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The first of an occasional series of publications dealing with all aspects of systems building. This issue is devoted to a general overview of all systems projects funded by the Ford Foundation's Educational Facilities Laboratories, since the School Construction Systems Development Project was first funded in 1962. It includes the following projects--(1) Study of Educational Facilities-Toronto, (2) Recherches en Amenagements Scholaires-Montreal, (3) Schoolhouse Systems Project-Florida, (4) Great High Schools-Pittsburgh, (5) University Residential Building System-University of California, and (6) School Construction Systems Development-California. (FPO)

Building Systems Information Clearinghouse

NEWSLETTER

Spring 1969
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Building Systems Information Clearinghouse
NEWSLETTER

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Cover: Butler SPACE-GRID

On Starting Something

During the years 1962–1968 the School Planning Laboratory at Stanford University and the University of California, Department of Architecture, Berkeley, acting under a grant from the Ford Foundation's Educational Facilities Laboratories (EFL) jointly attempted to develop new approaches to the design and construction of school facilities. The project, School Construction Systems Development (SCSD), is generally recognized as being the definitive study in the field of systems building. As such, this unique project forms the basis for an increasing number of new studies which seek to build on the pioneering work of SCSD.

As interest in the field of building systems grew, the need for an effective communication link between the many groups interested in this field became apparent. Educational Facilities Laboratories, recognizing this need, made a grant to the Systems Division of Stanford University's School Planning Laboratory for the purpose of establishing a Systems Information Clearinghouse. The clearinghouse staff began operations in the SCSD Mock-Up Building on the Stanford Campus in January 1969.

The clearinghouse intends to undertake research on matters pertaining to the development and use of building systems, accumulate and distribute systems information of interest to educators, architects and manufacturers, and to serve as a medium to encourage communication among those interested in building systems. First priority has been given to collection and dissemination acti ities in order to make pertinent information available as quickly as possible.

This Newsletter is the first of an occasional series of publications dealing with all aspects of systems building. The first issue is devoted to a general overview of all systems projects funded by EFL since SCSD. Future issues will deal with specific projects in more detail. The editors welcome suggestions for articles, areas of needed research and information on new system components and projects.

J.R.B.

SEF

Study of Educational Facilities

On February 25, 1969, the Metropolitan Toronto School Board authorized ten subsystem contractors to proceed with development and testing of the First SEF Building System. Upon fulfillment of the remaining conditions, which include submission of required documents and successful completion of the test series, contracts will be signed by the Metro Board and the nominated subsystem contractors. These contracts cover the construction of thirty-one schools and an office building and will result in the purchase of about $38,200,000 ($35,526,000 in U.S. funds) worth of system components.

Two sets of contracts will be signed for the construction work contained in the first SEF program. Series One Contracts bind the subsystem contractors to the Metro School Board for the quantities of components required to construct the thirty-two buildings in the first program. Series Two Contracts cover the management and site work on each project and are signed by the prequalified general contractor and the city or borough board constructing the plant. All Series Two Contracts for the 1969 building program (ten regular schools plus the test plant) will be signed on the 25th of April.

Project Background Early in 1965, Mr. Barry G. Lowes, Chairman of the Metro Board, and Mr. William J. McCordic, Director and Secretary-Treasurer, working with members of the newly established Ontario Division of School Planning and Building Research, made a study of the feasibility of an SCSD-type solution to building needs in the Metro area. This interest developed into the Study of Educational Facilities (SEF) which was officially established later in that year. Educational Facilities Laboratories made an initial grant to the project in 1966. SEF has been jointly funded by the Metro School Board, EFL, and the Ontario Department of Education.

A permanent project staff was created in August and September 1966 under a dual directorship: Mr. Hugh J. Vallery as Academic Director, and Mr. Roderick G. Robbie as Technical Director. A twenty-three member Advisory Committee, originally set up to consider project objectives and procedures, now functions primarily as the guardian of the client's interests. The actual SEF staff numbers twenty-three with architectural and educational researchers in about equal proportion. During the course of project development, SEF has made use of paid consultants in nine technical areas, such as acoustics, industrial design, graphics, etc.

Although the program arose out of an interest in the provision of new school plants at lower cost through an SCSD-type program, the real problem was identified at an early stage. The basic aim of the project is not simply to provide new buildings or a new set of building hardware, but to upgrade the general quality of education and to provide school facilities of improved environment and greater responsiveness to user needs. A parallel goal has been to stabilize the cost of providing school facilities while introducing these improved plants.

To accomplish these objectives, SEF planned and undertook three coordinated long-range studies:

1 A study of the educational needs and user requirements of the Metro area educational system which has resulted in the publication of the (E) Series Educational Studies.

2 Proposals for solutions to the various building requirements of the school boards; these studies, the (T) Series, include the development of the First SEF Building System, studies of land use, short-term school accommodation, and improvements in the specifications of traditionally built schools.

3 A series of administrative studies, the (A) Series, designed to explain the activities and management procedures required when using the First SEF Building System.

In this article, only the procedures and results of the First SEF Building System development project will be discussed. Although necessary, this limitation perhaps gives a false picture of the total effort made by SEF and the Metro Board in the analysis of the problem of improving the general quality of the educational environment.

Project Methodology The basic methodology used in the development of the First SEF Building System has been to involve industry in a project to create an "open" building system by using performance specifications and by guaranteeing a large market. The results obtained from a poll made of 100 leading manufacturers questioning minimum market size were inconclusive. In late 1967 the Metro Board established its own minimum of one million square feet of new construction to be built within a stipulated time period. SEF, working with the six City and Borough Boards, obtained a commitment of twenty-six projects which was later increased to thirty-two, totaling approximately two million square feet.

The nature of the educational hierarchy in the Metro area makes organization of a large volume an easier task than it has been in some other systems development projects. The five Borough Boards and the City of Toronto School Board created the Metro Toronto Board to act as their financial agent at the time of the adoption of the metropolitan area form of government. Thus, there was an already existent body to act as negotiating and sponsoring agent for the SEF program. This is in contrast to projects, such as the SSP in Florida and the SCSD in California, in which a separate legal body had to be created to act as agent for a number of local boards.

Performance specifications were developed and bid on a basis which is intended to insure wide product compatibility at minimum cost. The basic mechanism for achieving these goals is the concept known in the contract documents as the "mandatory interface," or areas of required compatibility with other subsystems as defined for each subsystem by SEF. Each bidder was required to name two compatible bidders in each subsystem with which he had a mandatory interface and to list prices with them. With one of the two he was required to list his base or lowest cost bid.

SEF specifically discouraged "linked package" or "composite" bids such as had been required by the SCSD and RAS bidding techniques. In a "linked package bid" a group of bidders submit a bid for the entire system on a choose all or none basis; in actuality such a bid is one form of bid by consortium. The aim of SEF was to put together the system by cost and performance characteristics after bidding rather than receive prearranged subsystem packages as bids.

Bidding Method and Bid Evaluation Before submitting his final proposal and bid data, each subsystem bidder had to prequalify himself and present his proposal at a mid-term review session. The prequalification procedure required each bidder to provide evidence of his ability to fulfill the demands of the program. Each was required to satisfy the Metro Board with respect to the following:

1 His financial capacity to undertake the program;
2 The availability of technical and productive skills in his firm;
3 The availability of sufficient productive capacity;
4 His proposed management and personnel;
5 Suitable arrangements with organized labor for both production and installation of his components.

The thirty-day mid-term review period gave the SEF staff an opportunity to study each proposal in depth with the manufacturers before the solution was made final.

In the bid package submitted on January 7, 1969, each subsystem bidder was required to submit data upon which SEF could base both cost and performance evaluations. This data was divided into four categories:

1 A description of the subsystem and its performance as a solution to the requirements of the performance specifications;
2 Evidence of interface compatibility;
3 A base bid which is the result of the application of the subsystem and its unit price schedule to the four sample school plans prepared by SEF;
4 Costs of operation on an annual basis, and maintenance costs over a five year period.

SEF received unexpected documentation in category two, as the manufacturers themselves prepared "interface agreements" in the mandatory interfaces which outlined the various responsibilities between the two interfaced subsystem contractors.

The basis for evaluation of the bids was a complex mixture of economic, functional, and esthetic criteria. The economic criteria were based upon the various cost figures submitted by the bidders. The functional criteria were the SEF staff evaluation of the ability of each subsystem to meet the requirements of the performance specifications. Aesthetic judgments insured the selection of a system which was architecturally sound.

A computer was used to analyze the alleged interface compatibility and cost structure of the various bidder combinations. Before the bids were programmed into the computer, penalty charges and equalization factors were assessed as outlined in the performance specifications. Because of doubts about the value of the maintenance and operating cost estimates, the SEF Technical Director decided not to include them in the economic evaluation.

The computer reviewed approximately two hundred thousand possible manufacturer combinations. From this number, over thirteen thousand compatible building systems were identified. These systems are complete and claim to meet the requirements of performance and interfacing as contained in the performance specifications.

Although the computer identified 4000 of these solutions with a total cost below the project budget of $20.85 per square foot for building cost, only the lowest thirty bid combinations were completely evaluated. SEF made a detailed analysis of the cost structure, performance, and interfacing of these systems and obtained additional data from the manufacturers where necessary. A panel of professionals was appointed by SEF to provide the Technical Director with an independent opinion of the systems' merit.

In making the recommendation to the Metro Board, Roderick Robbie, the SEF Technical Director, sought to insure selection of that system which will give the best overall value with a balanced emphasis on quality and cost. In Robbie's opinion: "Those submissions offering the best value tended to offer the lowest cost, and had, with few exceptions, carried out the most thorough preparation of their submissions."

The First SEF Building System Ten bidders have been designated thus far by the Metro Board as probable subsystem contractors. Following a testing and documentation period, contracts for construction will be signed between the appropriate boards and the subsystem contractors. The SEF staff feels, however, that the continued involvement of the unsuccessful bidders is of paramount importance. The fact that the designated ten bidders best fulfilled the specific conditions of this particular round of bidding should not compromise future markets for the others. This view is completely consistent with the SEF view of the "open system" described in the next section.

In keeping with SEF's view of the results of the bidding process, the following description of the First SEF Building System contains for each subsystem:

1 A description of some of the requirements of the performance specifications;
2 The designated subsystem bidder;
3 A list of all the bidders of that subsystem.

The Structural Subsystem. The structural subsystem performance specification called for:

1 A solution capable of use in buildings up to five stories in height, a break point provided by requirements of the fire code;
2 Spans of up to 65′ with a 100 pound per square foot general live load; spans greater than 65′ with the same loading conditions, to be custom designed;
3 A horizontal module of 5′ by 5′ with a 12″ vertical increment, this module is the same as that specified for the SCSD program, the SSP program in Florida, and the Great High Schools in Pittsburgh.

SEF received four bids on this subsystem, three steel frame solutions, and one in precast concrete:

1 Anthes Steel Products, Ltd., submitted the designated subsystem, a modified version of the Macomber V-LOK system, with a cost per gross square foot of $2.27;
2 Dominion Bridge Company, Ltd., submitted a steel solution which they also bid on the Montreal RAS project;
3 York Steel Construction, Ltd.;
4 Pre-Con Murray, Ltd., submitted the only concrete structural solution, DUOTEK, which was developed jointly with the Portland Cement Association.

The Atmosphere Subsystem. Quality improvements in the atmosphere, or heating-ventilating-air conditioning subsystem, were sought in a performance specification which called for:

1 Increased environmental control by adding air conditioning to the current heating and ventilating standards, allowing year-round operation in a climate with a temperature range of −10°F to +90°F;
2 Precisely regulated interior temperature and humidity levels;
3 Flexibility of rearrangements of interior spaces.

Five manufacturers submitted bids on the atmosphere subsystem:

1 Canada Electric Co., Ltd. and ITT (Canada) Ltd., submitted the designated subsystem, the ITT Nesbitt rooftop system, with a cost of $2.92 per gross square foot of building;
2 Lennox Industries of Canada, Ltd., a rooftop system;

3 Watts and Henderson, Ltd., a Trane system;
4 Chrysler Airtemp of Canada, Ltd.;
5 Sayers and Associates, Ltd., a Carrier System.

The Lighting-ceiling Subsystem. The lighting-ceiling performance specifications require a high performance subsystem with some improved characteristics:

1 A Visual Performance Index (VPI) of 63.0 at least equivalent to a 70-footcandle average maintained level;
2 An acoustic rating of minimum STC 35;
3 The ability to function well with all patterns of interior space subdivision.

Four manufacturers submitted bids for the lighting-ceiling system:

1 Canadian Johns-Manville Co., Ltd., submitted the designated subsystem with a cost of $1.67 per gross square foot;
2 Plastic Windows, Ltd.;
3 Armstrong Cork Canada, Ltd.;
4 York Steel Construction, Ltd.

Interior Space Division Subsystem. The insurance of an environment which is fully responsive to changes or modifications in the needs of its users is the goal of the interior space division performance specification. The heart of this specification is the totally relocatable partition.

Two manufacturers submitted bids for these relocatable partitions:

1 Westeel-Rosco Limited, a large manufacturer of office partitions in Toronto, submitted the designated subsystem with a bid cost of $2.09 per gross square foot;
2 B. K. Johl, Inc., who is the designated subsystem contractor on the RAS in Montreal submitted the other bid.

Vertical Skin Subsystem. As well as high standards of appearance, the vertical skin performance specifications required stiff heat and humidity transmission performance, including a U-factor of 0.10. In fulfilling the requirements, the designated manufacturer, Beer-Precast-Precon Murray Ltd., has developed a highly rational solution. This manufacturer has provided panels with openings of only one size, rectangular and oriented with the long axis either horizontal or vertical. Because the atmosphere system is required to provide total environmental control, the manufacturer fits the required window or louver into the opening at the factory and seals it in place.

