



ENGINEERING FOR ARCHITECTURE 1978

ARCHITECTURAL RECORD

MID-AUGUST 1978



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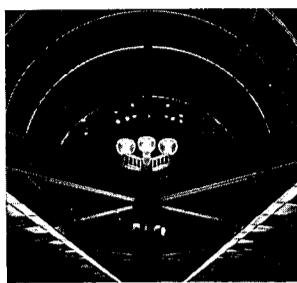
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ENGINEERING FOR ARCHITECTURE



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For all of the new systems and techniques, it's still the people that count

The fundamental truth that the skills and experience of building-industry professions is far more critical to quality design and construction than any "new approach" or "technological revolution" seems to press in on me every time we do this issue on "Engineering for Architecture" (this is the fifth in this series of mid-August issues).

There are (I find on thinking about it) two reasons for this anxiety to reinforce the idea that the profession must learn to better building

breakthroughs and new systems is that we somehow wish that it could be simpler. In our discussion this year of performance standards, speaker after speaker emphasized the notion that what everyone wants is a system of "simple numbers"—a number that expresses good lighting, or acoustical privacy, or adequate provision for life safety. The problem is, of course, that it just isn't that simple; nor will it ever be that simple. Architect Karl Justin made a related point early in

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There are (I find on thinking about it) two reasons for this anxiety to reinforce the idea that the most important key to better building is the right people with the right expertise in the right place at the right time. One reason is that this issue—as planned by editor-in-charge Bob Fischer—is always examining the cutting edge of new technology: for example, computer technology (1977); systems building (1975, 1974) new flexible wiring systems (1977); solar design (this year and 1977); strategies for energy conservation (this year, 1977, 1976, 1975, and 1974); task-ambient lighting (1976, 1975), and scores of individual case histories exploring new designs in structures, lighting, hvac, acoustics, and virtually every other discipline that affects building. And in researching these articles, any editor is reminded over and over again that this "out-front" work doesn't just happen or is not the result of some "technological breakthrough"—rather it is almost always the result of plain old hard-work problem-solving by individual architects and engineers. . . .

The other reason that the critical role of individual expertise presses in so strongly as we prepare this issue is that each year we hold a Round Table—this year on the effectiveness of performance criteria and performance specifications (see page 96). At those meetings, we assemble the most thoughtful professionals we can find to discuss the problem at hand—and each year my admiration for (maybe even awe of) the knowledge of the participants grows. The experts of the building industry—be they architects, engineers, manufacturers, researchers, government-agency people, experienced owners—are truly *expert*. Thus, I am reinforced in the notion that the solution to our now and future problems lies, very simply, with that expertise—not in breakthroughs or revolutions or new systems or new "approaches," but in people.

Maybe one of the reasons we keep looking for (and occasionally announcing)

breakthroughs and new systems is that we somehow wish that it could be simpler. In our discussion this year of performance standards, speaker after speaker emphasized the notion that what everyone wants is a system of "simple numbers"—a number that expresses good lighting, or acoustical privacy, or adequate provision for life safety. The problem is, of course, that it just isn't that simple; nor will it ever be that simple. Architect Karl Justin made a related point early in this year's Round Table: "We need to separate useful techniques from what I would call incantations and rationalizations. The incantation theory suggests that if we come up with a new body of jargon and apply it strongly to our field, the problems will go away. The rationalization theory suggests that we should go with what we have and ignore what we don't have. What we need to do," Karl reminds us, "is keep adding to our body of knowledge." That is, keep trying to improve the tools available for problem-solving.

Architect Robert Siegel of Gwathmey-Siegel made the point that seems most important to me: "Performance standards and criteria—indeed any kind of input be it technical or related to the needs of people—are useful as a common palette for all of us to work with. The better the standards are, the better off we all will be. I'm all for better standards—but they don't make a good building. The architect has to be the generalist—because very gradually, as the pressure mounts on a building, the systems can start to take over. The architect has to fight back with bigger ideas that have to do with non-systematic and non-measurable things."

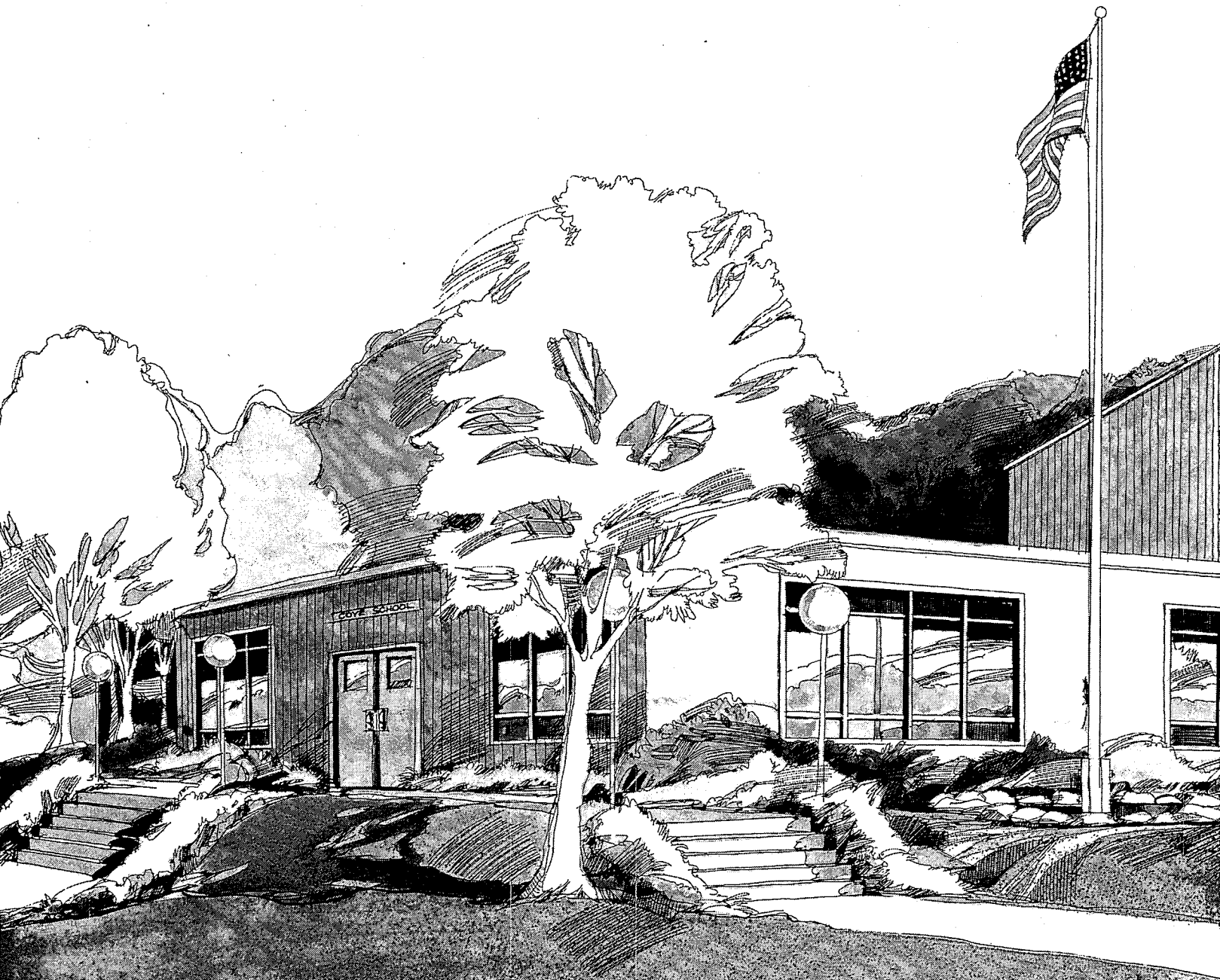
And so—one more time, in this fifth Engineering for Architecture issue—a plea from one editor to stop looking for ways to codify things that probably can't (and probably shouldn't) be codified—like design quality. Let's keep exploring new techniques for meeting problems of resource scarcity and rising costs and (most important of all) creating a better environment for human beings to live in or work in or look at—but let's remember that those new techniques and new "systems" are really just tools.

Obviously, the better the tools, the better. But "systems" and "new approaches" do not design great buildings. Only architects and engineers can design great buildings.

—Walter F. Wagner, Jr.

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Five concrete structures honored by CRSI

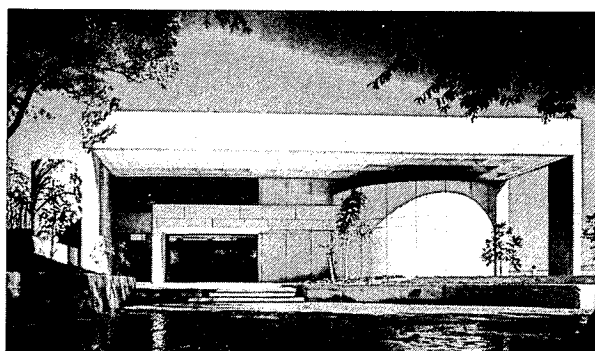
In its fourth annual CRSI Design Awards Program, the Concrete Reinforcing Steel Institute has recognized five structures for "their creative achievement in esthetics, engineering, functional excellence and economy." Architects, en-

gineers and owners share honors equally. The award-winning designs varied widely geographically and in building type, from office tower to underground library, from a residence to a dam that offers a ladder to spawning fish.



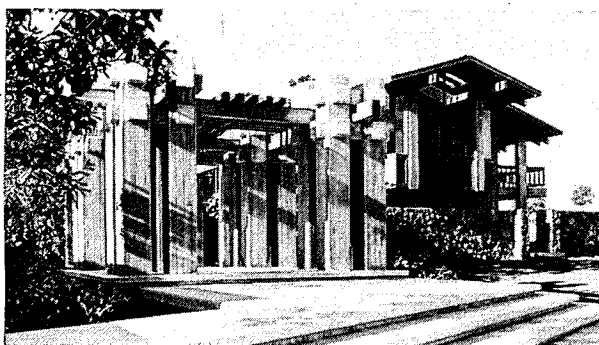
National Permanent Building, Washington, D.C.—Hartman-Pox Architects, architect; KCE Structural Engineers, structural engineer; the Lenkin Compa-

ny, owner and general contractor. The finely articulated concrete structure of the 12-story office building is exposed on the front facade.



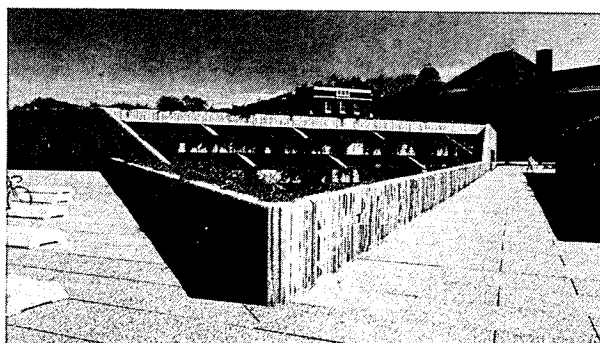
Hunter Museum of Art, Chattanooga, Tennessee—Derthick & Henley Architects, architect; Bennett & Pless, Inc., structural engineer; Hunter

Museum of Art, owner. Built on a natural bluff to harmonize with an existing mansion, the museum houses both exhibition and educational facilities.



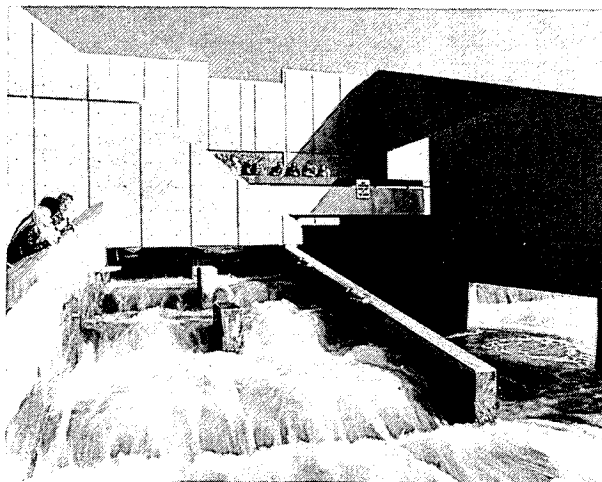
Country estate, Rancho Santa Fe, California—Fred M. Brigg, architect; Richard L. Foley, structural engineer; Roland Sahn, owner. Living spaces,

which are connected by glass bridges, are supported by board-formed columns that recall the timber houses of the Greene brothers.



Williamson Hall, University of Minnesota, Minneapolis—Myers and Bennett Architects/BRW, architect; Meyer, Borgman and Johnson, Inc.,

structural engineer; University of Minnesota, owner. To conserve energy, the building is sunk below grade, with terraces overlooking a garden.



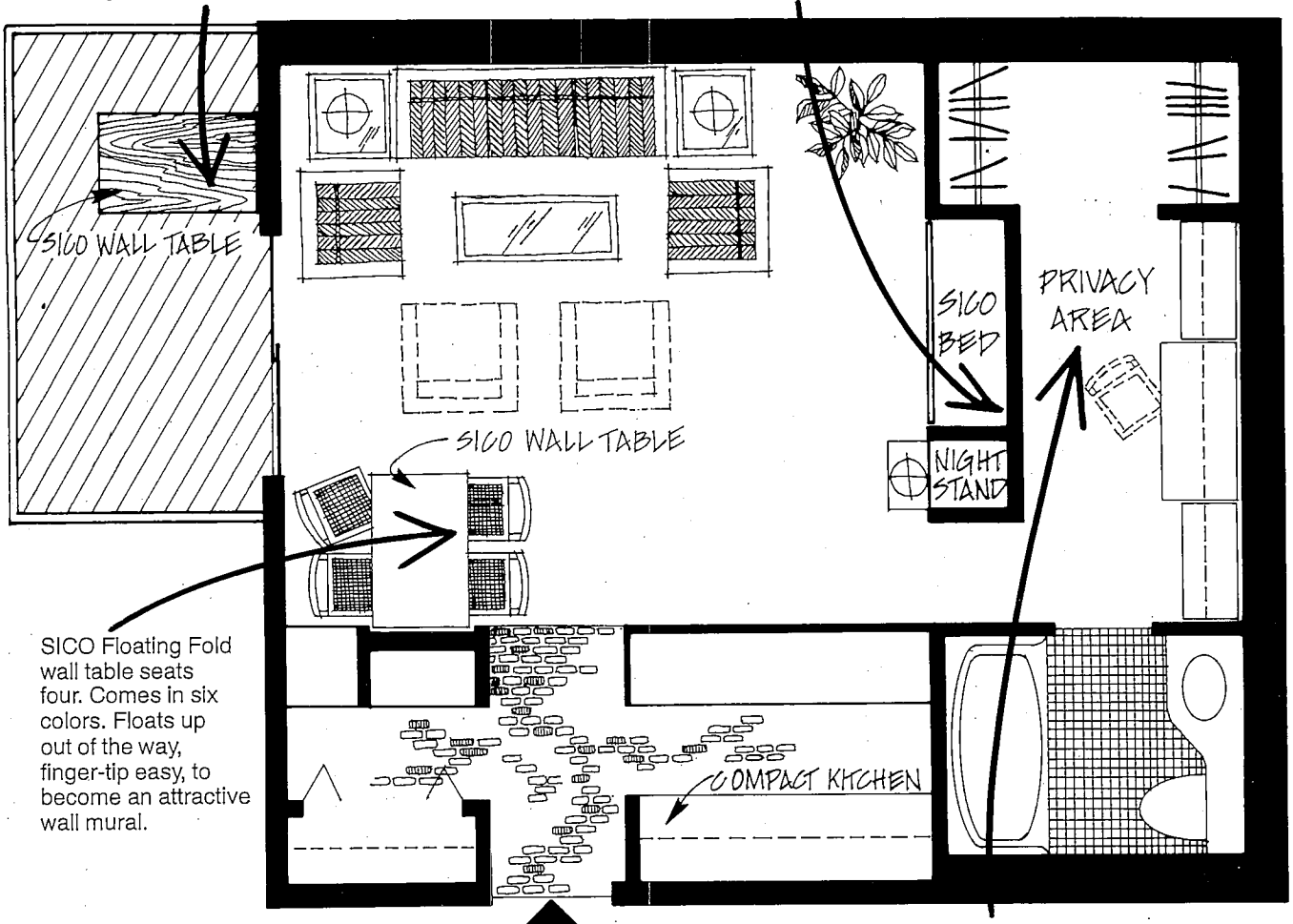
Grand River Fish Ladder, Grand Rapids, Michigan—W.B.D.C., Inc., architect and structural engineer; City of Grand Rapids, owner; Joseph

E. Kennebrew IV, sculptor. The large-scale concrete sculpture provides a vantage for visitors to view the migration of game fish by a Grand River Dam.

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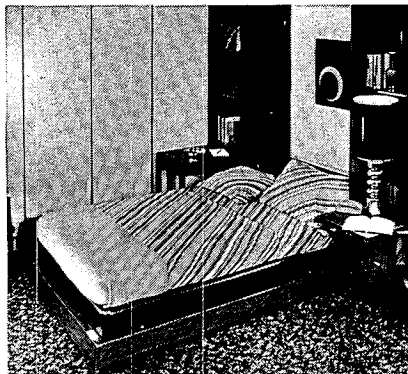


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Profile: a new reference to AIA firms is aimed at clients

The first comprehensive directory of architectural firms in America has been released with the express intent of leading potential building clients to members of the American Institute of Architects. Entitled *Profile/Architectural Firms/The American Institute of Architects*, the 674-page directory includes descriptions of nearly 6,000 firms, and represents the first time that more than minimal information (names and addresses) about AIA member firms has been organized for convenient reference by companies, agencies or other professionals in need of architectural services. The book is published by Archimedia, Inc. of Philadelphia and available at \$48 per copy to AIA members, \$56 to non-members. AIA has designated the new annual publication as its official directory of architectural firms.

Edited by Henry W. Schirmer, AIA, of Topeka, Kansas, *Profile* covers: the current and projected work volume of each firm by building type; the management and staff of each firm by discipline; the names of the principals and their designated responsibility; the geographic area of each firm's practice; and awards. (See excerpt below.) In addition, two separate alphabetical listings, an "Index of Firms" and an "Index of Principals," provide access to the master firm profiles.

Advice on finding, selecting and negotiating with an architect is also included

Recognizing the fact that most building clients enter the construction market once in a lifetime, the AIA has included in *Profile* two articles introducing the novice client to the services and goals of architecture, and to the accepted practices of working with an architect. Entitled "How to Find, Evaluate, Select and Negotiate with an Architect," one article recounts the selection process used most

frequently by public and private clients: the process of issuing invitations to firms to submit qualifications; the evaluation of these qualifications and the ranking of firms; discussions with the top-ranked firm and negotiation of the architect's compensation. This latter item—compensation—is discussed in terms of five traditional modes: 1) lump sum; 2) direct cost times a multiplier to compensate for overhead and profit; 3) percentage of construction costs based on a sliding scale; 4) cost plus fixed fee; and 5) per diem rates.

The directory provides well-written arguments for traditional practices

A good deal of attention is focused on why clients should not ask for competitive bids from architects. Summed up simply, the article advises the potential client to be wary of accepting an architect's fee before ample discussion of the project has occurred. A fee determined prematurely may never adequately cover the work that must really be

done, which means the work probably will not be done.

The second article, "You and Your Architect," was written by David Dibner, FAIA, and discusses the broad goals of architecture: the best building for the client, architecture of the highest quality, and a positive contribution to the community and nation. Under the heading of "Why do I need an architect," the article argues that "the architect is the single professional who is equipped through training and experience to guide you through the entire building process." The article goes on to point out that the client has no choice in seeing an architect, since every state requires the seal of a licensed architect on drawings for new buildings or major alterations. (In fact, this is an over-simplification of the law, since engineers may perform some architectural work in many states.)

In all, the article is persuasive, picturing the architect as the only one in the building process capable of balancing four distinct forces: esthetics, technology economics, and function.

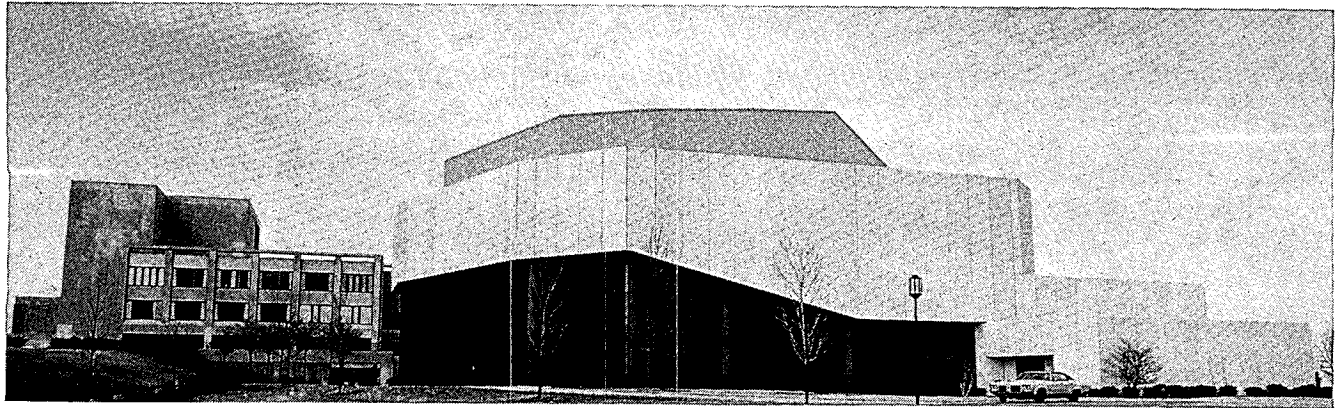
Profile will be updated for currency and for completeness of active firms

As the preface to this first edition states, not all firms are listed in spite of a vigorous attempt by the publisher to make the book comprehensive. In 1977, questionnaires were sent to all firms on the AIA list, and the *Profile* effort was promoted through AIA publications. Some firms did not return the questionnaire, and as a result, a perusal of *Profile* shows unfortunate omissions of otherwise prominent firms in some metropolitan areas. However, subsequent editions will be revised and the publisher hopes that omissions and errors will be brought to his attention.

To be included in the book, a firm must meet the following criteria: 1) It must offer architectural services to the public; 2) It must have permanent staff at the listed location; 3) It must have a licensed or registered architect on the staff at the listed location; and 4) At least one firm principal must be a member of the AIA.

As a well-organized, well-designed and well-written directory, *Profile* promises to be of value to both practicing professionals and building clients. To order a copy, contact Archimedia, P.O. Box 4403, Topeka, Kansas 66604. The book may also be ordered from AIA Publications, 1735 New York Avenue, N.W., Washington, D.C. 20006.

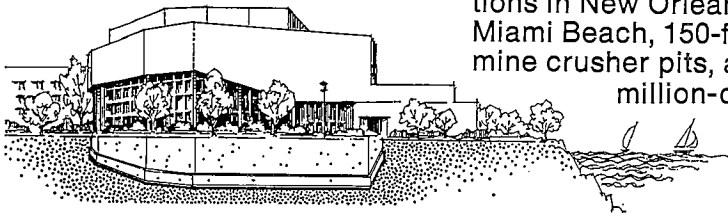
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	Interior Designers	3		
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	Administrative	4		
Work Distribution by % of Gross Income	Commercial, Office, Retail	Current % 50	Projected % 25	
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	Industrial	3	10	
	Educational	5	10	
	Medical	2	5	
	Other Institutional	5	8	
	Interior Design	10	10	
	Planning	10	10	
	Prime Engineering	6	7	
	Other	4	5	
Geographical Distribution of Work	Maine 80% - Other U.S. 5% - International 15%			Awards (Projects) Code
	Dunes Center	N/ - Observation Tower	C/ -	N/ - National Award
	Modern Mariners Museum	S/ - Office Building	S/ -	S/ - State or Regional Award
				C/ - Chapter Award



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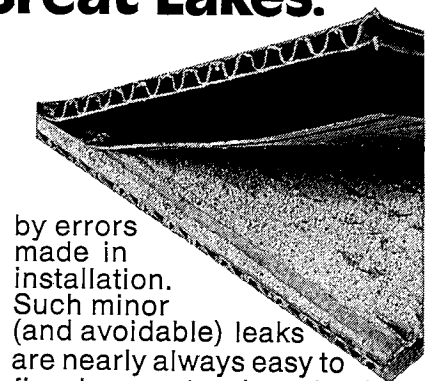
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ENGINEERING FOR ARCHITECTURE

BUILDING TYPES STUDY ©521

This is our fifth annual mid-August issue on Engineering for Architecture. In these issues—and this one is no exception—we have tried to give special recognition to engineers of all disciplines as they work with architects to achieve quality design. In our regular issues, the emphasis is on design from an architectural point of view; in this issue, the emphasis is on engineering design in support of better architecture.

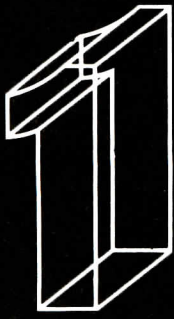
In this issue, beginning on the next page, you will see that even in subways good architects and engineers working together can enhance the structural imperatives with lighting and other design elements to make these underground spaces exciting, handsome, even a bit glamorous.

