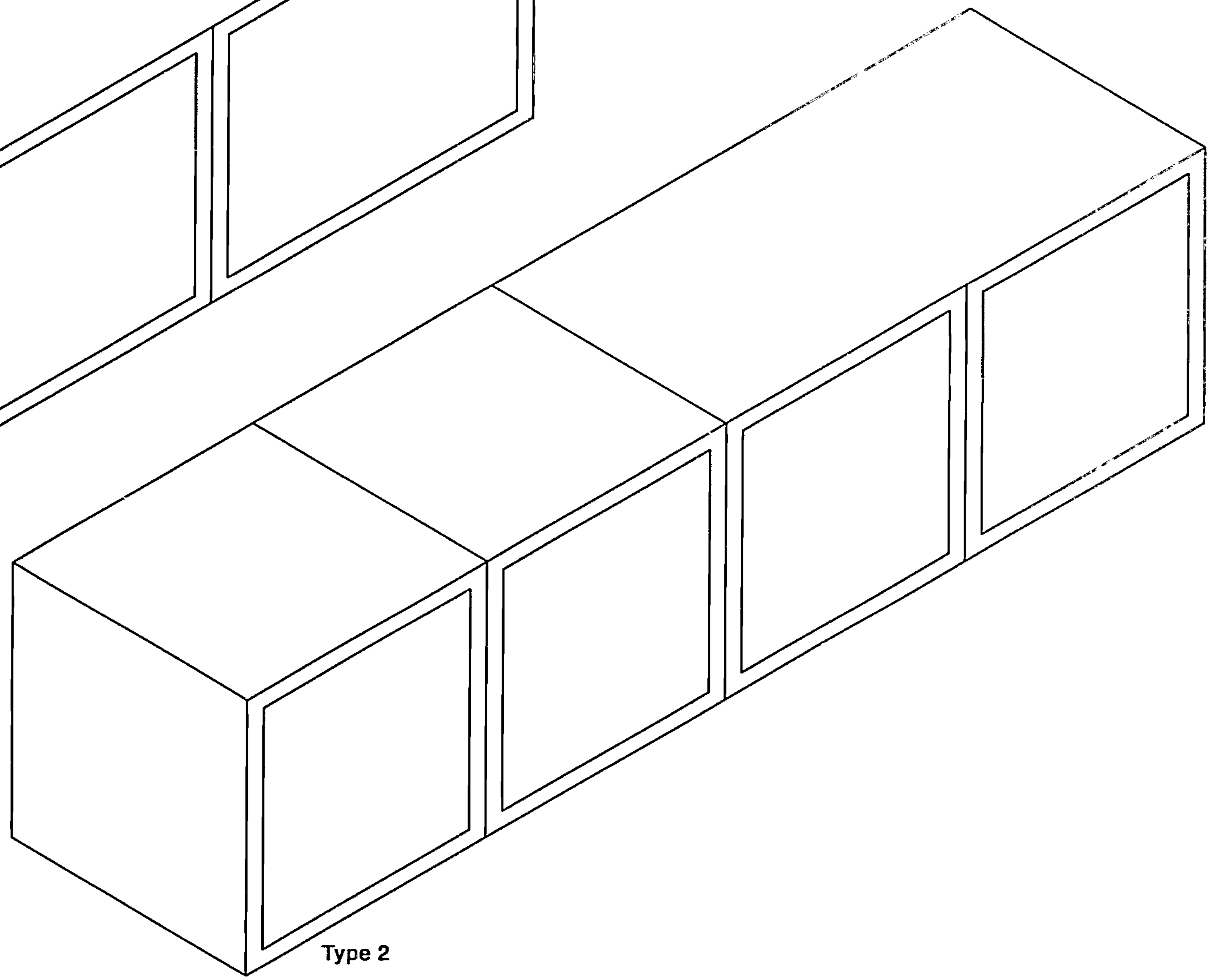
The locker dimensions were based on California requirements calling for less space for clothing and more for books. Traditional locker dimensions are based on clothing requirements in colder climates.

Arrangement requirements

All lockers are to be four tiers high. Minimum arrangement will be two lockers across. Beyond this arrangement, either odd or even locker arrangements must be possible. Lockers must be available in single or double rows (back to back). Design must permit lockers to be arranged free standing or backed up to an exterior wall with ends exposed or with one or both ends also against a wall.



Type 1



Type 2

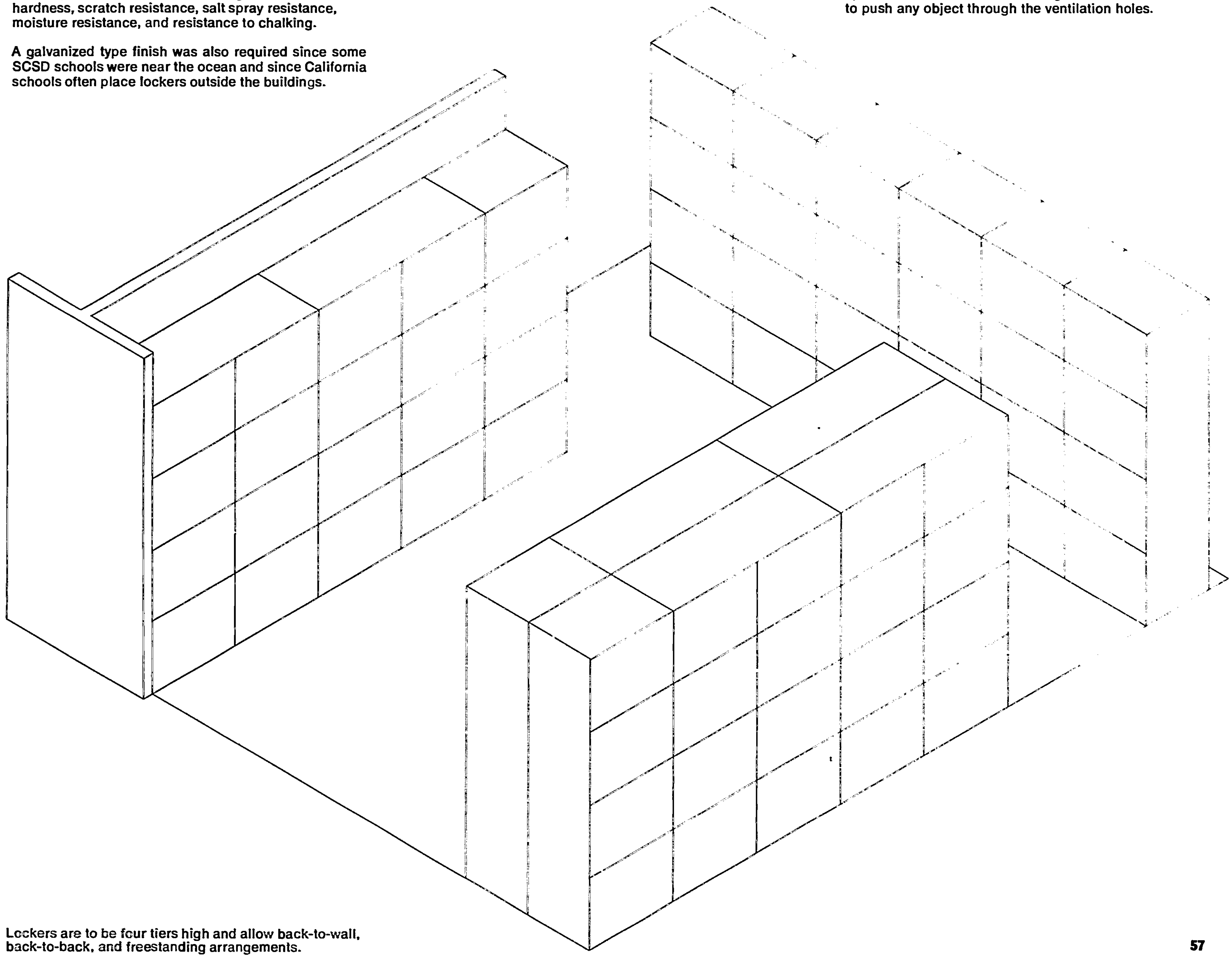
Finish

Manufacturer is to provide lockers in four colors and is to provide finishes which will be tested for satisfactory performance in the following characteristics: hardness, scratch resistance, salt spray resistance, moisture resistance, and resistance to chalking.

A galvanized type finish was also required since some SCSD schools were near the ocean and since California schools often place lockers outside the buildings.

Ventilation

Lockers are to be ventilated with one square inch of penetration for every 1,000 cubic inches of locker space. Ventilations must be designed to make it difficult to push any object through the ventilation holes.

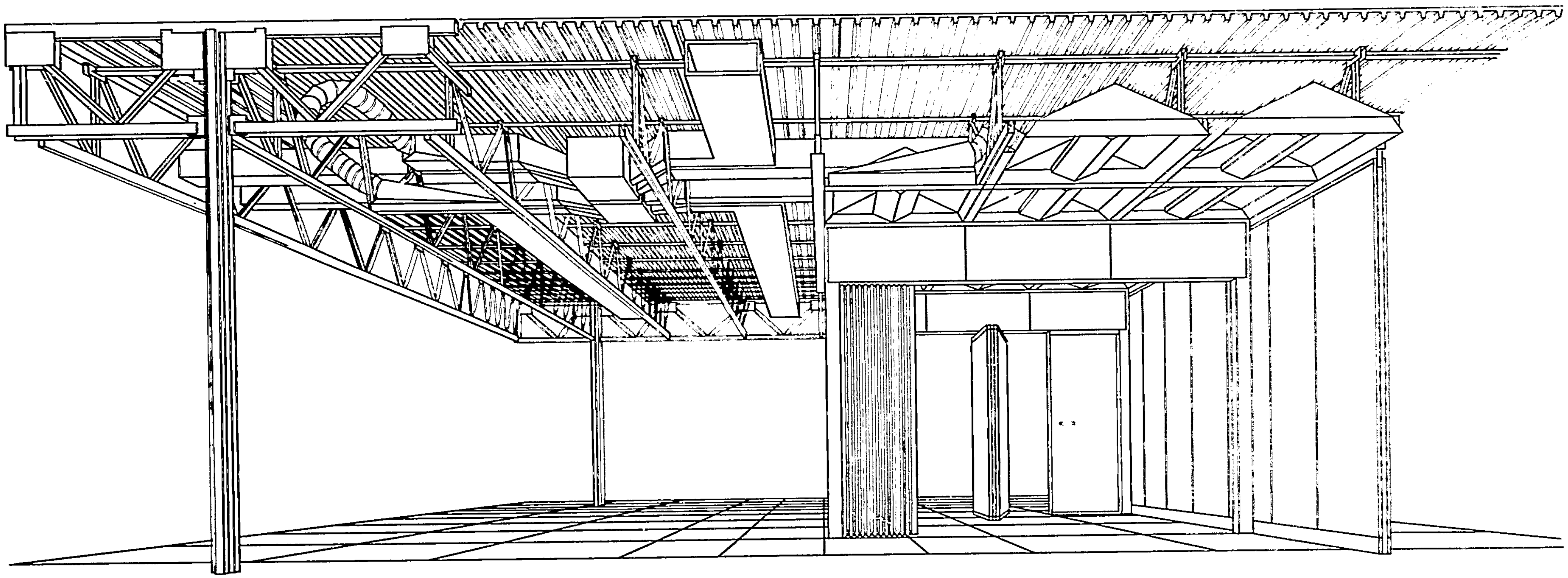


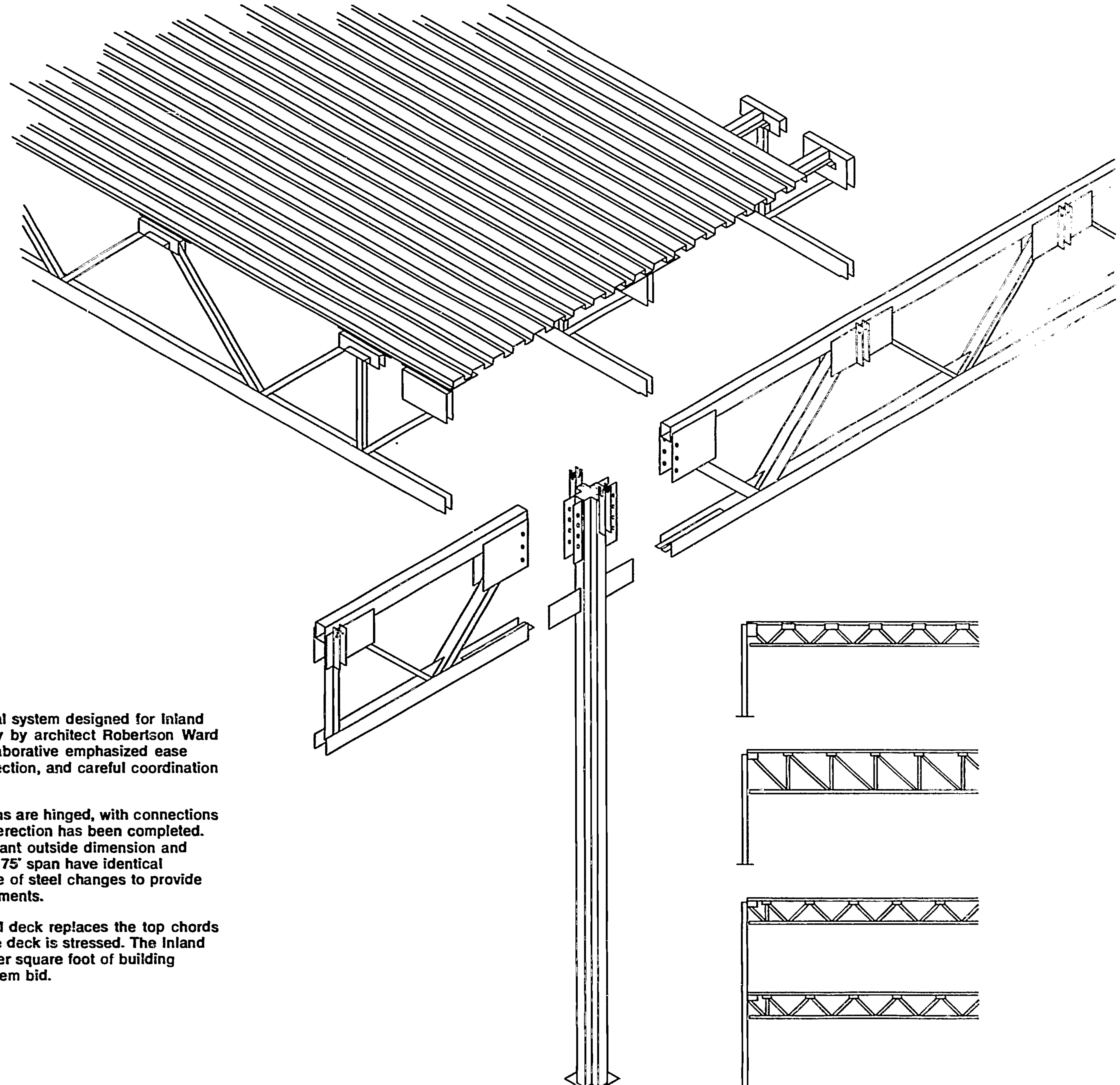
Lockers are to be four tiers high and allow back-to-wall, back-to-back, and freestanding arrangements.

SCSD Components

The SCSD system is a set of coordinated components. Coordination among manufacturers started, with the assistance of the SCSD staff, as the manufacturers prepared their designs for bidding. After bidding, efforts to effect a high level of coordination of components were continued at an increasingly intense rate among the successful bidders, guided by the SCSD staff. This process culminated in the prototype building, completed on the Stanford University campus in November, 1964. The refinement of details was continued for many months after initial completion of the building.

Much of the efforts toward coordination focussed on the space between ceiling and roof deck—the "integrated sandwich." In this space, freeways were arranged for plumbing, conduit, and electrical services to reduce subcontractor conflicts during construction.