Four manufacturers submitted bids for this subsystem:

1 Beer-Precast-Precon Murray Ltd., with a cost of $1.82 per square foot;
2 George and Asmussen, Ltd.;
3 Kawneer Co., Canada Ltd., submitted two systems;
4 Unit Masonry Construction.

The Plumbing Subsystem. This subsystem integrates all plumbing services contained within a line five feet outside the building. SEF hopes to obtain better prices and possible innovations by this method of bidding the plumbing. Three manufacturers submitted bids for this subsystem:

1 H. Griffiths Co., Ltd., the subsystem designee, submitted a cost of $.98 per gross square foot;
2 S. I. Guttman, Ltd.;
3 Watts and Henderson, Ltd.

Electric-electronic Distribution Subsystem. The inclusion of this subsystem, and the direction of the performance specifications, is an attempt by SEF to provide a method of electric and electronic communication distribution which is as flexible as the partition, atmosphere, and lighting-ceiling components. Traditional methods of distribution do not permit any real flexibility of space, rather they tend to fix the plan once they are built in. The solution submitted by Industrial Electrical Contractors, the subsystem designee, is a combination of fixed conduit, 40′ long extension cords, and fiberglass service columns. The columns, which plug into the ceiling runner intersections and rest on velcro pads, contain a variety of service combinations and vary somewhat in cross section. Columns are either free standing or rest like pilasters against the partition face.

Two manufacturers submitted bids for this subsystem:

1 Industrial Electrical Contractors, with a bid cost of $1.15 per square foot;
2 Executone Limited.

The Roofing Subsystem. Four bids were received in this category:

1 Dean-Chandler Co., Ltd., the designated contractor, with a bid of $.71 per square foot;
2 Seeback and Sons, Ltd.;
3 Heather and Little, Ltd.;
4 Peerless Enterprises (a Division of Tectum, Ltd.)

The Carpet Subsystem. Four bids were received in this category:

1 Perfection Rug Co., Ltd. was designated by SEF on the basis of a bid of $.41 per square foot;
2 The Robert Simpson Co., Ltd., Simpson's Contract Division;
3 Granwood Flooring Canada, Ltd.;
4 Northern Flooring Co., Ltd.

Additional Subsystems. At the January submittal, bids were not taken on four of the subsystems which comprise the First SEF Building System. The Hardware subsystem was bid in early March. The bid submittals are under study at this writing. The Casework, Seating, and Office Furniture documents will be distributed on April 22, 1969. Bids will be taken in August.

The Costs of the First SEF Building System Using the October 1967 budget figure of $20.85 per square foot of building cost (in US funds: $19.39), SEF has prepared the following cost comparisons from the cost figures submitted by the bidders. It should be noted that the budget figure of $20.85 per square foot is the school plant construction cost exclusive of land and site work for October 1967. All figures are quoted in costs per gross square foot.

Brule Terrace School	$21.23/sq ft.	1.82% over budget figure
Brooks Road School	$19.78/sq. ft.	5.13% under budget figure
Chartland School	$19.03/sq. ft.	8.73% under budget figure
Roden School	$18.52/sq. ft.	11.17% under budget figure
Average for the four sample schools	$19.38/sq. ft.	7.05% under budget figure

The budget figure escalated to the January 1969 equivalent yields a figure of $22.50 per square foot ($20.93 in U.S. funds). Using the $19.38 average cost of the four sample plans and the escalated budget figure of $22.50, the anticipated savings are 13.9 percent.

SEF and the Open System Concept The SEF Program has both a short-term and a long-term goal for its building system development. In the short-term, the First SEF Building System will be used on the thirty-two projects in the first construction program. In the long-term, SEF hopes to help in the creation of an open system for school construction in Canada and the United States. An "open system" is a number of components from different manufacturers which may be used interchangeably on building projects. The basis for this open system will be the currently available building system components, including those growing out of SCSD, plus the components developed for the First SEF Building System and for the Montreal RAS Building System.

Part of SEF's effort is being directed toward helping all the bidders on the First SEF Building System to find additional markets for their products. If markets for the unsuccessful First System bidders can be found, then a major step will have been taken in the creation of this open system. The goal is, therefore, the creation of a market situation in which there are available a number of compatible building systems, each with its own specific cost and performance characteristics. For example, on a school project requiring a long span structure, the precast concrete structural system bid unsuccessfully on the first SEF program by Precon Murray could easily prove to be the most economical and desirable.

In order not to prejudice potential component buyers by a separate release of documentation on the winning First SEF Building System, SEF has chosen to release drawings and full component descriptions on all bidders, both successful and unsuccessful, at the same time. A book of drawings is being prepared by the SEF staff showing comparative drawings of all the components. From this book, the prospective system user can see a number of available building systems which can satisfy his needs. SEF plans to distribute this book widely in about two months.

SEF's Next Steps As mentioned previously, before contracts are signed with the subsystem nominees, certain documentation and testing must be made involving both the performance of the individual subsystems and of the First SEF Building System as a whole. Each subsystem nominee must provide a complete unit price schedule, evidence of acceptance by the various officials and commissions having jurisdiction, and information for inclusion in a general system catalog.

The primary technical testing is being made on an addition to the Eastview Public School. This addition will house tutorial spaces and a library resource center and will contain about 12,000 square feet. The building program is based upon the first SEF user requirement publication, *E-1: Educational Specifications and User Requirements for Elementary (K-6) Schools.*

The construction of the Roden Public School will provide the first full scale test of the building system. On this project, SEF hopes to have "a practical working out of the main problems which faced SEF when it was organized in 1966." Stated simply, these problems involve the creation of a school environment responsive to the changing needs of its users at a cost which will save tax dollars on a "continuing and stable basis." The management procedures involved in using the First SEF Building System will be examined and tested during the construction of Roden in an effort to reduce extra costs which can result from poor or untried methods of planning and coordination.

Roden Public School is being designed by the SEF staff who are making use of the results of the studies performed in the total program. Roden, the largest elementary school committed to the use of the First SEF Building System, will be the first school contracted.

SEF and the six City and Borough Boards hope to let Series Two Contracts for the first eleven school plant projects in April of this year. These general contracts, or Fixed Fee Management Contracts, assign to the general contractor a project management role. He is also responsible for site work. Subsystem contractors and general contractors are mutually responsible for coordinating delivery and installation of subsystem components.

A monitoring group has been established by SEF to check the performance of manufacturers and contractors in producing and installing the components of the first system. This group will attempt to maintain the construction rate at the SEF target figure of 100,000 square feet per month. Extensive use of data processing by SEF will allow each manufacturer to use his own scheduling technique. SEF has required that each manufacturer have reserve capacity for production of components in order to meet contingencies.

The SEF staff, the Metro Board, and the City and Borough Boards see the First SEF Building System as just that, the first in a series of building system development and bidding projects in Toronto and Canada. Second and third bidding programs are foreseen by the end of the construction period of the first program in 1971. These programs may involve First System Contractors, unsuccessful first system bidders, and new bidders.

A number of school districts in Canada have made inquiries and studies of the feasibility of use of components or of developing systems themselves.

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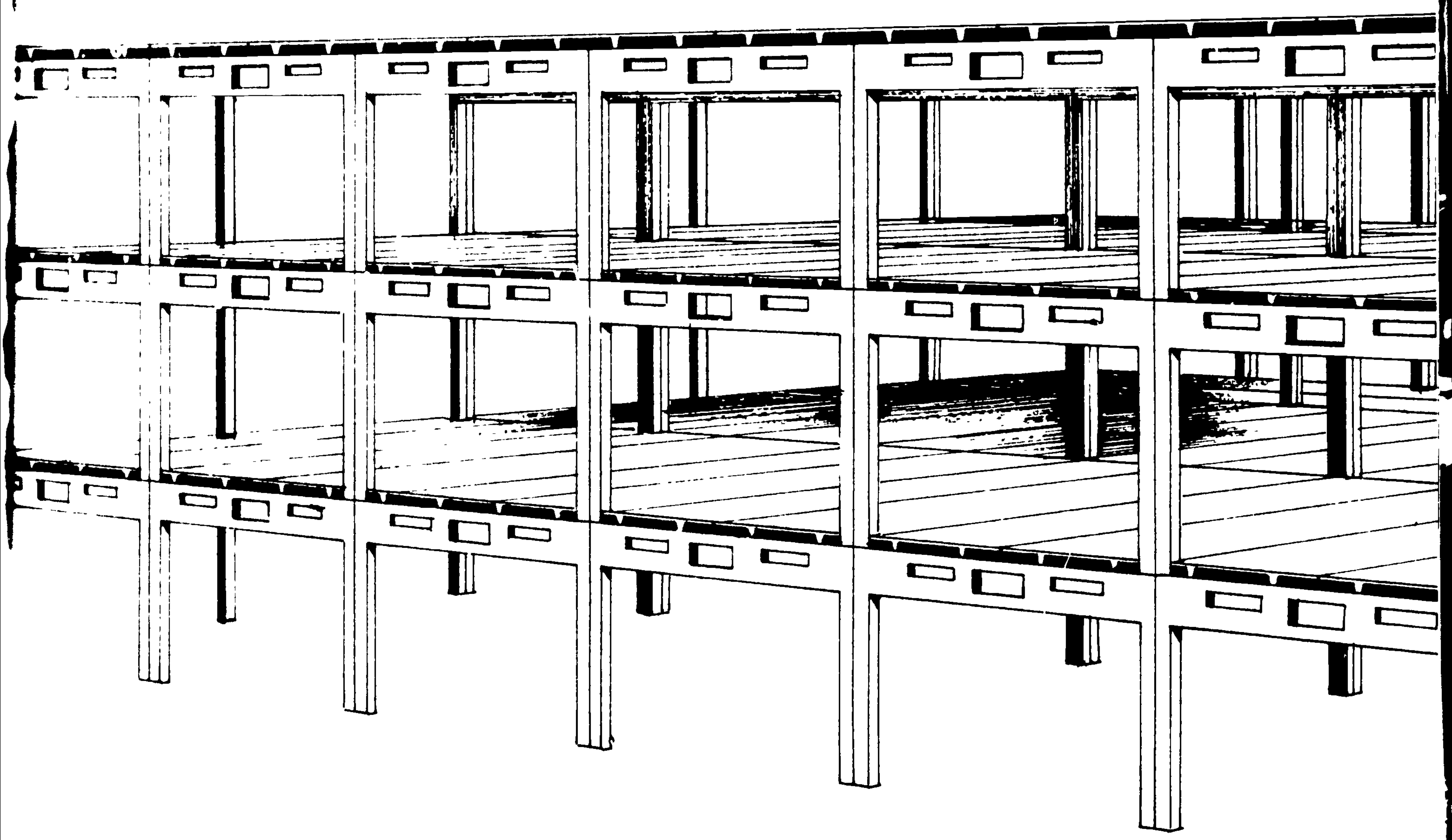


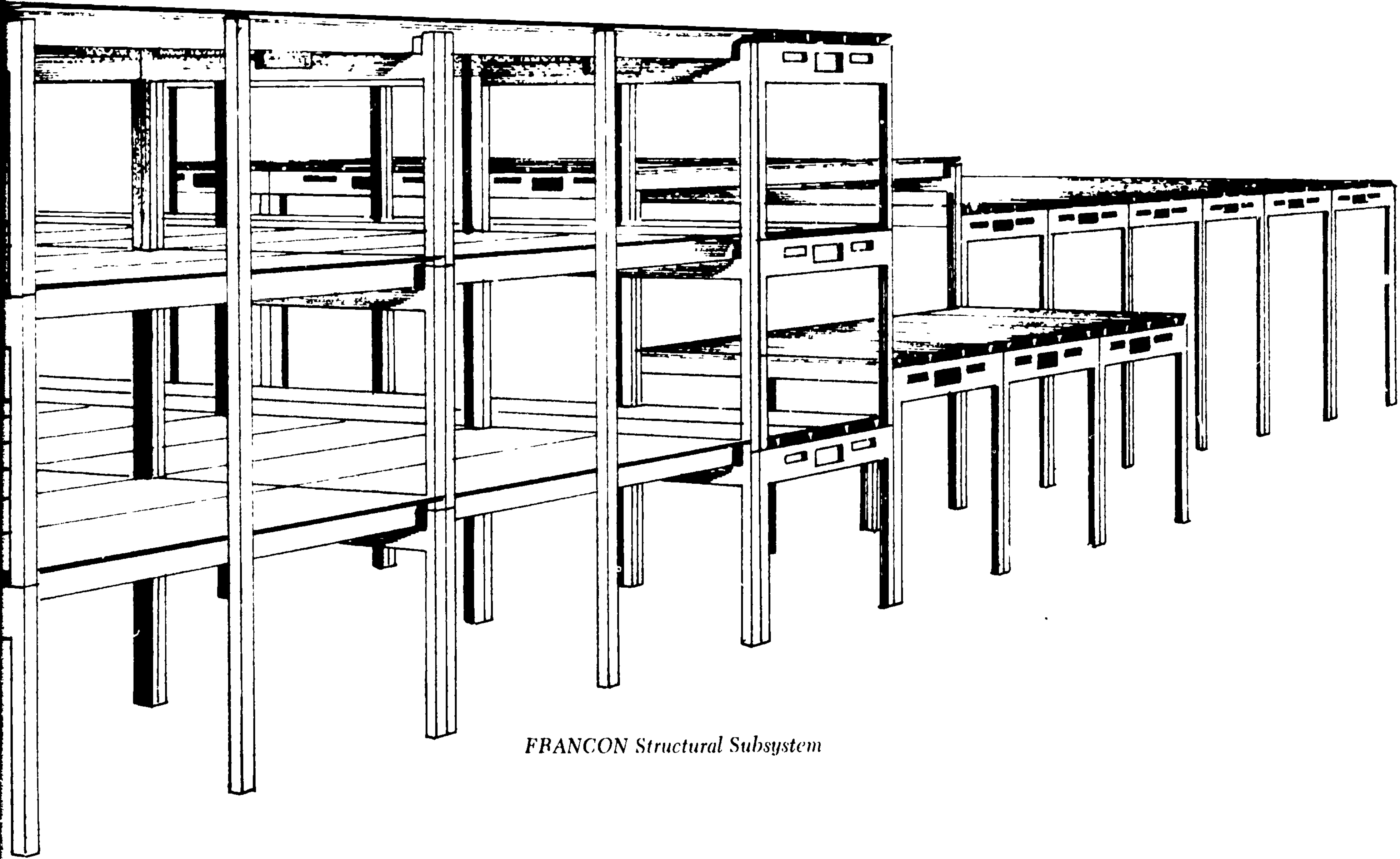
RAS

Recherches en Amenagements Scolaires

Results of the evaluation of bids on the second Canadian systems development project, the Recherches en Amenagements Scolaires (RAS), or Research in School Facilities, was announced by the Montreal Catholic School Commission (MCSC) in Montreal, Quebec, on March 21, 1969. By the end of 1972, MCSC plans to use the system components on an anticipated twenty school plants worth over $40,000,000 (in U.S. funds: $37,200,000). A further incentive to manufacturers is the potential construction of an additional seventy-five new school plants in the Montreal region by the end of the next decade.