Beginning on page 78, you'll see that in solar systems, the days of "tacking on" panels are clearly past; here we see them used handsomely as integrated design elements.

This year's Round Table, beginning on page 96, explores the complex field of performance specifications—and serves as a strong reminder that no matter how precise our technology becomes, we still must deal with all those imprecise and imperfect human beings who use our buildings.

The work of Antonio Gaudí is attracting a lot of attention these days as we search for alternatives to the disciplines of the Modern Movement. In the article beginning on page 104, structural engineer (and former Yale dean) Herman Spiegel takes a look at Gaudí's work from an engineering point of view, and his analysis may surprise you.

Finally, beginning on page 112, examples of new ways to use materials serve as a reminder that solving difficult design problems well requires the input of the best engineers and architects—working together. —W.W.



Architecture enriches mass transit engineering: majesty in Washington, sprightliness in Toronto

Though the theme of our mid-August issues is Engineering for Architecture, from time to time we like to show what happens when architecture is called in to serve engineering, as with the two metropolitan subways shown here.

In Washington, Harry Weese & Associates restored to civil engineering the visual grandeur and might characteristic of the great Roman and Victorian engineering feats. The vast coffered vaults do indeed recall the sober dignity of Roman structures and the power of Victorian railway stations.

In Toronto, the approach was more gentle. Two stations designed by Arthur Erickson Architects express charm, glamor, hospitality and festivity.

Both projects amply demonstrate the gifts architects have to offer such undertakings: their understanding of the way people move in spaces and of the way they perceive them, and their mastery of tools like form, light and color to shape those spaces.

Mighty vaults bathed in light inspire, reassure Metro riders

Harry Weese, asked to develop a design for Washington's subway stations, knew what he wanted. He wanted vaults.

The high coffered ovoids overarching the platforms make structural sense, first of all, because of the heavy loads they must carry—some of the stations are as much as 40 ft underground. The visible power of the bare concrete, moreover, offers psychological reassurance to passengers who, after a long escalator ride, may feel sure they have descended into the bowels of the earth.

Weese also felt strongly that these stations should exceed the merely utilitarian and somehow symbolize Washington, a center of worldwide power and, when it is at home, a city of classical architecture. The observer's perception of these majestic spaces is further magnified by groined vaults at L'Enfant Plaza (opposite) and at Metro Center (page 70). (At both of these stations, tracks cross at right angles, one line above the other.)

Not to ignore utilitarian considerations—the vaults, by allowing broad spans, obviate the multiplicity of columns that often clutters other subway systems and obscures the passenger's comprehension of circulation patterns.

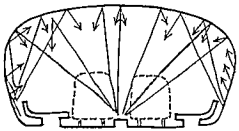
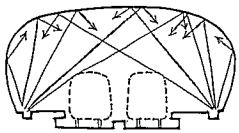
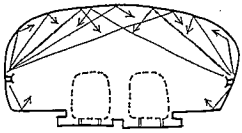
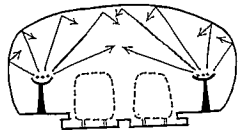
Like the vaults themselves, the coffers fill both functional and symbolic purposes. Symbolically, they reinforce the association with classical structures. Functionally, they lighten the weight of the concrete and they house acoustical batts.

All illumination at platform level is indirect, washing the lower walls to give a sense of spaciousness, to reduce claustrophobic reaction, and to dramatize the shape of the vault. At stations where platforms are located outside the tracks, they are free-standing, seeming to "float" about a yard from the wall, making the user pleasantly aware that the vault curves around and under him.

Weese's essential assignment was to establish a design vocabulary for the Metro's 86 stations. Local architects, using this vocabulary, completed working drawings for the various stations to meet the immediate conditions. But Weese and the WMATA—with strong support from the Fine Arts Commission—were determined to achieve a unified monumentality and to prevent a mélange of individuality.

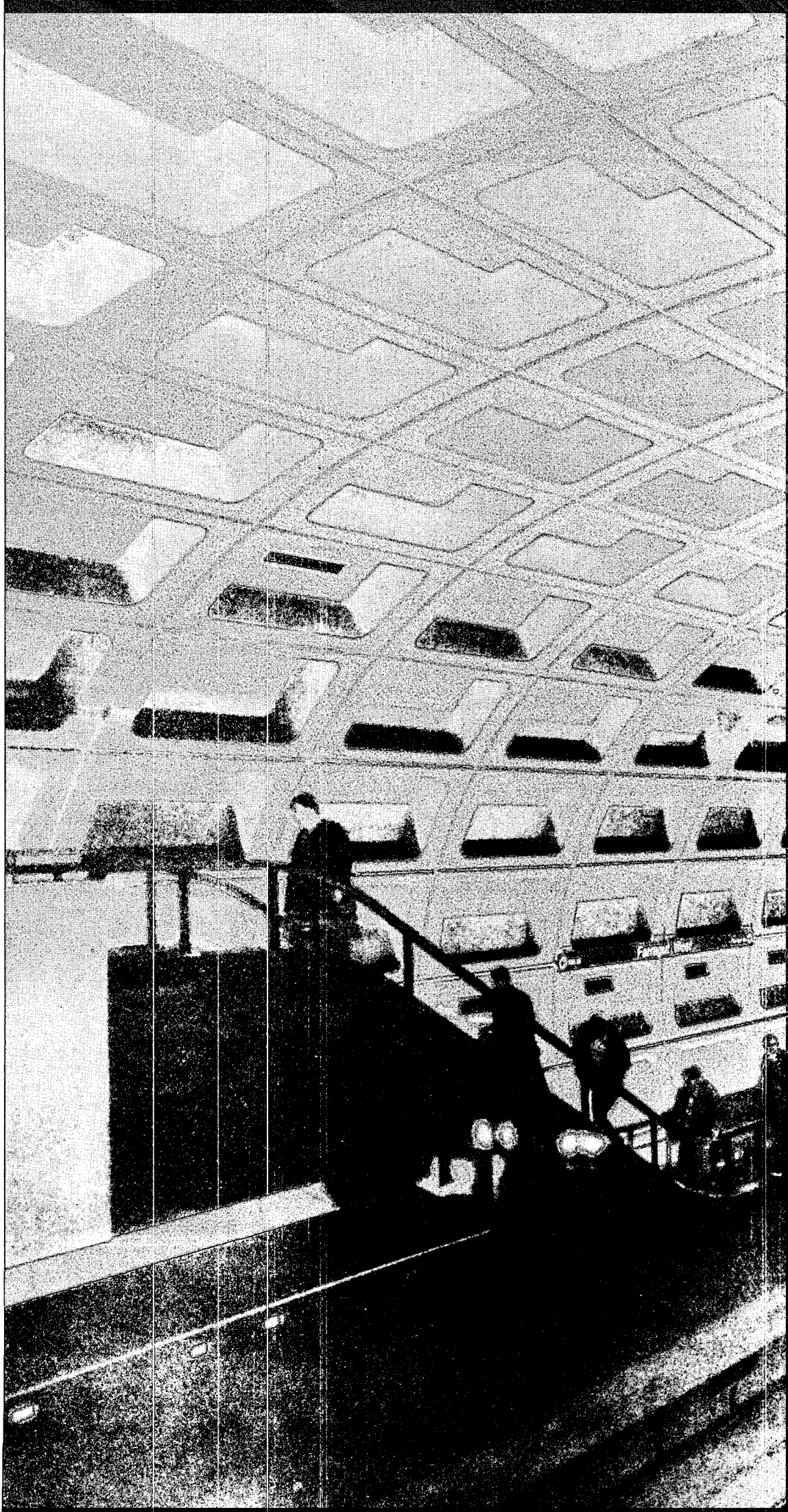
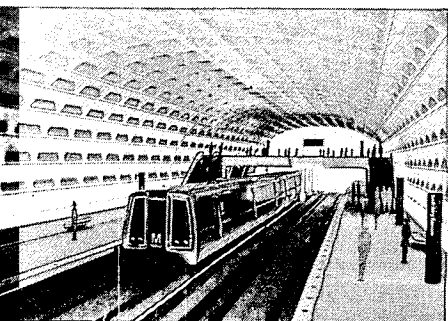
WASHINGTON, D.C., METRO STATIONS. Owner: *Washington Metropolitan Area Transit Authority*. General architectural consultant: *Harry Weese & Associates*. General engineering consultant: *De Leuw, Cather and Company*. Acoustical consultant: *Bolt, Beranek and Newman*. Lighting consultant: *William Lam Associates, Inc.* General construction consultant: *Bechtel Associates*.





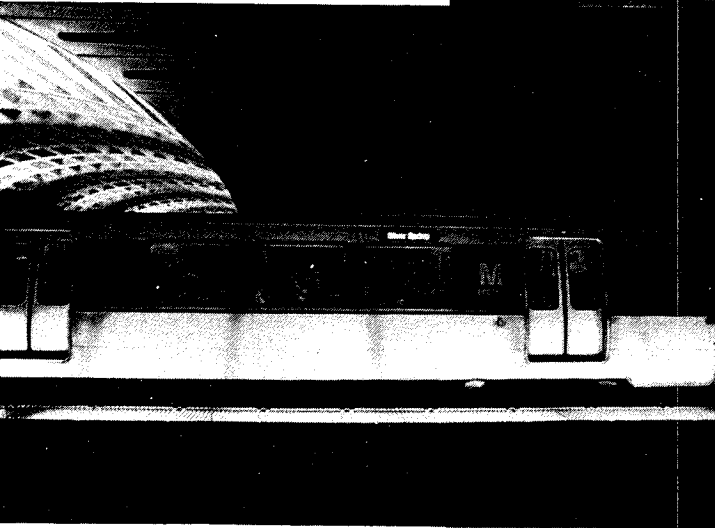
The objective from the beginning was to light the architecture—not the people. So indirect lighting was a given from the start. A number of approaches were considered by lighting consultant William Lam and the architects. The first concept, birdbath fixtures, would not have given even illumination. The use of valances would have given good illumination, but created dark bands that would have interrupted the continuity of the vault. Fixtures recessed in the floor would have created unpleasant glare, and incurred high maintenance costs. The solution was fluorescent fixtures concealed behind benches for side-platform stations supplemented by fluorescent fixtures under the grille of the safety walk between tracks.

Many models were built during the course of design, and the actual lighting is very faithful to the models (see below).



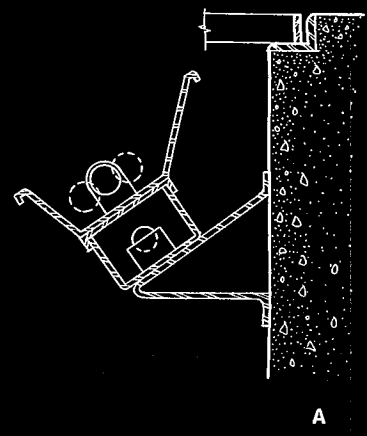
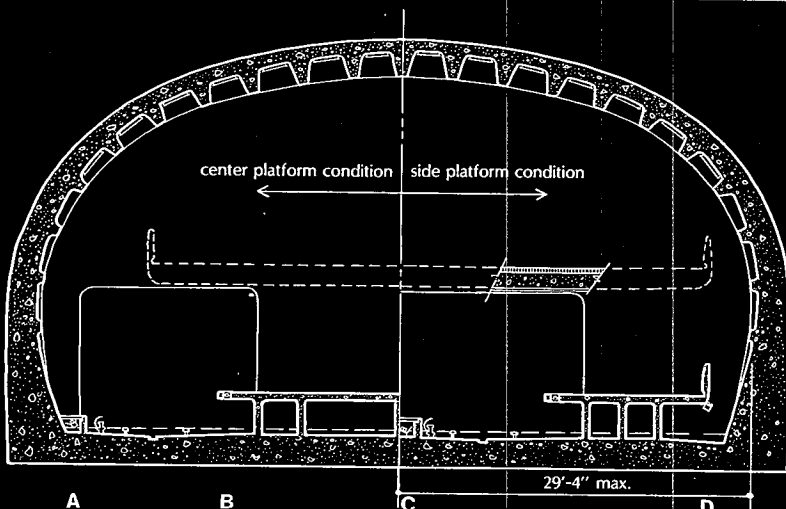


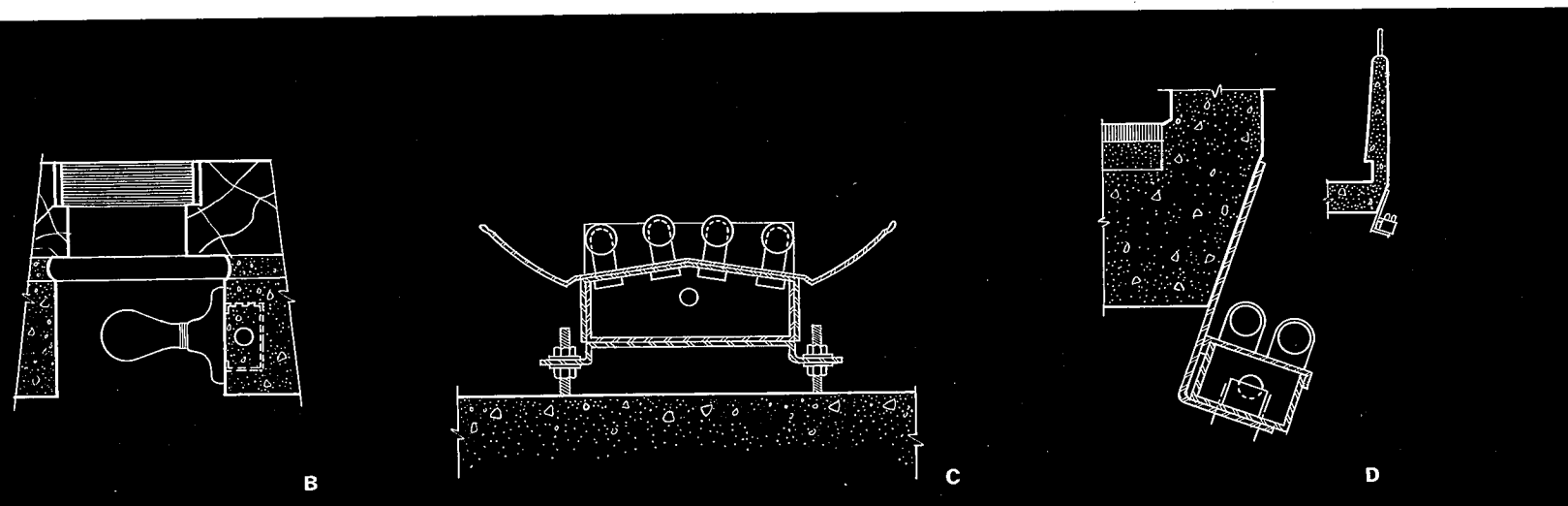
Lighting and architecture are a unity in the Metro stations. Inconspicuous fixtures wash the surfaces of the vaults so that patrons are not conscious of equipment. Furthermore, the fixtures are located so they cannot be vandalized, yet they are easy to maintain. At the side-platform stations, the center-strip fluorescent fixtures cast a bright light on the subway trains as they are viewed from the platform opposite the one the train is serving, creating visual interest. Riders are alerted to an ap-

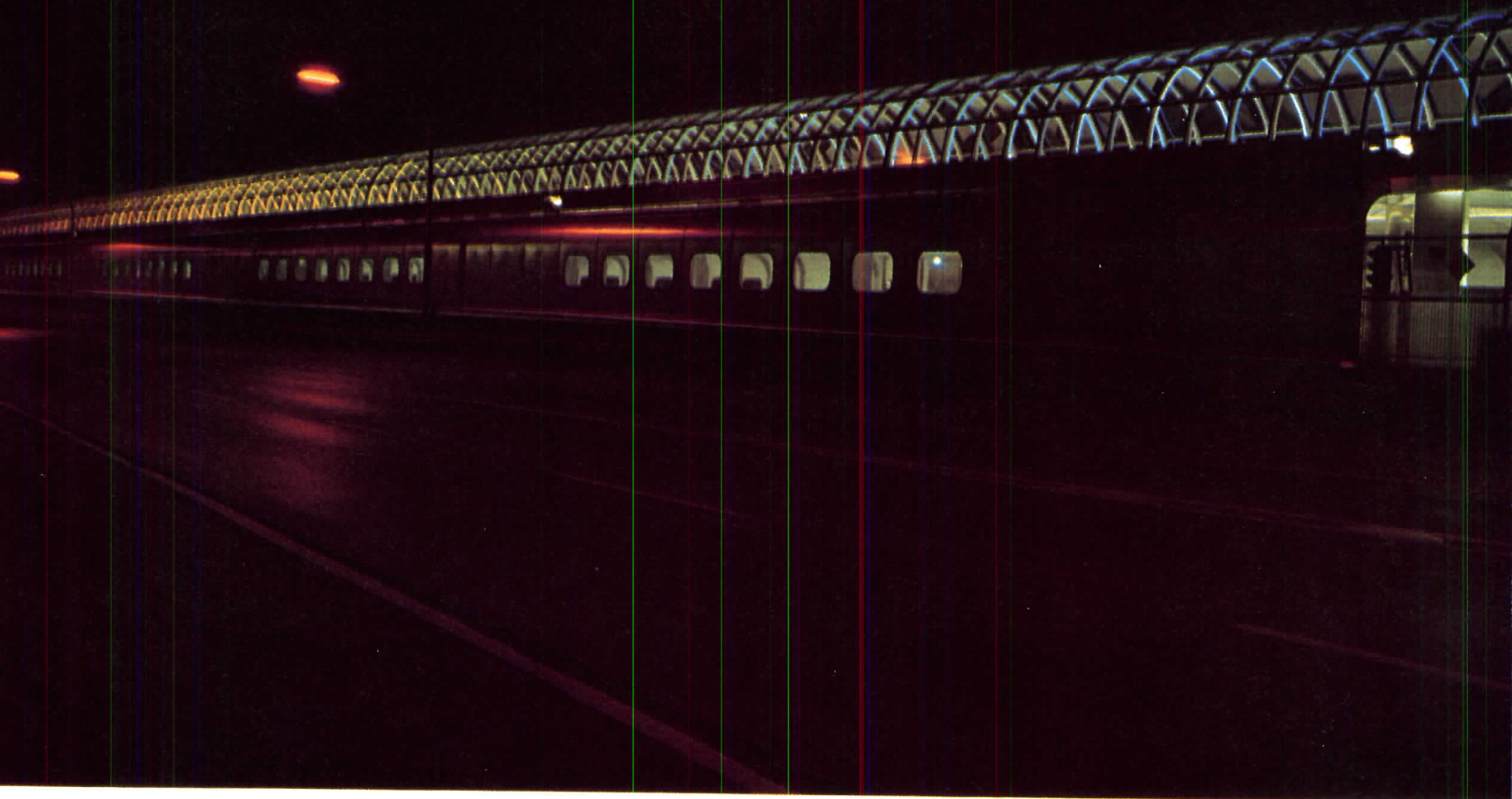


proaching train by the blinking of circular lights at the edge of the platform, set flush with the surface. The rest of the time the curb lights glow evenly. For the two stations with the groined vaults (where two subway lines cross), perimeter lighting is supplemented by two rows of pylons that house metal-halide mercury lamps. For the center platform stations the top portions of the vaults are illuminated by pylons down the center of the platform and the mezzanine.

Robert E. Fischer photos





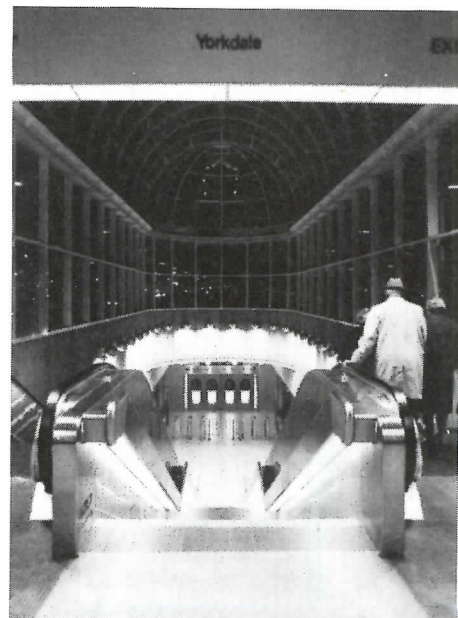


Patterns of light, always changing, enliven a subway station in Toronto

It's not a neon-lit Vista-Dome train you see above, but Yorkdale subway station on Toronto's new Spadina subway extension. Located in the median of a major expressway, Yorkdale serves a large shopping center/office building complex, so festivity seems appropriate, indeed. The platform level was constructed with precast concrete panels in an inverted "L" position, punched out for windows the height of train cars. The panels are clad in stainless steel for protection against salt spray from passenger cars in winter.

The roof is a skylight covering the 500-ft-long center platform, and extending out approximately 100 ft at each end in a glazed apse above the escalators and stairs. The skylight glazing system consists of extruded aluminum sections fixed to bent steel ribs.

A spectacular display of rainbow colors is produced by neon tubes in the skylight—an electronic sculpture called *Arc en Ciel* by artist Michael Hayden. The colors start with deep blue at one apse and graduate through the spectrum to red at the center, returning to blue at the other apse. A computerized controller scrambles patterns so that at one instant color sweeps from one end to the other, or it pulses in segments, or it spurts sporadically, and on and on. When a train is about to enter the station, the movement of light stops and all tubes are lit. Once the train is in the station the rhythms start once again.



YORKDALE STATION, Toronto Canada. Owner: Toronto Transit Commission. Architects: Arthur Erickson Architects—project team: James C. Strassman, Michael Jones, Myron Boyko. Engineers: M.S. Yolles & Partners Limited (structural); Tamblyn, Mitchell and Partners Ltd. (mechanical); Kalns Associates (electrical). Artist: Michael Hayden. Contractors: Janin Building and Civil Works Ltd.



Northbound

S
N

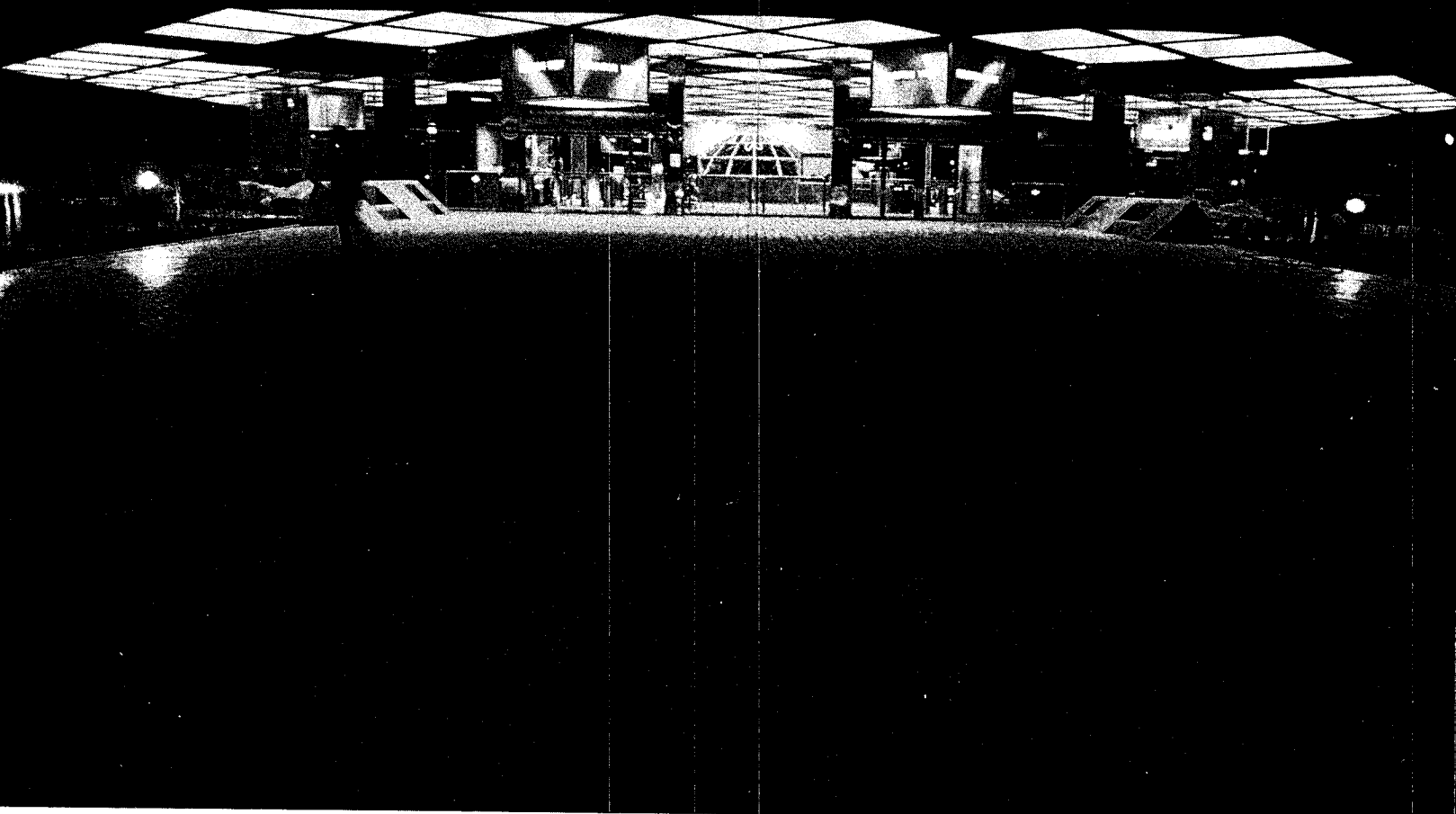
During the day the platform is flooded with light, and people can see through windows that suggest those used in railroad cars. At night

the skylight comes alive with ever-changing patterns of light—rainbow colors—constantly changing in response to computer control.