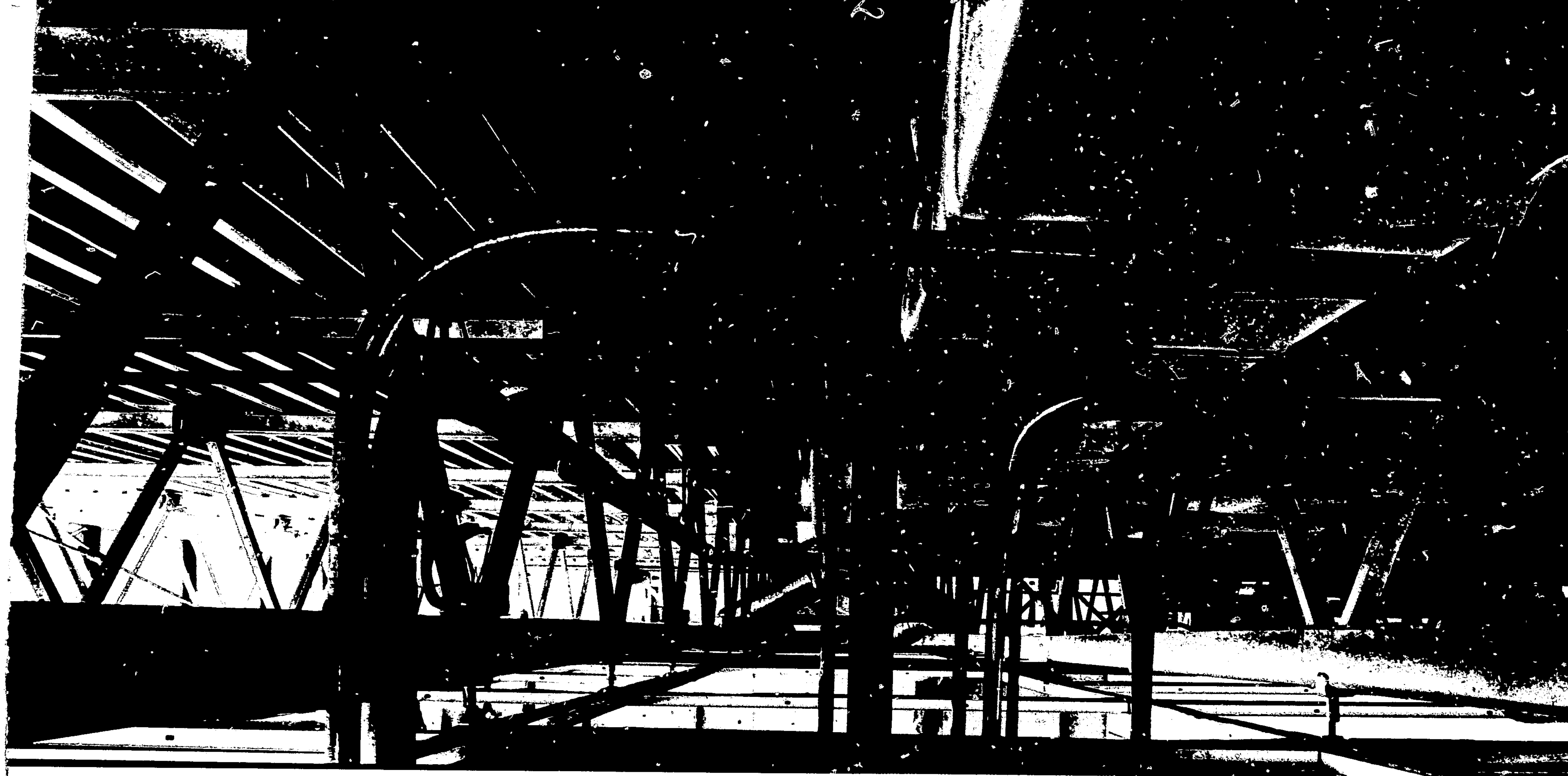


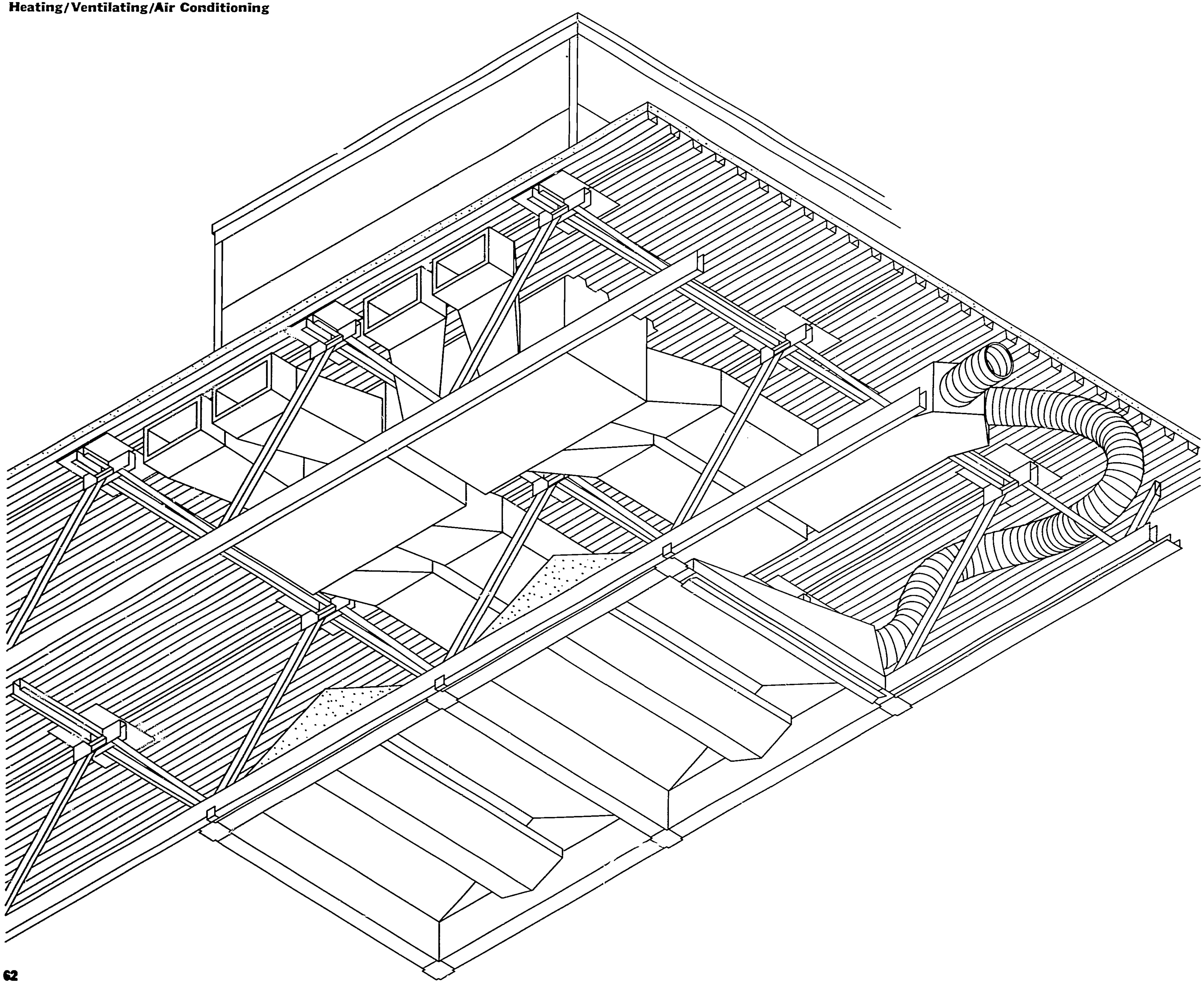


The orthotropic structural system designed for Inland Steel Products Company by architect Robertson Ward and The Engineers Collaborative emphasized ease of shipping, speed of erection, and careful coordination with other components.

Trusses and deck sections are hinged, with connections which are welded when erection has been completed. All columns are of constant outside dimension and all trusses of from 30' to 75' span have identical geometry; only the gauge of steel changes to provide for differing load requirements.

To save weight, the steel deck replaces the top chords of the trusses so that the deck is stressed. The Inland system used less steel per square foot of building than any other steel system bid.



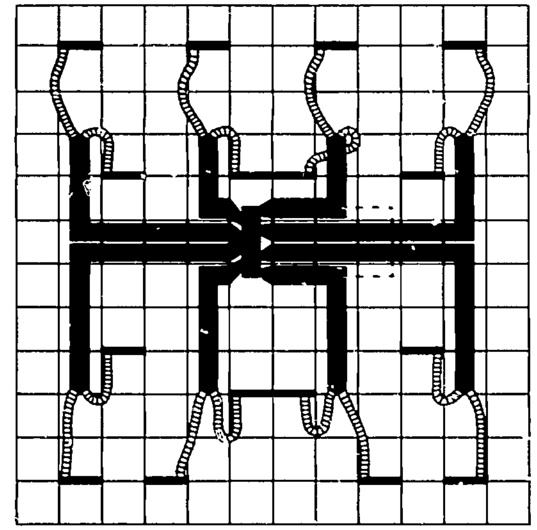


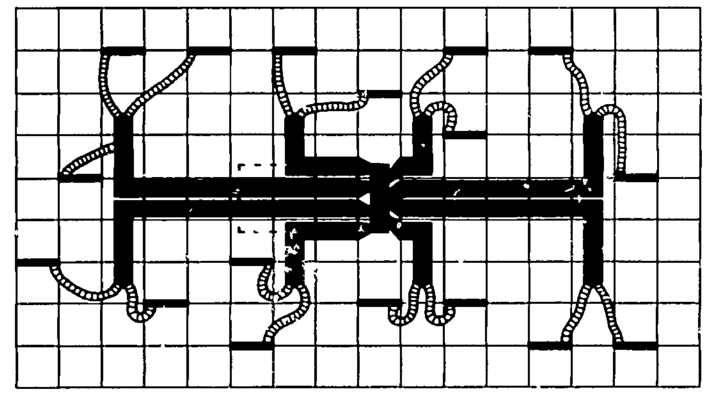
The Lennox HVAC system is based on a self-contained heating and cooling unit sized to match the mechanical service module. Depending on load, the unit may serve from 2,500-5,000 square feet of space.

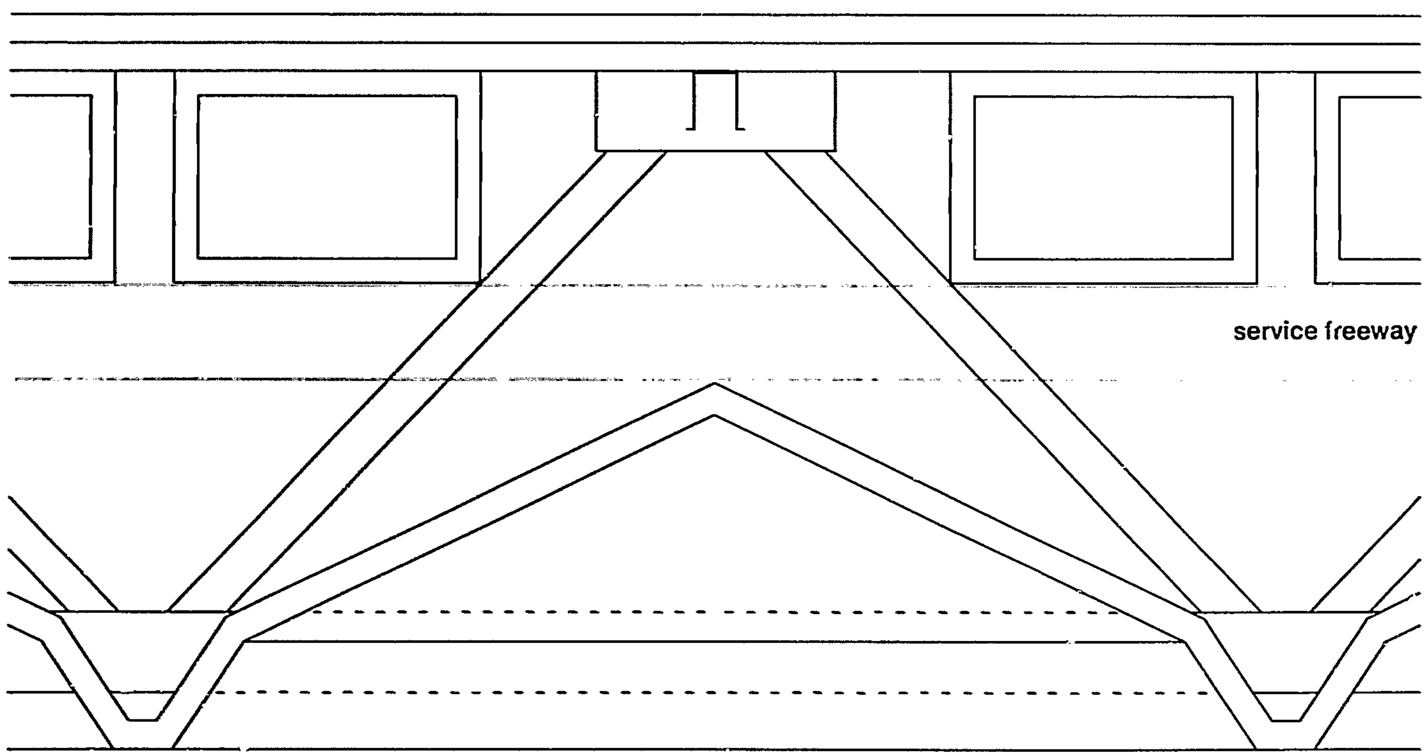
The roof unit feeds directly into mixing boxes below it which in turn provide air to the fixed ducts. Air is returned to the system through the open plenum.

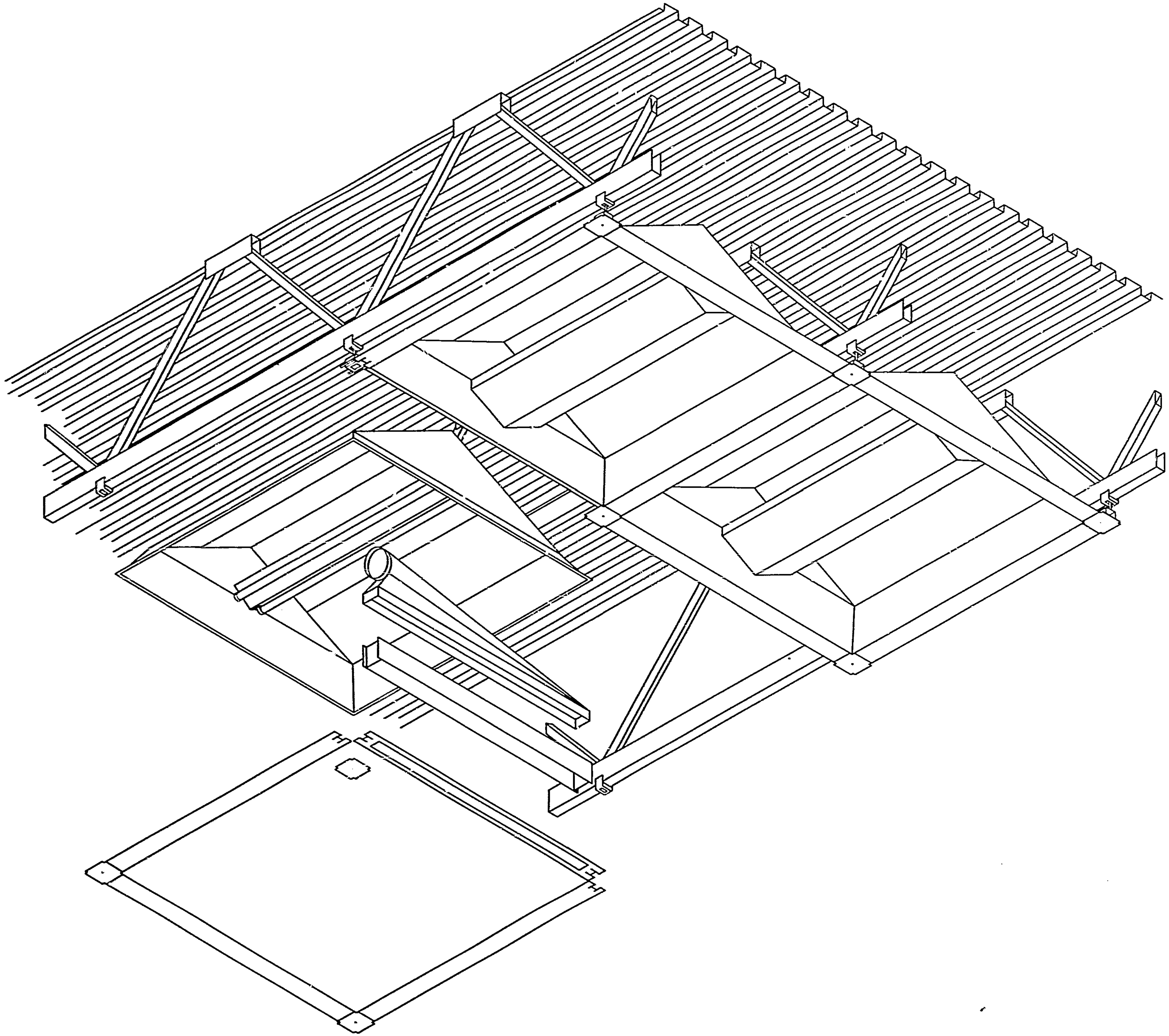
Patterns of standardized fixed and flexible ducts, combined with removable supply and return diffusers, allow for great freedom in arranging control zones. The cooling unit is completely separate from the heating and ventilating unit, so that cooling can be added at a later date, if desired.