The development of the RAS building system is one part of an intensive study of education in Montreal being performed by IRNES, Inc., under the sponsorship of the Montreal Catholic School Commission and the Educational Facilities Laboratories. IRNES, Inc., a highly respected Quebec research firm headed by M. Gaetan J. Cote, has in this three year project investigated the entire spectrum of educational problems ranging from the location of school plants and shared land use with city parks to out-of-school hour use of school buildings. As one facet of the effort to update school construction in Montreal, IRNES has managed the development of the RAS building system. Michel Bezman, IRNES' Technical Director, has supervised the development of the RAS building system.

To promote closer integration with the Montreal Public School system and other Quebec school systems, MCSC has attempted to involve the provincial Department of Education in the process of selecting the building system. IRNES and MCSC have discussed the nominated system with the Quebec Minister of Education and his Department. MCSC hopes that by involving educational authority



FRANCON Structural Subsystem

at the highest level, possible barriers to widespread use of the components in the province may be reduced.

Contract responsibility for the original twenty school plants in the program is, for the first time in a North American development project, directly vested in the single agency sponsoring the project. Another distinction between this and other system projects is that the subsystem contractors in RAS are bound to the MCSC by a single contract covering all components supplied and all work to be done in the entire construction phase. For each individual plant, a separate general contract is signed and the subsystem contractors attached as subcontractors with stated costs and responsibilities.

Project Methodology Initially IRNES had sought to include eight subsystems in the RAS building system. Consultations with architects, engineers, educators, and other specialists led to the abandonment of three of the subsystems—external skin, roofing, and plumbing—before development of their performance specifications. The exterior skin subsystem was eliminated for much the same reason it was excluded from the SCSD program, the need to reserve this area for individual esthetic expression by each of the project designers. Performance specifications were prepared for the remaining five subsystems: structure, ceiling-lighting, heating-ventilating-air conditioning, interior partitions, and electric-electronic distribution.

In the course of preparing the structural performance specifications, IRNES was able to obtain some modification of the Montreal Fire Code. The four hour column protection rating and the three hour floor rating would have made economic steel competition by structural systems virtually impossible. IRNES obtained code relaxation to allow the horizontal sandwich to have a three hour rating, and to permit the use of exposed steel in spaces 20 feet high, 5 feet lower than before. Finally, Code Authorities agreed to accept submission of the results of tests as proof of fire resistance and rating.

To insure the compatibility of subsystems, IRNES adopted a method similar to one used in the SCSD program. Rather than aim for the so-called open system of interchangeable components as was done by the Toronto group, IRNES sought bids in which the compatible functioning of subsystems was insured prior to bid. Bids were accepted on "integrated component systems" only; that is, on linked bids covering all five subsystems and with documentation of the compatibility. One effect of this approach can be seen by comparing the arithmetic of the two projects: In Toronto, SEF identified 13,000 allegedly compatible building systems out of a possible 184,000 manufacturer combinations, about one in fourteen; in Montreal, out of a possible 1200 manufacturer combinations, only 11 were identified as compatible building systems, or about 1 in 110.

Although the "open system" approach seems to produce a great potential for product substitution, the Montreal "integrated system" bid by requiring the submission of systems of documented compatibility seems to increase the actual integration of components into a building system. The Toronto approach seems to opt for future product competition at the cost of greater post-bid development while the Montreal approach seems to reduce post-bid development at the expense of possible future competition.

In the performance specifications and contract documents, IRNES included plans for four "sample" schools as well as a list of subsystem quantities required in the whole program. IRNES and MCSC established a "ceiling price" which was the cost of construction in conventional school plants. This ceiling price at the time of the bidding was $18,438,252 for five component subsystems, or $6.07/S.F.

Bidders were required to submit physical descriptions of their systems with drawings showing interfacing conditions with the other four subsystems. They were also required to submit a series of cost figures including:

a. a unit price schedule;

b. a lump sum bid which was the result of applying the unit price schedule to the list of quantities;

c. the annual maintenance and operating costs for the four sample school projects.

On January 21, 1969 bids were opened at a public session in Montreal. Bids were received from thirteen manufacturers on eleven integrated component systems. The range in the lump sum bids was from a low of $16.5 million to a high of $23.25 million. In the structural category, both steel and concrete solutions were represented. At least ten of the products bid had also been bid in the Toronto SEF program two weeks earlier.

Bid Evaluation and its Results The first step in this process was to preselect only those integrated component systems with costs below the ceiling cost figure. MCSC had established that it would not consider a system with costs above the ceiling. This preselection resulted in eliminating all but three of the submitted systems from consideration.

Following preselection, the basic strategy in the bid evaluations made by IRNES was to reduce the bid figures to annual costs of owning and operating the three systems and then to compare these costs and the performances. After adjustments were made in the lump sum bids using correction factors, adjusted lump sum bids were then converted to their annual costs.

This annual cost equivalent was added to an annual maintenance and operating cost figure to obtain the Grand Total Figure used in the cost comparisons. The annual maintenance and operating cost is a weighted average of the costs specified by the bidders for maintenance and operation of their system in the four sample school projects.

Final selection by IRNES was then made on the basis of three comparisons:

1 The performance of each system was evaluated against the requirements contained in the performance specifications;

2 The Total Unit Prices which are the lump sum bids divided by the gross area of the project schools were compared;

3 The annual costs of owning and operating the systems were compared.

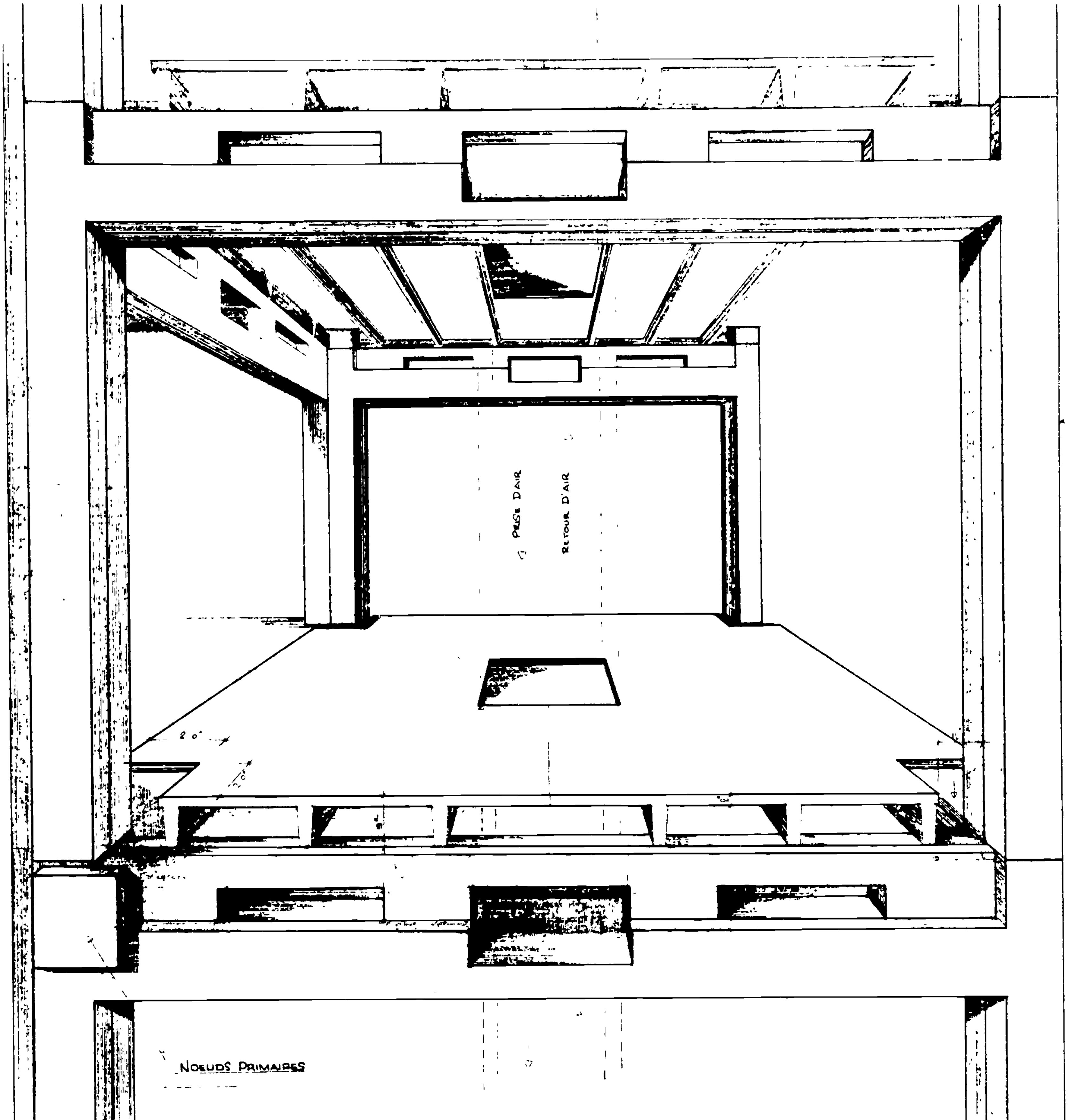
After making these comparisons, IRNES recommended one integrated component system to MCSC for their consideration.

This integrated component system, known to RAS as the Francon group, had the lowest apparent cost at the bid opening, and contained the lowest bids in three of the five subsystem categories. According to Michel Bezman, Technical Director of IRNES, evaluation did nothing to change the ranking indicated at the bid opening. Further evaluation by IRNES suggests that a possible savings in excess of $400,000 may be made in the twenty-one school construction program over conventional methods by use of the Francon system.

The system will comprise from 40 to 60 per cent of building costs, depending upon the type of school constructed. In elementary schools, where the number of specialized spaces is small, 60 per cent of the building costs may be in system components; while in comprehensive high schools with many specialized spaces this may be reduced to 40 per cent of building costs. Within this 40 to 60 per cent of total building costs, the use of the Francon group components should result in a savings of 12.8 per cent over conventional construction.

The RAS System. At the bid opening, the building system which has been recommended by IRNES had the apparent low bid of $16,546,132.54. Adjustment by IRNES reduced this to $16,084,103.05, or about $5.29 per square foot ($4.92 in U.S. Funds). The five subsystems which comprise the recommended system are structure, ceiling-lighting, heating-ventilating-air conditioning, interior partitions, and electric-electronic.

The Structural Subsystem. The five bids received included two precast concrete, one poured in place concrete and two steel frame structural systems. The



FRANCON Structural Subsystem, mechanical rooms

subsystem recommended is a precast concrete system submitted by Francon, Ltd. Francon did not have the lowest structural bid, but the Francon group submitted the lowest integrated component system bid. The lowest structural bid was for a steel framing system developed by Dominion Bridge, a system which was also bid on the SEF project in Toronto.

The Francon subsystem is a precast concrete system based upon an assembly of two types of elements. The first of these is a precast portal frame, one story in height with a span of ten or twenty feet. The horizontal spanning elements, precast double or single tees, frame into these portals. These assemblies are designed to stand independently, although adjacent assemblies may share a common portal frame to insure structural continuity.

To visualize the structural action of the subsystem, imagine a number of nearly identical tables grouped together. Horizontally the tables sit next to one another, with some pairs of tables sharing a pair of legs. Vertically the tables are stacked one on top of another with their legs superimposed.

The thickness of the sandwich formed by the structure is 48 inches. Within this sandwich, zones are provided for two types of services. Services provided by the components of the HVA/C subsystem and electrical supply for the ceiling-lighting subsystem are handled by openings cast into the portal frames. Non-system services are carried through the opening between the top of the portal frame and the slab of the precast tees and through openings cast into the tees.

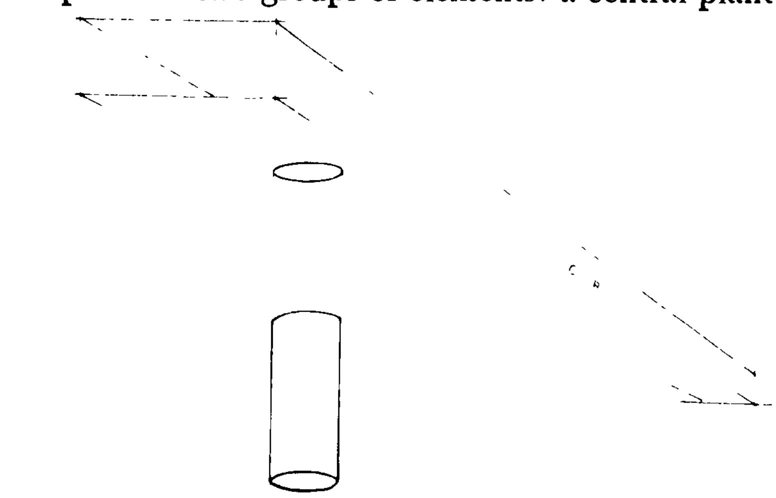
Provision for attachment of exterior walls has been provided. These attachments permit the exterior walls either to transfer their weight to the structure at each story or to carry this load to the ground with stability attachments only.