Robert E. Fischer photos





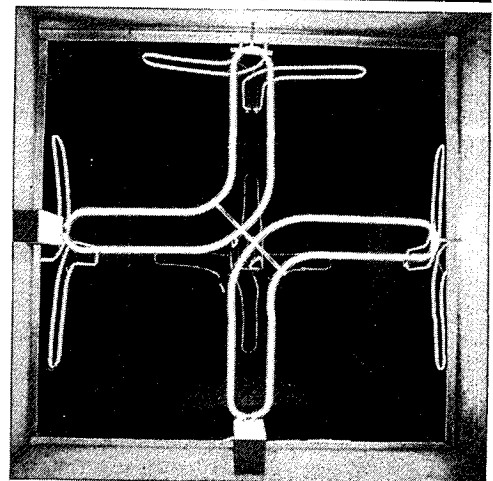
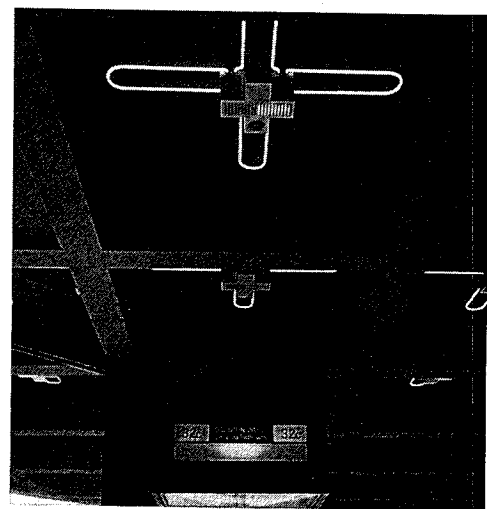


Form is perceived
with lights that sparkle
in a transit station
for buses and subway

A 400,000-sq-ft concrete space frame with cold-cathode lighting glowing in its 400 10-ft-square coffers—21 of them open to the sky via plastic skylights—provide a huge umbrella for transit riders changing from buses to the Spadina subway line at Eglinton West. At this station, the subway emerges from its tunnel to a natural grade separation at the present terminus of the Spadina Expressway, and continues north between the two sides of the divided highway. From the station at grade, escalators and steps lead down to the platform area in a staggered arrangement to ease passenger flow. To encourage the transfer process, the architects used a transparent enclosure of continuous glass which is set back 22 ft from the edge so that the roof appears to float. To enhance the illusion, the lighting continues outdoors. Since the glass divides the coffers diagonally, two boomerang-shaped fixtures were set on either side of the glass.

To make it easy for transit riders to select either north- or southbound platforms, a glass-enclosed bridge crosses the tracks midway between two series of stairs. Just beyond the stairs from the bridge to the platform on each side of the tracks is a floor-to-ceiling porcelain-enamel mural that on one side shows the front and back of a streetcar (across page) and on the opposite side depicts buses in the process of moving. Where the platform extends outdoors, a cantilevered roof is lit indirectly.

EGLINTON WEST STATION, Toronto, Canada. Owner: *Toronto Transit Commission*. Arthur Erickson Architects—project team: James C. Strasman, Wayne A. Cybulski, Khaja Vicaruddin. Engineers: *M. S. Yolles & Partners Limited (structural); Tamblin, Mitchell and Partners Ltd. (mechanical); Kalns Associates (electrical)*. Mural artist: *Gerald Zeldin*. Contractors: *E.G.M. Cape and Co. Ltd.; Folco Construction Equipment Ltd.*





Robert E. Fischer photos



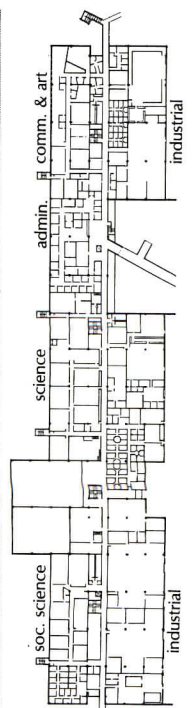
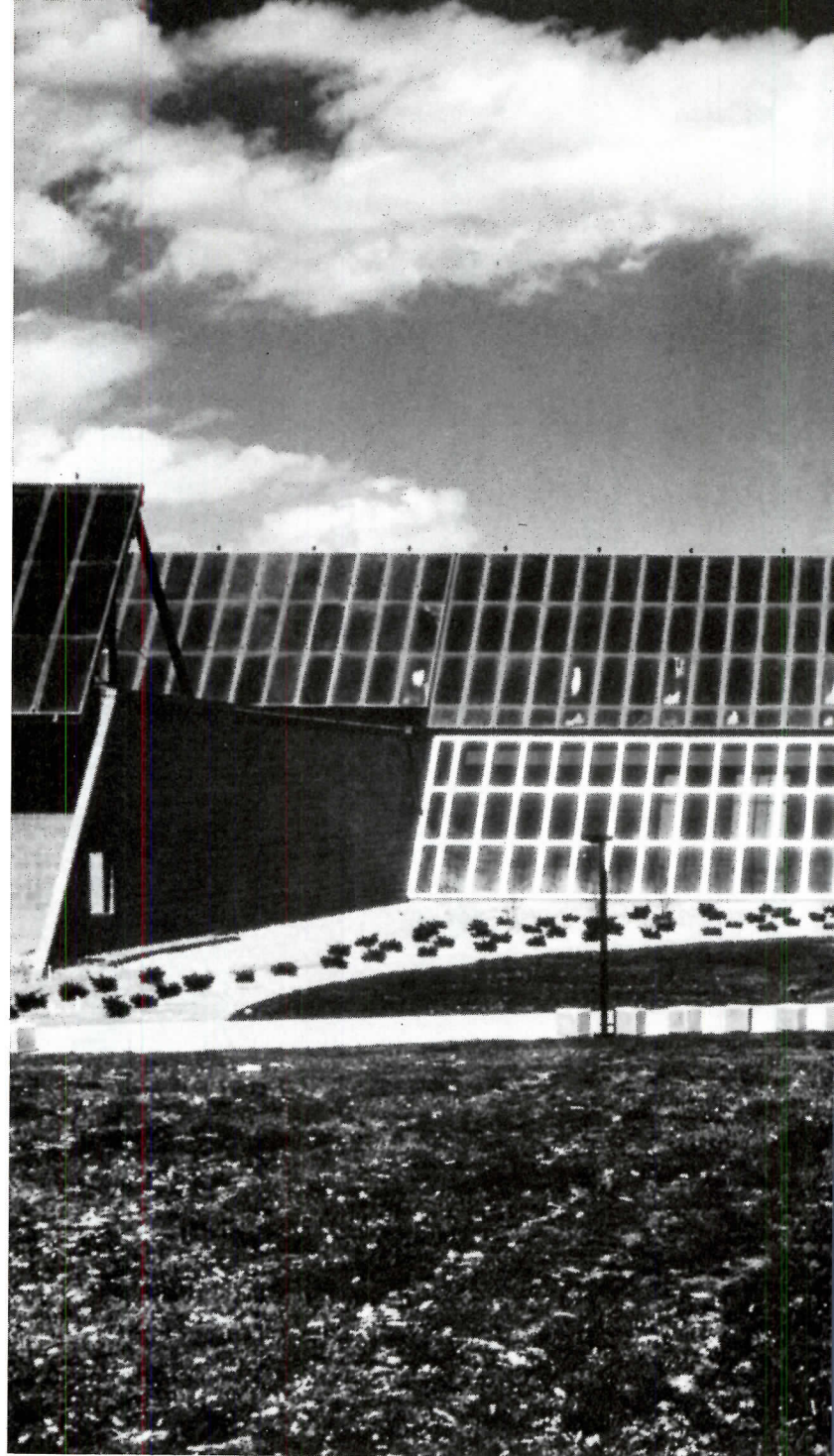


Designing for the sun, whether harvesting it or shutting it out, can be energy conserving, form-giving, and fun

It is clear from the examples following that architects are beginning to take solar seriously. Though paybacks on collector systems may not exactly thrill business clients, some systems do offer quite respectable paybacks. In any case, we should all be thankful to those clients, both public and private, willing to take the plunge and allow the rest of us to learn from their design and operating experience. Architects for some of the buildings shown here found that, with energy-saving techniques and economical building materials, total costs could be made comparable to those of like buildings.

But just as important, other examples demonstrate some inventive ideas for the use of solar heat and light through windows. Architects must recognize that this "passive" approach can lead to good design—and that more and more clients will be asking for it.

Reginald Wade Richey





Solar-heated campus treads chartless territory of solar on a large scale with sure-footed ease

COMMUNITY COLLEGE OF DENVER-NORTH CAMPUS, Denver, Colorado. Architects: *John D. Anderson and Associates*. Engineers: *KKBNA, Inc. (structural); Bridgers and Paxton (mechanical, energy conservation and solar energy); Sol Flax & Associates (electrical); Chen & Associates (soils)*. Landscape: *Alan Rollinger*. General contractor, construction manager: *Pinkard Construction Co.*

The mini-megastructure that is the North Campus of Denver's Community College flaunts its solar collectors with an architectural aplomb rarely manifested by mechanical systems.

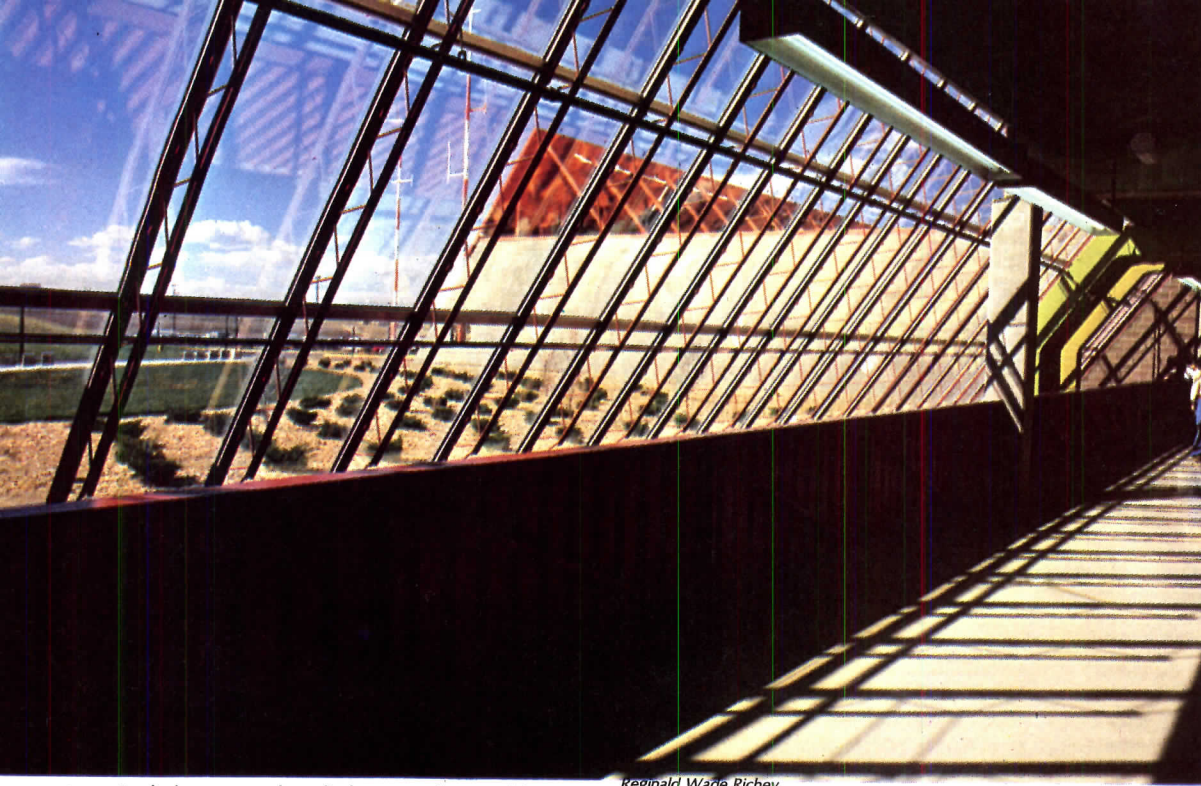
Early planning meetings for new quarters to replace the college's bursting temporary facilities took place in the summer of 1973, when warnings of impending shortages were given substance by long lines of motorists haunting still-pumping gas stations.

Thus alerted, architect John Anderson and the client commissioned the Albuquerque mechanical engineering firm of Bridgers and Paxton, pioneers in work with solar energy, to prepare a feasibility study including a solar option. The choice—later rendered moot when the local utility served notice of a cutoff of new natural gas allocations—narrowed quickly to conventional gas-heating and cooling versus solar-assisted heat pump system. The solar system commanded an

initial premium at 8.5 per cent over the original budget but was deemed a viable long-term option because of the relatively short payback period— 11 years on the conservative assumption of a 300 per cent increase in natural gas prices between 1973 and 1990.

The system as installed (comfortably within the revised budget) is, as Anderson notes, "nothing trailblazing." Playing safe with a fledgling technology, it employs 35,000 sq ft of steel flat-plate liquid collectors and water storage. Two centrifugal chillers needed for cooling serve as heat pumps to boost stored water temperature when it falls below the 100F required for the air-handling system. Back-up is provided by the domestic hot water boiler. In a typical insolation year, the system is expected to supply some 80 per cent of heating requirements.

The designers expect in addition a substantial bonus through use of the heat pumps to redistribute ambient heat gener-



Reginald Wade Richey

ated by people, lights and machinery, buttressed by a full gamut of heat-recovery devices. The resulting heavy heat traffic flow is directed by sophisticated control and monitoring instrumentation that Anderson and Bridgers agree is the *sine qua non* of successful system operation.

Anderson further stresses the thermal "buttoning-up" of the building as the essential point of departure for solar heating.

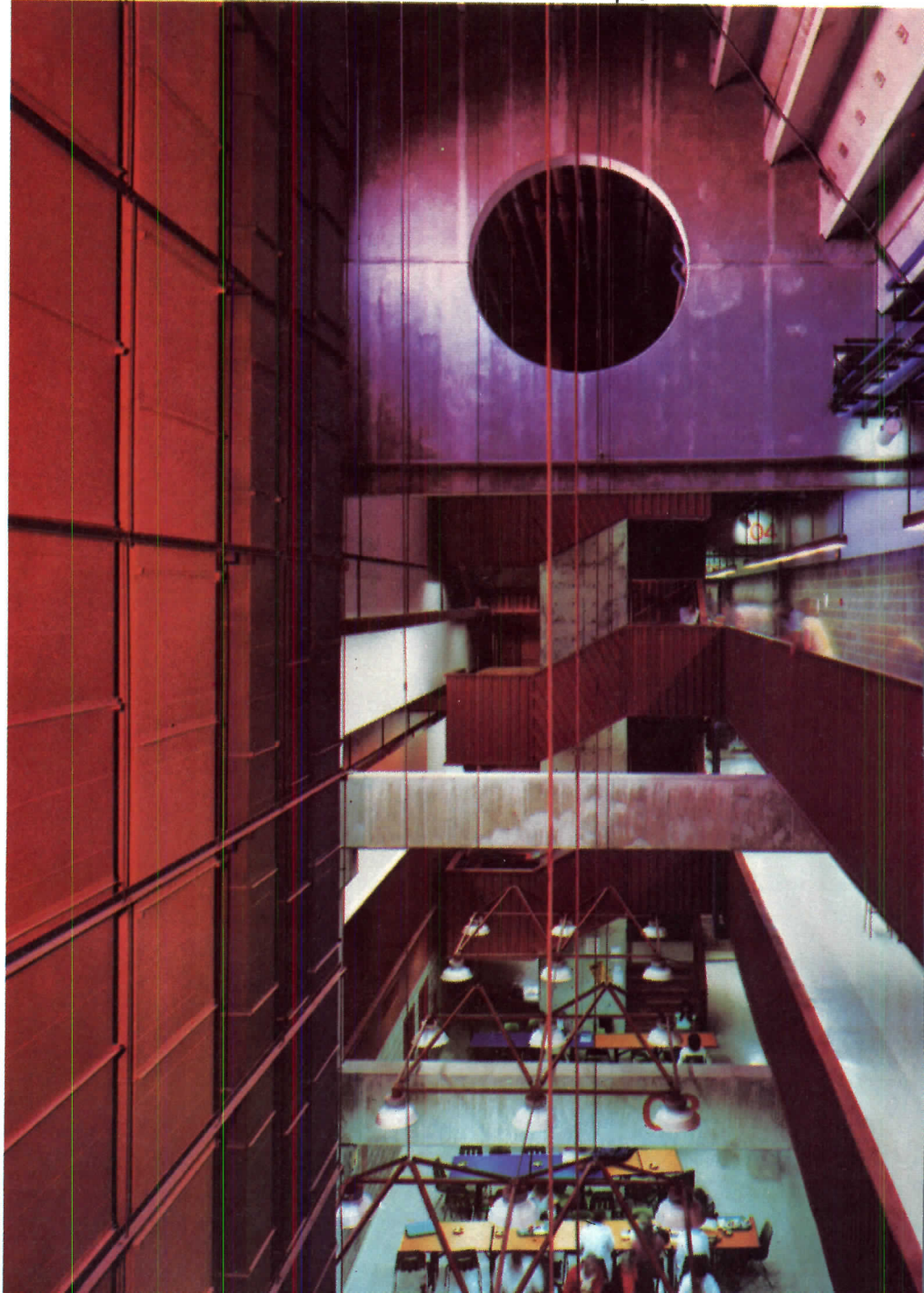
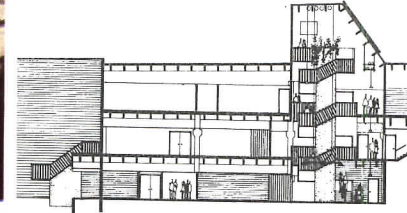
Particularly stringent constraints were imposed by a curriculum weighted heavily to occupational education.

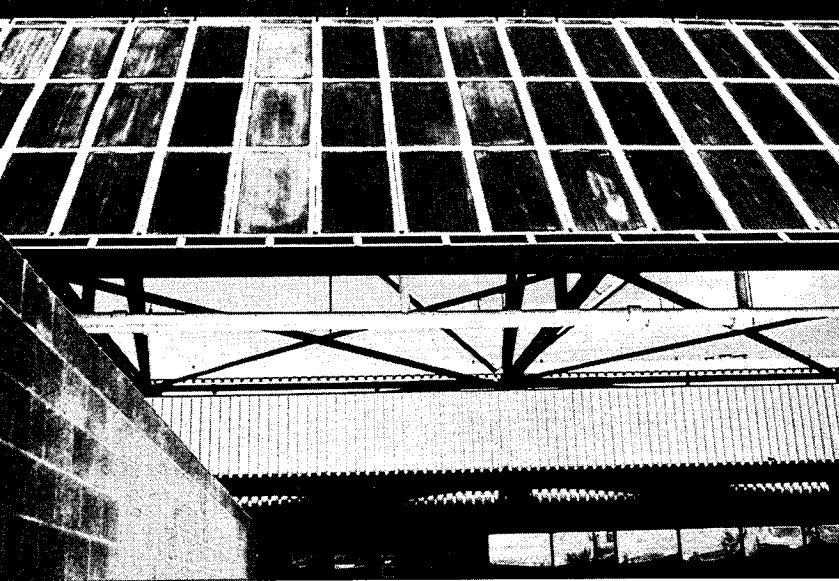
On the south, flanking the main entrance, are single-story units housing shops whose requirements for loading access and heavy equipment loads mandated their placement on grade. On the north a parallel element, two stories stair-stepping to three, contains additional academic spaces, with administrative, service and support areas.

Linking the two is a 28-ft-wide central spine that serves as a continuous interior street running the length of the building, and doubles as a buffer isolating the noise and vibration of the shops from areas opposite. Its elevated roof, angled at 53 degrees on the north side, provides surface support for the north bank of solar collectors and encloses eight fan rooms containing the bulk of the building's air handling equipment. The 10-in.-thick precast panels that span the monitor section at each bay transmit lateral loads across discontinuous roof diaphragms to concrete block shear walls. Where not occupied by fan rooms, the elevated monitor provides clerestory light and dramatic vertical space to the wide "places in the road" that punctuate the structure's length and serve as student gathering places.

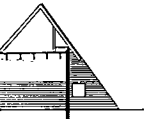
But it is the use of the "unused" areas of the highly—and multi—functional monitor to create the building's soaring, climactic spaces that perhaps best exemplifies Anderson's efforts to add spice without resort to prettifying or pretense.

Slope and framing of collector array supported by monitor structure is continued at main entrance by window wall which admits daylight to lobby and adjacent corridor-cum-"street" and, via a balconied light well, to a student lounge area below. Structure, exposed throughout, combines cast-in-place and precast concrete and concrete block. Precast double-tee roof framing members, supported elsewhere by beams, are carried at the monitor by massive concrete panels with sloping ends slotted to receive them.

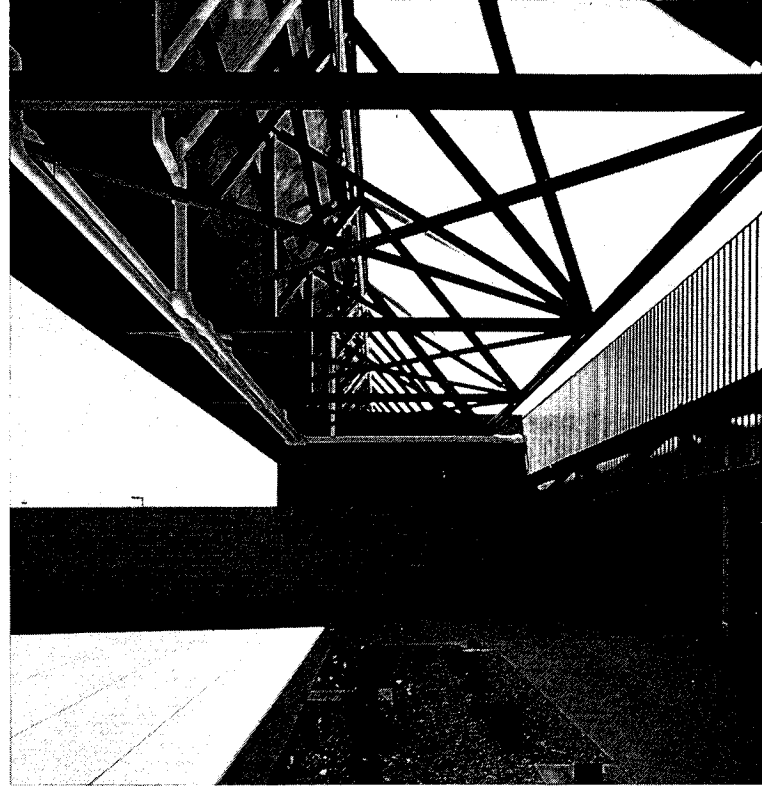




Portholes on north wall of monitor supplement lighting from industrial-style fixtures in cafeteria area—the campus's Great Hall. Repeated in transverse panels, portholes minimize their bulk visually as well as physically.