The glass fiber duct system, together with carefully designed vibration isolation from the light steel structure, makes for a very quiet system.







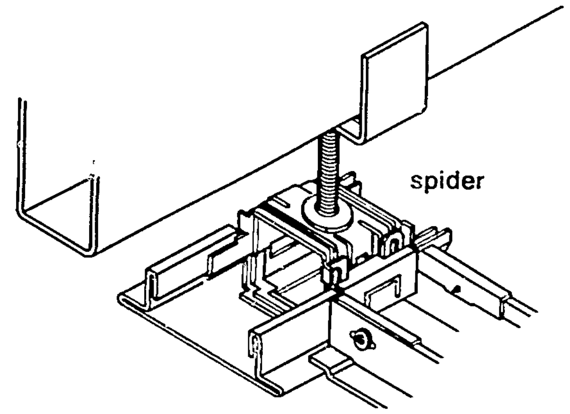


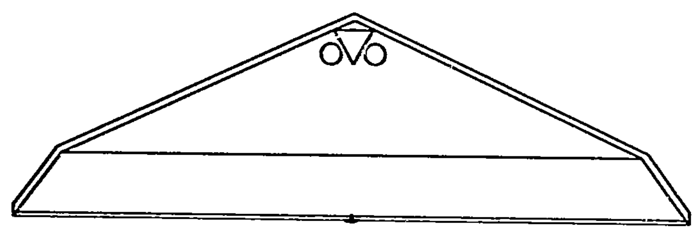
The lighting-ceiling system, also designed by architect Robertson Ward, for Inland Steel Products Company uses a small number of standard components to provide a wide variety of lighting intensities and visual effects.

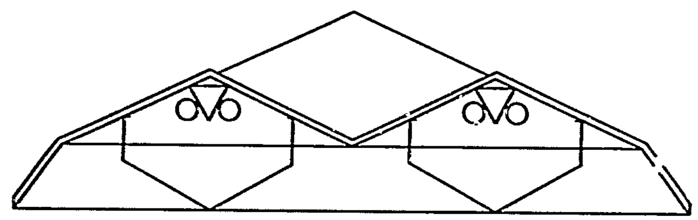
A uniform two-tube fluorescent lighting fixture is used with three optional plastic diffusers. The metal coffer can receive one, two, or three two-bulb fixtures, and the top section of the coffer (which is removable for access to the ceiling space) can be used, inverted. The ceiling-lighting system is fastened to the structure every 5' by a "spider" to which the ceiling runners are attached. The spider, which compensates for the camber or deflections in the trusses, provides a thermal break between ceiling and structure for fire protection purposes and provides lateral support for the partitions. The spider was developed by Fastex Division, Illinois Tool Works, Inc., for Inland Steel Products.

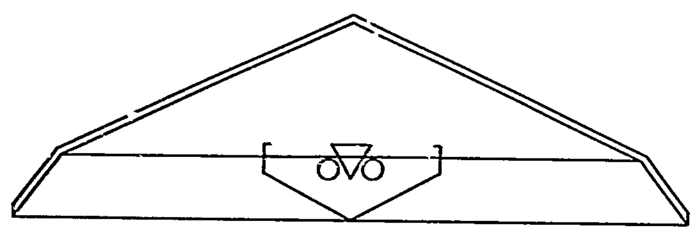
The flat metal pan system is provided plain or with perforation to increase acoustic absorption. The flat pan ceiling is suitable for both interior and exterior use. The top panel of the coffer may also be perforated for acoustic absorption. The mineral wool layer above the ceiling thus serves both for fire protection and for acoustic purposes.

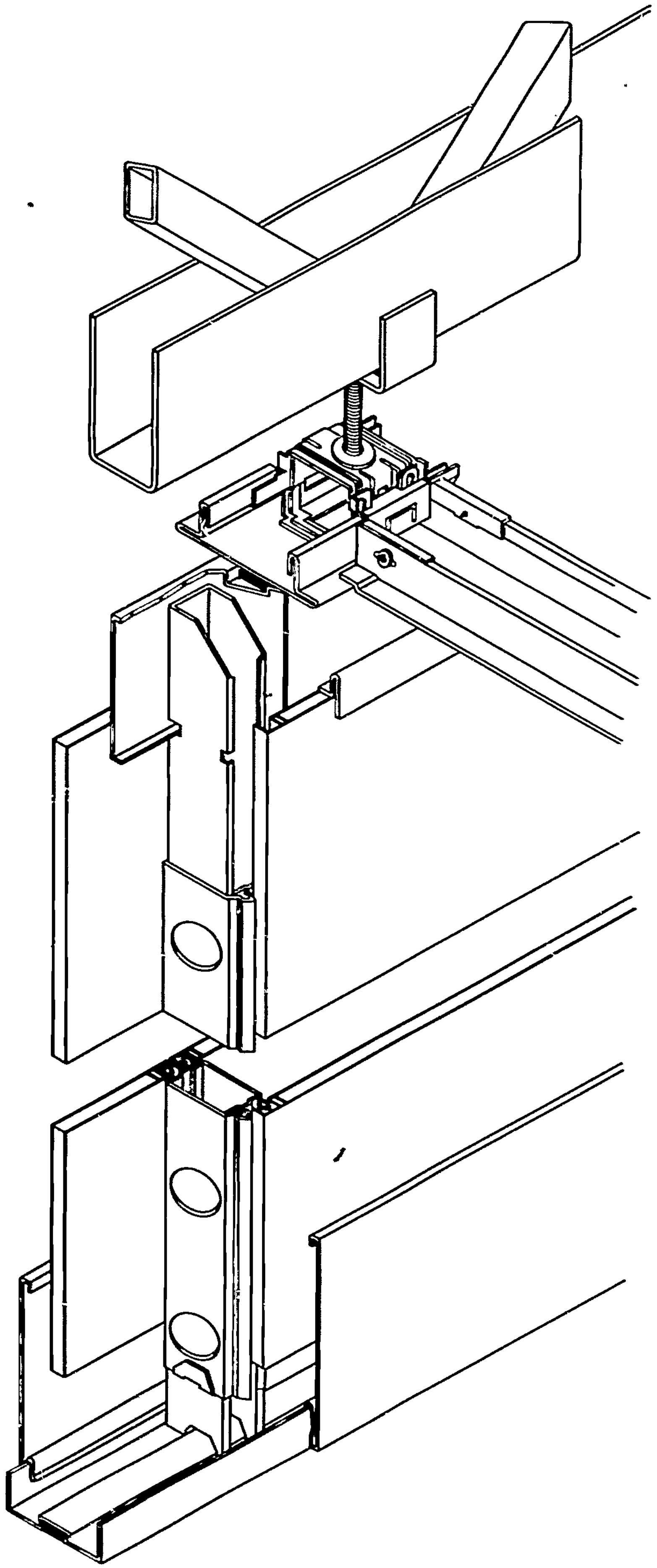
The three basic academic lighting systems are produced by simple rearrangement of the basic components. The direct system, with two two-tube units per coffer, using half the number of lighted coffers, provides the same lighting intensity as the other two systems.




luminous


direct


semi-indirect

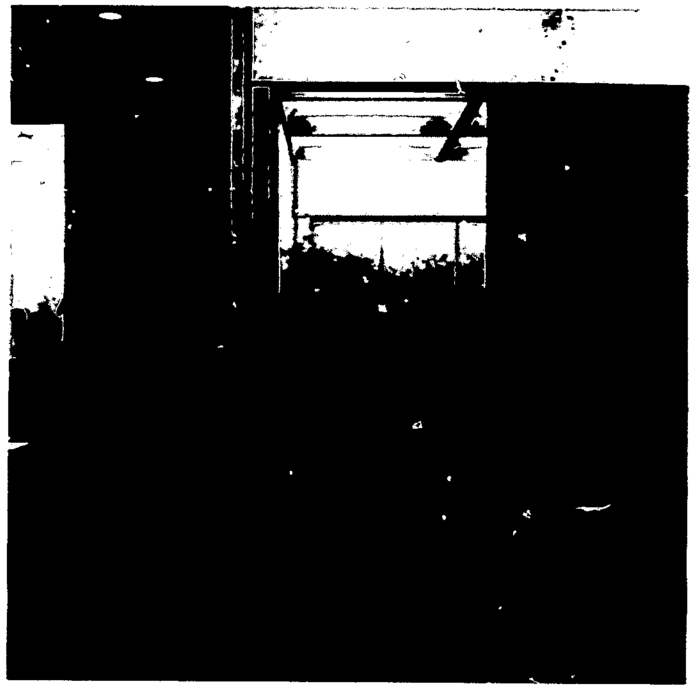


The fixed and demountable partition system developed for SCSD by the E. F. Hauserman Co. consists of 40-inch wide panels of steel-covered gypsum board which snap onto a specially designed metal stud. The studs are clipped to floor and ceiling channels, and the top of the stud incorporates a telescoping section which allows for 2 inches of structural deflection.

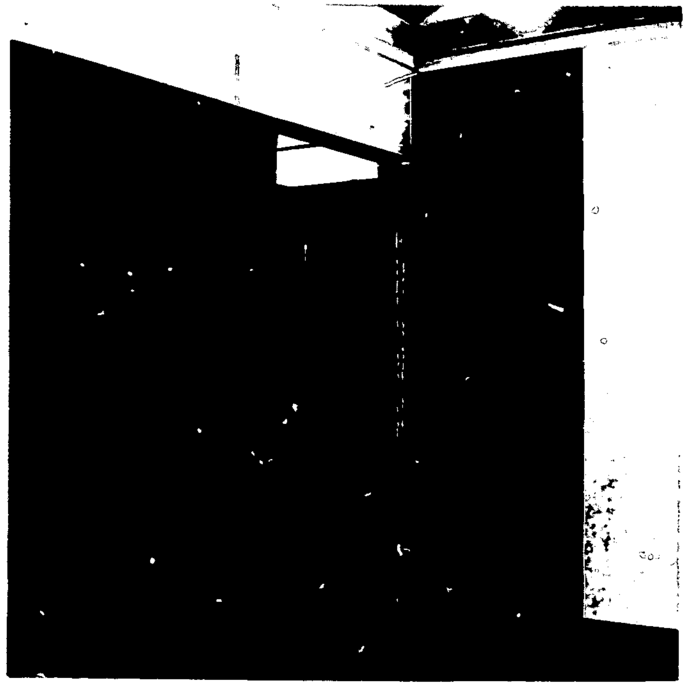
A variety of colors and finishes are provided, including a floor to ceiling chalkboard surface. Small magnets or magnetic tape are used instead of thumbtacks for holding display material.

The operable partitions have their own supporting structure, so that the weight of the partitions is not carried by the building structure. In the accordion operable partition, designed by Hough Manufacturing Company, the support structure is raised by a crank operated cam in order to release the acoustic seal and allow tree partition movement. In the panel operable, which was designed by Western Sky Industries and subsequently sold to Hough Manufacturing Company, a retractable top and bottom seal accomplishes the same purpose.