Additional alternatives offered by Francon include:

1 The use of spans in excess of 60'–0" at no greater cost than the use of several smaller spans;
2 Special horizontal elements for use in mechanical rooms;
3 A precast concrete exterior wall.

The Francon subsystem bid was $8,937,086.97. IRNES has adjusted this figure to $8,589,207.45.

The Heating-Ventilating-Air Conditioning Subsystem. The Heating-Ventilating-Air Conditioning (HVA/C) subsystem, a new product by Lennox Industries of Canada, was one of five HVA/C systems bid. The Lennox subsystem which was bid only with the Francon group was the lowest HVA/C bid received. This subsystem is composed of two groups of elements: a central plant



Air diffuser construction with the Lennox H-V-C Subsystem

and a distribution system for treated air.

The air treatment units are housed in pairs, each pair ocupying a mechanical room 20'–0" by 20'–0". Each room with its two units serves about 16,000 square feet of building. In a multi-story building, these rooms will be placed one above the other. The distribution of treated air to the zones is through a multi-zone mixing box arrangement similar to that of the DMS unit which was used in the SCSD program.

The treated air is supplied to the zones in ducts which lie on a 10 foot grid. At the ceiling grid line intersections, a junction box is connected to the duct by an 8" or 10" diameter connector. Each supply diffuser consists of three metal pieces which are fitted into the slot between adjacent lighting-ceiling units. Four diffuser units extend in a cross pattern about two feet along each slot from the junction box. Return air is through the space above the ceiling, air being taken from the rooms through collectors fitted into the slot between the lighting-ceiling units.

The lump sum bid submitted by Lennox was $2,715,-399.57. The adjustment of this bid by IRNES reduced it slightly to $2,703,794.73.

The Ceiling-Lighting Subsystem. Electrolier, one of the three manufacturers bidding products in the ceiling-lighting subsystem, entered the low bid in this area with the Francon group. As well as the lowest initial cost, Electrolier offers savings in operating costs brought about by a 16 per cent reduction in the number of fluorescent tubes required and a corresponding lower wattage per square foot.

The ceiling-lighting solutions had to fulfill a complex specification which gave four different combinations of lighting, acoustic, and physical criteria. Each combination called for a fixture for use in specific locations.

The Electrolier system is a suspended ceiling of five foot by five foot units containing fluorescent fixtures. Special units are provided for use with the electrical distribution columnette, described below, and a 40" by 60" lighting unit is also available for special conditions. The suspended individual fixtures for use in the gymnasiums have mercury vapor lamps.

The lump sum bid for this subsystem was $1,561,-367.00. After adjustment by IRNES, the cost is $1,493,-367.00.

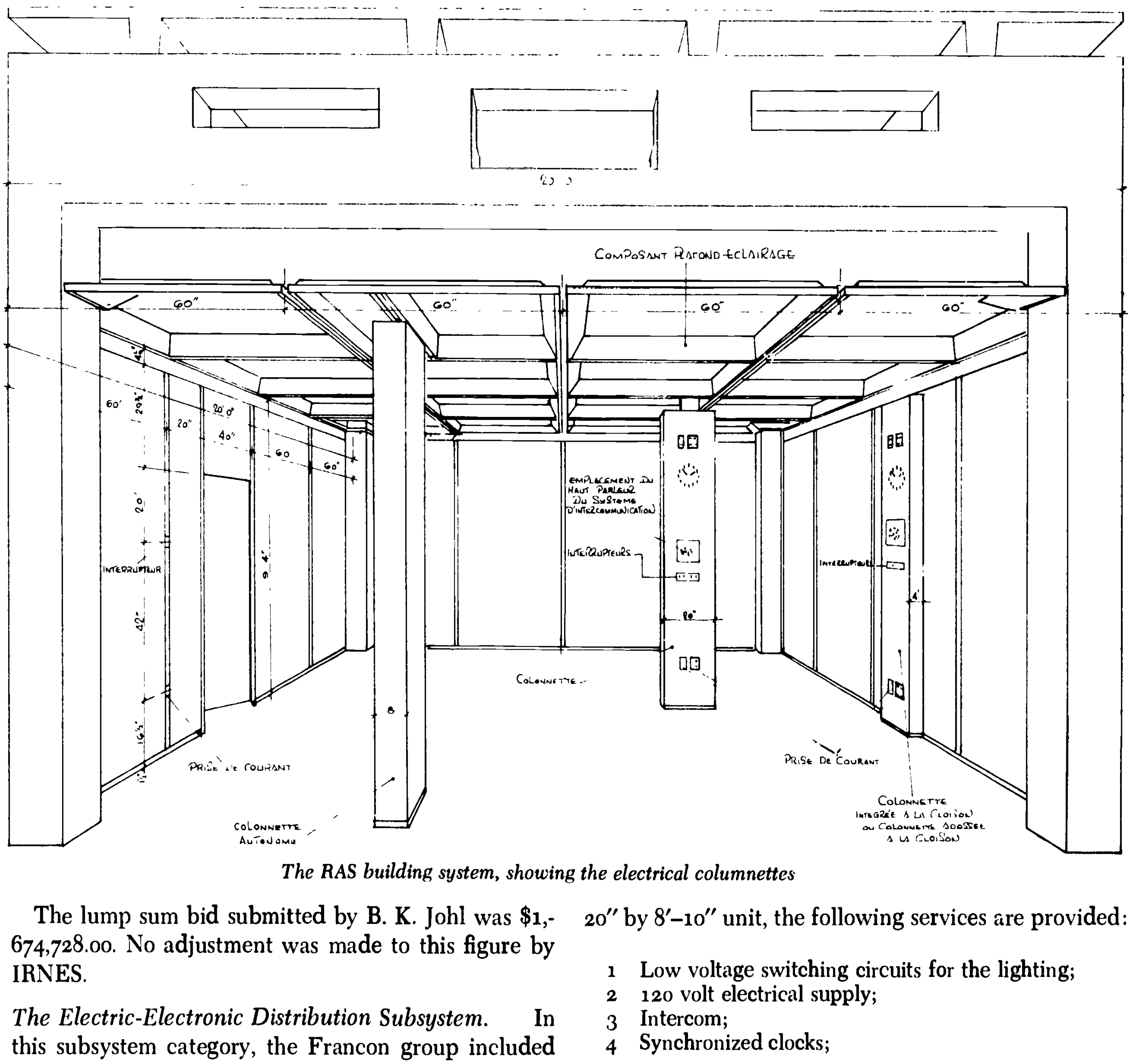
Internal Space Subdivision Subsystem. In the category of internal space subdivision, the Francon group included the lowest partition bidder, B. K. Johl. Johl also bid with three other consortia but had higher bids with each of them. Three other manufacturers offered space subdivision products.

The Johl submission answered a performance specification which called for a one-hour fire rating capability and a sound rating of STC 40, the highest acoustic rating thus far specified in a systems development project. As well as fulfilling these requirements, the Johl subsystem offers a number of innovative advantages of its own. The most notable of these innovations is the extreme thinness of the partition, the face to face thickness being only 2¼″. Previous partitions with similar characteristics have been 3″, 4″ or even 6″ thick.

In spite of its thinness either steel face may be removed and replaced without taking down the wall. Various factory applied finishes are available on the panels, including floor to ceiling chalkboard, a number of colors and special acoustical panels. Because of the dimensions of the partitions, window and door panels are readily interchangeable with solid panels.

the Bedard-Girard subsystem, one of four electric-electronic systems bid. The specifications for this subsystem sought, as they did in the Toronto SEF project, a method of electrical distribution possessing the same characteristics of flexibility found in the partition and HVA/C subsystems. As can be seen in the partition movement study in this issue of the *Newsletter*, the use of traditional methods of electrical distribution in potentially flexible plans can cause difficulty.

The Bedard-Girard system is based upon an electrical columnette which is coordinated dimensionally with the partition subsystem. In use the columnette may be either a part of a partition, freestanding, or against the face of the partition. To insure coordination of appearance, the columnette is to be finished by B. K. Johl, the partition contract nominee. Within this 4″ by



The RAS building system, showing the electrical columnettes

The lump sum bid submitted by B. K. Johl was $1,674,728.00. No adjustment was made to this figure by IRNES.

The Electric-Electronic Distribution Subsystem. In this subsystem category, the Francon group included

20″ by 8′–10″ unit, the following services are provided:

1 Low voltage switching circuits for the lighting;
2 120 volt electrical supply;
3 Intercom;
4 Synchronized clocks;

5 Television distribution;
6 Space in which to accommodate future service needs.

Connection of the columnettes with the primary electrical service nodes is achieved by heavy duty cables. The columnettes are structurally plugged into the ceiling runners. Electrically they plug into color coded "extension cords," which run in the ceiling sandwich from the primary nodes. Service to the primary nodes is through traditional wiring in conduits.

The cost of the Bedard-Girard system in their lump sum bid was $1,657,551.00. IRNES has adjusted this figure to $1,623,005.87.

Next Steps—Development, Testing, and Construction. Following subsystem nomination, IRNES will supervise the preliminary testing and document completion for the selected system. The two main activities in this phase will be the completion of the system's General Information Handbook and the construction and testing of a full scale mockup. Upon completion of preliminary testing, the construction of a Pilot School and the remaining schools in the program will be undertaken.

The General Information Handbook contains two parts, a system information catalog and a maintenance handbook. Much of the information contained in the catalog was part of each bidder's submission documents, although this must be supplemented in accordance with IRNES' wishes. The catalog will contain sufficient information and costs on the system including the results of the various tests to allow the designers to incorporate the components into their school plant designs without other documentation. The maintenance handbook contains information about replacement parts and costs, warranties, repair procedures, etc.

The component contractors will erect a full scale mockup somewhere in Montreal at their expense. This mockup will allow the checking of the compatibility of subsystems before production runs begin. IRNES will also conduct a series of tests upon this structure during the development phase. This mockup will also serve as a means of introducing the project architects and engineers to the system. The development phase will be completed with the delivery of the first components to the Pilot School Site, currently scheduled for early September 1969.

Testing will continue into the construction phase with identical tests scheduled to be performed on the Pilot Elementary School and the first of the Secondary schools. Costs for the various tests will be borne by the bidders, although any retesting for verification will be performed at MCSC expense.

Before the beginning of the construction phase, each component contractor is required to submit ten copies of his production and delivery schedule for components covering all construction projects in the program. The program is based upon the production and erection of the equivalent of 150,000 to 200,000 square feet of school plant per month. The production and delivery schedule will use Critical Path Method (CPM) and is to be coordinated with the CPM schedules of the general contractors of the various projects. Specific project supervision remains vested in the General Contractor and in the Architect as representative of the owner.

The plants contained in the construction program are divided into two groups: Elementary Schools of 56,000 to 57,000 gross square feet, and Comprehensive Secondary Schools of 270,000 to 300,000 gross square feet. There are currently twenty-one schools in the project—twelve elementary and nine high schools—the Pilot School being the first of the Elementary School projects. The first school of the regular construction program, a comprehensive high school, is scheduled to begin on-site construction in June of 1970 and to be completed the following year. Completion date for the Pilot School is January 7, 1970. All schools are scheduled to be completed by December 31, 1972. □

SSP

Schoolhouse Systems Project

In December 1968 the Schoolhouse Systems Project (SSP) nominated component contractors for the third group of schools to be bid under SSP's volume bidding program. The cost of components to be installed in the eleven schools included in the latest round of bidding is more than $3,000,000. This brings the value of the component contracts for the twenty-four schools included in the three SSP programs to more than $7,000,000.

SSP is an agency of the State of Florida Department of Education and is headed by State Commissioner of Education, Floyd T. Christian, educator Harold Cramer, and architect James Y. Bruce. Unlike the California SCSD Project which provided the model, SSP doesn't directly attempt to stimulate new product development. Instead it makes use of two other techniques introduced to the American building industry by the California project—bulk bidding, and the use of performance specifications. The goals sought through the use of these methods are—first, to provide higher quality schools at reduced costs, and second, to introduce the systems building concept to Florida. SSP hopes at some time in the future to undertake its own systems development project, possibly involving junior college and university buildings.

Organization of the Market Unless the sponsor of the systems development project has direct control of a large volume of work, such as is the case with the two Canadian projects, the creation of the market can be a major problem. One of the difficulties often encountered in combining building projects from a number of school districts to form a market is that of attrition during the long period of organization and development that is required before the products are ready for use. SSP avoids this problem by reducing to a minimum the amount of development work required by using performance criteria which can be met by currently available systems components.

Program 1-A A performance specification modeled on the SCSD document was issued by SSP in July 1967. This specification covered four subsystems: structure, heating-ventilating-cooling, lighting-ceiling and partitions. Ten manufacturers bid fifteen combinations of products in the first three categories. No nominations were made in the partition category. Successful component bidders, nominated in October 1967, are shown in Table 1.

TABLE 1

1. Structure	Macomber V-LOK	$ 453,495	$1.626/ft^2
2. Lighting/ceiling	Armstrong Cork	$ 364,000	$1.305/ft^2
3. Air Conditioning (HVAC)	Lennox Industries	$ 489,400	$1.754/ft^2
	Total	$1,306,895	

Program 2 The second program included nine building projects. The number of component categories was increased to seven; however, prior to the taking of bids the roofing component was deleted for lack of bidder interest. Fourteen bidders submitted a total of 5,760 combinations for the six subsystems. The successful combination of bidders, nominated in August 1968, is shown in Table 2.