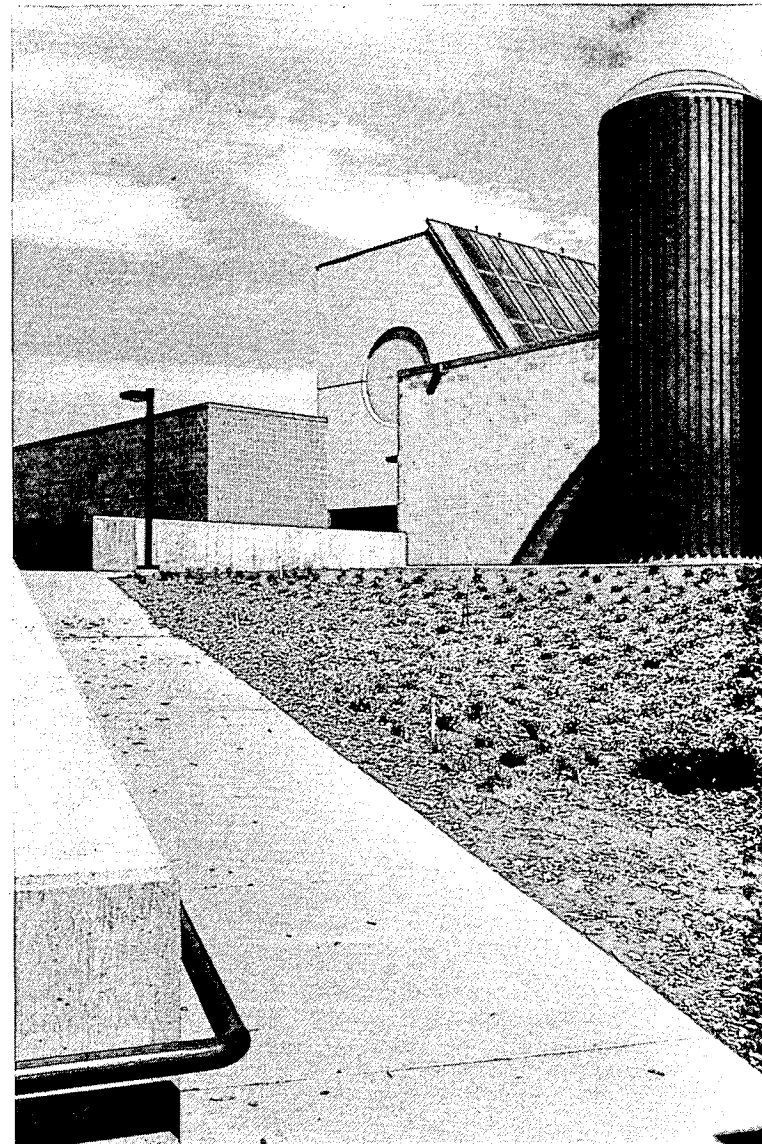
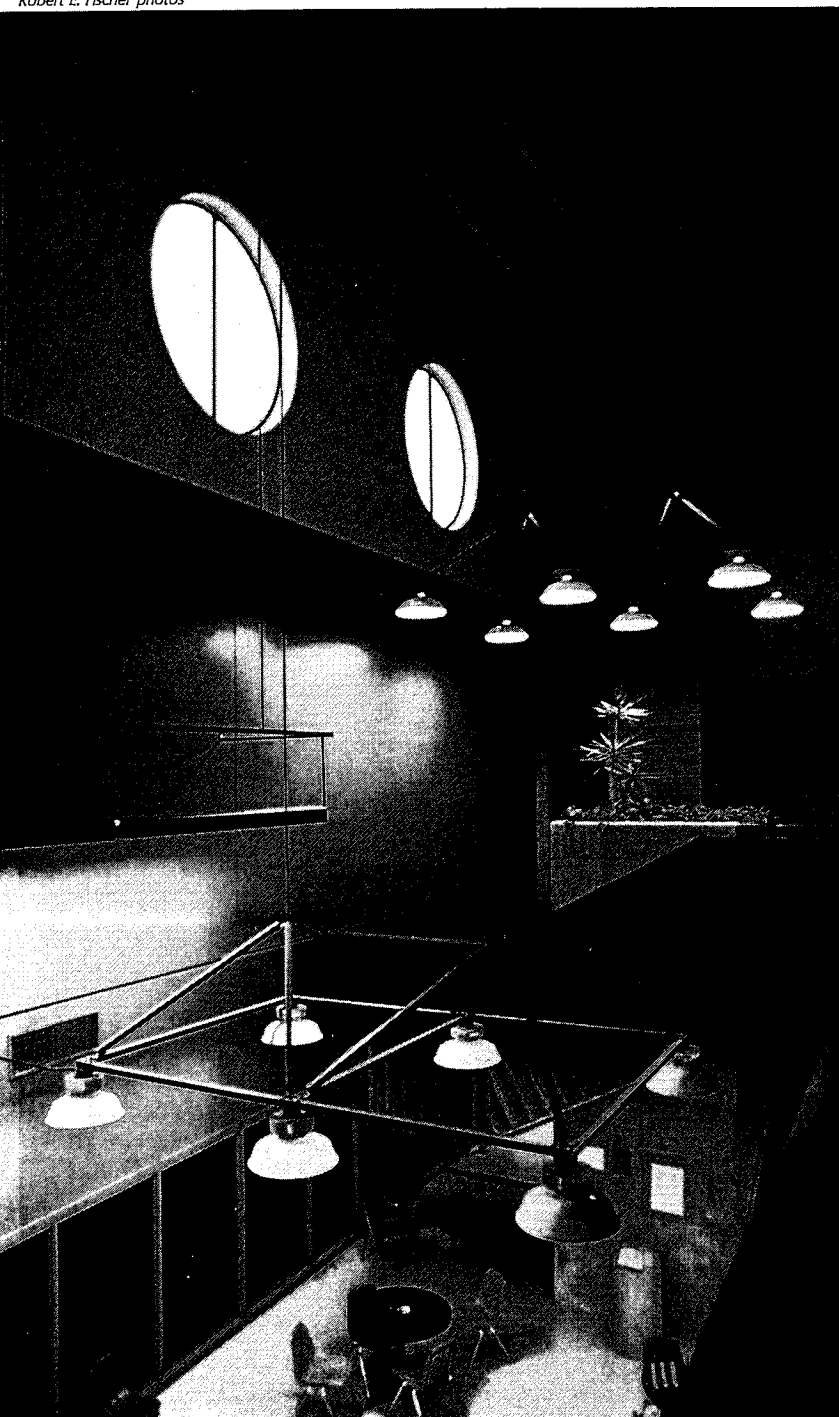


Robert E. Fischer photos



Freestanding collectors are supported by steel frames every 9 ft and by a space-frame section (above and left) spanning 84 ft. Frames are anchored to double tees with flanges beefed up to handle wind loads.

Skylit, barn-red "silos" at building ends form playful enclosures for access stairs to roof between monitor and south bank of collectors. Indented circle on end facade of monitor echoes interior porthole motif.





Inventive control of sun creates pleasant offices and conserves energy in Vermont headquarters

FAMOLARE HEADQUARTERS, Brattleboro, Vermont. Owner: *Famolare Inc.* Architects: *Banwell, White & Arnold.* Consulting engineers: *R.D. Kimball (mechanical/electrical); Carroll Lawes (structural).* Solar consultant: *A.O. Converse.* General contractor: *O'Bryan Construction Co., Inc.*

The positive effect of pleasant work space on worker productivity and morale has not been lost on Joe Famolare, the exacting president of Famolare Shoes Inc. When Famolare decided to move operations from leased warehouse space in New Jersey to the mountains of Vermont, he requested attractive work space with a sharp eye kept on energy consumption.

After preliminary designs for an elaborate high-technology solar collector system were declared not cost-effective, the architects created a passive solar system for the new headquarters, using sun scoops, skylights, and special window shutters to take



Robert Perron photos

maximum advantage of natural light and sun.

Set amid farms in mountainous Vermont, the office building is topped by a large sun scoop yawning open to the south. Manually-adjusted fiberglass panels bounce sun into the scoop in winter, flooding the offices with light, and are turned to deflect sun in summer. Several smaller skylights brighten showroom areas of the office building and movable fiberglass panels hung inside the skylights can be used to deflect sun.

A system of monitors on the adjoining warehouse roof admits sun in winter for direct solar gain, and excludes sun in summer by use of overhangs. The monitors provide

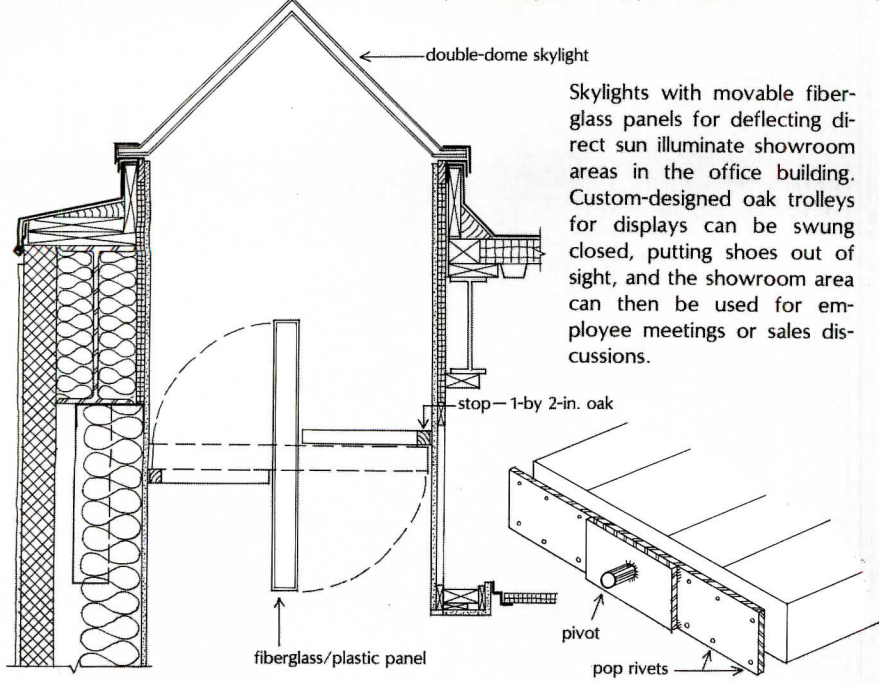
sufficient warehouse lighting about 80 per cent of the time; high-pressure sodium fixtures are used only in recessed areas or on overcast winter days.

Office building windows on the south are fitted inside with special sliding shutters of translucent fiberglass. The shutters are closed when the building is unoccupied to insulate the glass, and are used to exclude direct sun from offices facing south. When the shutters are closed, solar-heated air in the space between the shutter and window is collected and transferred in winter to the north side of the building. The window shutter system is estimated, conservatively, to reduce the

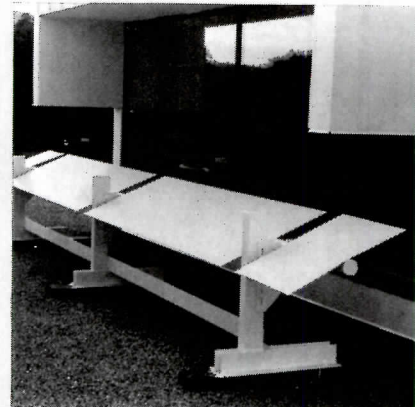
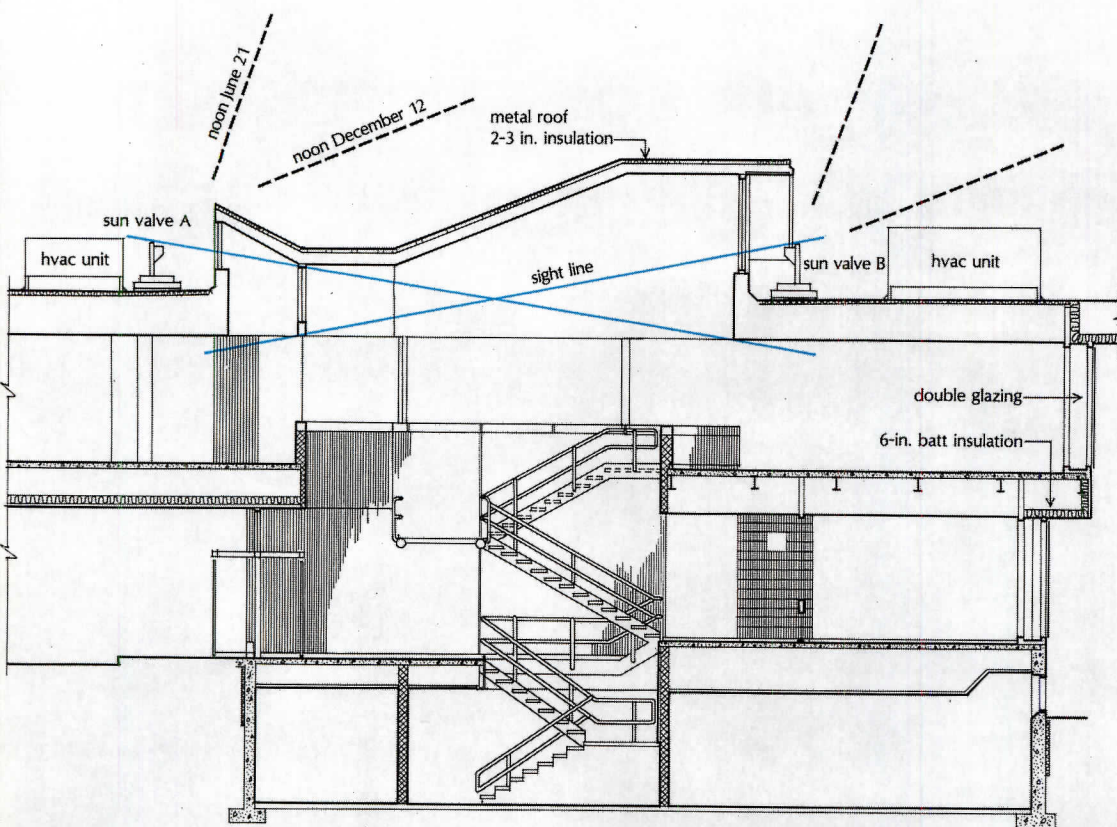
building's heating and air conditioning load by 10-15 per cent annually.

To encourage communication between the office and warehouse personnel, even in harsh Vermont winters, a suspended tunnel of bronze-tinted acrylic plastic is used to connect the buildings. Heated air in the tunnel is collected for circulation throughout the rest of the building.

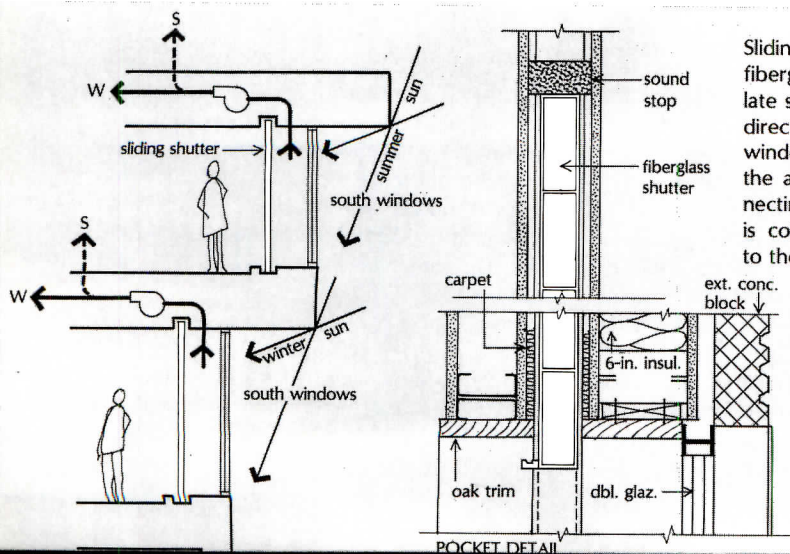
Energy conserving measures extend to the use of 6-inch thick fiberglass insulation in the office building walls, and an insulation of 2.35-inch thick isocyanurate foam board in the roof. Task-ambient lighting in the offices is designed to use only 2.2 Watts per sq ft.



Skylights with movable fiberglass panels for deflecting direct sun illuminate showroom areas in the office building. Custom-designed oak trolleys for displays can be swung closed, putting shoes out of sight, and the showroom area can then be used for employee meetings or sales discussions.

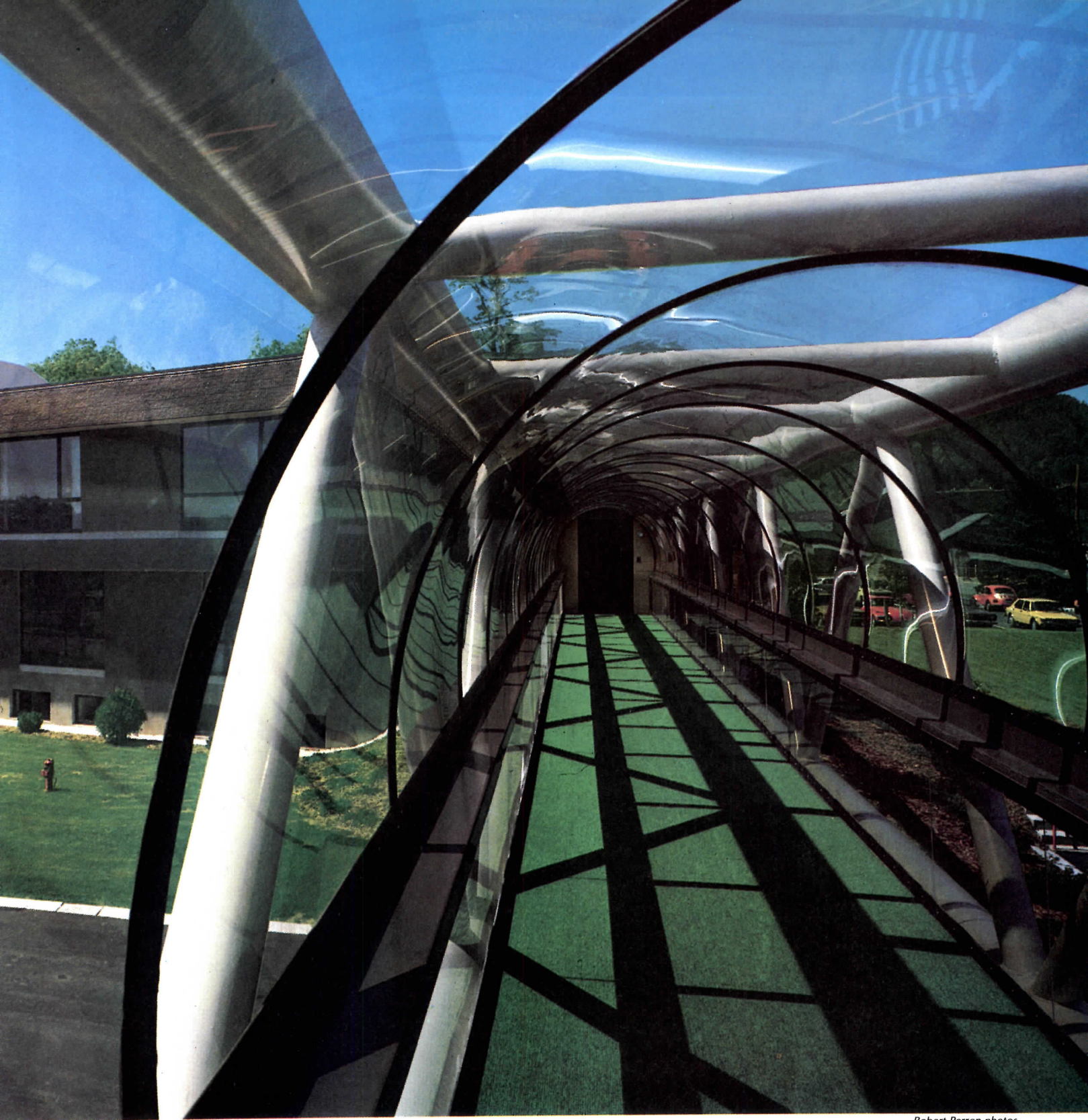


Movable rooftop panels (called "sun valves" by solar consultant Professor A.O. Converse of Dartmouth) tip sun through a large scoop into the office building, creating a bright center well and airy open office space (photo below far right). Hvac units on the roof near the scoop are placed so as to be out of sight from inside the building.

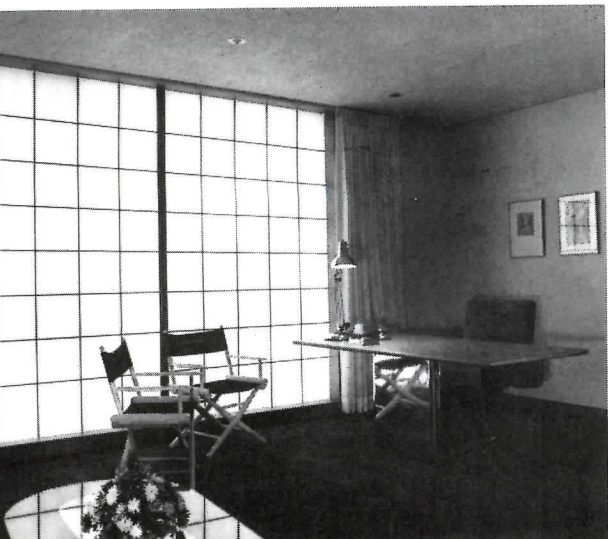


Sliding shutters of translucent fiberglass trimmed in oak insulate south windows and block direct sun. Heated air between windows and shutters, and in the acrylic plastic tunnel connecting office and warehouse, is collected and redistributed to the north side.





Robert Perron photos





Solar works for cooling and is a symbol for energy conservation in a post office along a Houston freeway

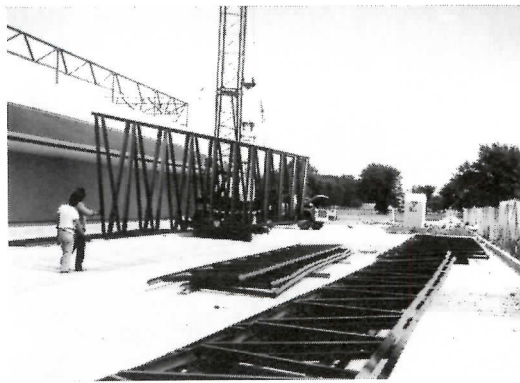
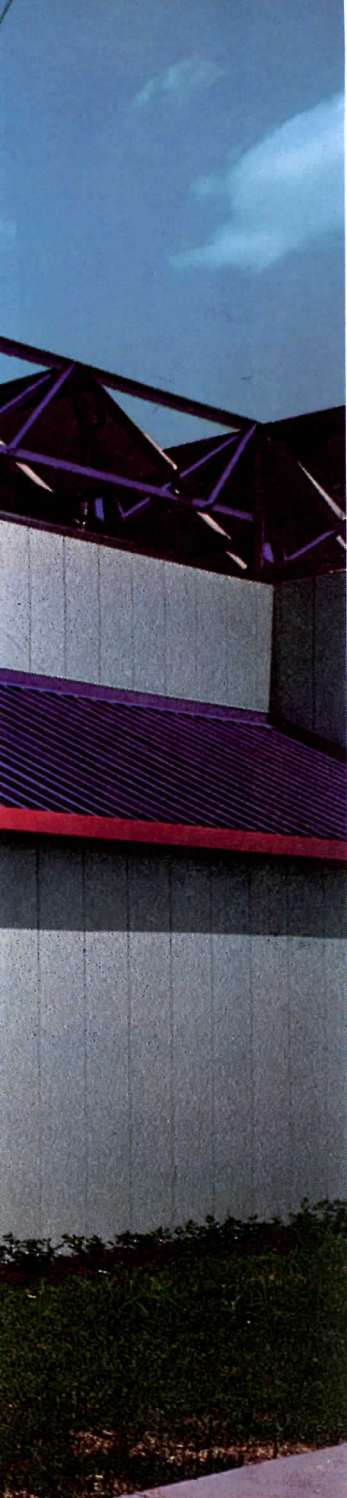
MEMORIAL STATION, Houston, Texas. Owner: U.S. Postal Service—Bill Wright, Gordon Steger, John Wright, liaison. Architects: Clovis Heimsath Associates—Ray Wobbe, project architect; Harold Carlson, supervising architect. Engineers: Nat Krahl & Associates (structural); Timmerman Engineers, Inc. (mechanical). Contractor: Westpark Construction Company.

Because this postal facility is in a large shopping center visible from the Southwest Freeway in Houston, thought of by many as the energy capital of the country, and because he was encouraged by the Postal Service to stress energy conservation, architect Clovis Heimsath felt that the inclusion of a solar system would be an appropriate symbol, and that patriotic colors would provide an appropriate palette.