accordion operable and panel operable

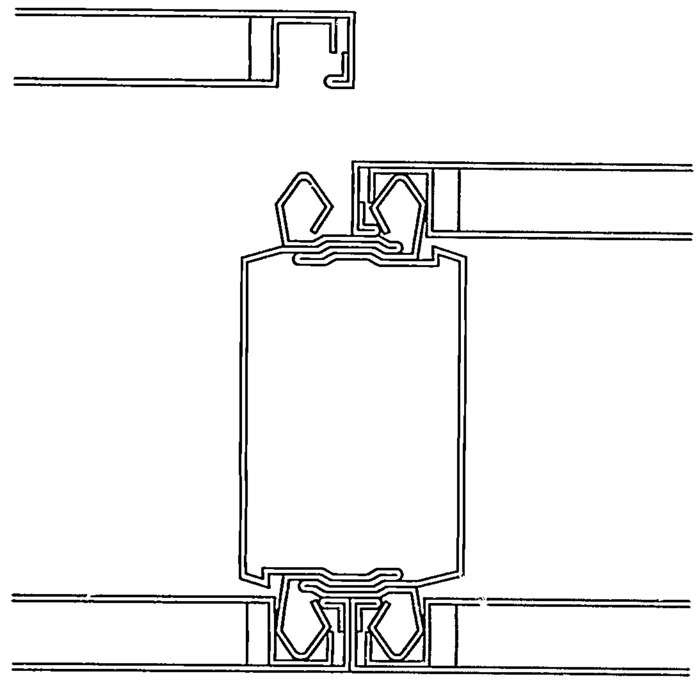


accordion operable and demountable



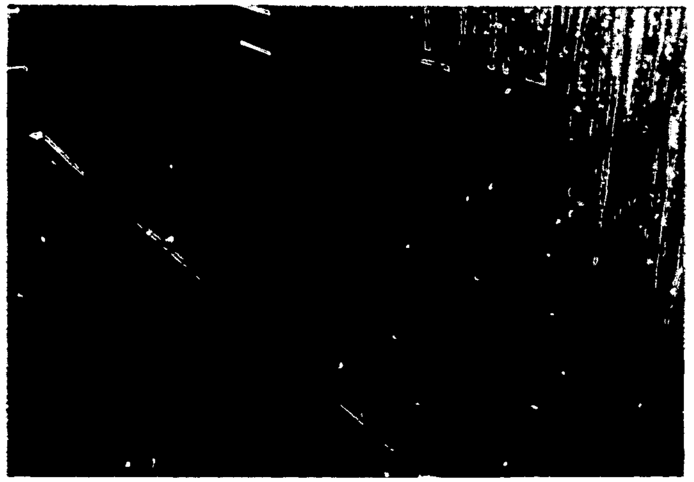
panel operable

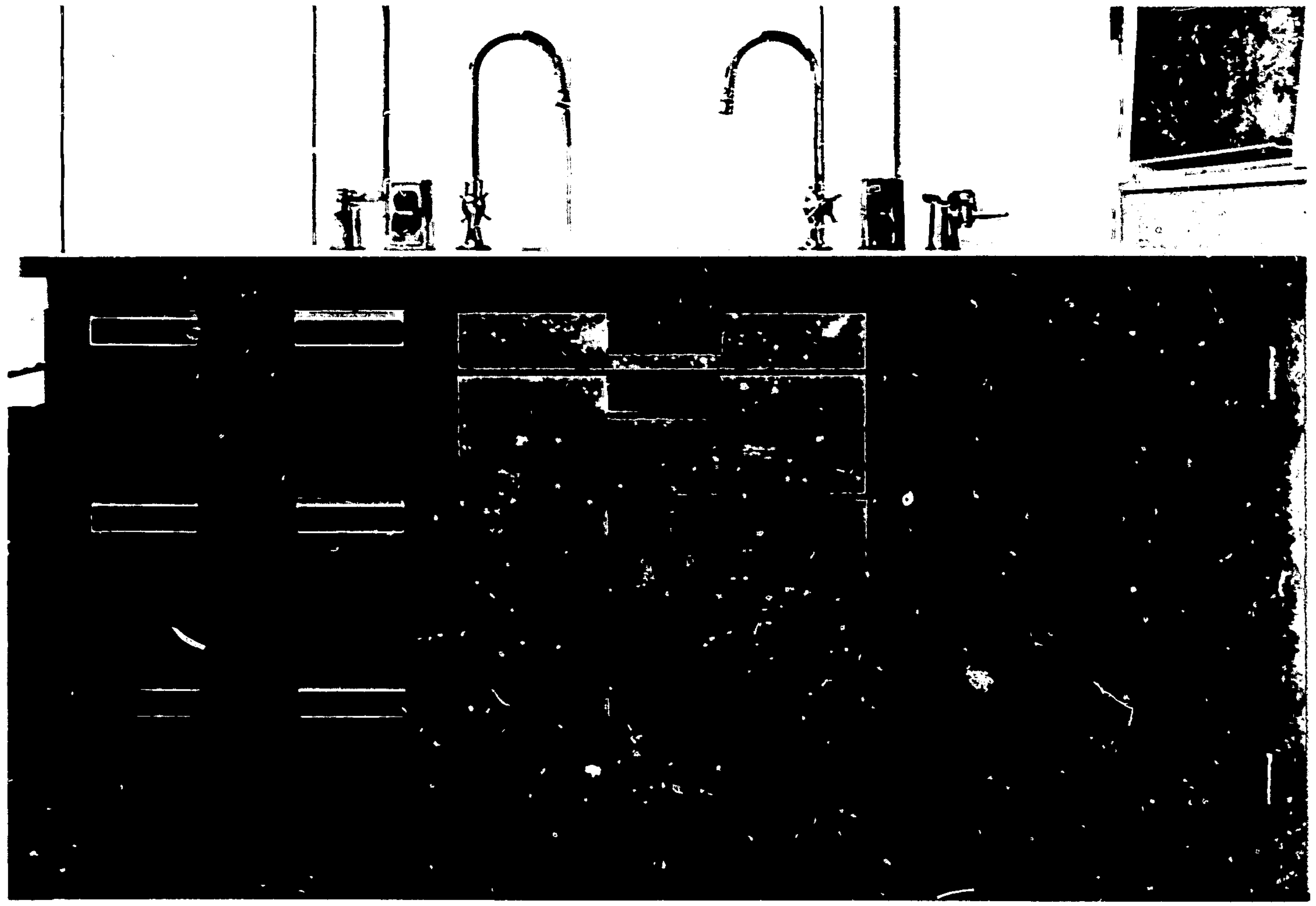
demountable



Cabinets

The cabinet system is constructed of wood and particle board, with tops in laminated plastic or colorceran. The system was developed by Educators Manufacturing Company. Drawer and door faces are melamine plastic, in four solid colors or teak wood grain finish. Hinges and pulls were specially designed for this cabinet range to meet SCSD specifications. Plastic inserts in predrilled holes allow for effective relocation of interior shelves, drawers, and doors in combination so that the functional use of the cabinets could be changed without moving the cabinet carcasses. Wall hung cabinets hook onto the partitions without permanent fastening to facilitate flexibility.





Lockers

Lockers built by Worley are conventional in construction; refinements include sound dampening hardware. Architects may choose up to 4 colors for a given school out of a total range of 56 colors. The new size has proved effective for storing books and binders, but the march of events has overtaken the original performance specification—the lockers cannot accommodate some motorcycle helmets.

Other Systems

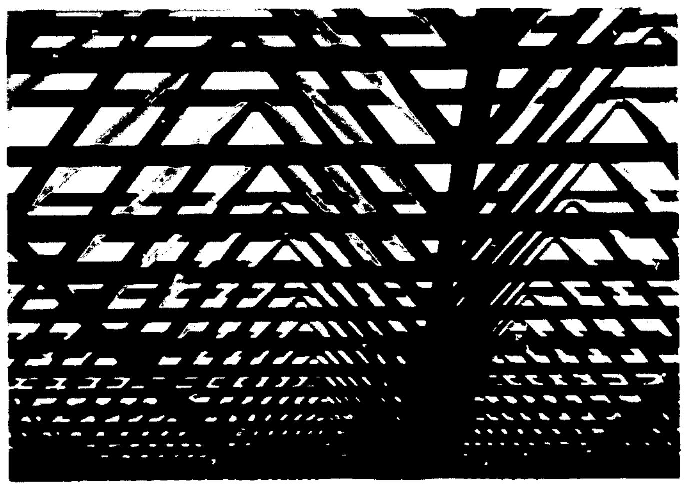
A result of the SCSD program has been the appearance on the market of a number of systems and components designed to be competitive with the SCSD range. This accomplishes one of the aims of the program, which was to make a new range of components available to the educator and architect for the solution of their problems.

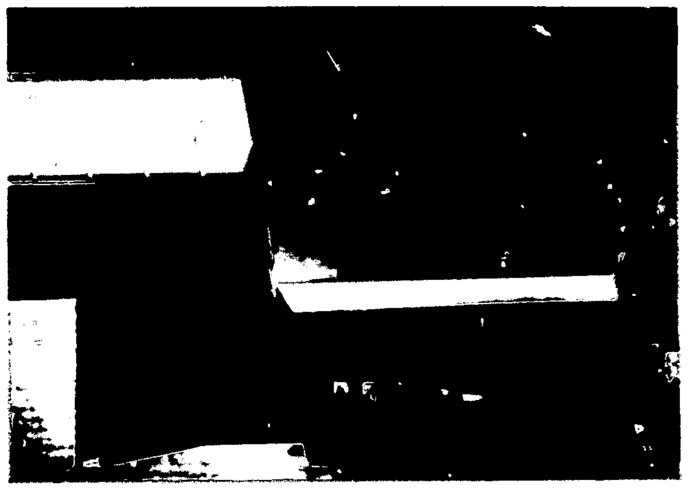
Some of these components have been developed by manufacturers unsuccessful in the initial SCSD bidding process; others have been developed since in anticipation of the market opened by the SCSD specifications and products.

The Bertha Ronzone Elementary School in Las Vegas, Nevada, was built using a structural system designed and developed by the Butler Manufacturing Company of Kansas City, Missouri, for the SCSD project. The Butler Space Grid System was the next to low bidder on the SCSD project.

The lighting-ceiling system for the Ronzone School was provided by the E. F. Hauserman Company which bid unsuccessfully in this category for SCSD. Hauserman's SCSD partitions were used as well. The Lennox SCSD unit was employed, though not the SCSD distribution system. The Butler structure, in conjunction with various combinations of components, is now in use in many buildings across the country.

Architects: Julius Gabriele, AIA, and Associates

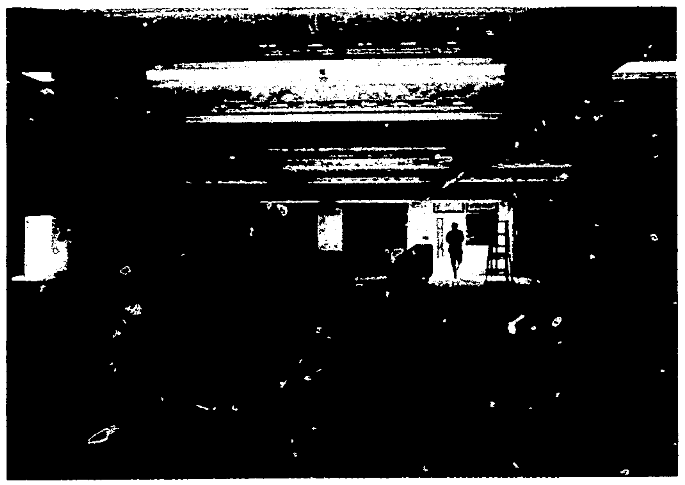


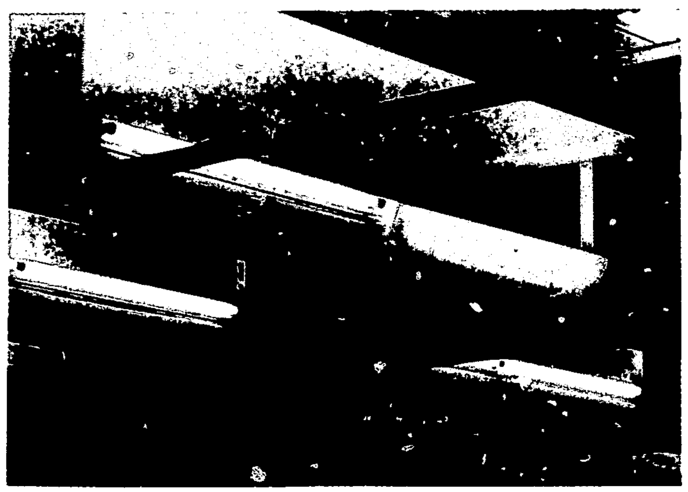


The Furgeson Elementary School in Hawaiian Gardens, Los Angeles, California, uses a precast concrete structural system by Interpace Precast Concrete Products. This is used in conjunction with a lighting-ceiling system by Luminous Ceilings, Inc. and partitions by Advanced Equipment Corporation, and a heating, ventilating, and cooling system by Hayes Furnace Mfg. & Supply Co.

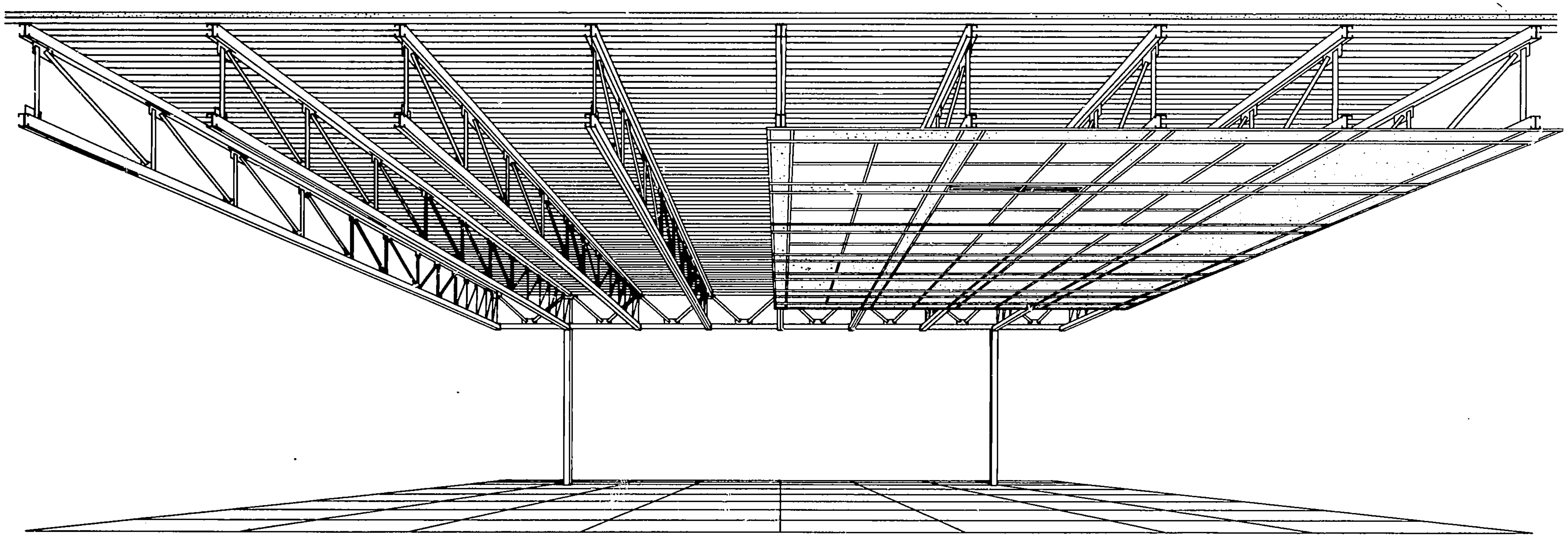
The space between the concrete channels is used to provide duct space to serve the ceiling air distribution, and the underside of the channels serves as a finished ceiling. The long span concrete channels provide a large, column-free, flexible space for each building.