TABLE 2

1. Structure	Macomber V-LOK	$ 630,611	$1.275/ft^2
2. Air Conditioning	Hill-York (ITT)	$ 736,090	$1.512/ft^2
3. Lighting/ceiling	Anning-Johnson	$ 382,225	$0.785/ft^2
4. Partitions			
a. Demountable	E.F. Hauserman	$ 250,170	
b. Oper. Panel	Malone Products	$ 54,816	
c. Oper. Accdn.	Buck Taylor (Modernfold)	$ 58,998	
5. Cabinets	Educators Mfg. Co.	$ 195,181	
6. Carpeting	Don Myer & Assoc.	$ 202,491	
	Total	$2,510,582	

Program 3 The third program again involved nine school projects, plus two districts from Program 2 who participated in the purchase of the cabinet subsystems. Sixteen manufacturers bid on the six subsystems in Program 3. The nominated contractors are shown in Table 3.

TABLE 3

1. Structure	Romac Steel	$ 629,500	$1.16/ft^2
2. HVAC	Hill-York (ITT)	$1,016,390	$1.88/ft^2
3. Lighting/ceiling	Acousti Engineering	$ 534,131	$0.99/ft^2
4. Interior Partitions			
a. Demountable	Mills Company	$ 195,984	
b. Oper. Panel	Hough Mfg.	$ 10,229	
c. Oper. Accdn.	Hough Mfg.	$ 20,146	
5. Cabinets	Educators Mfg.	$ 454,283	
6. Carpeting	Sears, Roebuck	$ 280,523	
	Total	$3,141,186	

The structural contractor, Romac Steel Company of Ft. Myers, Florida, had bid its MODULOC System unsuccessfully on the second program before being selected for the third. MODULOC is a steel joist system on a five-foot horizontal module capable of framing into either the special MODULOC column or a bearing wall. Although as bid in SSP it uses a 26 g. galvanized deck with light weight aggregate concrete fill, MODULOC is capable of receiving a variety of decks.

Acousti Engineering Company of Florida was not the apparent low bidder with the Armstrong C-60 lighting/ceiling system. However, when bids were evaluated it was found that the annual power savings from the low 2 watt per square foot C-60 ceiling and a corresponding savings in air conditioning costs, brought the C-60 cost below that of the apparent low bidders.

The second and third program performance specifications made use of the new Visual Performance Index (VPI) method of evaluating lighting design. The older method of evaluation by illumination level was included in both programs as an option.

The Research Advisory Committee and Program 4 In September 1968, the first meeting of the Superintendent's Advisory Committee on School Building Research was held. This committee was formed to provide the State Superintendent of Public Instruction and the SSP staff with advice and assistance in defining the course of future school building system research and development. The committee members were selected from among the educational and professional associations in the State including, among others, the Associated General Contractors, the Building Trades Association, the Florida Engineering Society, the Florida Association of the American Institute of Architects, the Florida School Board Association, and the Association of County Superintendents of Schools. A committee member was also selected from each house of the State legislature.

At the committee's business meeting on December 3, 1968, State Senator Ralph Poston of Miami, who describes himself as a "business man in the steel erection business," was elected chairman. Under the leadership of Senator Poston, the committee has toured the various systems development projects underway in the United States and Canada. On the same tour, members of the committee visited a number of the country's more dynamic junior college districts. The committee hopes to make use of these experiences in helping to define the role of building systems research and development for the various educational systems of Florida.

Feedback from the committee has led the SSP staff to alter the organization of the fourth bulk purchase program being prepared for bidding in June 1969. This program will differ from the first three in that the program will be administered and bid by the individual districts. The SSP staff will prepare performance specifications as before, and will work closely with the districts in an advisory capacity. At the present time, several school districts have shown interest in the program, including one district planning construction of a $6,000,000 complex.

The Accomplishments of SSP The Advisory Committee feels that the Schoolhouse Systems Project has fulfilled three of its goals. These goals are, in the words of State Commissioner of Education, Floyd T. Christian: "to build better schools, to build more economical schools, and to build schools faster." SSP can point to the twenty-four school plants built or under construction using systems components, and to the fact that while construction costs of new school plants in some areas of Florida are rising by as much as 40 per cent per year, the costs of some of the subsystems of SSP have actually declined in the course of the program.

Another goal stated by SSP at its inception was to introduce the "systems concept" to the State of Florida through the various bulk purchase programs. SSP has managed to raise the level of awareness about this approach in the State to the point where significant debate and discussion among professionals can be held about the advantages and disadvantages of building systems and building research.

Since its inception in 1966, SSP has sought to undertake its own program of building system research and development involving all levels of education in Florida from kindergartens—a full kindergarten program will be initiated on a state-wide basis in 1973—to universities. Formation of the Advisory Committee is an important step toward the implementation of such a program. ◻

GHS

Great High Schools

On February 25, 1969, the Pittsburgh Board of Public Education officially authorized its architects, Hellmuth, Obata, and Kassabaum to proceed with design development of the first two of Pittsburgh's five Great High Schools. The architects estimate that construction may begin on the first of these schools, East Liberty, in about fourteen months, and on the second, Moore Field, soon thereafter. The action taken by the Board is another step toward the completion of one of the most ambitious school building programs ever undertaken in the United States, a program which may ultimately cost as much as $250 million for development and construction.

The Great High Schools Project is seen by Pittsburgh not only as a much needed physical plant renewal for the school system, but also as part of the post-war "Pittsburgh Renaissance." As such, GHS will be a means of extending the renewal effort which began over two decades ago with an ambitious smoke control program followed by the now famous Golden Triangle Project in the nation's first full scale urban renewal program. Along with its educational plan GHS may provide a nucleus for general land use and transportation planning for a troubled city.

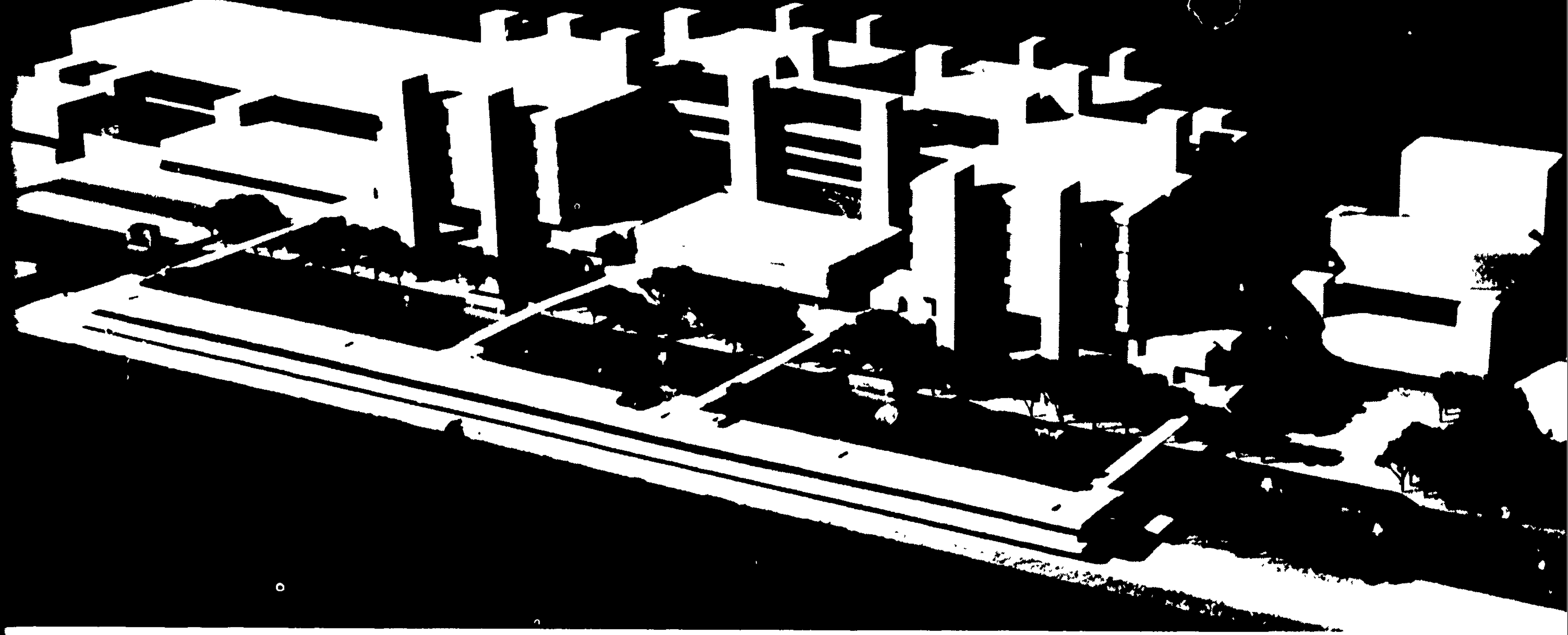
Project Background A preliminary site location and physical planning study for the Great High Schools was begun in 1964 by Urban Design Associates of Pittsburgh (UDA) under an Educational Facilities Laboratories grant. In this study, UDA, after consultation with the Pittsburgh City Planning Commission and numerous other official and private agencies, designated five high school areas and prepared schematic models of two of the schools, Northside and East Liberty. The results of this study were published in the June 1967 issue of *Architectural Forum* magazine.

In the same period, a study of Pittsburgh population trends and its educational needs was made by the Center for Field Studies of the Harvard Graduate School of Education. The report of this group, *Education in Pittsburgh*, was published in 1966 and outlined a program involving all levels of education, including the Great High Schools.

Public recognition of the state of educational facilities in Pittsburgh was reflected in the passage by a 3 to 1 majority of a $50 million bond issue in the 1966 primary election. The funds obtained from these bonds were committed to new school construction and renovation of still-useful existing plants. At the time of passage of this bond issue, no new high school construction had taken place in the City of Pittsburgh in over forty years.

After formal announcement in 1966 of the Great High Schools Program, the Board of Public Education commissioned Odell-MacConnell Associates, now Davis-MacConnell-Ralston, Inc. (DMR) to prepare educational specifications for the high school program. Working with the Superintendent of Schools, Dr. Sidney P. Marland, and two of his associates, Mr. Bernard McCormick, the present Superintendent, and the late Dr. Donald D. Duawalder, DMR began to develop a program combining a departmental education plan with a student "house" concept to strengthen the social-personal-guidance services to students.

While Odell-MacConnell was completing the preliminary draft



Model of the proposed East Liberty Great High School

of the educational specifications, the Board appointed a screening committee to nominate architects for the project. Over a period of a year, this screening committee studied and visited numerous firms and finally recommended five firms to the Board. Early in 1967, the Board selected Hellmuth, Obata, and Kassabaum (HOK) of St. Louis, Missouri, as coordinating architects.

A project team of consultants was organized to support HOK, including Davis-MacConnell-Ralston, educational consultants; Ayres and Hayakawa, coordinating mechanical and electrical engineers; LeMessurier Associates as coordinating structural engineers; Building Systems Development, building systems consultants; and the George A. Fuller Company, cost consultants. Two Pittsburgh area firms—Celli-Flynn and Curry, Martin, Pekruhn, and Roberts—were selected as associate architects.

The Great High Schools Program Socially, the GHS program has at least two major goals other than the simple provision of new educational facilities. The first is to achieve by the centralization of facilities, five high school attendance districts so extensive that the problem of "de facto" segregation which might occur with smaller districts is eliminated. By this method, the Board hopes to achieve in each Great High School a racial balance that will reflect the racial composition of the city rather than any given neighborhood. The second social goal is to stem the flow of Pittsburgh residents to the area's suburbs by creating educational institutions of the highest quality within the city.

The program developed by DMR and the District makes use of the size of the Great High Schools to provide facilities which would be too expensive or too diffuse to be effective in a system of more numerous, conventionally sized units. Each Great High School is to contain complete facilities for both academic and vocational educational programs, and provisions are to be included for the latest technological aids for learning.

The educational program of each school is based upon a departmental organization scheme with each academic specialty in a separate department. Each departmental center will contain offices for the director and his staff, preparation and storage areas, and a collection of specialized resource materials.

A large central resource center will provide an extensive collection of materials available for all departments. This center is to contain both the main library and the learning materials center, and will provide the latest in television production and audio-visual equipment.

The basic social unit will be the 1250 to 1400 student "house." The purpose of the student house is to integrate the students into a school "community," much like a small high school. Each group within the student house will contain students of all races and of both academically and vocationally oriented courses of study. The organization of each house as a hierarchic collection of groups of different sizes will provide opportunity for individual development at many levels. Each house will have its own athletic teams, school newspaper, drama and music groups and literary magazine.