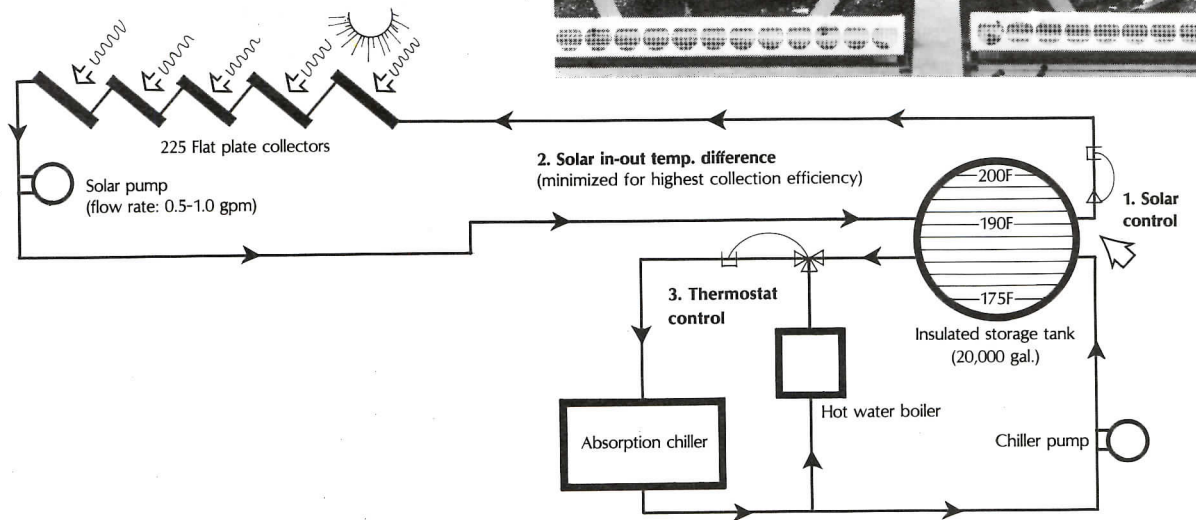
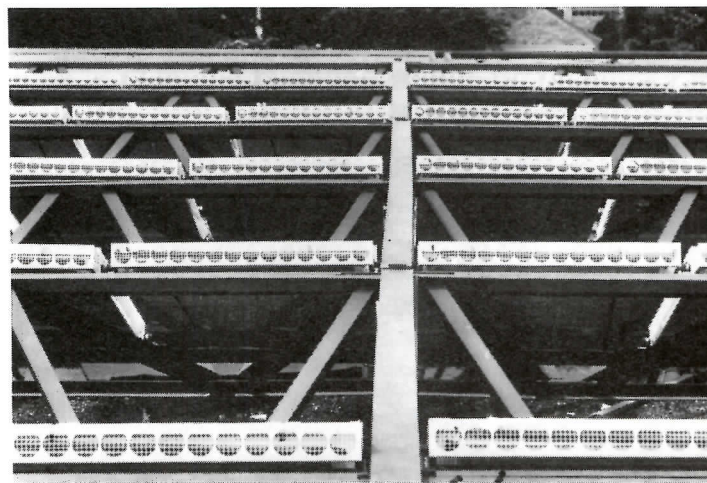
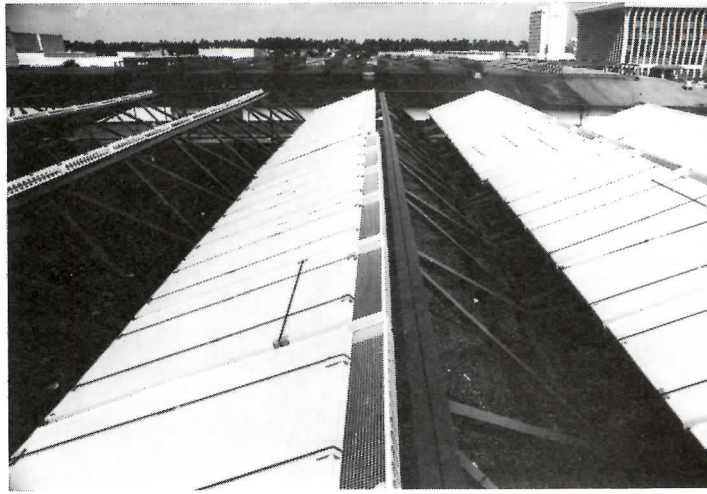
Two major considerations dominated the design: First, only off-the-shelf technology could be considered for solar because the building had to be kept on schedule. Secondly, the solar system was possible from cost and size standpoints only through substantial reduction in load derived from energy-conservation techniques. These included: 1) reducing makeup air; 2) zoning spaces so the workroom could be substantially closed down much of the workday; 3) facing all glass

north, and using it only for the lockbox lobby; 4) using a square plan to reduce exterior wall area; 5) using mercury HID lamps for the workroom; 6) using insulated metal wall and roof panels to reduce heat flow.

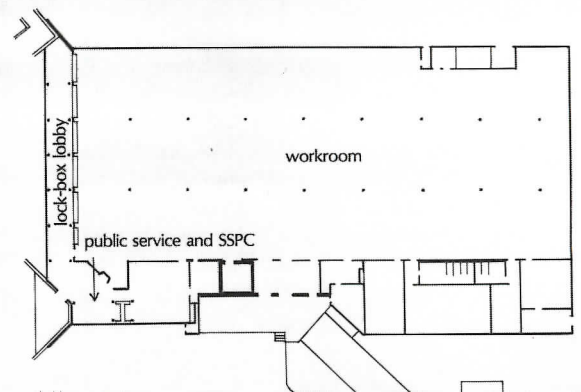
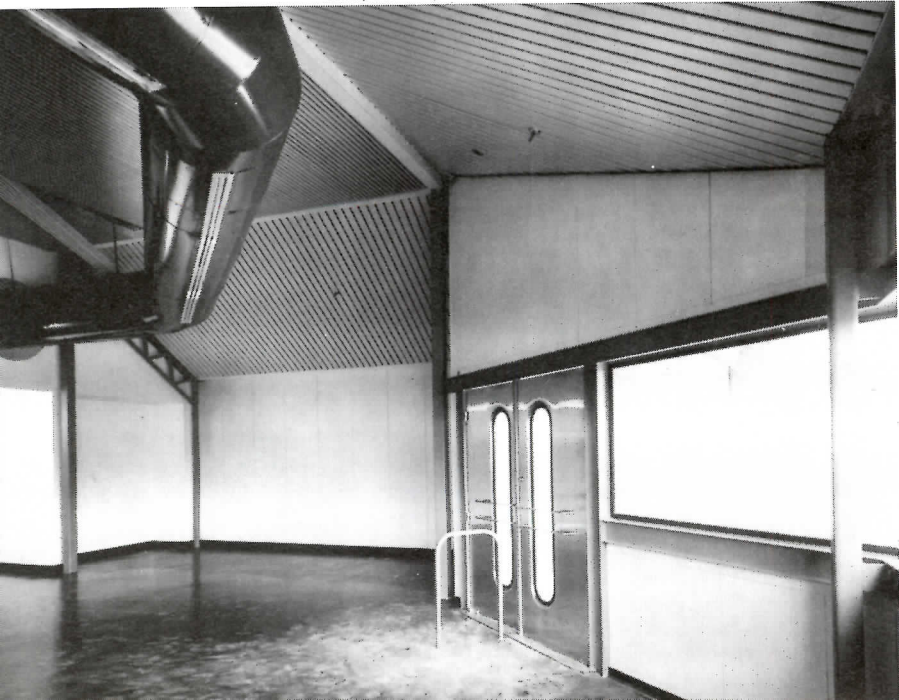
By saving money on the building exterior and simplifying every element of design, including exposing the structure, lights and ducts, the designers could afford the additional first cost of solar, while still bringing in the building at about \$40 per sq ft (less site) which was under budget. Premium for the solar energy addition was \$130,000 (using a central station water-cooled-condenser system for comparison). With a \$6,144 per year estimated operating cost savings, the payback at current energy costs would be 21 years. Projected increases in energy costs would reduce this payback to nine years. The solar collector system is designed to provide 80 per cent of the cooling requirements.

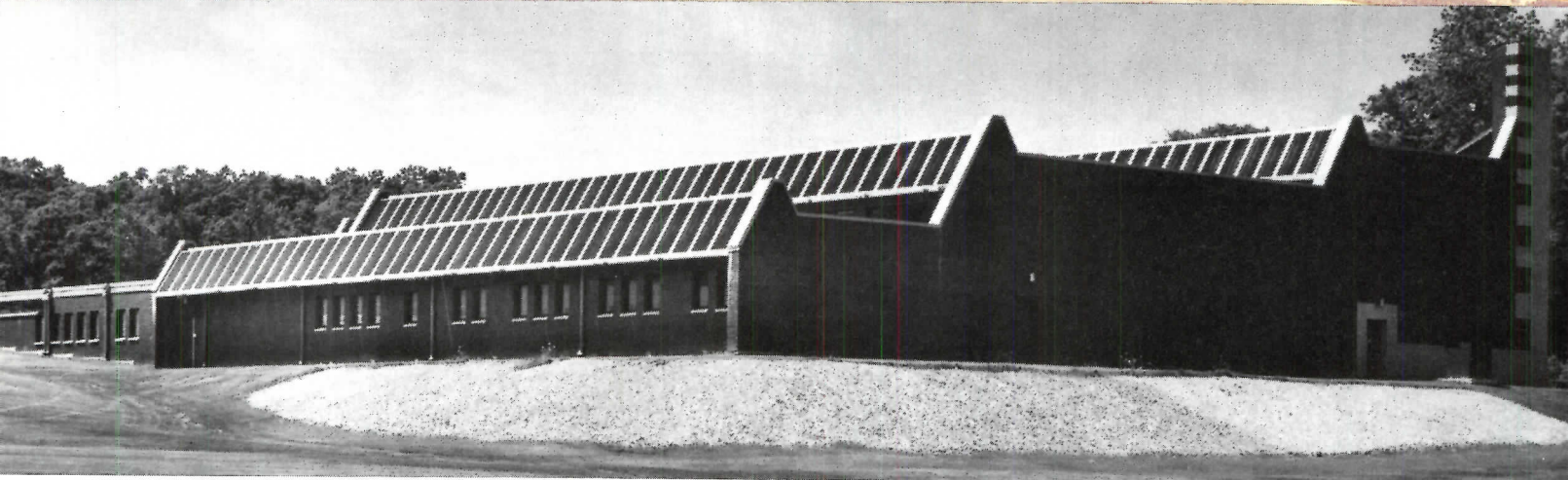


In Houston there are two times as many cooling degree days as heating degree days, so cooling was the major consideration for the solar system. The 5400 sq ft of collectors have been calculated to satisfy 40 tons of air conditioning. The absorption chiller used for cooling has a nominal capacity of 100 tons (it must be derated for use at the temperatures provided by flat-plate collectors). The collectors each have a special convector at the top to dissipate heat in case pumps fail and the system is stagnant. They are supported by folded-plate frames that span 60 ft between light steel frames that span 24 ft.



Henry Navratil photos, left, below and right, courtesy H.H. Robertson Company





Active/passive systems and eclectic touches combine with ease in Connecticut armory

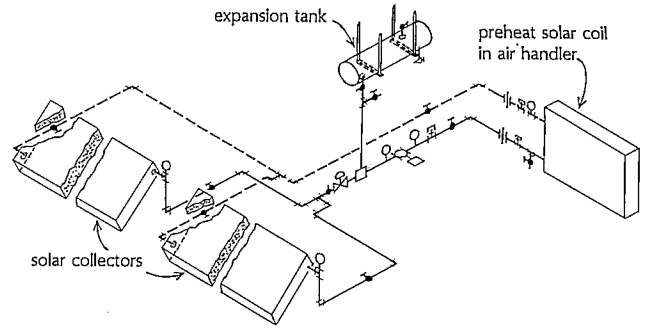
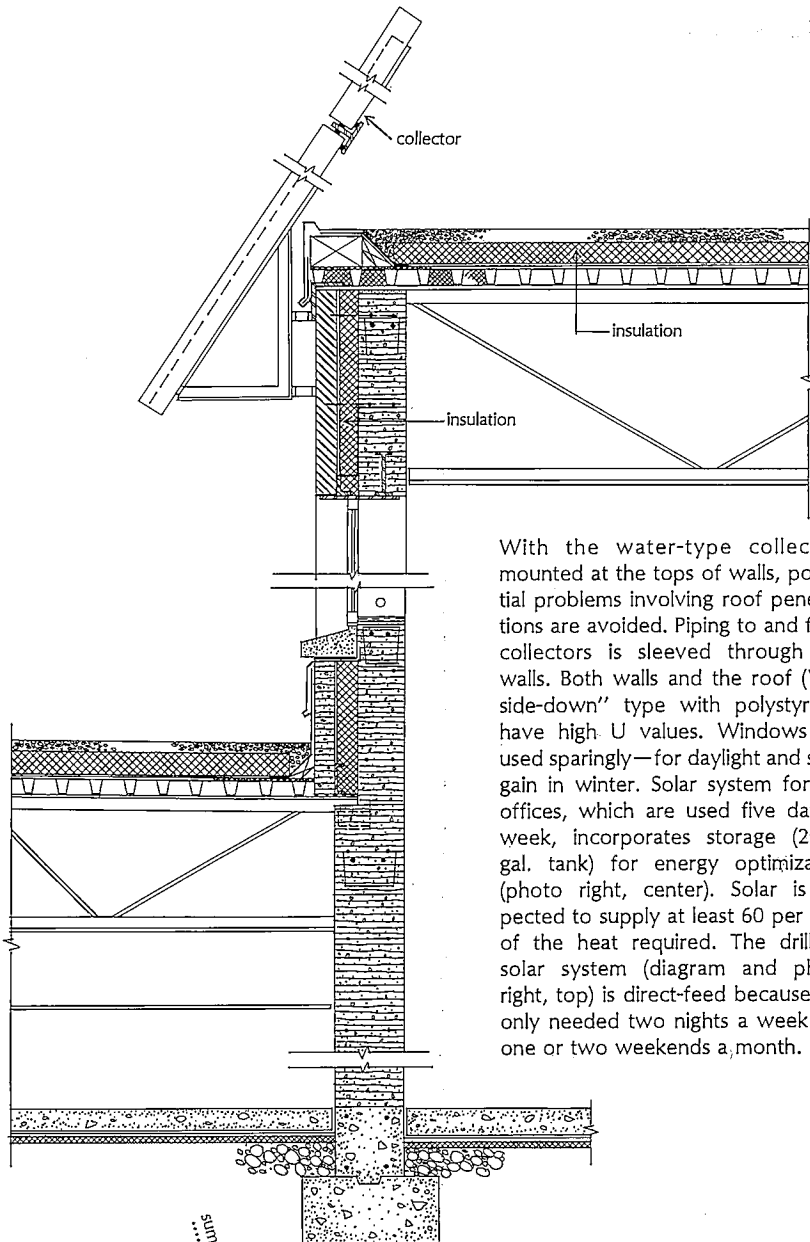
ARMED FORCES RESERVE CENTER, Norwich, Connecticut. Owner: *State of Connecticut Department of Public Works and Connecticut Military Department—Major General John F. Freund*. Architects: *Moore Grover Harper, PC—Robert L. Harper, William H. Grover, Glenn W. Arbonies, Jefferson B. Riley, Charles W. Moore*. Engineers: *Besier and Gibble (structural); Helenski Associates (mechanical)*. Consultants: *Arthur D. Little Company (solar)*. Contractor: *F. W. Brown Co.*

It is clear upon examining this armory in eastern Connecticut that, when architects stop to think about it, energy-conserving features can evolve as a very natural part of building design. Here Moore Grover Harper have disposed spaces naturally by function and size in a way that assists energy conservation, and that leads to logical application of both active and passive solar heating techniques. For instance, the main building steps up in three tiers, allowing logical placement of solar collectors overhanging three walls so they act as sunshades in summer. And at the far corner, the architects, in a droll step, designed a quoin tower that heralds the entrance while also serving as a chimney.

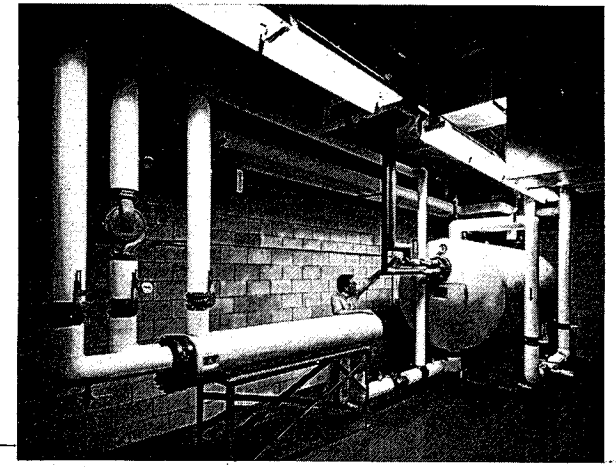
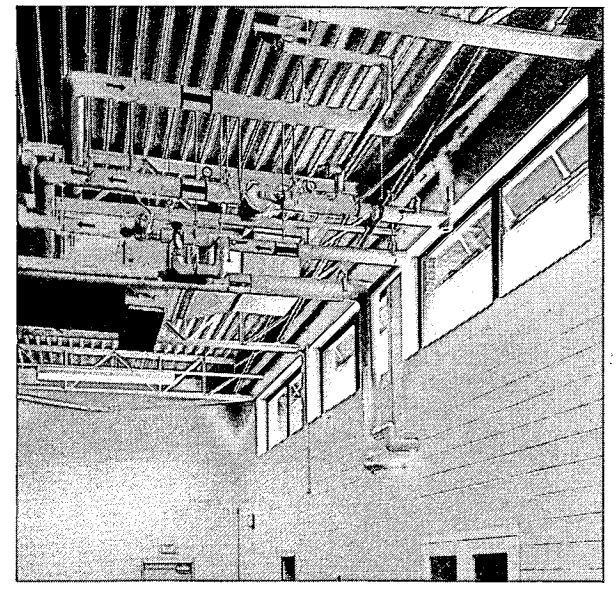
Both the State of Connecticut (which financed 25 per cent of the project and pays the operating costs) and the military wanted energy-conserving techniques, including so-

lar. The 10-acre site in Norwich Industrial Park was selected because it was clear of trees to the south, but had woods on the north to serve as a windbreak. The project comprises an Armory Building with offices, drill shed, classrooms and rifle range and a separate Organization Maintenance Shop (OMS) for vehicle maintenance and repair. Because the offices and OMS building are in continuous use, while the drill hall and ancillary spaces are used only occasionally, the solar-heating systems are functionally separate. Only the office-section solar system utilizes storage (a 2000-gal. tank). The two other systems for the armory and for the OMS building feed directly to air-handling units.

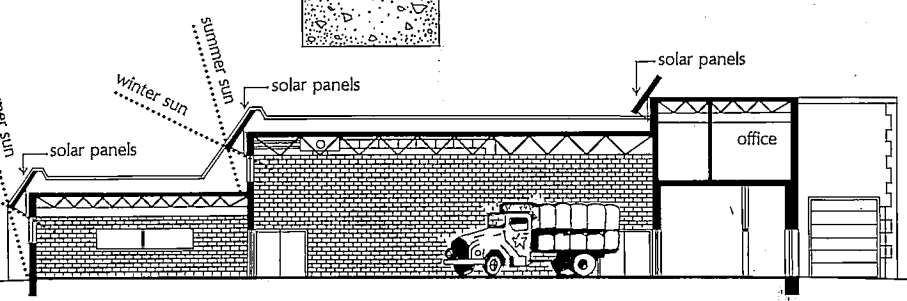
The project cost \$1,459,147 of which solar heating systems cost \$88,489 and other energy-saving components, \$54,600. It was 25 per cent under budget.



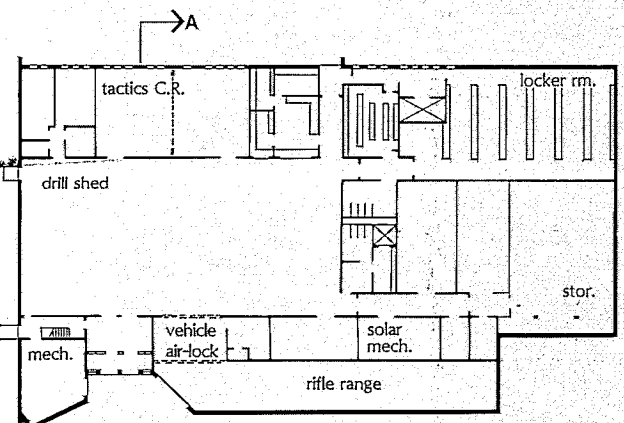
With the water-type collectors mounted at the tops of walls, potential problems involving roof penetrations are avoided. Piping to and from collectors is sleeved through the walls. Both walls and the roof ("upside-down" type with polystyrene) have high U values. Windows are used sparingly—for daylight and solar gain in winter. Solar system for the offices, which are used five days a week, incorporates storage (2000-gal. tank) for energy optimization (photo right, center). Solar is expected to supply at least 60 per cent of the heat required. The drill-hall solar system (diagram and photo right, top) is direct-feed because it is only needed two nights a week and one or two weekends a month.



Norman McGrath photos

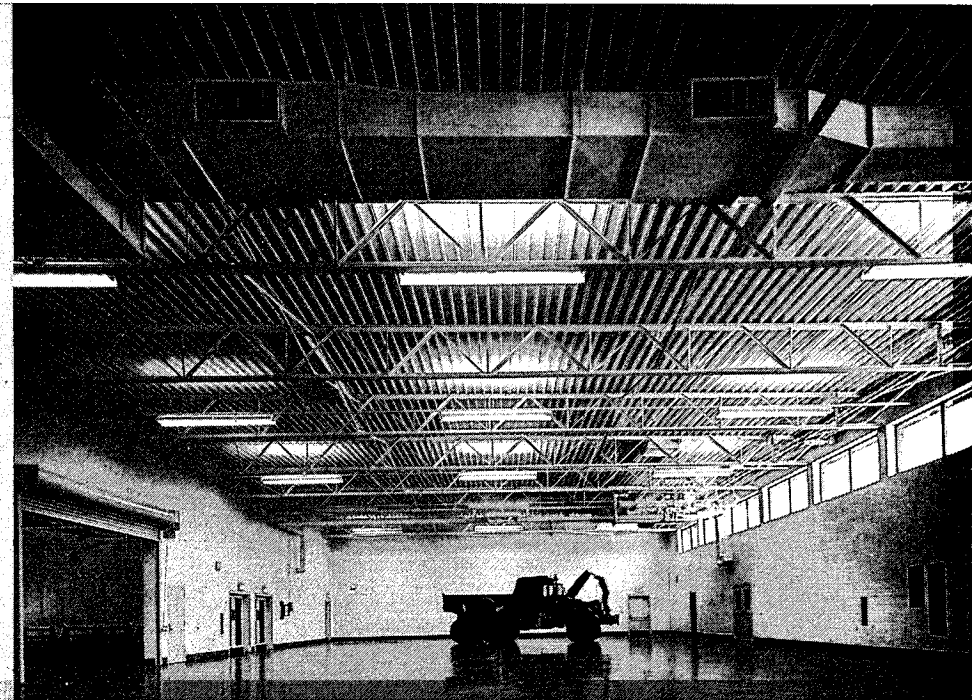


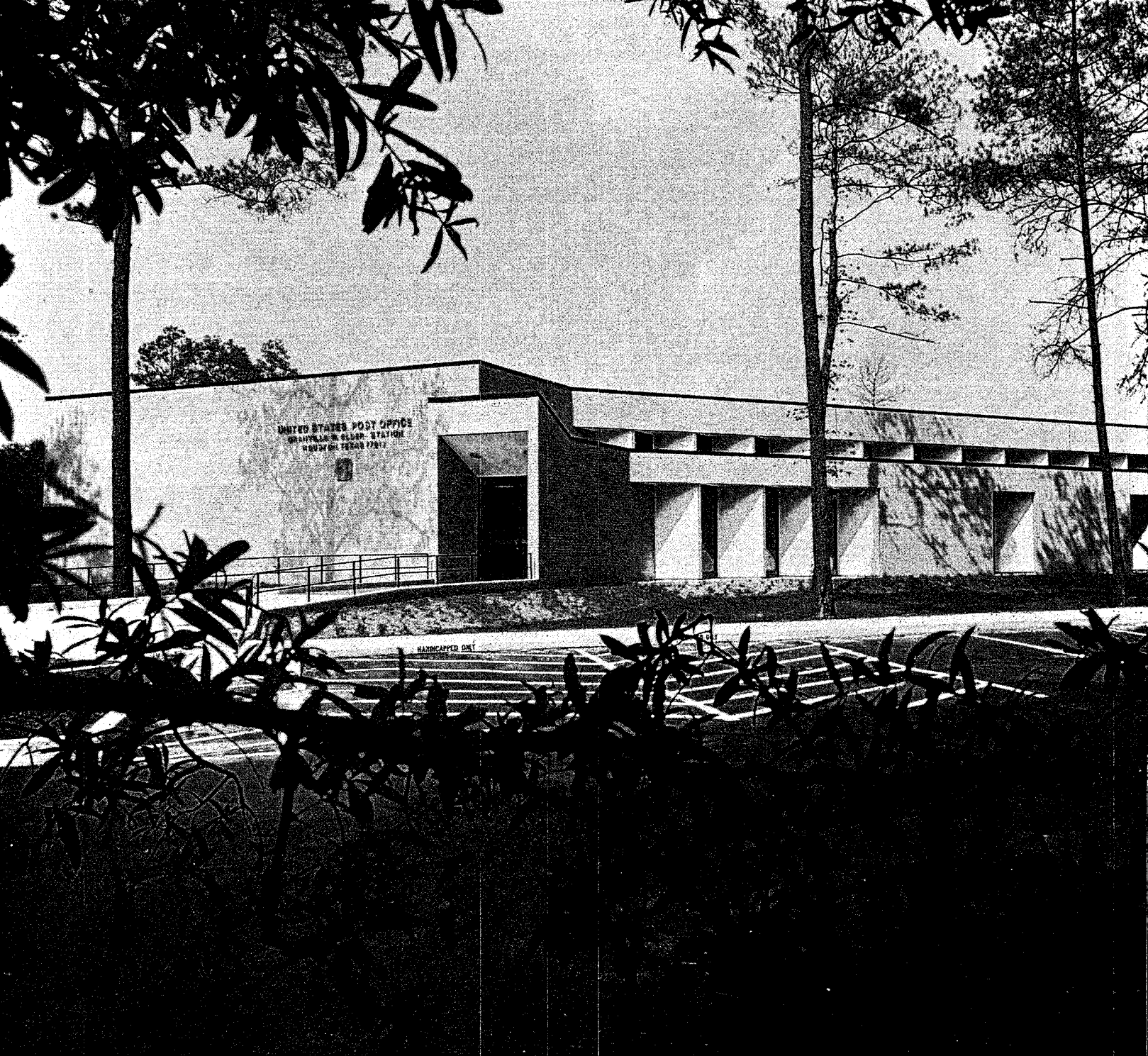
A-A



Ventilation load is reduced by air locks at entrances. An overhead door at the rifle range and one at the drill shed perform this function for vehicular movement. Temperature

is allowed to float in the drill shed when it is not in use; heat is added when it drops below 50F, and exhaust fans go on above 75F. The masonry walls act as thermal storage.