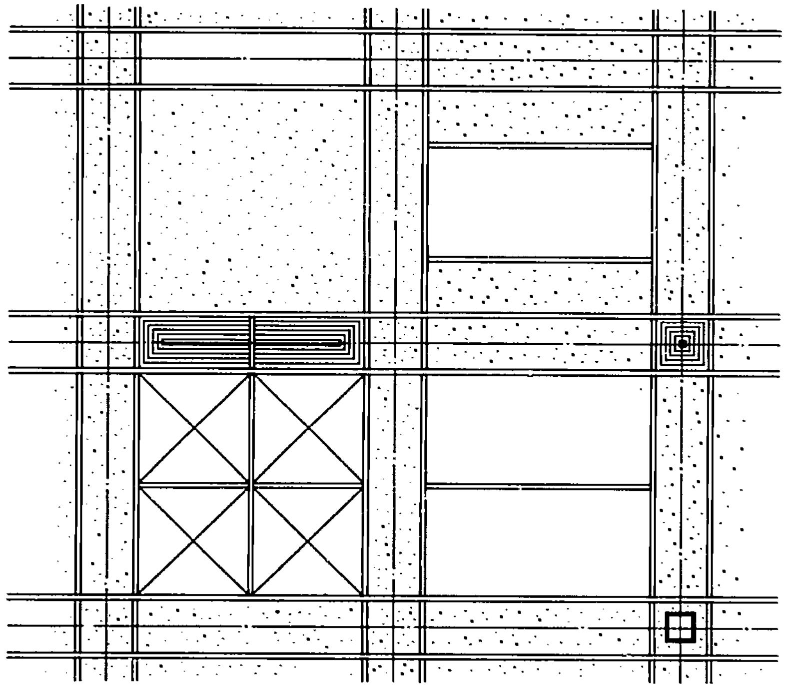
Architects: Duffy & Dreher AIA

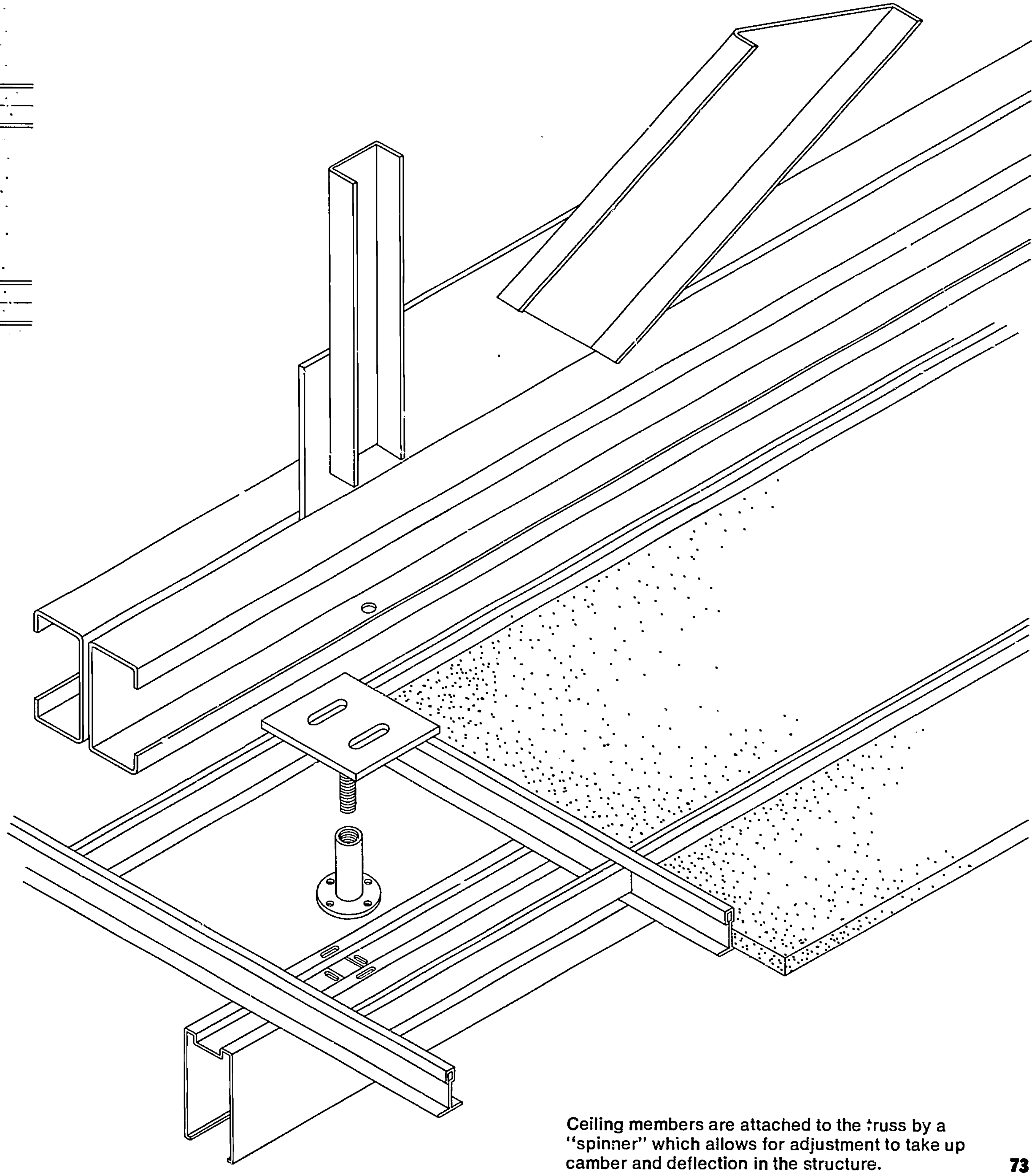




The Compatible Design Systems structural and lighting-ceiling system (Rheem/Dudley Corporation) has been designed closely to the SCSD performance specifications since the original bid process. It is a light steel structure of conventional design, using largely bolted connections. The ceiling is built up from supporting members, acoustical board, and lighting fixtures, and hung directly from the structure. This system has been successfully bid on school jobs in California.




detail of ceiling



Ceiling members are attached to the truss by a "spinner" which allows for adjustment to take up camber and deflection in the structure.

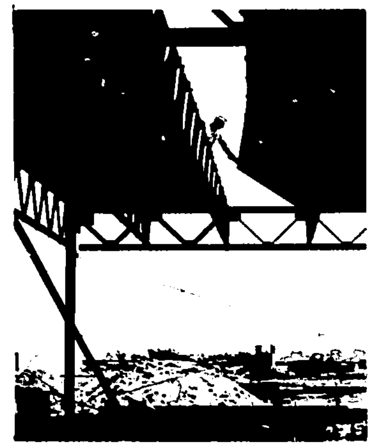
Components In Use

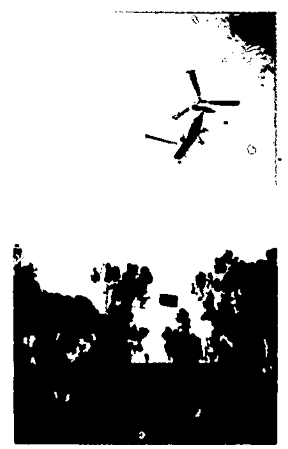
By October, 1966, six of the SCSD schools were in operation, with others in various stages of bidding or construction. On pages 78 and 79 the vocabulary of the SCSD components, articulated by a number of different architects, can be seen in action.

Starting on page 80, the school plans shown with the photographs indicate the range of type and size of facilities which have been built within the program. The detailed plans show some of the less traditional spatial arrangements which have appeared in the schools built to date.