The organization of the student center is hierarchic,

Prototype Great High School counseling group at Oliver High School

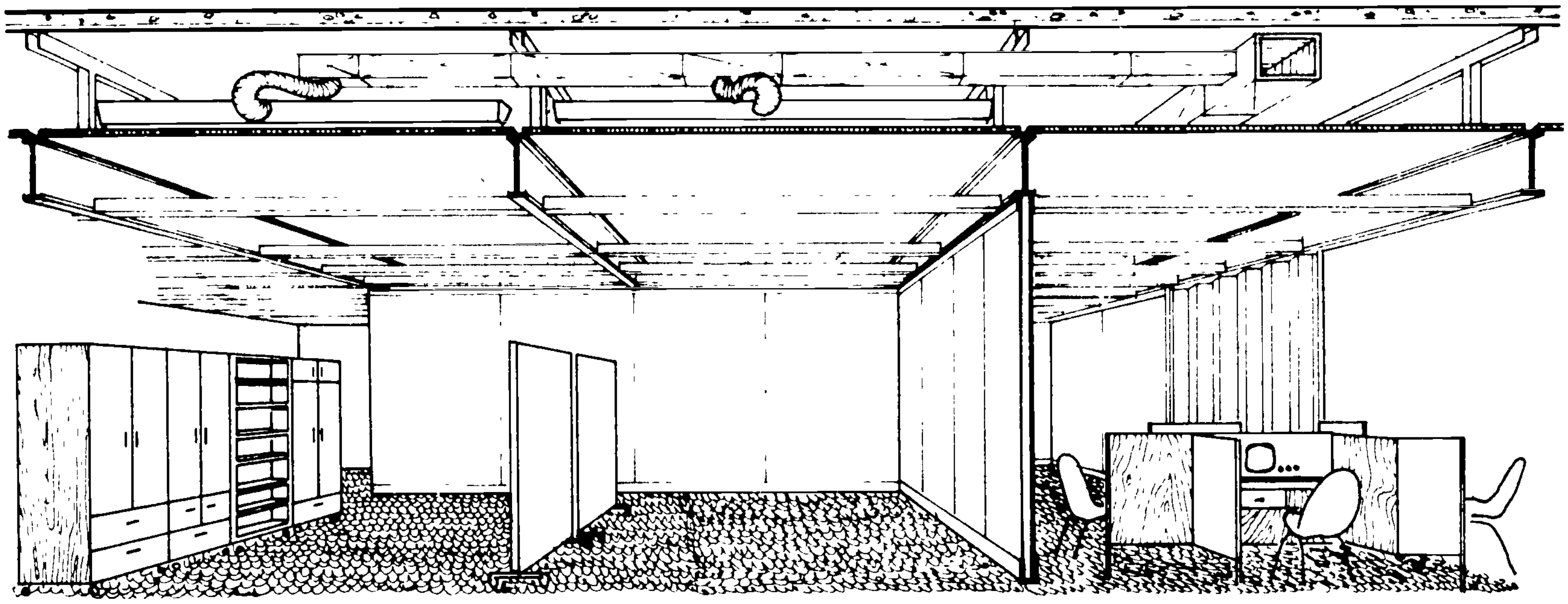
each student center contains four houses, each house contains four counseling groups, and each counseling group contains ten advisory groups. Each house will have a "dean" and counselors, or advisors, who are permanent "members" of the house. A student will remain a member of the same house for his entire high school career. The counseling group of 315 or more students has at its head a full-time counselor assigned to it on a permanent basis.

The functional unit of the house is the advisory group of one teacher and thirty-five students. The advisory group space contains storage for the individual's materials and apparel, and sufficient equipment, such as typewriters, audio-visual devices, etc. to allow the student to use the space as his "home base" while at school. The designers hope that some freedom can be allowed to each advisory group to "personalize" its immediate environment. Activities which involve larger groups of students, such as student elections, dances, etc., will take place at the counseling group or house level.

Research in the Great High Schools Project In developing the GHS program, the Board of Public Education and its architects have made use of the research capabilities of the consultant team. Much of this research has resulted in reports containing information of interest to a wider audience than the project team, and at least one report will be published for general distribution. Some of the areas researched are:

1 Integration of services—development of an academic tower floor sandwich containing structure, services, and relocatable lighting fixtures;
2 The costs of demountable versus permanent partitions;
3 Electronic Teaching Aides and Related Equipment—prepared by BSD and now being published by the Educational Facilities Laboratories, Inc.;
4 Project communication—to speed the essential flow of information and decisions between members of the design team, BSD has developed a computerized information retrieval system;
5 Food service—a detailed analysis by Flambert and Flambert, food consultants, of food service to the entire Pittsburgh educational system;
6 Construction scheduling—a study by George A. Fuller Company of the most effective use of Pittsburgh's labor force.

In a warehouse on the East Liberty site, members of the Neighborhood Youth Corps have constructed a wooden mockup of a section of the typical academic tower. The purpose of this construction is to allow members of the Board and the design team to see at full scale the ceiling system and the lighting design as



Schematic subsystem integration of a typical academic tower floor

they might appear in the final design.

The Great High School counseling program has been adopted for the Oliver High School, and a working prototype of a student counseling center constructed.

The Typical Great High School The typical Great High School plan developed by Hellmuth, Obata, and Kassabaum will have about one million square feet of floor area divided between four academic towers and a multi-level linear base. The academic towers will be linked at each floor by a large central "promenade" which will provide vertical circulation in the form of escalators, elevators, and stairs. Large parking lots for faculty and evening school students' automobiles will be linked with the lower promenades by pedestrian bridges and walkways.

The academic towers contain about 25 per cent of the total building floor area. Each tower has open loft floors of about 14,000 square feet which will be subdivided by demountable partitions. Space in the towers is assigned to general academic departments which will subdivide their floors according to their specific needs. Flexibility of space is a key element in the design of these interiors.

The linear base structure below the towers contains both academic and vocational departments and the student houses Departments with highly specialized spaces, such as music, performing arts, and physical education, as well as departments with heavy service needs, such as technology, are housed in this structure. The central administration of the school is located in this structure adjacent to the planned school computer center. A number of community-shared facilities, including library, music hall, theater, etc., have been placed here to facilitate their out-of-school-hour use.

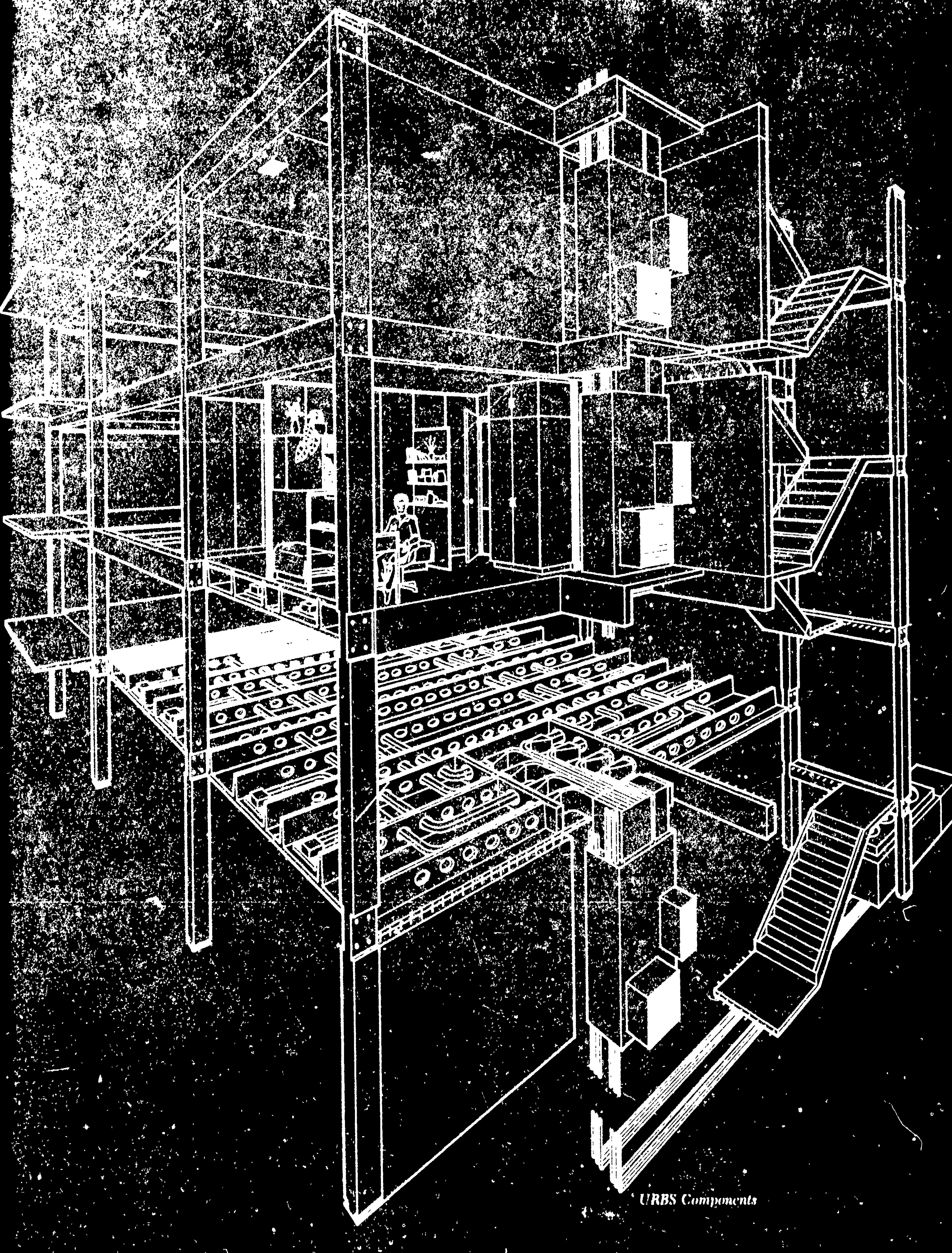
Where Does Great High Schools Go From Here?
The Board of Public Education has accepted the preliminary scheme presented by Hellmuth, Obata, and Kassabaum for the first two schools and has authorized appropriations of $2–3 million to complete site acquisition and working drawings. Based on the architect's estimate of fourteen months for this work, construction on the East Liberty site could begin in August of 1970.

The Board is aware of a parallel need, that of preparing the administrative and teaching personnel who will staff these two schools to make full use of the buildings' potential. Although the Great High Schools are flexible enough to function as conventional high schools, to make such use of these plants would be wasteful. Training of staff in the operation of the educational, counseling, and student house programs, and in the use of the new facilities is being programmed.

The Great High Schools program should be a commitment by an entire community to a concept. As with any project affecting a large part of a community there has been and will continue to be much debate about the value of the project and its underlying concepts. The Pittsburgh Board and staff has demonstrated its faith in Pittsburgh's "Renaissance" by its efforts to renew its secondary education system.

From the inception of this program, the Board has stressed the necessity of greatly increased state and federal financing to build and operate the Great High Schools.

Such aid has not yet materialized and has compelled the Board to extend its time table for the total Great High Schools program. However, by its February action authorizing working drawings on two facilities, the Board has renewed its commitment to this program even though all of the financial pieces are not yet in place.



URBS Components

URBS

University Residential Building System

The University of California is currently sponsoring two systems development projects: the University Residential Building System (URBS), and the Academic Building Systems (ABS). Both URBS and ABS seek to take advantage of the tremendous construction volume generated by the University's nine campuses.

Both projects are being directed through the Office of the President, Vice-President—Physical Planning and Construction of the University. Although both building systems are being developed for the same sponsoring agency, the University feels that the nature of user requirements and physical characteristics of the two building types will produce distinctive performance specifications allowing little product crossover.

While URBS is currently undergoing component contract negotiations, the ABS program is undertaking the development of user requirements.

Project Background Stimulated by the results of the initial phases of the SCSD project, the University of California with the financial assistance of the Educational Facilities Laboratories established the University Residential Building System (URBS) program in November 1965. The purpose of URBS was to develop a building system which could be used to construct dormitory and other residential buildings of improved environmental quality and adaptability at reduced costs. The scope of the project is now set at the construction of a minimum of 2,000 student units, totaling about $18.5 million in construction costs by 1974.

The University contracted with Building Systems Development, Inc. of San Francisco, a firm composed primarily of former members of the SCSD staff, and headed by Ezra Ehrenkrantz, the SCSD project architect, to develop the building system. For the University, the project is supervised by the Office of the Vice-President, Physical Planning and Construction, who is entrusted with all construction for the University's nine campuses.

Project Methodology The methodology of the project closely parallels that of SCSD. This methodology defined broadly includes five steps:

1. Preparation of a feasibility study;
2. Collection of analysis of user requirements;
3. Development of performance requirements to be embodied in a Performance Specification for the system;
4. Receiving and evaluating bids by manufacturers to produce and install components which satisfy the performance requirements;
5. Testing of the various components for conformance to the performance specification.

The user requirements studies included a detailed study of storage requirements for students at the various campuses. A report containing cost comparisons of various construction techniques used on dormitories and related building types was also published. Both of these studies are available from the University.

In June 1967, performance specifications for the five URBS subsystems were released. These specifications describe a building system which is adaptable for buildings which are flexible enough to permit modification in response to change in residential use and which allow the individual student the maximum opportunity for individual expression. The subsystems described in this performance specification were:

structure/ceiling
bathrooms
heating, ventilating and air conditioning
interior partitions
furnishings

Following a bidding period of one year, bids were received on the five subsystems on June 17, 1968. These bids were in the form of lump sum proposals based on a set of hypothetical conditions for a student housing program of 1,600,000 square feet of floor area for 4,500 students. The lump sum bids included a five-year maintenance contract on the HVAC equipment, and projected relocation costs through 1979 on the partitions. In all, eight firms bid twelve combinations of products.

Bid Results In three of the five categories, components were bid which offered increased performance at less cost. The single bid for the bathroom component offered increased performance but at greater cost. Therefore, the bid was rejected. The furnishings component bid is still under consideration.

After examining the lump sum bids, it was decided to compare the cost of the three compatible URBS components with those of similar components in four existing University of California student housing projects. Construction drawings and specifications were submitted to the low bidders who were required to give verifiable costs for the most economic application of their components to these four projects.

The result of this evaluation was that, had these four projects been constructed using the three compatible URBS components, a possible savings could have been achieved. The cost of structure, ceiling, partitions, and HVA/C in the four projects was $12.08 per OGSF (outside face to outside face of exterior walls plus one-half of covered but not enclosed areas). The estimated cost for constructon with URBS components is $11.04 per OGSF. When only the structure/ceiling and partition components are compared, the URBS cost saving is 22 per cent.

Since the beginning of the program, however, the guaranteed volume for URBS has been reduced from a 4,500 student unit minimum to a minimum of 2,000 student units. As the bids were based upon the manufacturers recovering part of their development costs over the larger volume, the University has been negotiating with the nominated bidders. At the time of publication, contracts with the three compatible component bidders have not been signed, but signing is expected within the month. There remains a possibility that the furnishing bid may be accepted. In spite of these delays, the University hopes to begin final development of the system soon and to start erection of a pilot building.