A postal station in Houston sparked a study in energy-conserving techniques

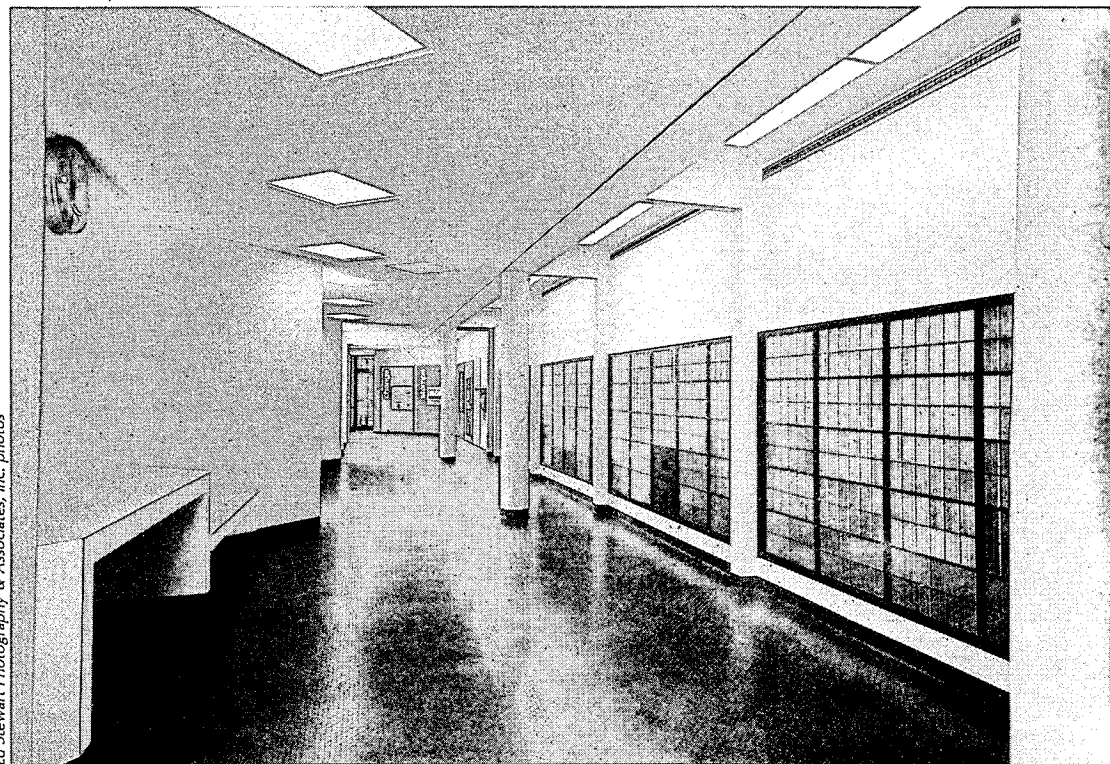
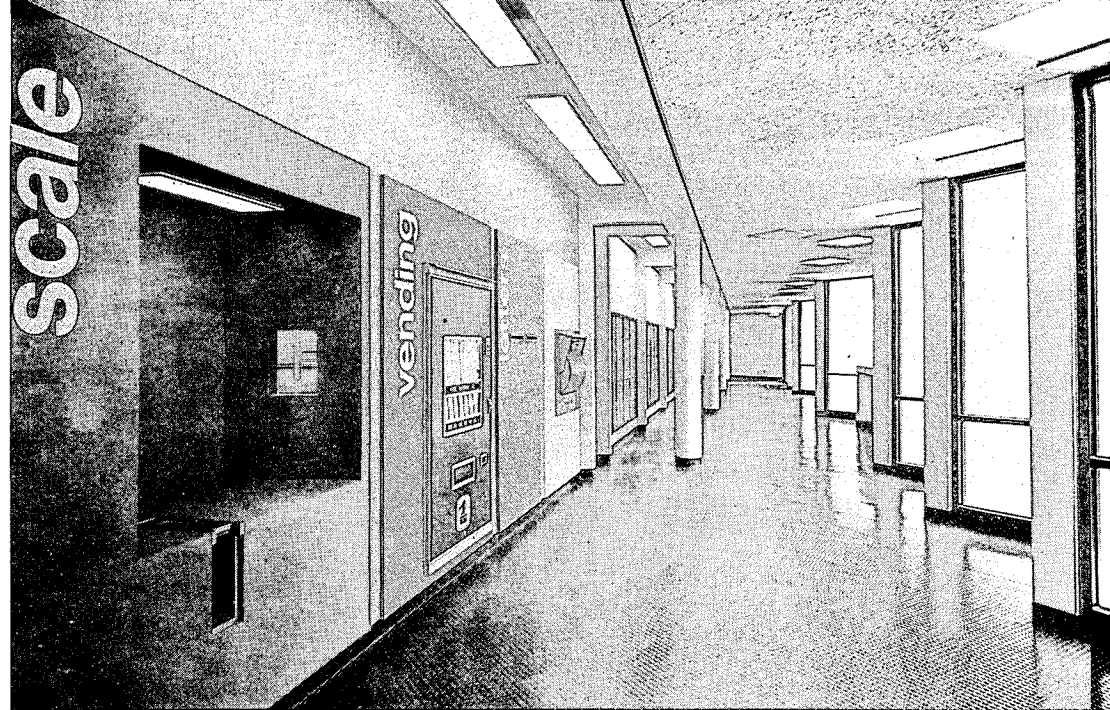
GRANVILLE W. ELDER STATION (NORTH SHORE), Houston, Texas. Owner: U.S. Postal Service—Bill Wright, Gordon Steger, John Wright, liaison. Architects: Clovis Heimsath Associates—design/production: Clovis Heimsath, Emmett White, Ray Wobbe, Jerry Mendenhall, Harold Carlson. Interiors: Lacey Flagg. Engineers: Nat Krahl & Associates (structural); Timmerman Engineers, Inc. (mechanical). Contractor: Capellen Construction Company.

When architects Clovis Heimsath Associates were commissioned to design a postal service facility for a rapidly developing area northeast of Houston, they were urged to make this a cost study in energy-saving opportunities. For the resulting building, the architects and their engineers predict an energy savings of close to 40 per cent plus a reduction in cooling demand of 39 per cent, when compared with a "baseline building model." They developed the baseline building from a plan type of the U.S. Postal Service and from its design guidelines. Systems specified by the Postal Service for this size building in Houston are air-cooled electric compression refrigeration and electric resistance heating.

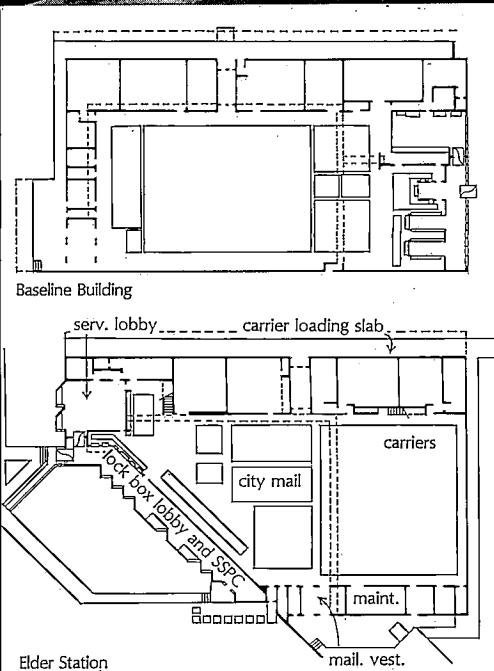
Importantly too, the architects have achieved operational efficiencies in the layout of the facility, a more efficient lookout gallery, and much more pleasant spaces for the workers and customers.

The largest savings (16 per cent, of which 60 per cent is power for lights, and 40 per cent power for cooling) resulted from using improved-color mercury HID lighting in the workroom, and by shutting off some lights in the carriers' sorting area which are not needed for two-thirds of the time.

The next largest savings (10 per cent) came from ventilating the locker room and toilets with exhaust air from the workroom. Another 8 per cent was lopped off the baseline building by reducing the U value of the roof from 0.12 to 0.06 and the walls from 0.20 to 0.07. Savings were less for changes in fenestration, inasmuch as there was not much glass in the baseline building. Nonetheless, glass is used much more effectively here. All windows face north in sawtooth fashion along the lockbox lobby, and at the clerestory above the workroom, giving a more pleasant space plus daylight.



Ed Stewart Photography & Associates, Inc. photos





Sun is blocked from interior spaces, but garnered on the roof

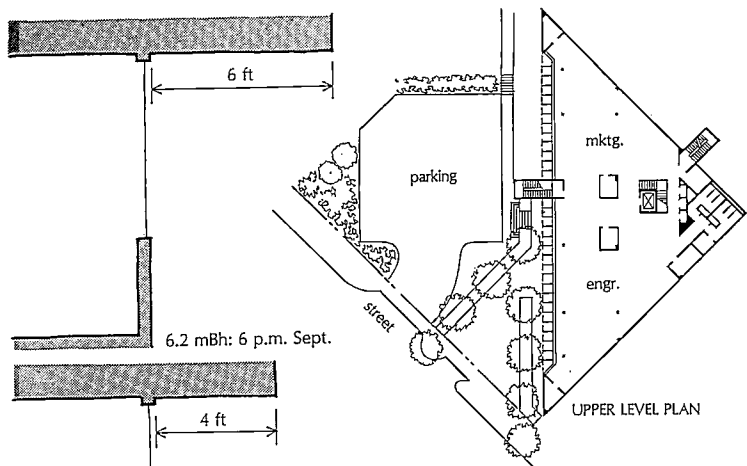
ALABAMA POWER COMPANY DISTRICT OFFICE, Montevallo, Alabama. Owner: *Alabama Power Company*. Architects: *Cobbs/Adams/Benton—Doyle L. Cobb, principal; Aubrey Garrison III, project architect*. Engineers: *Miller & Weaver, Inc. (mechanical); Cater & Parks, Inc. (electrical)*. Consultant: *Vachon & Nix, Inc. (solar)*. Contractor: *Andrew & Dawson*.

In their design of a 17,000-sq-ft office building near Birmingham for the Alabama Power Company, an energy-conservation demonstration project for the utility, the architects discovered not only that saving fossil fuels was not as forbidding as they had first thought, but also that they could develop a new esthetic in the process.

From a planning standpoint, the building was skewed at the front end of its long, narrow site so there would be room for a pedestrian plaza and for visitor parking, and so that the rear of the site where company vehicles are parked would be blocked from

view. The 2½-floor building has spaces for operation/marketing, accounting, display/auditorium and appliance repair.

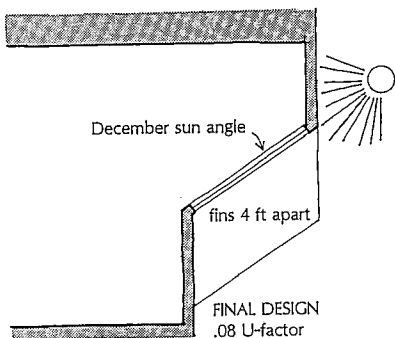
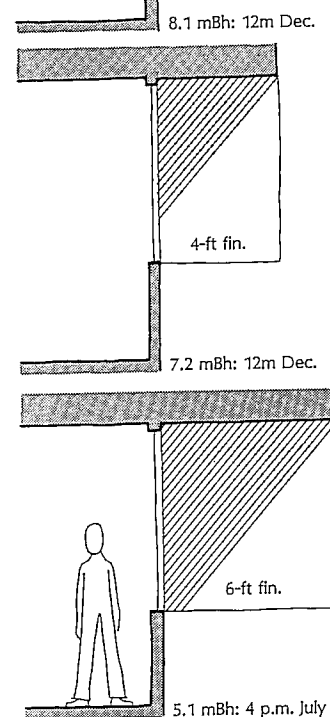
With the building oriented so that the long wall faces directly south the rooftop solar collectors could be mounted parallel with the front. To keep sun from entering, however, was a challenge for the architects which they solved through a study of overhang and vertical-fin configurations, and with an awning for the entrance. The building was selected by ERDA (DOE) as one of the first 32 projects to be funded by the Solar Demonstration Act of 1975.



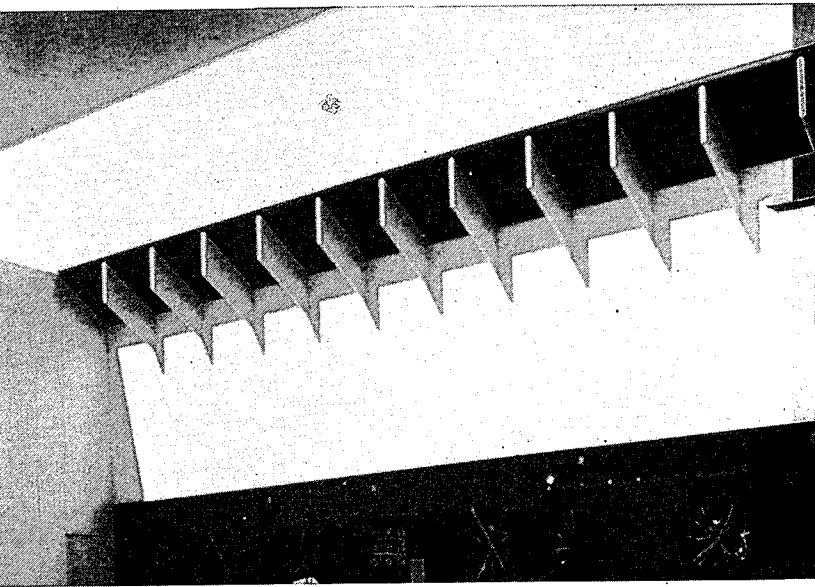
Following a series of studies on solar shielding, the architects adopted an exterior design (below) that has the glass sloped 32 degrees away from the building, fins 4-ft apart, and a 4-ft overhang. The tilt of the glass is the angle of the sun at about noon in December. The fins block the sun from southeast and southwest. The fenestration has a sill height of 3½ ft above the floor and a head height of 6 ft 4 in., so a person can see out whether seated or standing.

Daylight is supplemented by indirect fluorescent lighting at the perimeter, and desk lights plus indirect lighting are used for the interior.

The exterior wall is a 2-in. prefabricated, foam-filled metal panel with a U value of 0.08.



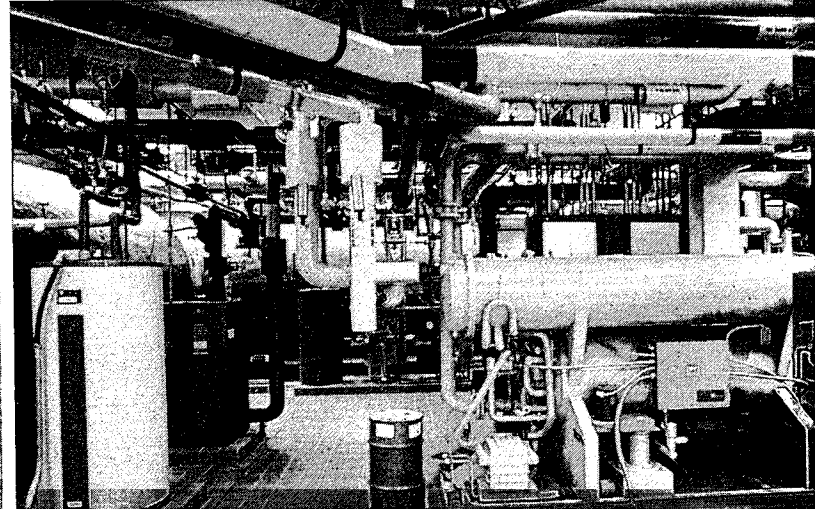
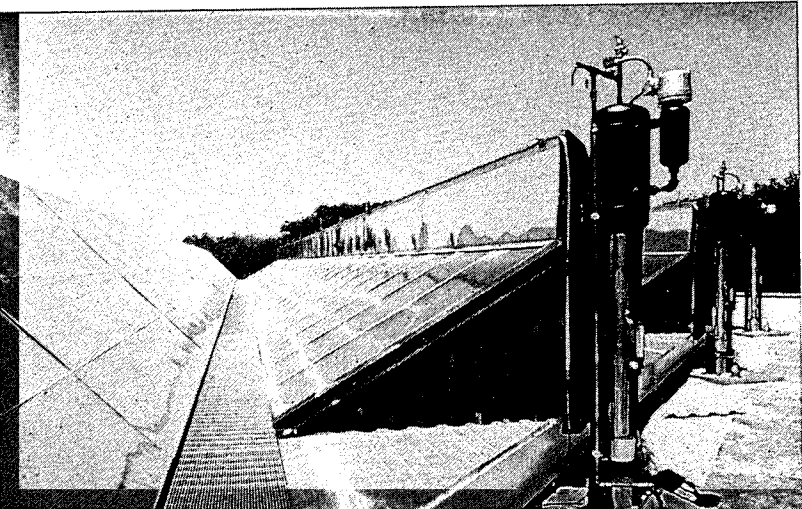
The solar-assisted system comprises 2500 sq ft of flat-plate collectors using a black chrome finish, an 8000-gal. hot water storage tank, a nominal 25-ton absorption chiller, inert gas freeze-protection system, and control and data-monitoring equipment. To enhance the efficiency of the



Henry Navraill photo, courtesy H. H. Robertson Company

collectors for cooling, which are mounted at 30 deg., the system has 8-ft-high front mirrors set at 45 deg., and top mirrors, 2-ft high. Standby heating (100 per cent) is provided by an electric boiler. Solar cooling is available when the solar water temperature is above 170F. The remain-

ing time, a 30-ton reciprocating water chiller is utilized which has an 8000-gal. tank, sized for offpeak storage of chilled water. Freeze protection is accomplished by draining the collectors and replacing the water with nitrogen gas. Premium for the solar was about \$170,000.





Courtesy Butler Manufacturing Company

High performance solar collectors form canopied walk at experimental college arts complex

ARTS VILLAGE, HAMPSHIRE COLLEGE, Amherst, Massachusetts. Owner: Trustees of Hampshire College. Architects: *Juster Pope Associates*. Consultants: *Cosentini Associates (mechanical engineering)*; *Joseph Frissora (energy)*. Landscape architect: *V. Michael Weinmayr*. Construction manager: *Edward J. O'Leary Co., Inc.*

High performance tubular solar collectors form graceful blue-canopied walkways linking simple but tastefully detailed buildings of pre-engineered components in this new Arts Village at Hampshire College.

Architects for what eventually will be a five-building arts complex at the experimental college wanted the solar system to serve the entire complex, despite a phased construction schedule. At the same time, they wanted to incorporate the solar system as a major design feature of the complex in order to put the sometimes obtrusive collectors back in proportion to the buildings. Consequently, the rows of all-glass, selectively-coated evacuated tubular collectors were transformed into a string of canopies on a bright blue steel structure between buildings. The result was a functional but clean "environmental sculpture" overhead and large sheltered building walkways below.

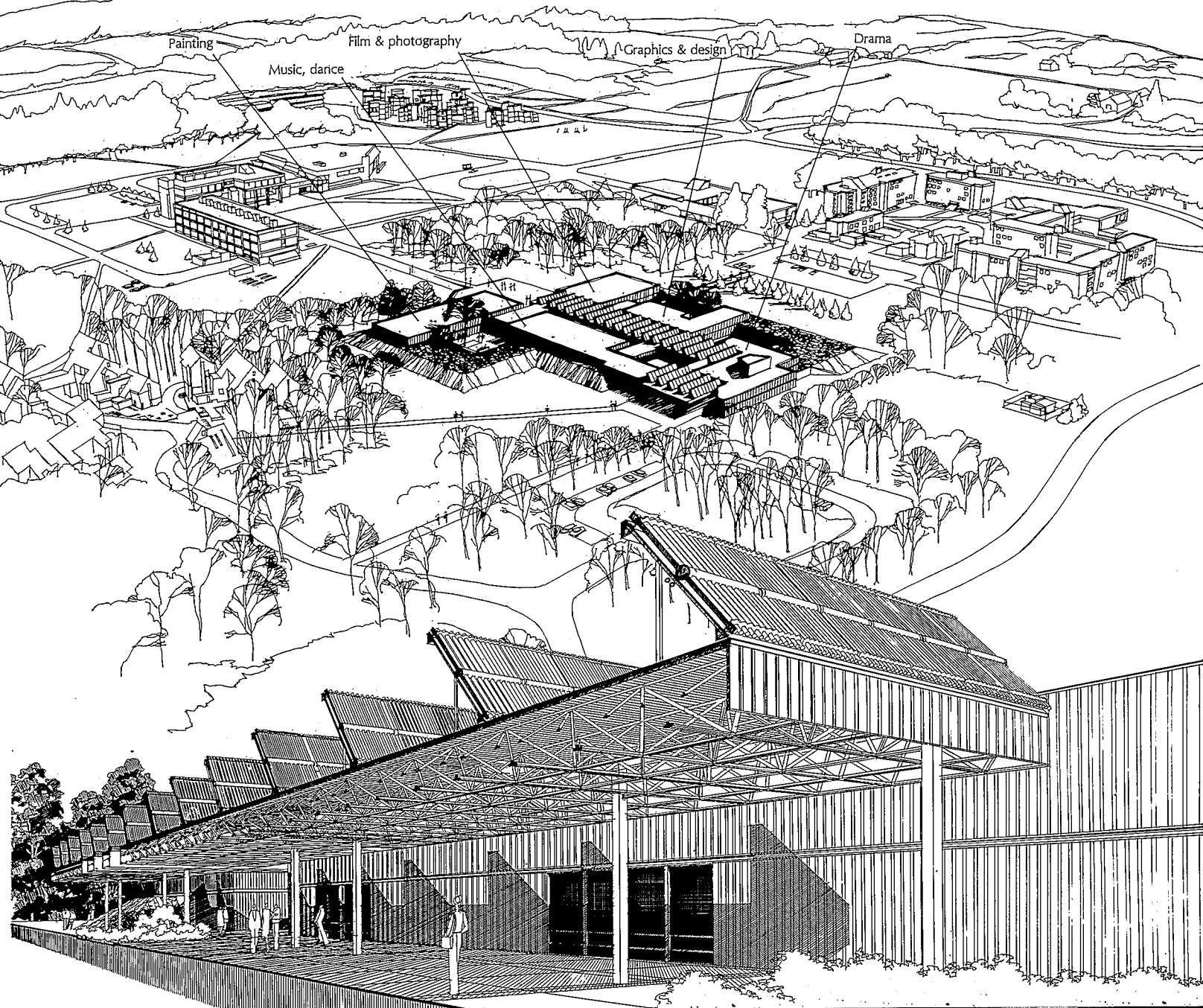
The design solution solved several practical problems of building with the solar elements as well. Moving the collectors from building roofs eliminated extra load which

could have prohibited use of the simple buildings of pre-engineered components, and allowed use of a standing-seam metal roof system.