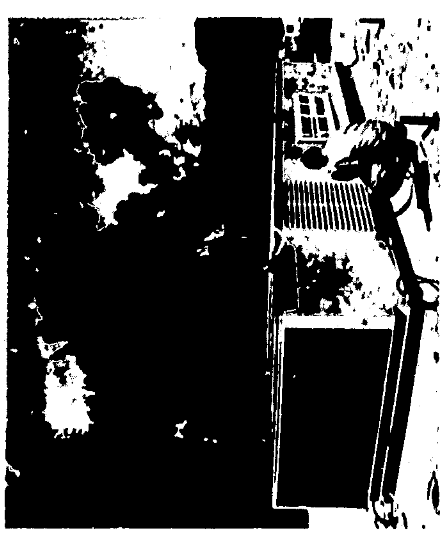


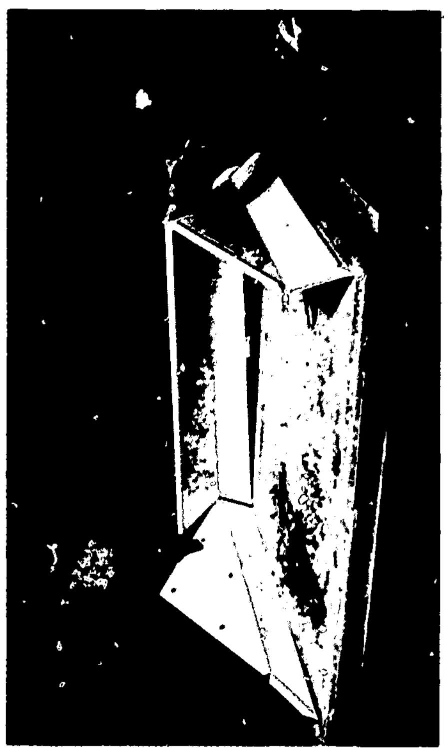


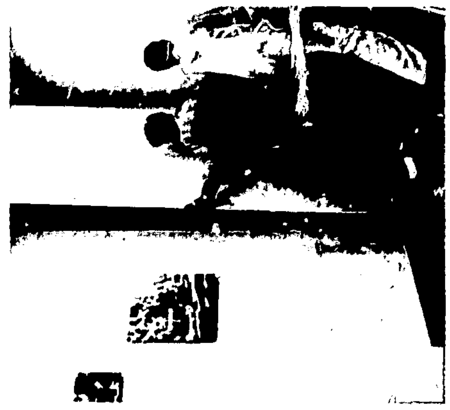





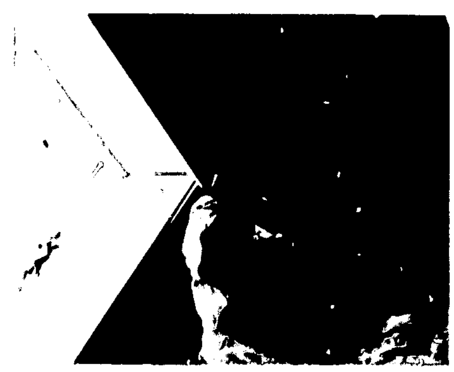


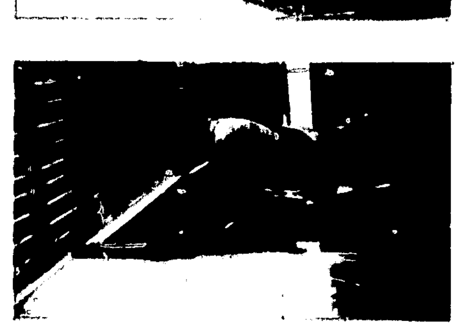



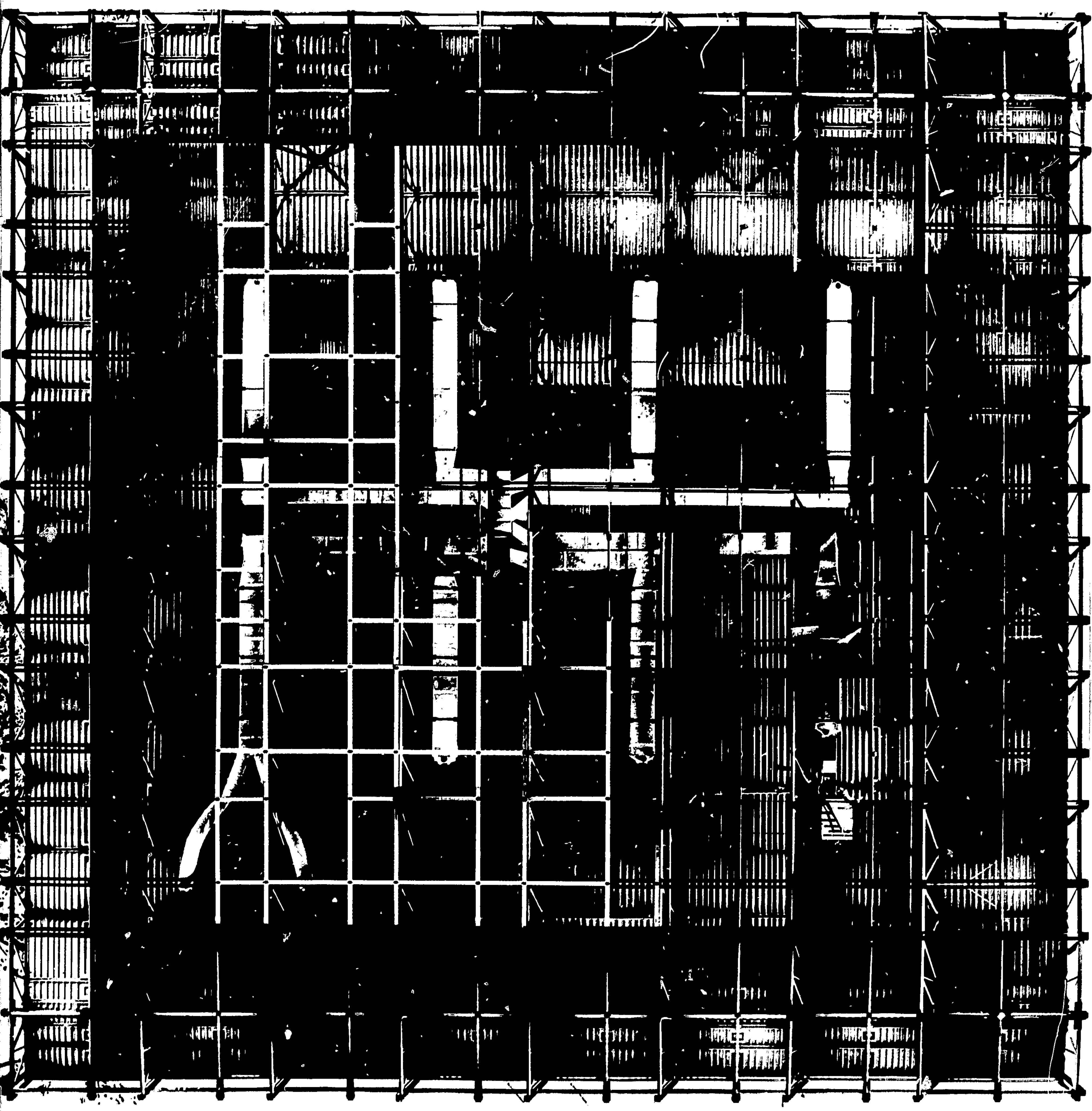


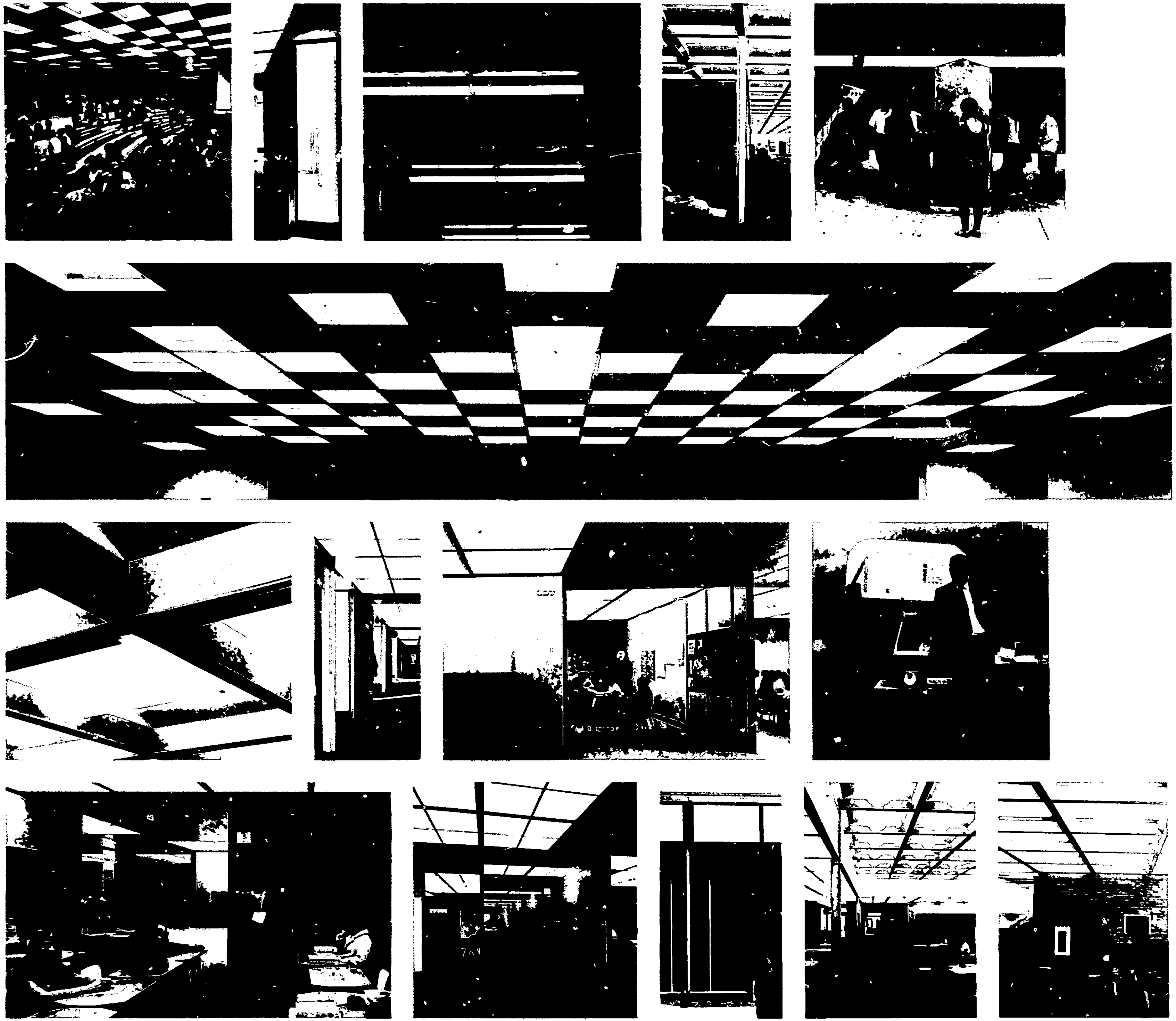










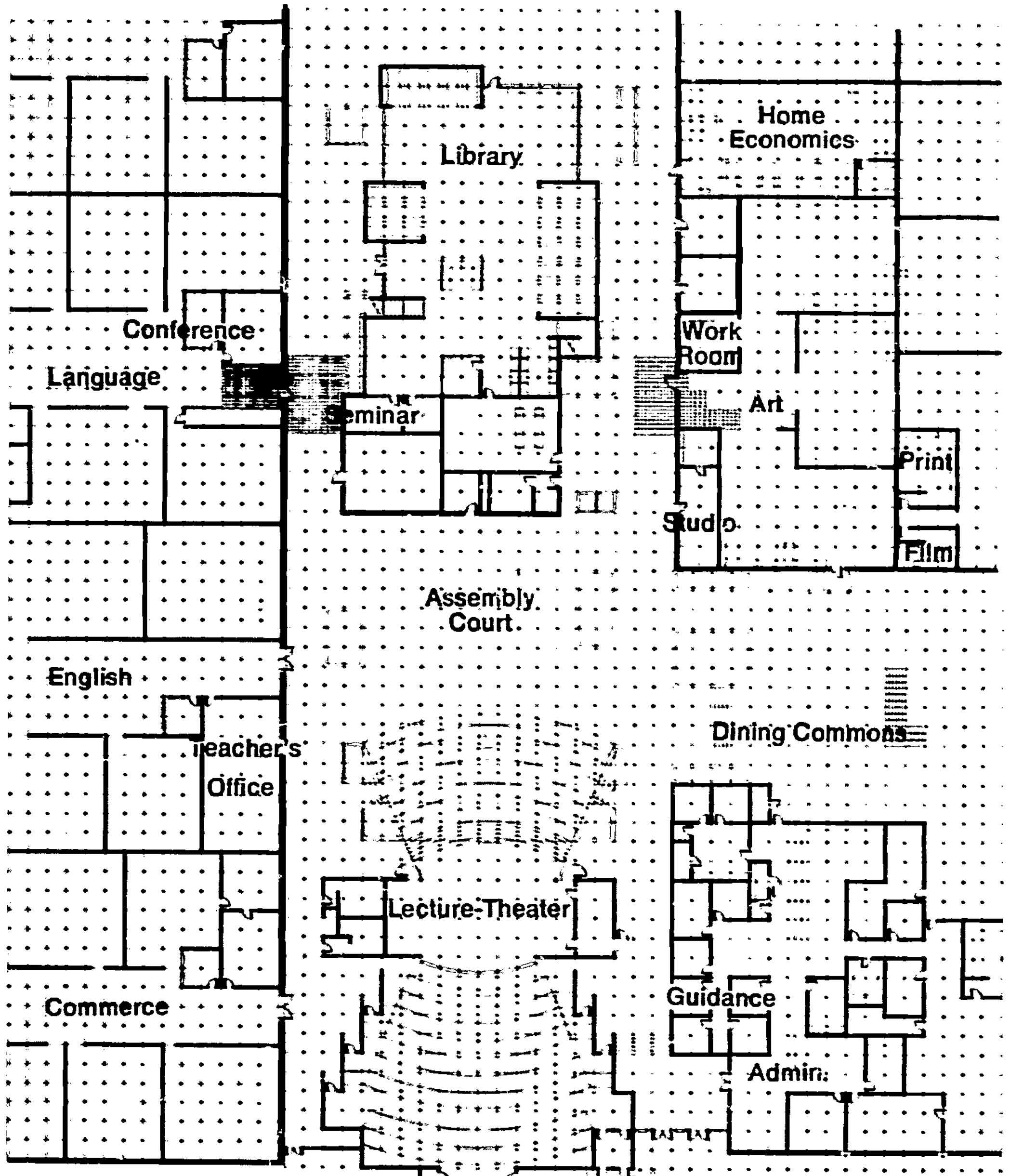


Senera High School

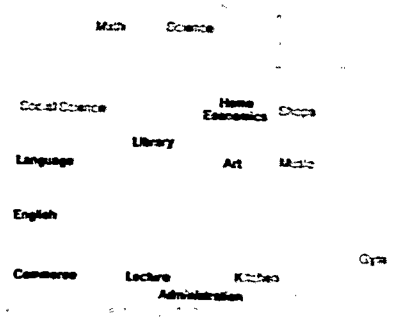
Fullerton Union High School District
Fullerton, California

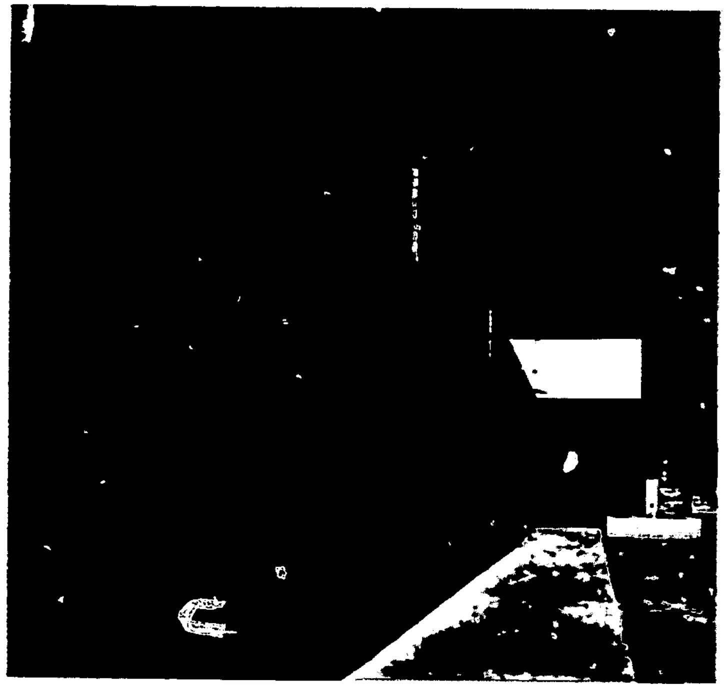
architects: Wm. E. Blurock & Associates
area: 204,644 sq. ft.
capacity: 2,000 students
construction began: October 1965
school opened: 1st section—September 1966
2nd section—December 1966
building cost: $3,172,320
square foot cost: $15.50

All areas are based on state aid formula which provides that open corridors shall count as one-half.



Five Foot Grid

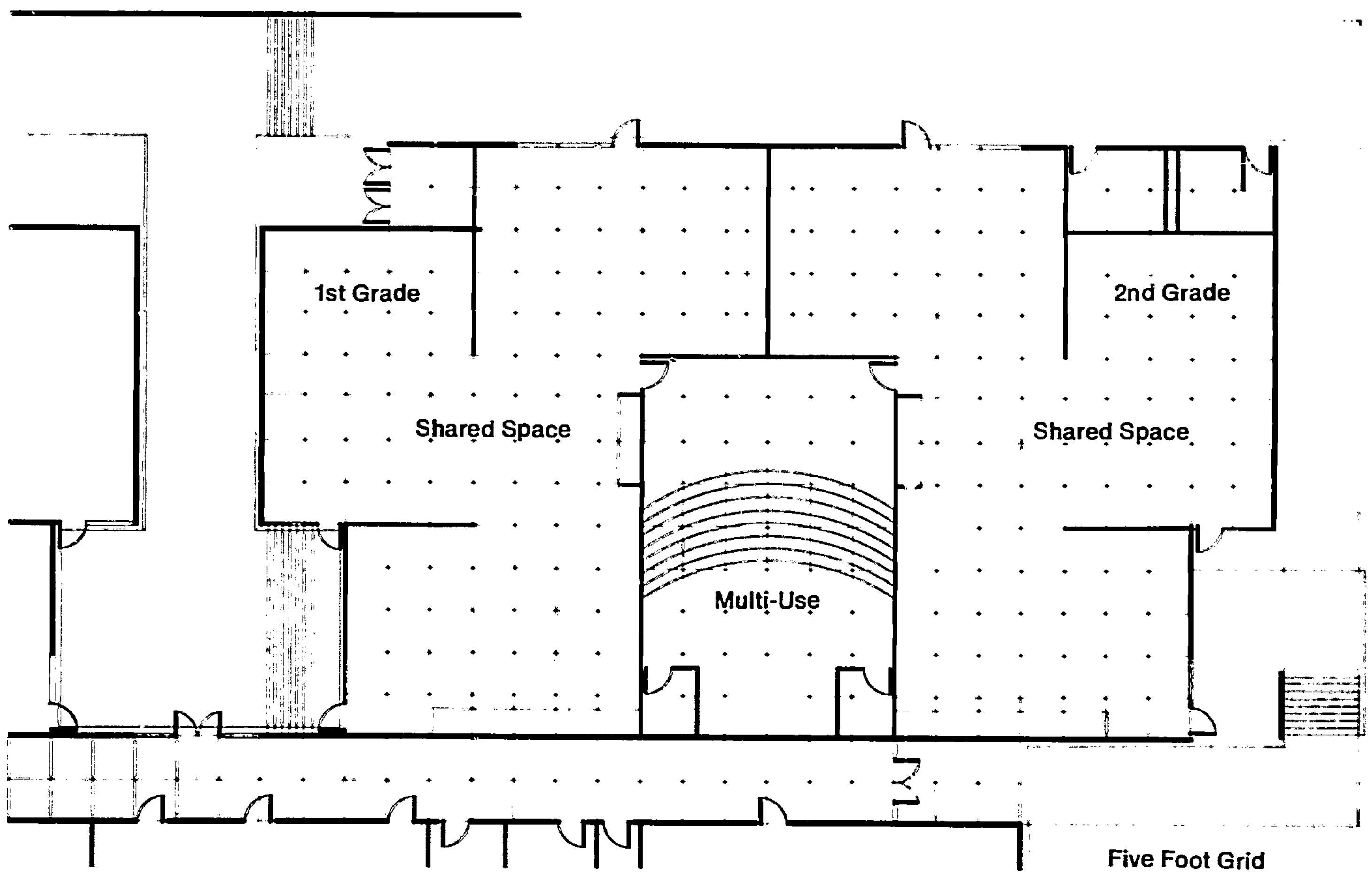


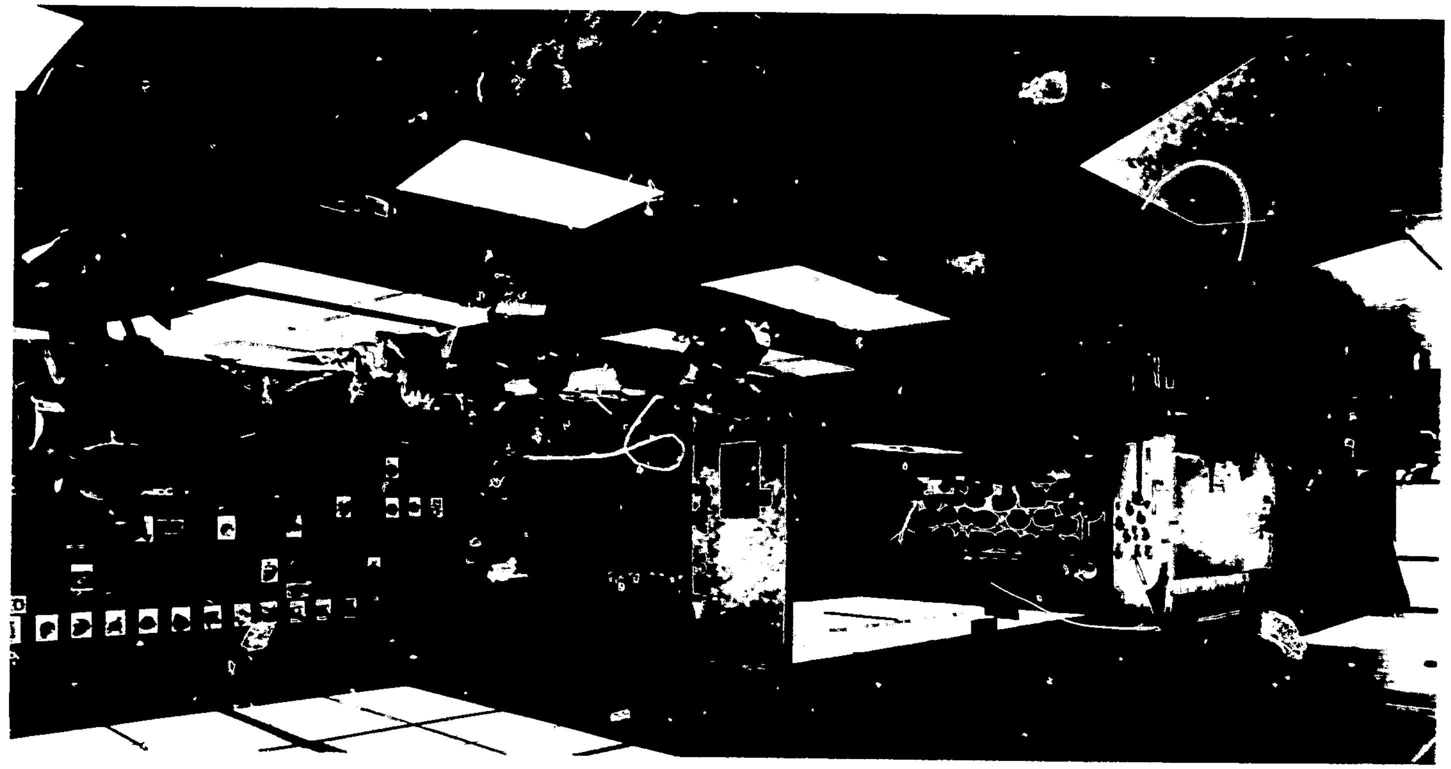


De Laveaga Elementary School

Santa Cruz Elementary School District
Santa Cruz, California

architects: Leefe & Ehrenkrantz
area: 40,000 sq. ft.
capacity: 270 students (1st increment)
construction began: January 1966
school opened: October 1966 (1st increment)
building cost: $468,379 (covers most costs)