The URBS System The URBS building system is composed of three "compatible" component subsystems: structure/ceiling, heating-ventilating and air conditioning, and partitions.

Structure/ceiling. The structure/ceiling subsystem is manufactured by Interpace Corp., a large Southern California precaster who bid a system developed by Hellmuth, Obata, and Kassabaum, Architects, for the Portland Cement Association. This was the first concrete structural system nominated in a North American systems development project.

The floor structure is inverted precast double tee beams tied together by poured in place floor slab and by perimeter beams. The floor slab is poured on metal forms, tying the tees together and leaving a void between the floor slab and the ceiling tee which may be used for services and ductwork. The floor structure is designed to be the most economical on spans from 30′ to 35′, thereby reducing the number of columns required.

Heating, Ventilating, and Air Conditioning. Ayres and Hayakawa of Los Angeles designed the winning HVAC subsystem for Chrysler Airtemp Corporation. The Chrysler solution uses a multi-zone system serving up to 2,000 square feet. The basic package consists of heating and ventilating equipment plus an option for cooling, which may be added before installation or in the future.

Heated or cooled air is supplied to each space through ceiling diffusers from ducts within the structural sandwich. Themostatic control is available offering a variety of control options from single room control to a single control for the entire 2,000 square foot zone. The cavity in the sandwich is used as a return air plenum.

Partitions. The winning partition bid was submitted by Vaughan Interior Walls, Inc., with design collaboration by U. S. Gypsum Corp. The submission includes both fixed and demountable partitions, both with a one-hour fire rating. The partition is of laminated gypsum panels with gypsum studs and removable panels. The panels are finished in a variety of surfaces including natural wood and a supporting surface for student applied finishes ranging from velvet to sketching paper. The partition system includes provisions for attaching elements of the furnishings. □

SCSD

School Construction Systems Development

Studies of Partition Relocations in Two SCSD School Plants One of the purposes for which the Educational Facilities Laboratories funds the Clearinghouse is to collect and prepare research reports on various aspects of systems building for schools. This brief report represents the first such study to be made by the Clearinghouse. It is admittedly short, although it does bear upon some of the most encountered questions about SCSD: does the school staff make use of the flexibility building into an SCSD school? If so, how much does it cost?

This first article reports on the use made of this inherent flexibility in two school plants built under the SCSD program. Neither school has made extensive changes which involve SCSD components, but the changes made do prove that it is possible to modify the school's plan to conform to a new teaching program.

Sonora High School, Fullerton Union High School District, Fullerton, California Among the SCSD schools, Sonora High School is unique in that it is a single building. Similar in concept, perhaps, to the campus plan schools, it has completely enclosed circulation spaces between departments in the form of a large indoor mall. This school was opened in two increments; the first in September 1966, and the second in December 1966.

In the summer of 1968, Sonora High School made some modifications to its instructional spaces. The work performed included:

1 Taking down of 180 lineal feet of Hauserman double-wall partition in 7 classrooms;
2 Re-erecting 125 lineal feet of partition;
3 Installing two doors and frames in five-foot openings;
4 Changing two air supply ducts and diffusers and two returns;
5 Patching the carpet under all removed partitions;
6 Miscellaneous electrical work including the removal of convenience outlets and TV jacks in the removed partitions.

The partition work was performed by a Hauserman crew. Local personnel observed the work and will perform all future partition relocation. All electrical and mechanical work was performed by district personnel, while carpet patching was done through competitive bids. The costs for all work were as follows:

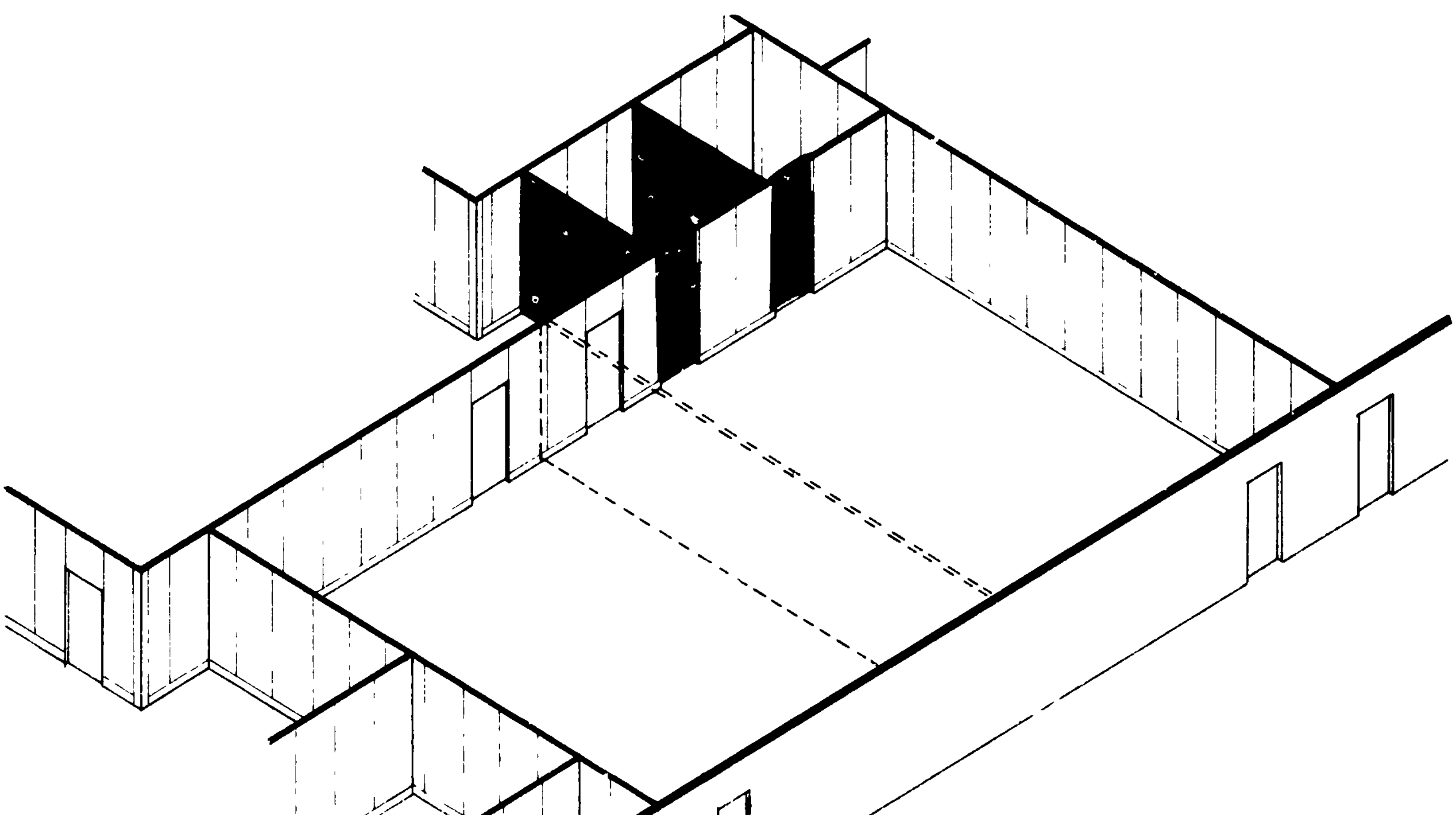
All partition work	$1,780.00
Carpet repair	245.00
District maintenance personnel (electrical and mechanical)	100.00 (Est.)
Total	$2,125.00

Carpeting proved to be a major problem. As in many of the SCSD schools, the floor finish had been laid after the partitions were in place. When the partitions were removed the concrete subfloor was exposed, requiring patching of the carpet.

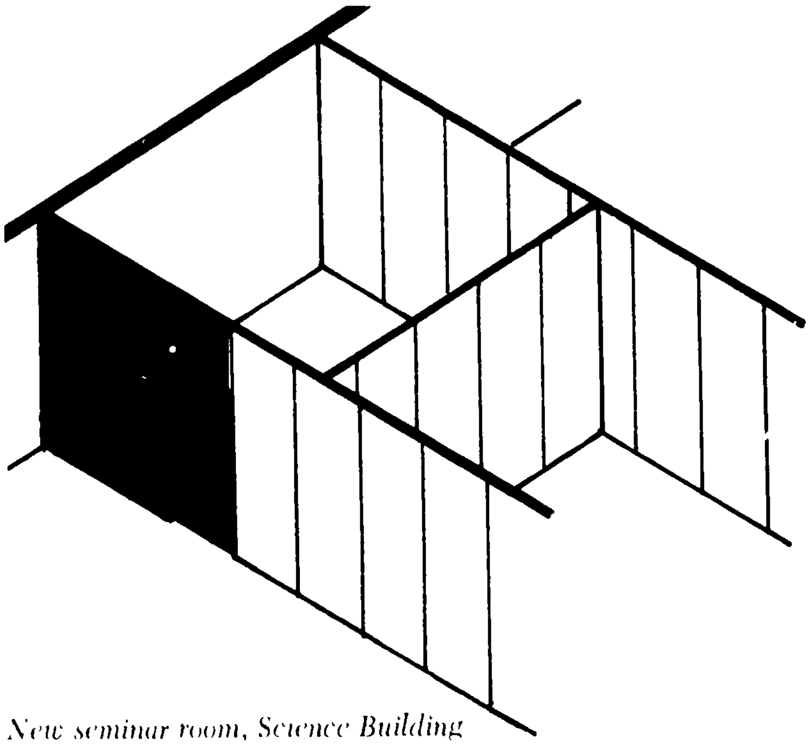
The size of the building, a result of the enclosed mall concept, was the indirect cause of another problem. The size of the enclosed area required that the building have automatic fire sprinklers. The partitions had to be relocated in such a way that they did not interfere with the proper operation of the sprinkler system.

Oak Grove High School, East Side Union High School District, San Jose, California Oak Grove High School is a campus plan SCSD school which first opened for students in September 1967. As an SCSD facility, Oak Grove makes use of the Hauserman demountable partition and the Inland Steel lighting/ceiling subsystems. In the fall of 1968 after a year of use, several buildings were remodeled by removing and relocating Hauserman partitions.

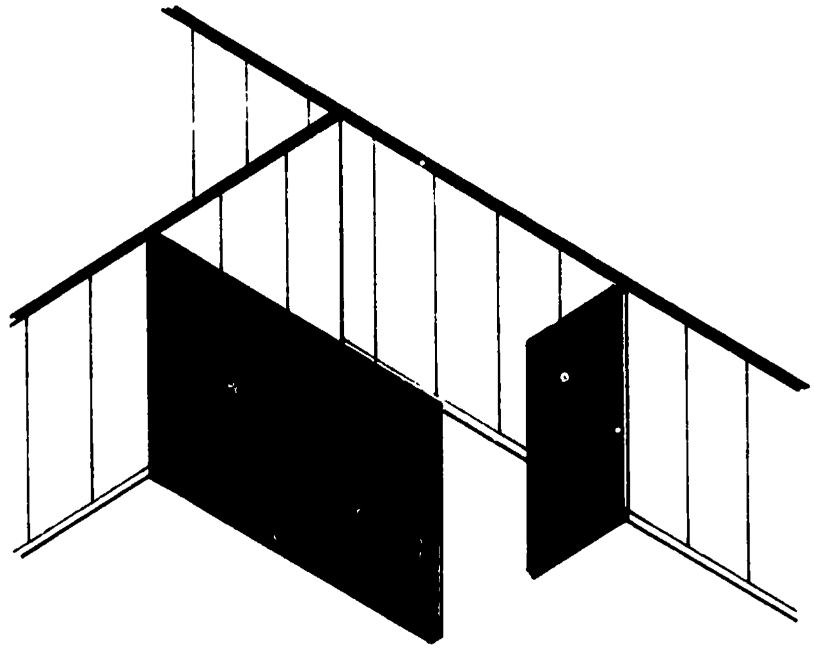
Most of the changes were in the Mathematics and Science Departments where new departmental curriculums have been adopted to emphasize individual work by the student both in and out of class. In the Science Department, a large resource library and laboratory were created when an intervening wall between two laboratories was removed. At the same time, three small group meeting rooms were created out of storage space. In the Mathematics Department, a similar wall removal converted two classrooms into a large team teaching space plus a small testing area. A small seminar room



New resources Library and small group rooms, Science Building



New seminar room, Science Building



New small seminar room, English Building

was added to the English Department.

In terms of actual work performed, the building changes involved the following:

1 Taking down of 70 lineal feet of Hauserman partition in 4 classrooms;
2 Re-erecting 76′–4″ of partitions, including 17 lineal feet of new panels;
3 Purchasing and installing three glazed doors and frames, two into existing partitions and one to close an opening;
4 Miscellaneous electrical work, including removal of a conduit in the lab wall and the capping of this conduit at the floor level.