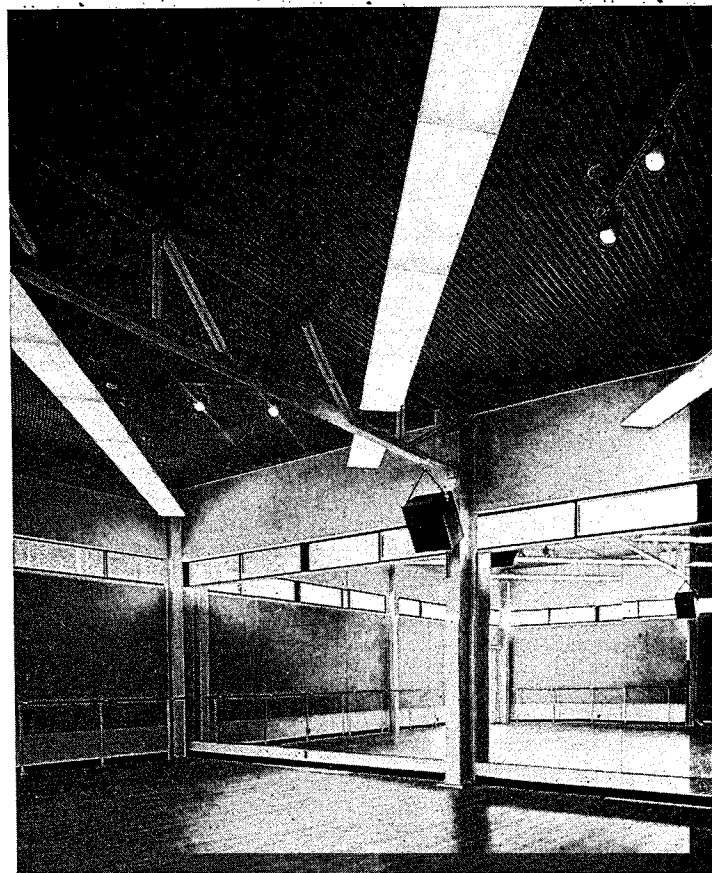
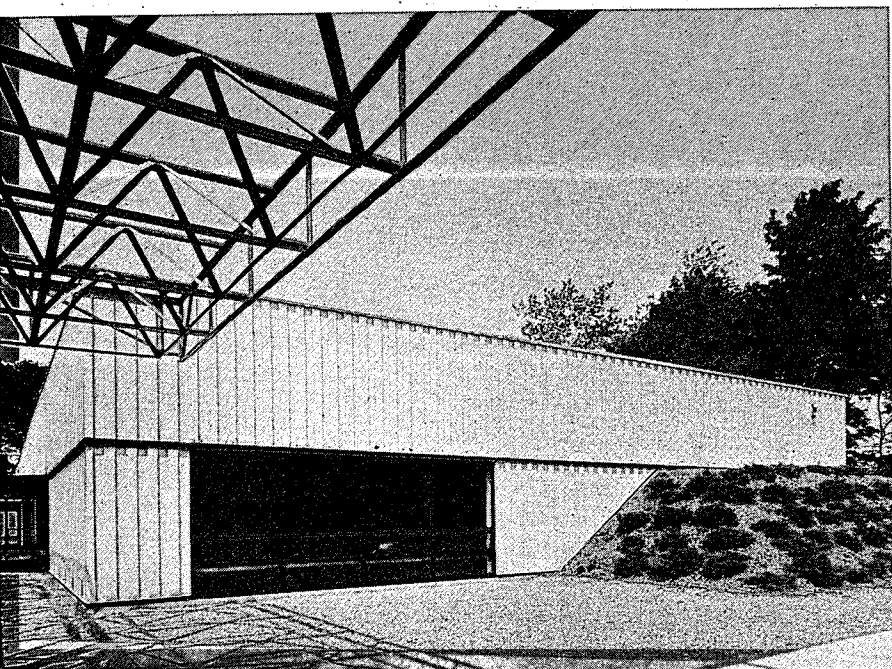
The solar system, made possible largely by a \$355,000 Federal grant, is expected to supply 95 per cent of the complex's cooling needs, 65 per cent of the space heating requirements, and all domestic hot water. Coordination of the solar system is done by a microprocessor. Additional energy not supplied by solar will be obtained from a central electric boiler in the complex.

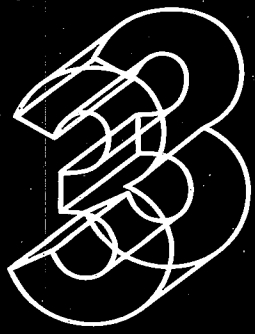
Because of the build-as-funded nature of the project, and the need for flexible work space that could change with curriculum and teaching techniques, the architects used understated but well-detailed pre-engineered building components that are complemented with landscaping and the solar canopies.

Two of the five buildings have been completed to date, with the Painting Studio taking just 10 months from design to occupation, and the Music and Dance building requiring a similar construction timetable.



Eight-foot earth berms enclosing the village insulate and shelter the buildings while reducing them visually to half their height, and create a number of protected outdoor courtyards.





ROUND TABLE

How effective are performance criteria and performance specifications in meeting users' needs?

To answer that difficult and timely question, RECORD assembled, in New York City on May 16th, a talented and thoughtful group of architects, engineers, and officials of government and private organizations concerned with the performance approach to design and building.

The seven pages that follow explore a broad range of thinking on the benefits and problems. A few key points:

It is obvious that no performance specification can be any better than the criteria established—and it became obvious that the weakness of existing criteria is the ability to measure and predict human response. But several panelists were convincing that we could perfect some very sophisticated analyses of human behavior and preference, and thus develop meaningful criteria.

To wildly oversimplify the complicated but fascinating debate that follows: it seems the majority view that you can use complete performance specifications for some building types some of the time; use some performance specifications for some sub-systems all of the time; but that it will surely diminish quality to try to use performance specifications all of the time.

Finally: No one thought that performance criteria and specifications were a substitute for talented and thoughtful design. As ever: Quality design and building to meet users' needs will continue to require the right people with the right expertise at the right time. —W.W.

The Round Table began with the very basic question: How well are we as architects and engineers doing to meet the needs of people who use buildings? Architect/engineer Karl Justin opened: "There's an old story about Orson Welles, directing a movie, ordering the cameramen to move here, and move there, and try this angle, and then try something else. Finally, the cameraman threw up his hands and said: 'Mr. Welles, if you'll just tell me what you want, I'll be glad to give it to you!' Welles screamed back: 'You blithering idiot! Don't you understand? I don't have the slightest idea what I want!'"

"To some extent that is the nature of architecture. We are trying to create a whole with a sense of life out of a collection of parts—we are trying to run an abstract curve through plot points of reality.

"Sometimes reality [for example: performance criteria] puts lumps in the purity of our curve—sometimes even if we know the facts, we don't *want* to know them: sometimes we ignore them—sometimes properly.

"Sometimes, as we struggle more and more to measure the performance of our buildings, we limit the focus only to those things that *can* be measured . . . and we need to remember that the parts aren't the whole and they don't assemble themselves.

"Right now, as we consider performance criteria and performance specifications, we have to separate useful techniques from what I would call incantations and rationalizations. The incantation theory suggests that if we come up with a new body of jargon and apply it strongly to our field, the problems will go away. The rationalization theory suggests that we should sell what we have and ignore what we don't have. . . .

"What we need to do is keep trying to add to our body of knowledge. . . . We need to know more."

We clearly need to know more about human reaction to spaces—and how to measure those reactions

Said Dr. Edward T. Hall, the anthropologist and social scientist: "My partner and I work primarily with architects and designers. Our skills are in unraveling the rather complex threads that bind people to their environ-



The Round Table:
Participants and their titles
are given on the next page

ment, and in helping the architect define for the client what it is that the building is supposed to do. As you all know, the picture that the client has in his head seldom matches the finished product. Only the occasional gifted client has a clear picture of the multiple functions a building performs. These functions range from providing a suitable working environment to integrating organizational functions and may well include image building on a variety of levels.

"In this country we like definite, clear-cut answers; and if we were considering only the *materials* of building systems, sub-systems, and products, there would be few problems in setting performance criteria. The problem is *people*.

"Years ago I used to be overwhelmed by the complexity of performance criteria for people. Now I am no longer intimidated. We happen to live in New Mexico where there is great interest in solar heating—and we hear a lot about R values. Yet R values can be very misleading. An adobe house can outperform a much higher-rated structure—why? Because all of the published data are on how much it takes to heat buildings rather than what it takes to heat people. A great deal of information is available on heating and cooling buildings—practically nothing is known about heating and cooling people. The human skin is a particularly effective absorber of radiant energy. We are wasting a lot of energy because we don't make the distinction between heating buildings and heating people. There are many similar examples.

"All buildings are compromises. The trick is to know where to compromise—and this is where performance criteria can be very helpful. But again, we must return to people. Given a building that won't fall down, won't freeze or fry its occupants, or otherwise endanger the user—we arrive at a point where human satisfactions and performance can be considered. How *do* you arrange departments, cluster them as to function, zone them from each other, screen and protect those individuals whose job demands screening (even if their rank does not), provide for proper hierarchical, organizational, and symbolic ego functions congruent with the goals and resources of the organization we're designing for?

"The bottom line is not just: 'Is it a building that works?' The question is on how many different levels does it work and by what criteria? Most buildings are not successful when individual or organizational needs are not explicit. In these cases important decisions about how many square feet per person are too often left to 'the boys with the sharp pencils.' These decisions should be left to designers working with the people who are actually doing to use the space."

Interior designer Florinda Doelp was asked how well architects and interior designers are meeting the needs and aspirations of office workers with open planning: "I think we are developing what I would call a Modified American [Open] Plan—one that reflects the American work ethic and American feeling about our work space as compared with our superiors and our peers. We've done a lot of studies—working with users—uncovering many of the concerns that Dr. Hall touched upon. We certainly do study the interior needs by a) how the company functions, and b) how people respond to their environment.

"We need to recognize that the major concern of most building users—the workers—is, very simply, themselves. If a person does not think he or she has enough light, or enough acoustical privacy—no matter what the experts or the instruments say—you have a problem."

Designer/programmer William Parsons: "We usually are involved in a job very early—with the duty to develop the user program. That is a difficult job when you consider all of the aspects that you have to incorporate into a project and still leave enough room for the architects and engineers to do their jobs. If you can create a good framework of user needs, the design professionals can really interact effectively. And a great deal depends upon what kind of client you have—a good client, a bad client, a naive client. The goal is to take the client from where he is to where he wants to be; providing enough framework so that all of the work of the architects and engineers and other consultants is all in the right direction."

Architect Bob Siegel: "I am not very experienced in this area of performance standards and measurements. Frankly, they make

me nervous. I think what ties different kinds of buildings—from houses on up—together are the basic concepts of architecture, which include public spaces and private spaces, natural orientation, light, view. . . .

"The better the standards are, the better off we all will be. I'm all for better standards—but they don't make a good building. The architect has to be the generalist—because very gradually, as the pressure mounts on a building, the systems can start to take over. The architect has to fight back with bigger ideas that have to do with non-systematic and non-measurable things."

Engineer Gershon Meckler suggested that: "What we are talking about is a sense of excellence and trying to achieve excellence. The problem is really a procedure to structure the design process so that the whole we are going to create is not just a combination of parts or components, but a synergistic combination, something more than the sum of the parts. I think what Mr. Siegel is saying is that his sense of design indicates you cannot quantify the 'feel' of good design.

"Perhaps you can't—but perhaps down the road away we *will* be able to—in some other language or terms. But it *is* part of the process; a whole performance-based effort to predict up front what we are trying to achieve not just in function but in form."

Architect Peter Kastl: "The question seems to be: Is performance specification an appropriate way to specify all aspects of the building? The answer, at least so far, is no. In deciding what a building ought to be, there is a spectrum of issues that range from completely rational and objective to completely intuitive and subjective. I don't think anyone should be under the impression that performance specification is appropriate for covering that entire spectrum."

Lighting expert Dave DiLaura: "I guess I would disagree that there is a line over which you cannot or should not cross in applying performance specifications; I don't think there is an architect's equivalent of the Heisenberg Uncertainty Principle in physics—that there are certain things you cannot measure. . . . If you are dealing with enough people you can predict with arbitrary precision what they like, how they will react to stimulus, what they enjoy. All you need is



James R. Benya, PE
Smith, Hinchman & Grylls
Detroit, Michigan

Dr. Frederick B. Clarke, III
acting director, Center for Fire Research
National Bureau of Standards

David L. DiLaura
Smith, Hinchman & Grylls
Detroit, Michigan

Florinda Doelp
president, Interspace Incorporated
Philadelphia, Pennsylvania

measured data on enough people.

"It may be *easier* to measure the performance of an air-conditioning system than it is to measure whether the open-office plan works. But I would contend that we do know enough about how people react to begin classifying some of these 'subjective' things."

Professor John Flynn: "it is all a matter of asking smarter and smarter questions and getting better and better answers. We have, for instance, gone beyond simply measuring the brightness of light. We become aware that there is a sensory problem, we research it, the research is widely reviewed, we develop a consensus procedure, we build prototypes—and finally we get a performance standard. Even more recent research gets into areas of *preference*—attitude reinforcement. We're studying the influence of lighting on not just productivity, but feelings of comfort, of cheerfulness, or of depression and sensory deprivation."

Said acoustician Parker Hirtle: "We've done a lot of testing to try to establish what people consider adequate acoustical privacy. But of course you have a whole spectrum of responses when you deal with a lot of people. If you try to satisfy everyone, you overdesign. So what you have to do is draw a line and say we are going to design to satisfy 90 per cent . . . or 80 per cent.

"But even then you have a problem left. What most people want to know is 'What screen should I use? What ceiling should I use? How big should the screen be?' They want specific answers, and you cannot give specific answers because if you do you lock them into a specific layout—you lose flexibility in the office. That, to me, is the problem."

Michael Slifka of the Veterans Administration on life safety: "The data are out there in the fire safety field. We measure the fire resistance of any wall assembly or construction system against our legendary and sacred infinite-time, standard-temperature curve. That curve was developed in 1925 at the National Bureau of Standards by loading five buildings with furniture, breaking every window, and burning them down. Buildings aren't like that any more—there is just not enough fuel in the building. We make endless

measurements and never get to the question: In a modern office building, do you ever need more than 20 minutes of fire resistance?

"When it comes to structure: A structure designed to withstand a fire load really has little impact on life safety. In most fires, those who die are dead long before the fire reaches them—it is smoke and toxic products that are the most dangerous to life."

So it became clear early in the Round Table that before you set performance specifications, you need the right criteria

And in lighting, for one example, the criteria for "what is good light" is changing fast. . . .

"One benefit of the energy crisis," Dave DiLaura pointed out, "has been a renaissance in lighting technology. Lighting is such an obvious user of electrical energy that it has gotten a lot of attention. Yet the relationship between lighting and what it does for people—how well they can see—is not so obvious. Lots of light does not necessarily mean lots of sight.

"There are three basic considerations in setting lighting criteria:

"1. What does a certain level of lighting buy you? I'm talking about cost-benefit analysis: How does it affect employee performance, employee attitudes, safety—the general working environment?

"2. How does a certain level of lighting affect the way we feel? This is the question of human preference.

"3. What does a certain level of lighting do to our innards—what kind of emotional response do we have, what makes a certain place beautiful and attractive? And this is the most mysterious criteria of all.

"The first question," DiLaura continued, "is the easiest to answer. We can relate photometric properties to how well people do visual work—how quickly, how well, how efficiently, how error-free.

"But we are getting more sophisticated in how we measure light. What we are trying to do is to get people to abandon the foot-candle as the measure of lighting-system quality and use a new standard called 'visibility level.' [This "visibility level" system is expected to be built into the sixth edition of the IES Handbook, which is due in 1980.]

"And so we are approaching being able to measure the second and third considerations—how does lighting affect the way we feel and our emotional response. . . ."

In lighting—as in many other fields of design—you come up against the problem of human variance

Adds DiLaura: "This is not the problem it is sometimes thought to be. The fact that you get a bell curve of human response to almost any stimulus does not mean 'gosh, we don't know anything.' Human variance is a fact of life and we can deal with it very precisely.

"We can tell, for example, that if we establish a certain lighting system, half the people who have normal eyes and are between 20 and 30 years of age will be able to perform a given task. The same lighting will work for 40 per cent of the 30- to 40-year-olds, perhaps 30 per cent of those over 40. My point is that we have that information; we have a hard fix on human variation and reaction to lighting stimuli.

"Thus, it is evidently going to be possible within five years or so to predict at design time exactly how well any person will be able to perform a given task. Further, it appears that we will be able to provide a good cost-benefit analysis—a good answer to the question, 'Should I spend the money on better lighting, or flocked wallpaper?'"

Said Prof. Flynn: "We are always going to have some people who think there is not enough light or that 'it is too bright in here!'; those who are cold and those who are hot, those who think it is too noisy. You cannot take a vote and ignore those people; and you cannot consider them 'troublemakers.'

"Yet we must make decisions that we can only satisfy, say, 70 per cent—which means we have made a conscious decision to discriminate against 30 per cent of the people. The solution is to recognize who they are, and make some special provision.

The Round Table saw the same kind of problem in setting performance criteria for thermal and acoustical environment

Said engineer Meckler: "Just as we need more design information in the application of



Dr. Charles G. Field
 director, real estate practices staff
 Department of Housing and Urban Development

John E. Flynn, AIA
 professor of architectural engineering
 The Pennsylvania State University

Dr. Edward T. Hall
 Edward T. Hall Associates
 Santa Fe, New Mexico

Parker W. Hirtle
 Bolt, Beranek & Newman
 Cambridge, Massachusetts

lighting to space, we need more design information in establishing the thermal environment. We are not concerned just with a given temperature and relative humidity—we are really concerned with the heat released from the body by conduction, by convection, and by respiration. A single number like 68 or 75, or a given relative humidity, is not necessarily the proper criterion for measuring human comfort; there is also the matter of air velocity, mean radiant temperature, and so on. These other variables have not been explored effectively."

John Flynn commented: "Let's say you make the decision to cut the thermostat back from 74 degrees to 68. What are the implications of that? As with lighting, it is most often the older people who will be most affected; the people who will be least affected are schoolchildren."

Said acoustician Parker Hirtle: "Our goal, of course, is to provide acoustical privacy. We can put numbers on that—we can measure the level of intruding speech between work stations, and the amount of background noise level that masks it.

"Ideally, you put a single number on it and say, 'OK, the ideal background noise in an open plan office is 45 dBA, or 50. The problem is that those single numbers do not adequately define the environment.

"When you get to fairly high levels of background noise, you have to define the noise very carefully. You have to define not just the level, but the spectrum shape, the frequency content, the distribution. You can sit in one spot and think you have an ideal background noise, but if you move around you get some peculiar effects. We can define the right background sound, but it requires a lot of measurements in the completed job.

"The same thing is true of sound attenuation between work spaces. We can say what we want the total attenuation to be—but how do we get it? You have to look at a lot of different sound paths between the source and the listener. If there is a barrier, it is going to go through the barrier (and how much depends on the construction) and it is going to go around (depending on the size). The sound will be reflected from the ceiling—and how much depends on how high the ceiling is and how much sound absorption the

ceiling provides. The same is true for walls and windows. How do you then define sound in a single number? You can't. But you can use a computer to look at all these paths work station by work station, and you can get an articulation index which you can equate to acoustical privacy. I don't mean you have to analyze every work station by means of a computer. You can look at an office layout, predict the toughest problems, and analyze them. If you solve for these problems, the lesser problems will very probably also be solved."

Hirtle also reminded the Round Table that "No matter how careful your analysis, you still have a problem with people who have been in private offices and are moved into an open plan. No matter how good your design, they *know* it isn't going to work—so for them it doesn't. We have the engineering know-how, we can solve the technical problems—but the human problem remains."

Structure and life safety: can a performance approach help avoid building failures?

Said structural engineer Charles Thornton: "I think it can, for some building types. Most structural failures short of collapse are caused by lack of foresight in determining the interaction of the structural system with other systems and other nearby buildings. Writing a performance specification for a structural system without being cognizant of the curtain wall and the floors and ceilings and the glass and all other building systems that are going to interact with it would, I think, be a mistake.

"Our experience has been that the simpler projects lend themselves very well to performance specifications. An open parking deck is the classic example. But to come up with a performance spec for the structural system for a hospital without taking into account all of the other complex interactive systems would be a disaster."

Said Fred Clarke of the National Bureau of Standards Center for Fire Research: "The ability to make cross checks between one method of promoting life safety and another is primarily a measurement problem.

"Our present codes and standards go

back a long time, and they are relatively simple to administer: we simply look at the code and say 'The following are the conditions that have to be met.' Taking that as a given level of safety, it is possible—by assigning a point value to the various conditions—to develop a coding system for equivalent protection levels.

"The more difficult problem is postulating how people are going to behave in a fire. If you try to sit down and envision the likely safety problems that are likely to arise, and how people will react, you get totally different answers for office buildings and apartment buildings and industrial plants.

"The question remains: once you know what the problems and some of the solutions are, what *level* of safety do you specify?"

Handling the problem of code enforcement gets difficult with performance specs

Mr. Slifka: "If we could only have the right code-enforcement officials in the right place at the right time, we could go in with almost any new building technology that is sound and justifiable, and sell it. But . . .

"We're going to face a lot of problems—as performance specifications become more prevalent—of explaining to the enforcement officials what you want to do and why your solution is justifiable. They're going to open that little book and say: 'Sounds fine—but where does it say you can do that?'"

The discipline where performance specs are farthest along is energy conservation. The Round Table talked about the hopes— and the remaining restraints

Dr. Charles Field of HUD, whose agency will be administering the standards, began by outlining the government program: "By the 1976 statute, HUD and the Department of Energy were required to come up with a series of energy performance standards. Our target date right now is for standards to be published in August of 1979 to cover all Federal construction and to be used in state and local codes. The standards as they are now perceived will be of a budget variety that would apply at the design stage.



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Frank J. Matzke, FAIA
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National Institute of Building Sciences

Gershon Meckler, PE
Gershon Meckler Associates, PC
Washington, D.C.

"In terms of implementation at the state and local levels, we do face a problem of concurrent jurisdictions. We will be issuing minimum criteria for conservation by class of building and by climatic zone. States and localities can either meet or exceed those standards—though the statute is somewhat unclear on just what must be in place at the state and local level. However, it is clear that these regulations must meet an equivalency test to be passed on by HUD.

"We do have to devise standards," Dr. Field went on, "that are practical and that the building code officials can work with. This means that the standards will not be at the cutting edge of technology.

"We also have to be cost-effective and this does create a tension between the policy objective of energy conservation and the costs that are implied in meeting the standard. So we are concerned with and studying that. Further, we are conscious that the standards must encourage innovation—that too many codes inhibit innovation. I'm not sure how we will deal with that question, particularly with the concurrence of jurisdiction involved in state and local codes—but we will come to terms with that question.

"And we are aware that there must be a smooth transition in bringing code agencies from where they are today into the environment that will be created by this program. . . . Somehow we have to go through a training process with code officials."

Performance specifications and building systems and sub-systems: they're not necessarily related

The important thing, Gershon Meckler pointed out, is not the hardware—but the process. "There is an essential difference between using performance specifications in design and using the building-systems concept for construction. You can have performance specifications and build in a traditional manner. . . .

"To me, the thing that is new and unique—that is an overlay on the whole construction industry—is not conservation of energy but the attempt to design minimum-energy systems.

"The performance concept forces you

to set up budgets, to set up goals, to quantify and integrate sub-systems so they work together to minimize the energy flow. But the building designer still has plenty of flexibility.

"As we find more and more jobs awarded on the basis of minimum energy use, we will see more and more design concepts involving careful inter-relating of sub-systems. In turn, we'll be more and more innovative in finding (or developing) components—hardware—that are compatible."

Question to the Round Table: Are the government-developed specs usable in the private sector?

Said architect Kastl: "There are three aspects to the question: procurement itself, the specification requirements, and the hardware results. They are all related, of course.

"In both the SCSD and the GSA programs, the performance specifications were invented to respond specifically to large-scale and continuing programs. But both the Construction Research Council and a new Federal bill—the Childs bill—are working to bring at least some of the aspects of these programs into broader use.

"To answer the second question—how do they work—I think we can say SCSD was very successful. The hardware designed has been broadly used. I'm told that the operators of the SCSD schools who took advantage of the built-in flexibility and learned how to use the devices that had been put in their hands are well satisfied. All told, some 1200 buildings were in operation in the early 1970s that were built in whole or part from SCSD components. So I think you must argue that the system—and the hardware—are widely applicable."

Architect Robert Ramsey commented on the GSA performance specification approach: "I've been involved in all three of the GSA projects [Social Security Administration payment centers, 1971; the SSA headquarters expansion, 1974; and the Norfolk (Va.) Federal Office Building, 1976]. In some respects, these projects have some parallels to the moon-landing project. NASA didn't know exactly what hardware it wanted and it didn't care exactly what it got—as long as it got to the moon and back with the people

protected. You may not think the LEM was handsome, but it did its job. The GSA projects were similarly intended to promote innovation and to look for new solutions—and they certainly did that. There are products on the market today that are a direct result of that innovation—by both the winning producers and the losers. Some of it is good, some of it is bad hardware. The performance specification approach seems appropriate to me when there is no established solution—because you get a lot of people interested and working on your problem. As others have said earlier—the performance specification approach is one of the tools we can use, one of the ways to get at solutions, one of the ways to produce better environments. But let's look at it that way—not as a way to just go out and buy buildings."

Added John Tato of the National Institute of Building Sciences, who was also involved in the three pioneering projects as well as the preparation of the Peachbook and the Norfolk procurement: "GSA has two programs involving building systems and performance specs. One is the Peachbook approach [for the non-cognoscenti, PBS' Performance Specifications for Office Buildings has a peach-colored cover]. It covers seven sub-systems—structure, hvac, electrical distribution, luminaires, finished floor, finished ceiling, and space dividers—essentially the guts of the building. The other approach is the integrated ceiling and background-sound system spec—which has had wider application, perhaps five to six million square feet.

"The GSA has recently initiated a program to make post-evaluation surveys in six to a dozen buildings with performance-specified lighting and acoustical systems. Some are clearly not meeting the specifications—and the logical question has to be: Was any additional expenditure worth it?"

Mr. Tato pointed out that it is still early in the game: "There's a big uncertainty here. As it works out, the systems (the hardware) are refined and screwed down to respond to the specification—but we're not quite sure yet the specifications meet all the considerations." And so the question arises again: Do we have the right criteria?