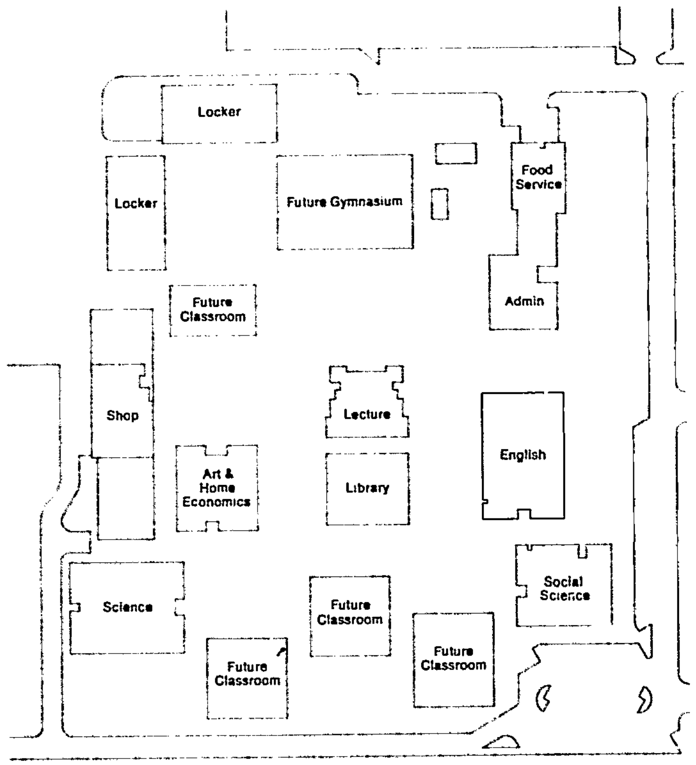


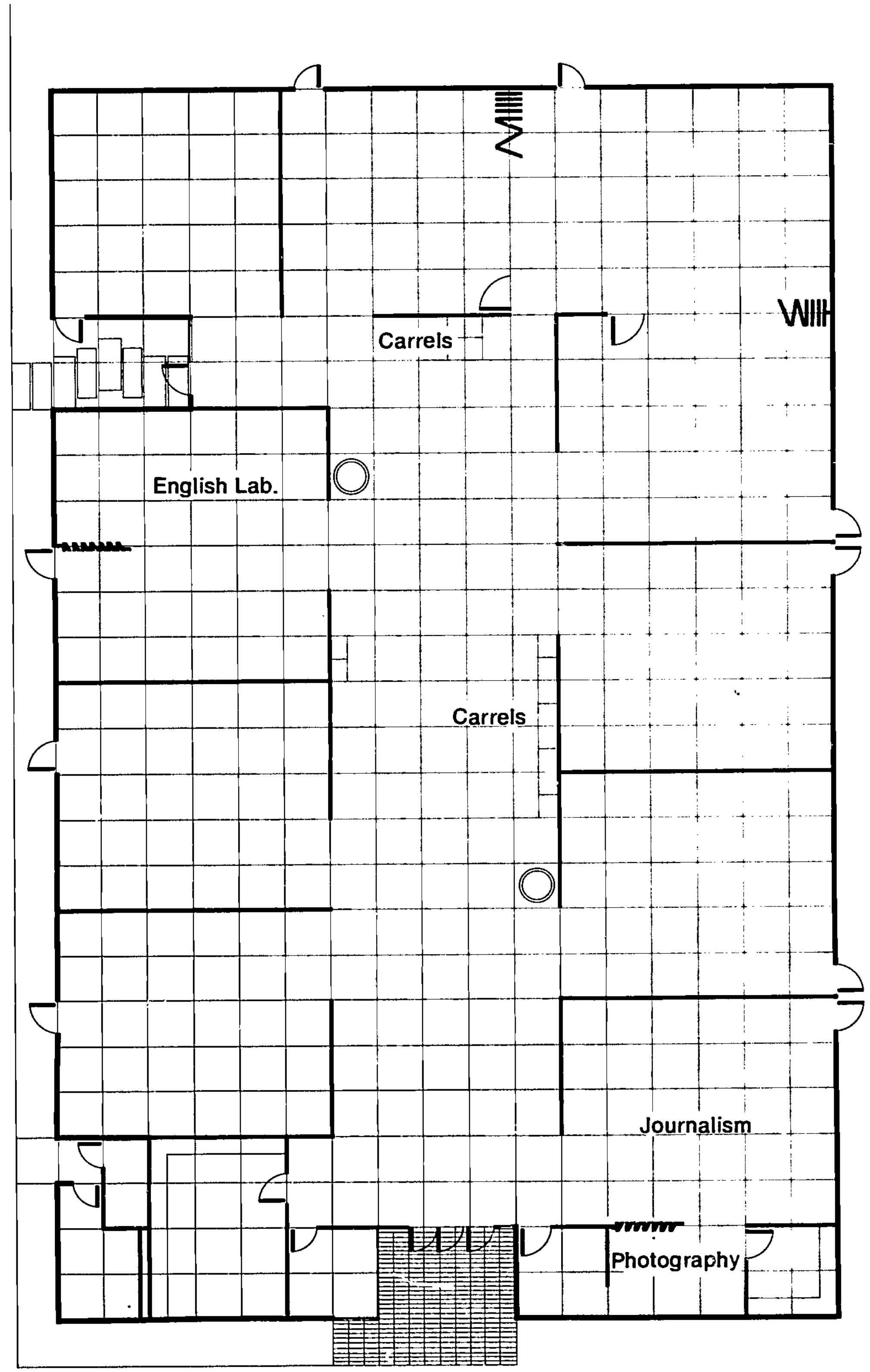


El Dorado High School (1st increment)

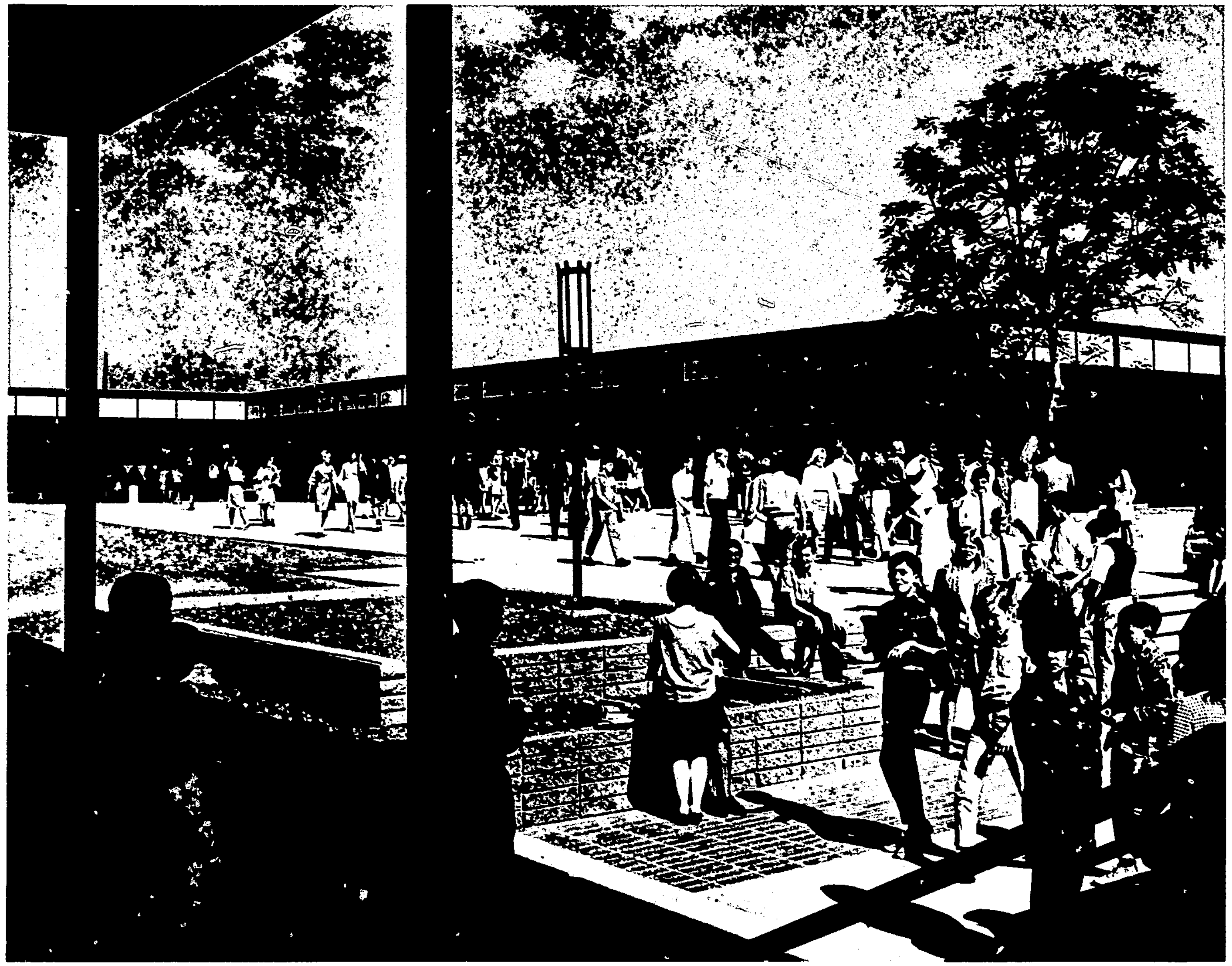
Placentia Unified School District
Placentia, California

architects: Wm. E. Blurock & Associates
area: 94,941 sq. ft.
capacity: 1,000 students
construction began: August 1965
school opened: September 1966
building cost: $1,750,000
square foot cost: $18.43





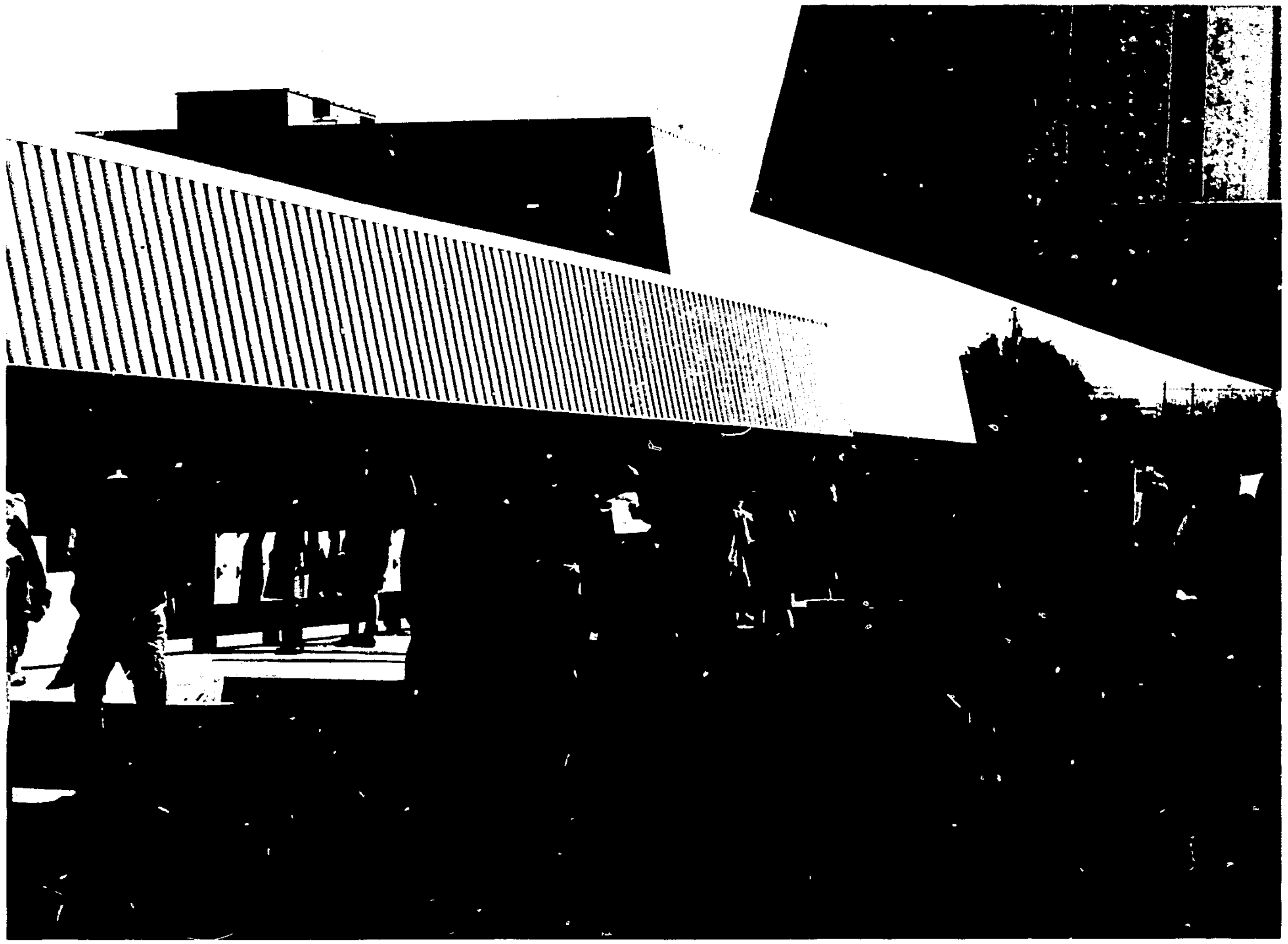
Five Foot Grid

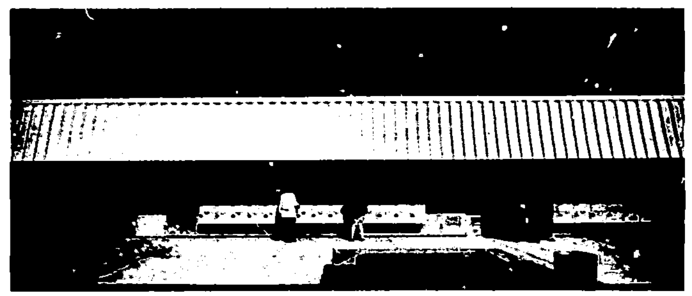


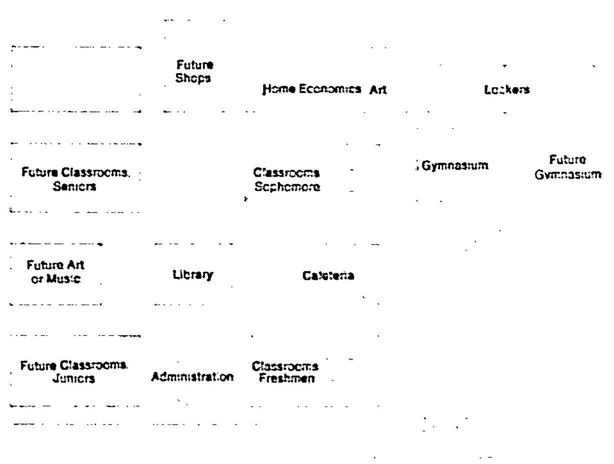
Casa Roble High School (1st increment)

San Juan Unified School District
Carmichael, California

architect: Nicholas A. Tomich
area: 79,466 sq. ft.
capacity: 900 students
construction began: November 1965
school opened: October 1966
building cost: $1,447,748
square foot cost: $18.22



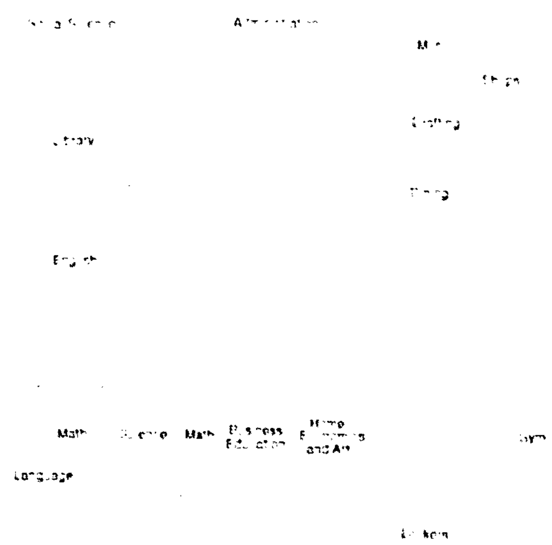




Fountain Valley High School

Huntington Beach Union High School District
Huntington Beach, California

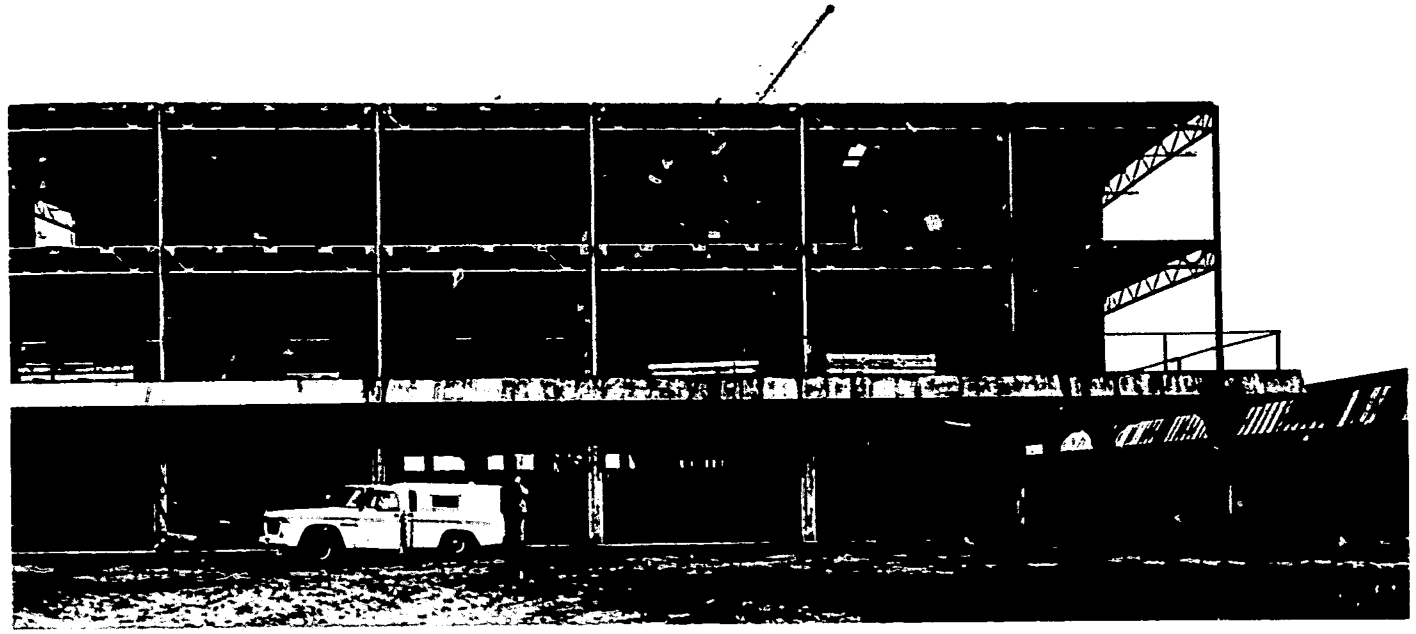
architects: Neptune and Thomas
area: 235,418 sq. ft.
capacity: 3,000 students
construction began: August 1965
school opened: September 1966
building cost: $3,741,830
square foot cost: $15.90