The partition work was performed by a Hauserman technician who trained school district personnel to perform all future partition relocation. All electrical, mechanical, and repainting work was done by the district. The costs for all the work performed in making the changes were as follows:

All partition materials, including three doors and frames, and 17 lineal feet of new panels	$1,333.34
The Hauserman technician, including his travel	409.00
District maintenance personnel, about 20 man hours	70.00
Total cost	$1,812.34

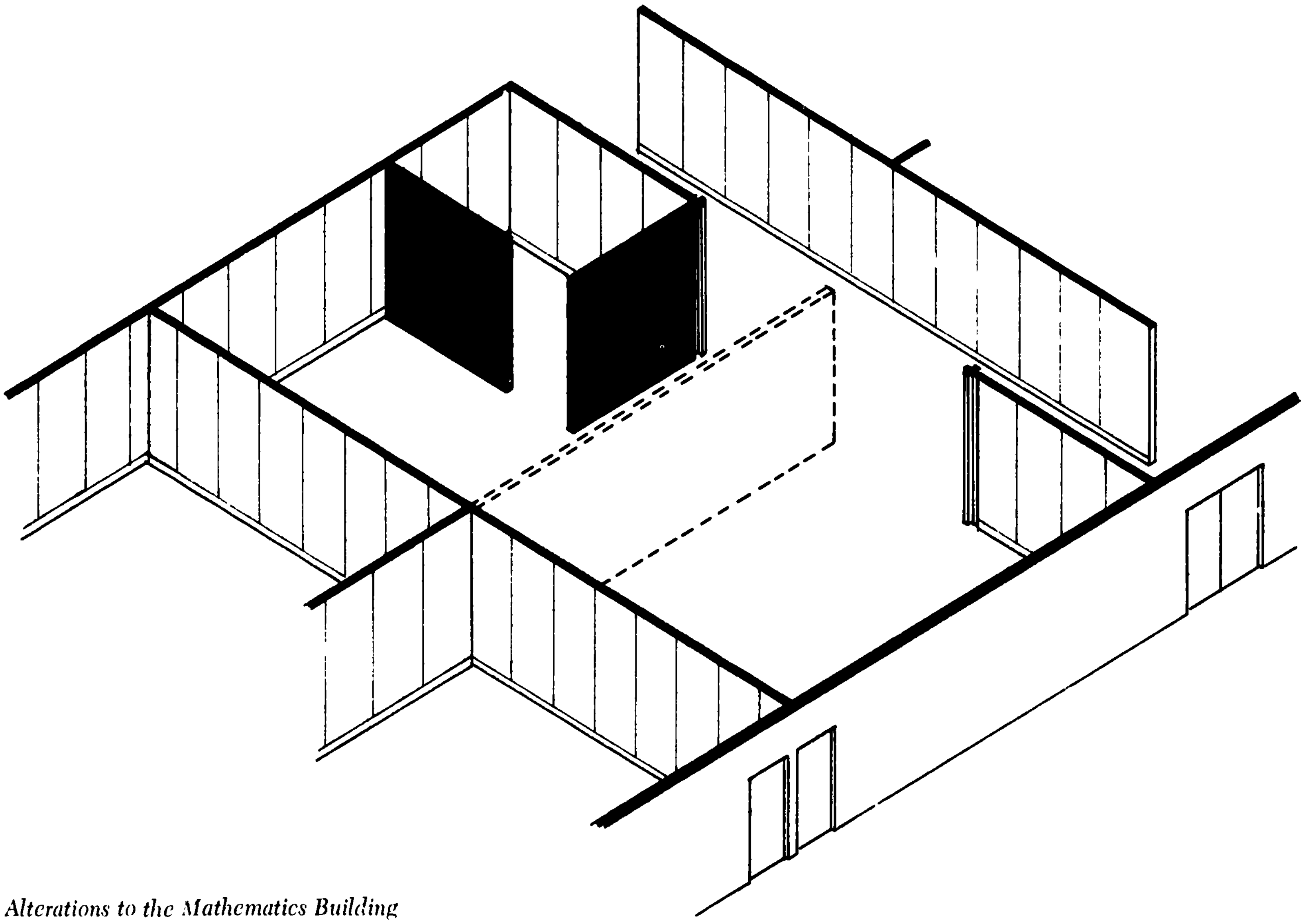
The major problems encountered were with the floor beneath the removed partitions. In the Science Building, a conduit had been routed through the floor and into the partition which was removed. The removal of this conduit from the partition caused few problems, but the riser portion had to be cut flush with the floor and capped.

The floors had been finished after partition installation. Thus, wherever a partition was removed a three inch strip of concrete was exposed. In the new resources library in the Science Department, there is a three inch strip of exposed concrete separating a carpeted floor from one finished with vinyl tile. The district plans to carpet the rest of this space and this condition will then be alleviated.

At the time this study was made in January 1969, the heating-ventilating-air conditioning system had not yet been modified to meet the changed environmental conditions. As a result of this, the new resources library space has two environmental zones with separate controls, while the small spaces have their environments controlled from a larger zone, but no exhaust. It seems likely that, given the flexibility built into the HVA/C system, this situation can be readily remedied.

Comparison of Oak Grove Remodeling Costs with Conventional Costs In order to provide a comparison between the costs of remodeling using SCSD system demountable partitions and the costs which would have resulted in a conventionally constructed school plant, a procedure which was developed by Building Systems Development and the George A. Fuller Company for the Pittsburgh Great High Schools Project was followed. Under this procedure, a hypothetical school was developed with an identical plan to that of Oak Grove, but built using entirely conventional techniques.

The partitions in the hypothetical Oak Grove are 4″ thick, gypsum board on steel studs, such as are typical in California schools. This hypothetical model was then submitted to Visscher Boyd, formerly of the SCSD project group and now with Building Systems Development. He developed the costs of doing identical re-



Alterations to the Mathematics Building

modeling to this imaginary school plant. In neither the real or the model school did the remodeling have an effect on the structure, ceiling system, or floor.

First, the costs per lineal foot of conventional steel stud partition construction were developed. The total cost per lineal foot of 10 foot high partition in the San Francisco Bay Area is about $21.90 for labor and materials, which can be broken down as follows:

Steel track	$2.00/ln ft.
Steel studs	6.00/ln ft.
Gypsum board on clips	6.00/ln ft.
Insulation	1.50/ln ft.
Trim	4.00/ln ft.
Painting	2.40/ln ft.
Total for 10′ high partition	$21.90/ln ft.

This cost of construction of conventional partitions and other costs of conventional work were applied to the remodeling project and a total cost of $3,372.40 was obtained. This cost is broken down in the following table. Items marked with an asterisk (*) are costs taken from the actual Oak Grove remodeling.

Build and remove dust shields	70 ln ft. @ $5.00/ln ft.	$ 350.00
Demolish and remove existing walls	70 ln ft. @ $2.50/ln ft.	175.00
Remove electrical		17.50*
Build and paint walls	76 ln ft. @ $21.90/ln ft.	1,664.40
Patch and paint old walls	40 ln ft. @ $4.00/ln ft.	160.00
Furnish new doors		838.00*
Install doors	3 @ $50.00 per door	150.00
Labor-mechanical		17.50*
	Total	$3,372.40

When the figures from the actual Hauserman remodelling are compared with these hypothetical remodelling figures, an estimated savings of about $1,560.06 results.

Conventional remodeling costs	$3,372.40
SCSD Hauserman remodeling costs	$1,812.34
Advantage of SCSD Hauserman over conventional	$1,560.06

Mr. Boyd made this statement about the cost advantage of the SCSD partition: "This condition is favorable by reason of the relatively small amount of new wall material required for the demountable partitions." It should be noted that most of the Hauserman panels which were removed were recoverable and were reused in the remodeled plan. □

The Pennsylvania Project

A school building program using the systems concept of construction is being undertaken in Armstrong County, Pennsylvania. At the present time, this school district and its consultants are preparing a timetable for the development of educational and performance specifications and the publication of contract documents.

The program will consist initially of approximately 460,000 square feet of new construction worth about $15 million. Three projects are included in the program: a new K–6 elementary school, a new senior high school for grades 10–12, and an addition to an existing six-year high school converting it to a senior high school.

THE WORK OF THE CLEARINGHOUSE

Investigations will be undertaken in the following areas:

COLLECTION OF INFORMATION

1 Gather pertinent information about all EFL-supported systems development projects.
2 Identify and obtain information about systems built schools.
3 Identify and gather information about manufacture and manufacturers of component subsystems.
4 Establish a library of systems publications.

DISSEMINATION OF INFORMATION

1 Prepare and distribute a bibliography of all systems publications produced by the EFL sponsored projects.
2 Prepare and distribute a bibliography of articles about EFL projects, systems schools, manufacturers, etc.
3 Collect, prepare, and distribute progress reports on the various EFL supported projects.
4 Prepare and distribute periodic newsletters on systems project activities.
5 Make available regional lists of systems built schools to interested parties.

RESEARCH

1 Conduct studies of the effectiveness of various component systems used in project and significant non-project schools.
2 Other research problems will be identified through contacts with persons involved in research projects connected with or concerning EFL sponsored or other systems building projects.

SELECTED CRITERIA FROM THE PERFORMANCE SPECIFICATIONS
OF THE VARIOUS EFL SUPPORTED SYSTEMS DEVELOPMENT PROJECTS
COMPARING THE THREE SUBSYSTEMS MOST OFTEN BID

	DEVELOPMENT PROJECT DATE OF BID PLACE OF BID	SCSD August 1965 California	SSP 1 A October 1967 Florida	SSP 2 August 1968 Florida
STRUCTURE	HORIZONTAL MODULE	5' 0" by 5' 0"	5' 0" by 5'-0"	5' 0" by 5'-0"
	VERTICAL MODULE	12"	12"	12"
	SANDWICH THICKNESS	36" 60", if span is greater than 75'	36" 60', if span is greater than 75'	36" 60", if span is greater than 75'
	MAXIMUM HEIGHT	2 stories	2 stories	2 stories
	FIRE RATING	1 hour capability	1 hour capability	1 hour capability
	SPECIAL REQUIREMENTS	Earthquake code	Special wind loads	Special winds loads
	SUCCESSFUL SYSTEM	Inland Modular	V LOK	V LOK
	BIDDER	Inland Steel Products Milwaukee, Wisc	Macomber, Inc Canton, Ohio	Macomber, Inc Canton, Ohio
	BID COST/SQ FT	$1 70	$1 63	$1 28
	ADJ COST/SQ FT*	$1 93	$2 00	$1 44
HEATING-VENTILATING-COOLING	MINIMUM AIR SUPPLY	30 cfm/person	30 cfm/person	None specified
	MINIMUM OUTSIDE AIR	8 cfm/person	7 5 cfm/person	7 5 cfm/person
	ZONING	8 zones of 450 sq ft in 3600 sq ft	10 zones of 450 sq ft in 4500 sq ft	Min zone 450 sq ft Min of 12 zones
	SUCCESSFUL SYSTEM	DMS	DMS	ITT Nesbitt
	BIDDER	Lennox Industries Marshalltown, Iowa	Lennox Industries Marshallto n, Iowa	Hill-York Corp Miami, Florida
	BID COST/SQ FT	$2 10	$1 76	$1 51
	ADJ COST/SQ FT*	$2 39	$2 16	$1 71
LIGHTING-CEILING	ILLUMINATION LEVEL	70 footcandle min	70 footcandle min	TVI min 63 0
	ACOUSTIC RATING	28 db	28 db	STC 35
	WATTAGE/SQ FT	None specified	None specified	None specified
	SUCCESSFUL SYSTEM	Inland Modular	Armstrong C-60	AJ System
	BIDDER	Inland Steel Products Milwaukee, Wisc	Armstrong Cork Co.	Anning-Johnson Co Tampa, Florida
	BID COST/SQ FT	$1 51	$1 31	$0 78
	ADJ COST/SQ FT*	$1 72	$1.61	$0 89

The criteria contained in the chart are taken from the performance specification documents published by each systems development project Where a number of criteria are applied to cover various use conditions, the criterion covering the largest quantity of components has been selected Projects which have not yet taken bids are not included These projects are Pittsburgh Great High Schools, the Pennsylvania Project, and SSP Program No. 4

[illegible]	SEF	RAS	URBS
December 1966	January, 196[illegible]	January, 1969	June 1968
Florida	Ontario	Quebec	California
[illegible]	[illegible]	[illegible] by 20'	30' by 30'
[illegible]	12'	[illegible]	24'
42" 60' if span is greater than 30'	48 60', if span is greater than [illegible]	24" to 48" 4' 0", 4' 8", 5' 4" if span greater than 60'	None specified
2 stories	5 stories	4 stories	13 stories
1 hour capability	2 hour capability	3 hour capability	High rise Type I
Special wind load	100# live load	150# live load	Earthquake code
MODULOC	Modified V LOK	FRANCON	TRIPOSITE PCA
Romac Steel, Inc Ft Myers, Fla	Anthes Steel Ltd Toronto, Ontario	Francon Ltd Montreal, Quebec	Interpace Inc Los Angeles, Calif
$1 16	$2 27 ($Can)	See article	$5 39**
$1 27	$2 [illegible] ($US)	See article	$5 75**
None specified	30 cfm person	None specified	None specified
7 5 cfm person	5 cfm person	10 cfm person	20 cfm person
Max of 12 zones in 5400 sq ft	Room size zones	Various size zones up to 9000 sq ft	Min zone 90 sq ft, 12 zones/2000 sq ft
ITT Nesbitt	ITT Nesbitt	Central Plant	
Hill York Corp Miami Florida	Canada Electric Ltd ITT (Canada) Ltd	Lennox Industries Montreal, Quebec	Airtemp Division Chrysler Corp
$1 88	$2 92 ($Can)	See article	$3 40
$2 05	$2 72 ($US)	See article	$3 63
VPI min 63 0	VPI min 63 0	VPI min 63 0	Ceiling included in structure sub system
STC 35	STC 35	STC 40	
Max 4 watts	None specified	Max 4 watts	Lighting not included
Armstrong C 60			
Acousti-Engineering Jacksonville Fla	Canadian Johns Manville Co Ltd	B K Johl Ltd Montreal, Quebec	
$0 99	$1 67 ($Can)	See article	**Included in Structural Cost
$1 08	$1 55 ($US)	See article	

*The ADJ COST/SQ FT is provided as a means of comparing the costs of the various sub systems This figure is obtained by applying two processes to the bid figures First the current price equivalent of each bid was calculated for the locale of the bid Then these current price equivalents were brought to a common location by the use of comparative indices The ADJ COST figures are therefore cost index figures and do not represent actual costs

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The Systems Clearinghouse was established by a grant from the Educational Facilities Laboratories, Inc. This report, as well as subsequent publications dealing with building systems, is available from the Systems Division, School Planning Laboratory, 770 Pampas Lane, Stanford, California 94305.