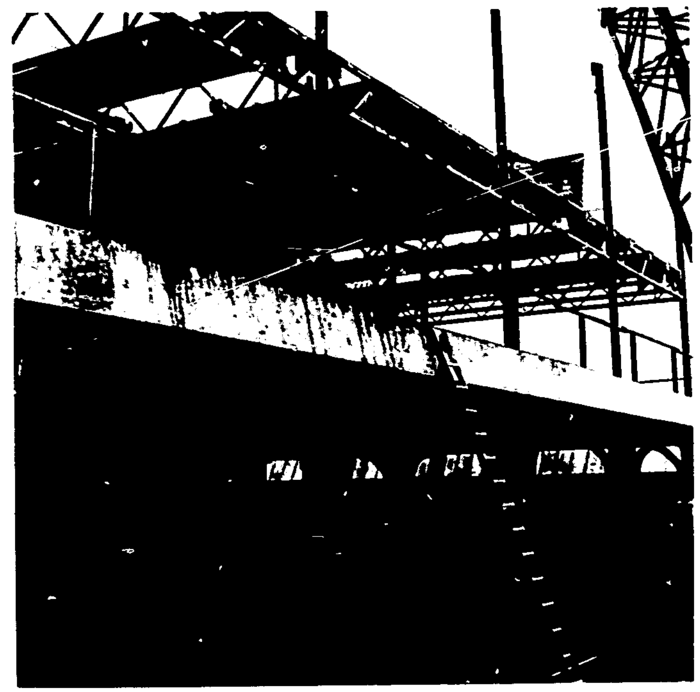


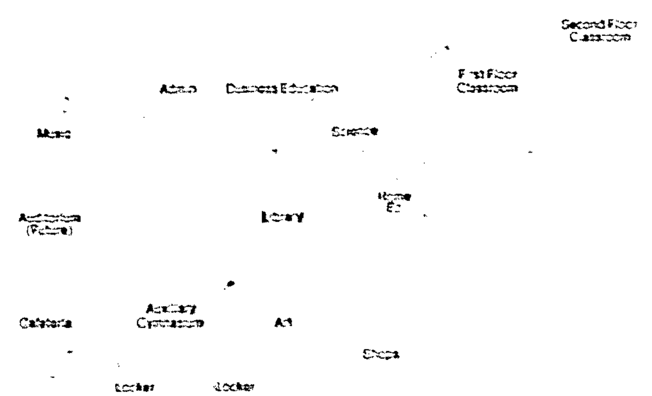
John F. Kennedy High School

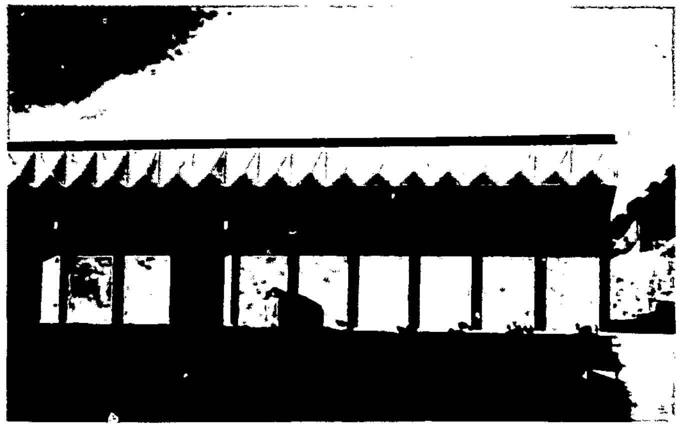
Sacramento City Unified School District
Sacramento, California

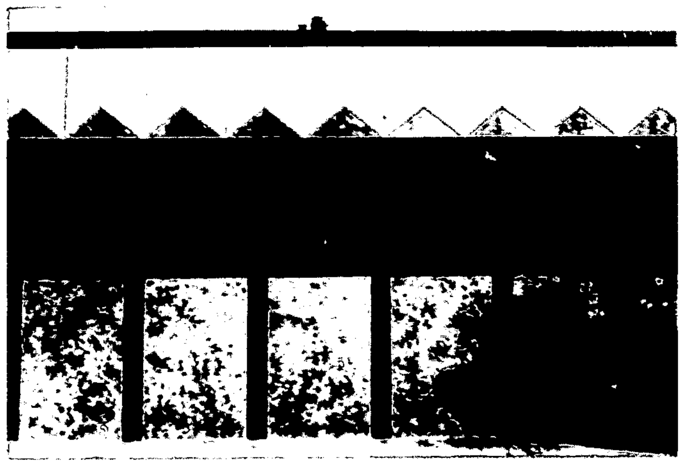
architects: Stafford & Peckinpaugh
area: 230,732 sq. ft.
capacity: 2,000 students
construction began: June 1966
school opens: September 1967
building cost: $4,408,214
square foot cost: $19.10











San Dieguito High School (addition)

San Dieguito Union High School District
Cardiff, California

architects: Jung & Cloyes
area: 29,050 sq. ft.
construction began: May 1966
school opened: October 1966
building cost: $625,747
square foot cost: $21.54

This addition contains Music, Homemaking, Industrial Arts, Art, and lecture and classroom facilities.

Glen Wilson High School

La Puente Union High School District
La Puente, California

architects: Kistner, Wright & Wright
area: 123,238 sq. ft.
capacity: 1,500 students
construction began: September 1966
school opens: September 1967
building cost: $2,184,326
square foot cost: $17.72

William Workman High School

La Puente Union High School District
La Puente, California

architects: Kistner, Wright & Wright
area: 104,350 sq. ft.
capacity: 1,300 students
construction began: September 1966
school opens: September 1967
building cost: $1,838,374
square foot cost: $17.62

Oak Grove High School

East Side Union High School District
San Jose, California

architects: Allan M. Walter & Associates
area: 157,707 sq. ft.
capacity: 1,800 students
construction began: September 1966
school opens: September 1967
building cost: $3,018,000
square foot cost: $19.14

Simi West High School

Simi Valley Unified School District
Simi, California

architects: Daniel, Mann, Johnson & Mendenhall
area: 156,488 sq. ft.
capacity: 1,800 students
construction began: November 1966
school opens: December 1967
building cost: $2,886,525
square foot cost: $18.45

Casa Roble High School Addition

San Juan Unified School District
Carmichael, California

architect: Nicholas A. Tomich
area: 72,790 sq. ft.
capacity: 900 students
construction began: February 1967
school opens: September 1967 (Jr./Sr. Units)
building cost: $1,323,222
square foot cost: $18.17

High School No. 3

Santa Cruz City High School District
Santa Cruz, California

architects: Porter, Jensen & Associates
area: 92,773 sq. ft.
capacity: 1,200 students
construction began: March 1967
school opens: September 1968
building cost: $1,592,320
square foot cost: $17.16

SCSD Project Schools Component Bid Data/March 10, 1967

	BASE BID BUILDINGS	[3]AREA IN SQUARE FEET PER STATE AID FORMULA	CEILING AREA IN SQUARE FEET	STRUCTURE AND ROOFING AREA IN SQUARE FEET	COST PER SQUARE FOOT/ STATE AID FORMULA	COST PER SQUARE FOOT/ STRUCTURE AND ROOFING	COST PER SQUARE FOOT/ CEILING	COST PER SQUARE FOOT/ HEATING-VENTILATING-AIR CONDITIONING	COST PER LINEAL FOOT/ DEMOUNTABLE PARTITIONS
Fountain Valley	$3,741,830	235,418	220,643	249,303	$15.90	$1.58	$1.49	$2.28[1]	$28.53
[2]**El Dorado**	1,750,000	94,941	85,579	104,304	18.43	1.60	1.54	2.24	27.35
[5]**Sonora**	3,172,320	204,644	198,150	200,300	15.50	1.90	1.49	1.80	23.74
[2]**Casa Roble**	1,447,748	79,466	77,011	88,450	18.22	1.77	1.57	2.37	22.97
De Laveaga	468,379	40,000	38,775	40,700	—[4]	1.71	1.51	1.64[6]	23.86
San Dieguito	625,747	29,050	26,350	31,750	21.54	1.76	2.01	3.05[1]	36.17
[5]**J. F. Kennedy**	4,408,214	230,732	173,100	173,100	19.10	1.86	1.49	2.49	27.81
[2]**Oak Grove**	3,018,000	157,707	157,575	163,325	19.14	1.80	1.63	2.43	22.71
[2]**Glen Wilson**	2,184,326	123,238	97,200	138,700	17.72	2.15	2.04	2.35	24.99
[2]**William Workman**	1,838,374	104,350	84,375	120,125	17.62	1.96	1.91	2.21	22.13
[2,5]**Simi West**	2,886,525	156,488	149,800	153,600	18.45	1.76	1.59	1.73	25.81
Casa Roble Addition	1,323,222	72,790	66,350	76,600	18.17	1.91	1.87	2.47	25.52
High School No. 3	1,592,320	92,773	56,625	78,450	17.16	2.16	1.92	1.37[6]	32.85

1 5-year maintenance policy included
2 state aid projects
3 state aid formula provides that open corridors shall count as one-half
4 22,851 square feet of structure was enclosed but left unfinished to be finished later as district population needs require
5 schools showing less Component Structure and Roofing Area than Area per state aid formula have some non-system structure
6 air conditioning not provided

Technical Consultants to Project

Acoustical
Dariel Fitzroy
Consulting Acoustical Engineer
San Rafael, California

Air Conditioning
G. L. Gendler
G. L. Gendler & Associates
Mechanical and Electrical Engineers
Berkeley, California

Color
Miriam Leefe
Color Consultant
Sausalito, California

Electrical
Foster K. Sampson
Sampson, Randall & Press
Consulting Electrical Engineers
Los Angeles, California

Case *Work*
Burgess P. Standley
Laboratory Planning Consultants
Chestnut Hill, Massachusetts

Structural
L. W. Graham
Graham & Hayes
Consulting Structural Engineers
San Francisco, California

Clarence Rinne
Structural Engineer
Palo Alto, California

Alexander G. Tarics
Reid and Tarics
Architects and Engineers
San Francisco, California

Photo credits

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Pages 2, 21, 29, 33
El Dorado High School
Placentia Unified School District
architects: Wm. E. Blurock & Associates

Pages 5, 12
Fountain Valley High School
Huntington Beach Union High School District
architects: Neptune & Thomas

Pages 8, 22
Barrington Middle School
Barrington, Illinois
architects: Cone & Dornbusch

Page 15
De Laveaga Elementary School
Santa Cruz Elementary School District
architects: Leefe & Ehrenkrantz

Page 25
SCSD Prototype
architects: Ezra D. Ehrenkrantz and SCSD Staff

Page 30
Sonora High School
Fullerton Union High School District
architects: Wm. E. Blurock & Associates

Other Reports from EFL

The following publications are available without charge from the offices of EFL: 477 Madison Avenue, New York, New York 10022.

Bricks and Mortarboards. A guide for the decision-makers in higher education: how the colleges and universities can provide enough space for the burgeoning enrollments of this decade; how the space can be made adaptable to the inevitable changes in the educational process in the decades ahead. (One copy available without charge. Additional copies $1.00.)

College Students Live Here. A report on the what, why, and how of college housing; reviews the factors involved in planning, building, and financing student residences.

The Cost of a Schoolhouse. A review of the factors contributing to the cost and effectiveness of schoolhousing, including planning, building, and financing.

Design for ETV—Planning for Schools with Television. A report on facilities, present and future, needed to accommodate instructional television and other new educational programs. Prepared for EFL by Dave Chapman, Inc., Industrial Design.

Relocatable School Facilities. A survey of portable, demountable, mobile, and divisible schoolhousing in use in the United States and a plan for the future.

The Schoolhouse in the City. EFL's annual report for 1965 and an essay on how the cities are designing and redesigning their schoolhouses to meet the problems of real estate costs, population shifts, segregation, poverty, and ignorance.

The School Library. A report on facilities for independent study, with standards for the size of collections, seating capacity, and the nature of materials to be incorporated.

School Scheduling by Computer/The Story of GASP. A report of the computer program developed by MIT to help colleges and high schools construct their complex master schedules.

To Build or Not to Build. A study of the utilization of instructional space in small liberal arts colleges, with a do-it-yourself workbook for the individual use of the institutions that wish to survey their own utilization levels.

Profiles of Significant Schools

A series of reports which provide information on some of the latest developments in school planning and design:

Holland High School, Holland, Michigan

High Schools 1962—educational change and architectural consequence

Schools Without Walls—open space and how it works

Middle Schools—controversy and experiment

Case Studies of Educational Facilities

A series of reports which provide information on specific solutions to problems in school planning, design, and construction.

6. *A College Health Center.* Case study of a model center for small private colleges; architectural design by Caudill, Rowlett & Scott.

7. *New Building on Campus: Six Designs for a College Communications Center.* Graphic representations of the results of an architectural competition for a new space to house the accouterments of instructional aids and media.

8. *The Schools and Urban Renewal.* A case study of the Wooster Square renewal project in New Haven, Connecticut.

9. *Air Structures for School Sports.* A study of air-supported shelters as housing for playfields, swimming pools, and other physical education activities.

10. *The New Campus in Britain: Ideas of Consequence for the United States.* Recent British experience in university planning and its implications for American educators, architects, and planners.

11. *Divisible Auditoriums.* Operable walls convert little-used auditoriums and theaters into multipurpose, highly utilized space for the performing arts and instruction.

12. *The High School Auditorium: Six Designs for Renewal.* Renovation of little-used auditoriums in old and middle-aged schools to accommodate contemporary educational, dramatic, and music programs.

Technical Reports

1. *Accustical Environment of School Buildings* by John Lyon Reid and Dariel Fitzroy—Acoustics of academic space in schools. An analysis of the statistical data gathered from measurement and study.

2. *Total Energy*—On-site electric power generation for schools and colleges, employing a single energy source to provide light, heat, air conditioning, and hot water.

College Newsletter

A periodical on design questions for colleges and universities.