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Omaha, Nebraska

Anthony J. Riggi
Real Estate & Construction Div.
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The two representatives of the National Institute of Building Sciences gave an encouraging update to the Round Table

Said John Tato: "NIBS is still in its infancy. One of our basic missions is fostering the introduction of new technology into the industry—and we're beginning by taking a careful look at just who is involved in that introduction, trying to understand the research and development needs of the industry, and trying—rather than usurping anyone else's role—to be an integrating influence."

Added Frank Matzke, NIBS vice president of technology and programs: "NIBS is also an interface between the government and private industry—and we hope it will become an authoritative source of what is happening in the industry—from the point of view of technology and codes and standards. NIBS is charged to advise and assist government as it serves our industry—and while all of our funding is now Federal, we have a mandate to be self-supporting within five years. . . ."

"In terms of what this Round Table is discussing today—the application of new technologies to performance specifications—we intend to find out what is going on out there, who is doing what, and how we can build some synergy into the system. There is a great current need for all of us to know what the other guy is doing in terms of research, in terms of trying to introduce new technology, in terms of fighting the codes and standards problem. If we do nothing more than that over the first year, I think we will have accomplished something. . . ."

And the Round Table heard an update on the Construction Research Council—organized by owners and users

Said architect (and CRC coordinator) Tom Sluiter: "Our organization is made up of both public and private owners—but we have a joint goal of developing performance standards that meet the needs of owners."

"Our intention is to establish the owner's needs, translate them into performance specifications, and then prequalify sub-systems against those specifications—giving the owner an assurance that a product or sub-system will conform to our performance specifica-

tions. That's the goal: we have a long way to go. But we have some major owner/users involved in the program, and they establish a market. We've learned from GSA and from the Peachbook approach—and our approach is slightly different: we're working in the sub-system area where the average producer—without being a member of a consortium or getting involved in heavy research—can have his product or sub-system pre-qualified. We feel this is a more realistic approach."

Near the end of the day, the Round Table began summing up the complications of and concerns over wider use of performance specifications

Said William Parsons: "The real problem is when you try to define performance criteria, you immediately get into a lot of human judgments. Too many people who say 'Give me some ground rules; give me something to hang my hat on'; want those ground rules because they don't have the ability to make judgments themselves. IBM gets a lot of good buildings because it has staff people who can step back and take a good look at the design and say: 'Are we really doing this job properly?' Performance specifications are no substitute for good professional judgment."

John Tato on change orders and liability: "On one job we had a performance standard for lighting that specified the level of illumination 'as verified by this test. . . .' The lighting met the test—but we found out that the test was deficient. Thus the lighting was deficient and we swallowed a \$300,000 change order to fix it."

"On the other hand, performance specifications do tend to reduce change orders resulting from design deficiencies simply because the design is put on the shoulders of the consortium and they have to solve the problems of performance and fit and compatibility. . . ."

Architect Ramsey: "Performance specification is not a way to design buildings—it is just a valuable new tool. It is a way to tackle problems that cannot be solved otherwise; it is a way to get elegant integration of sub-systems. It is a difficult tool to use—more difficult than prescriptive specs—but it can generate some good results."

Anthony Riggi of IBM's Real Estate and Construction Division told the Round Table: "We've tried some buildings using performance specifications, some with partial performance specs. I'd have to say that it's too early to evaluate this new tool: We need proof, based on private-sector buildings, that the performance specification approach results in better buildings, or real dollar or time savings. We need more concrete results."

Michael Slifka of the Veterans Administration also saw performance specs as easier to use in the public sector: "At the Federal level, we have some good performance criteria—and they work where the owner also happens to be the operator and the building official—and the purchaser and the financier, the final controlling entity of every aspect of the building. Neither does the Federal government have any problem in selling the building from a code-enforcement point of view."

"But to try and take this approach into the private sector—where all of those roles are filled by a different person, all with different perceptions of what the user needs and wants—is more difficult. . . ."

Architect Robert Siegel: "The more that owners know about the performance they want, the better—because I think all professionals would agree that they do their best work for their most knowledgeable clients. An architect can also raise questions about why the client wants this or that—and get answers that are really helpful in programming. Given that information, I think the professionals can determine what parts of a building do lend themselves to the performance approach. . . ."

Thomas Sluiter of CRC, representing building owners: "One of the things we need more of is owner input. He has a great deal at stake—more, perhaps, than he realizes. The liability of the building, the whole program, is his. One of the ways to do this is to increase the emphasis on a sound post-mortem on every project. Sure, the designers get a token response from the owner—but do you ever try to really find out what has happened or not happened in that building you designed? That would surely help in defining the specifics that we should set up as performance criteria and that need to be included in



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performance specifications."

NIBS' John Tato made a related point: "The essence of the difficulties in perfecting criteria and establishing standards is translating user needs (both human needs and organization needs) into criteria that can be expressed in terms of the components and sub-systems of the building.

"In answer to another question I've heard raised: Is there an infringement of the architect's design prerogatives when there is a rigorously stated set of performance criteria for the building? Perhaps. But to me you have produced a good design when you take the criteria, put them together with the constraints of time, of budget, of scarcity of materials or energy—and make them work in terms of a handsome building. Nonetheless:

"Another major threat to continued or expanded use of performance specifications is the apprehension of not being able to predict what you are going to get as a solution when you turn over to a contractor a specification expressed not in specific material terms but in terms of performance. . . ."

Engineer Charles Thornton reinforced that point: "The performance standard approach, if it is handled correctly, can introduce an additional dimension, another level of quality control in the design process. If it is used incorrectly, it eliminates—at least in our opinion—most of the quality control of the design process.

"Any idea that pre-engineered buildings or components of buildings, together with performance specifications, are going to diminish the design professions is—as recent experience has shown—just not sound. Even if a good performance specification is used correctly, there is still a need for good, solid professionals on the project.

"To reinforce a point made earlier: Do not confuse performance specifications and systems building. They do not necessarily go together. Our experience has been that performance specs seem to work well for most manufactured items—but a building (the total building) is not a manufactured item. I think Operation Breakthrough showed us you cannot manufacture buildings. . . ."

Henry Wald—engineer-turned-client as director of facilities planning at Yale-New Haven Medical Center—made three points:

"I think that the technologically oriented people at this Round Table have much more faith in a deterministic methodology than is realistic. Performance specifications, in order to have meaning, have to come from much more substantial knowledge of what human performance characteristics are—and we really don't know much about the interrelationships between a large series of variables. What we really need is some common denominator, some common measure, so that we can make trade-offs between different human needs and different sub-systems—should we invest in temperature control, humidity control, air changes? Or lighting of some higher quality? Or green paint on the wall? How do we measure that against sound-absorbing material on two walls instead of four? What will be the common denominator: Productivity? We're not very good at measuring that. Should the measure be economic?"

"Point two: Even if we can evaluate all these things under some common denominator, should we? Because this leads inevitably to some ethical decision-making which we cannot escape—for example: how much are you ready to invest as an incremental cost in a life-safety system versus the number of lives you might lose to some assumed level of disaster? The medical profession is already being called to task by recipients of medical care on how they make their decisions. Many patients are deciding that they are not ready to pay for decisions being made by the experts. The architects and engineers are on the verge of having to face this kind of problem. And of course, in the end, it is going to be the owner of the building who has to decide how much he is willing to spend.

"The third point: How is all this going to be implemented? That is a very pragmatic and practical question. How do we measure, how do we enforce?"

Stanley Warsaw of the National Bureau of Standards' Center for Consumer Product Technology: "From my background as a product-oriented person, I think you can look at a building not as a product—but as a synergistic integration of many products. I think you can alleviate many problems—social problems, conservation problems—by the product-performance approach. It does

encourage innovation. I think and hope that it will allow for increased effectiveness in the users of our resources—be they people or materials—and this is essential to the nation's best interests.

"But I am aware that it will continue to be difficult to establish performance-measuring criteria and test methods and evaluation—especially in the area of human factors. There is a real lack of ergonomics data—the military has some, the National Institute of Aging has some, relating to their small and special groups. There are no average individuals; people's psychology is changing; the mix of age groups is shifting. All that really has to be taken into account if you are going to make an effective performance standard for any product or sub-system. . . ."

Engineer James Benya: "It's clear here today that there is some disagreement, even among experienced people, about the practical use of performance specifications. Many seem to feel that we are headed in the right direction, and can use performance measures soon. Others of us think we have something right here on the table that we can use today. We've applied performance standards, we've tried on real projects; we think we have the mechanism. For example: several participants commented that the luminous environment, the visual environment, is a rather subjective area for evaluation. But Mr. Flynn and Dave DiLaura discussed the matter of visibility level as a currently usable evaluation of lighting performance. We can, right now, measure whatever level of performance we are after for any given percentage of the population. The question is: what level of performance do we need, for what population percentage? Perhaps we just have to make some arbitrary decisions. . . ."

Interior designer Florinda Doelp: "I don't believe a total building environment can be manufactured from a collection of pieces—and I don't believe that performance specifications *per se* can be made categorically applicable to any design.

"For one thing, there are too many variables: today's clients are more sophisticated and progressive; they are much more demanding of us as professionals—we interior designers are no longer looked upon as cosmeticians concerned only with color and



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Henry J. Wald
 director of program and facilities planning
 Yale-New Haven Medical Center
 New Haven, Connecticut

Dr. Stanley I. Warshaw
 director, Center for Consumer Product Technology
 National Bureau of Standards

These building-industry manufacturers and others audited the Round Table:

Joseph A. Anderle
 director of material & standards control
 Levolor Lorentzen, Inc.

Muriel Burns
 general manager
 Preco Industries, Ltd.

George W. Clark
 manager of technical liaison
 GTE Sylvania, Inc.

Richard Codel
 marketing planning manager—
 construction
 Westinghouse Electric Corp.

Carl Deimling
 sales manager
 Stark Ceramics Inc.

Arthur Sworn Goldman
 president
 Arthur Sworn Goldman
 & Associates

James D. Kaloudis
 Meyer Strong & Jones

David Lopatich
 consultant architect
 Kalwall Corp.

Edward A. Moran
 manager, national accounts
 U. S. Steel

James A. Newbrey
 director, marketing
 PPG Industries, Inc.

Ernest W. Nolder
 manager, architectural service
 & builder sales
 The Sherwin-Williams Co.

Carol Plass
 DeSoto Inc.

Thomas J. Sowinski
 marketing services manager
 Midland-Ross Corp.

R. D. Spencer
 director, government &
 external affairs
 PPG Industries, Inc.

Donald W. Spivey
 marketing manager
 AmarLite Anaconda

Vladimir Zazworsky
 project coordinator,
 sales engineering
 Bethlehem Steel

esthetics—we are expected to be aware of available technologies. We have to educate our clients as to the processes we use, the mutual objectives. We have to insist that our clients become part of the design team—early in the game—because programming is an important part of analysis and design—it is synthesis. We need jointly to realize that environments are not created for static beings—and that therefore people should not be expected to function in static environments. I believe that in the practice of our profession, the psychological factors are as important as the functional requirements—and that therefore performance criteria cannot be established to develop a concept of system that automatically becomes a panacea and/or is automatically tailored to everyone. I believe that by definition a successful environment cannot be conceived by a single source—and that what we need is strong emphasis and dependence on all possible disciplines that must interplay to create a good environment."

**Where do we go from here?
 Three panelists gave the Round Table
 some final food for thought**

Said Frank Matzke: "Today we've talked about definitions of performance, application of performance standards, measurement of performance, testing and evaluation systems. To me it adds up to this: we are capable of doing a lot more than we could in the past; but what we need is a more systematic way of finding out just what users' needs are, and a more determined way of meeting those needs.

"I think that if we are going to pursue this performance concept further, we need to structure some kind of framework or matrix within which to do that. Down the left-hand side I would list consumer, owner, user, architect, engineering, manufacturers, builders, labor, code administrator, building operator, lender. Across the top I would list the environmental qualities we have been talking about: light, the quality of air, temperature, humidity, noise level, energy usage, contracting methods, life-cycle costs, the effect of liability and responsibility. Perhaps productivity. On such a matrix there are a lot

of blanks that haven't been filled in—and such a study would tell us what work needs to be done to make performance specifications work.

"This could be a major role of the National Institute of Building Sciences—we could do the research or organize the research that is needed, and certainly be aware of needed research that is going on elsewhere. This Round Table has brought out into the open many of the questions that need answering. . . ."

Peter Kast: "We have heard several times, and I concur, that performance specifications are a good way to buy parts of buildings; they are not a way to buy whole buildings. The problems with performance specifications are in no way unique—as with traditional processes we pile great precision as architects and engineers on top of extremely crude information on user need—on human need. We calculate our building pieces to three-point accuracy—but if we have two-point accuracy in our description of the need, we are lucky. If we can get better information on user satisfaction and user performance in existing buildings, we could make great gains in both areas; reach towards performance standards that really meet our needs."

A final word from Karl Justin: "I think performance standards as a measure and compilation of our knowledge, and performance specifications as a document for building, are two very different things.

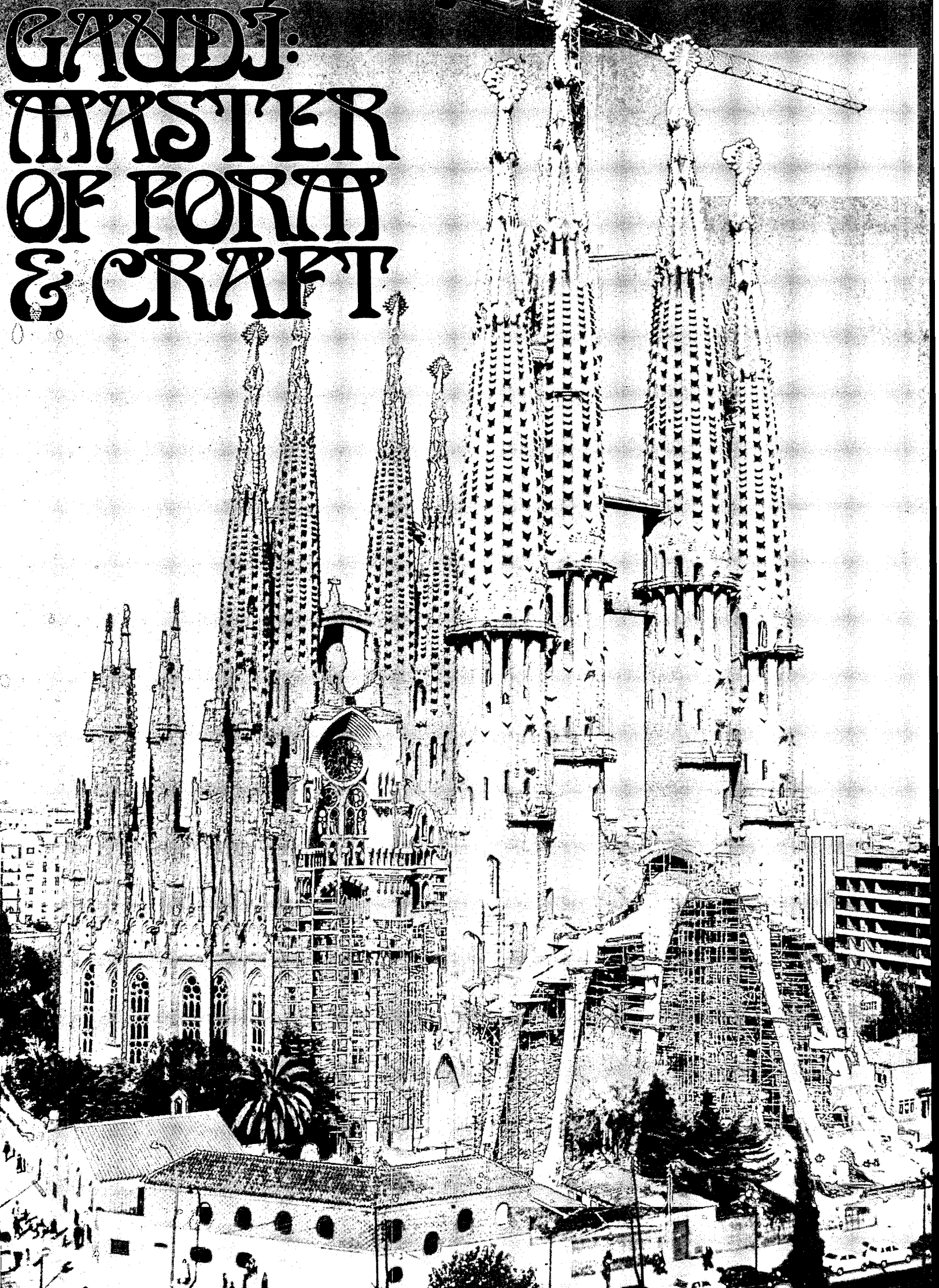
"Better standards are something much to be sought to raise the quality of design—if you don't know, you are only guessing. We need a lot more work before we can disseminate all the information we have, get the information we don't have, and integrate it into a successful whole.

"Performance specifications as contract documents to get buildings built, are still an imperfect tool. We have a long way to go in establishing standards.

"So I think it is still early to send the boy up in this crate.

"Nonetheless, if the performance approach—including performance specifications—can be made to work as well in our industry as it did for NASA—we may yet find intelligent life on earth. . . ."

GAUDI: MASTER OF FORM & CRAFT



H

ow good a structural engineer was Antonio Gaudí?

Herman Spiegel, educated as an architect, and a practicing engineer and an academic by profession, wondered, his curiosity stirred by the claims of architectural historians and of Gaudí himself—"Gaudí said that just about every move he made architecturally was controlled by structural engineering." So, on finding some leisure after Cesar Pelli took his place as dean of Yale's school of architecture, Spiegel embarked on a wanderjahr (or at least three and a half months) in search of Gaudí, assisted by his camera and a \$500 grant for research from the Philosophical Society of Philadelphia.

Not much to his surprise—he had started out a skeptic—Spiegel concluded that Gaudí did *not* think like a structural engineer. He thought like an architect, of course, but like an architect "with a subtle structural understanding used visually, adding sophisticated little nuances to show you he knew all the tricks."

Gaudí moreover had "absolute mastery" of the materials and techniques available to him. "He got more out of his materials and the craftsmen than any architect I know about." Spiegel was especially taken by his "incredible" masonry. "It would take a helluva lot of guts to do some of these things even now (and probably the codes wouldn't allow us to)."

More especially, Spiegel admired Gaudí's confident employment of the *bóveda catalana*, a system of structural tile vaulting traditional in the Barcelona area (see page 106).

If the engineer Spiegel finished his wanderjahr without evidentiary support for the engineering claims made in Gaudí's behalf, the architectural Spiegel finished "an absolute fan," full of awe and enthusiasm for Gaudí's grasp of structure, his inventive variations on many themes, his manipulation of daylight to create structural illusions.



All photographs by Herman Spiegel

At Casa Milá, Spiegel admired particularly Gaudí's manipulation of light for illusion. "Out at the front of the balcony, a slim column seems to support that heavy stone—you think, 'Wow! That's one slender goddam little column! Why can't I do that?' But occasionally, when the sun is low enough, you can see that just behind it he has that big son-of-a-gun doing the job. Nothing structurally daring, but it *looks* as though there is." Work continues on the Sagrada Familia (opposite), but though "it's phenomenal in many ways," Spiegel found it less instructive than Gaudí's more modest buildings.





In the basement stables of the **Palacio Güell at Barcelona**, Gaudí employed the *bóveda catalana*. This traditional Catalan vaulting is constructed of terra cotta tiles that measure 6- by 12- by 1-in., set by hand with fast-setting mortar and without any centering or formwork. As Spiegel describes the method: "You butter up the edges of one of these thin, brittle tiles, hold it against another for 30 or 40 seconds, take your hand away—lo and behold, it stays there. When you have a few tiles laid edge to edge, you immediately start a second layer, with its edges overlapping the joints of the first. It's a little like building a cantilever bridge, poking forward as you get more weight at the back. Clearly these were remarkable masons, and Gaudí took full advantage of their skills." Beyond his respect for the workmanship however, Spiegel observed Gaudí's adept structural approach to the material: "He corbeled the top of those massive brick piers, reducing the distance spanned by the vaulting. He understood that bending, that combination of tension, compression and shear, meant trouble, particularly in the masonry world he lived in—a lot of people don't understand this even now."



"Gaudí takes the humblest of materials, this little red tile, to shelter Mary with *bóveda catalana*." For the chapel at Colonia Güell in Barcelona, Gaudí designed a spiral canopy of

uncommon subtlety, as Spiegel describes it: "As you look up at the front from below, it appears to have only one layer of tile, which makes it more remarkable than you can

believe. But when you climb up and look at it from the side and above, you find at least five, maybe six, layers. That feathered leading edge, then, although it looks daring, is quite

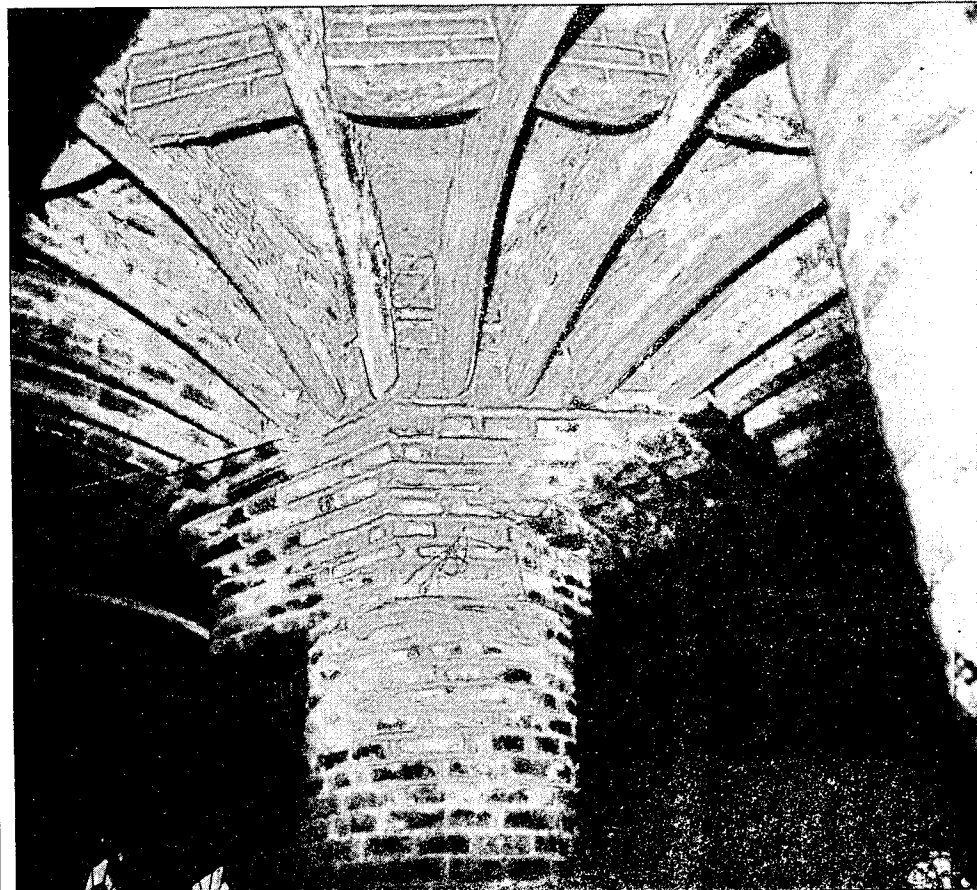
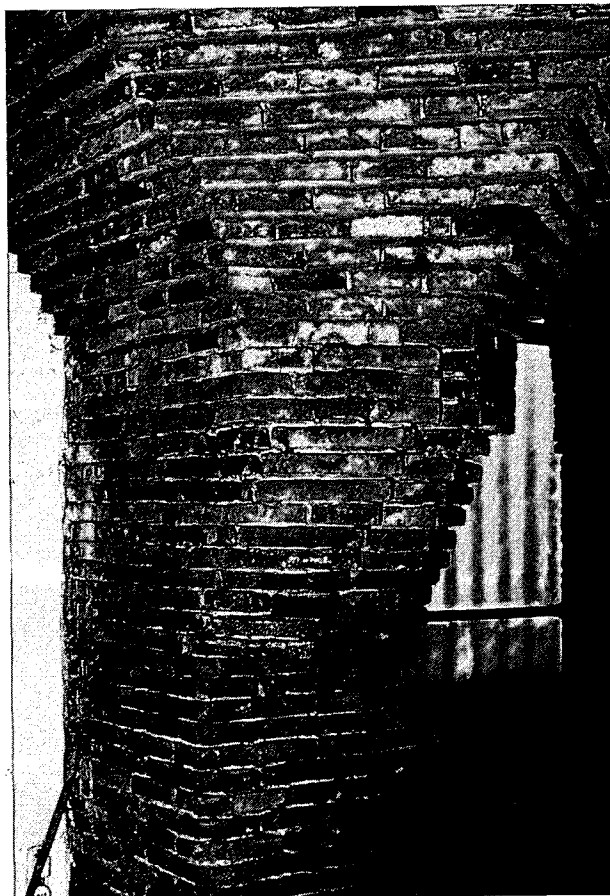
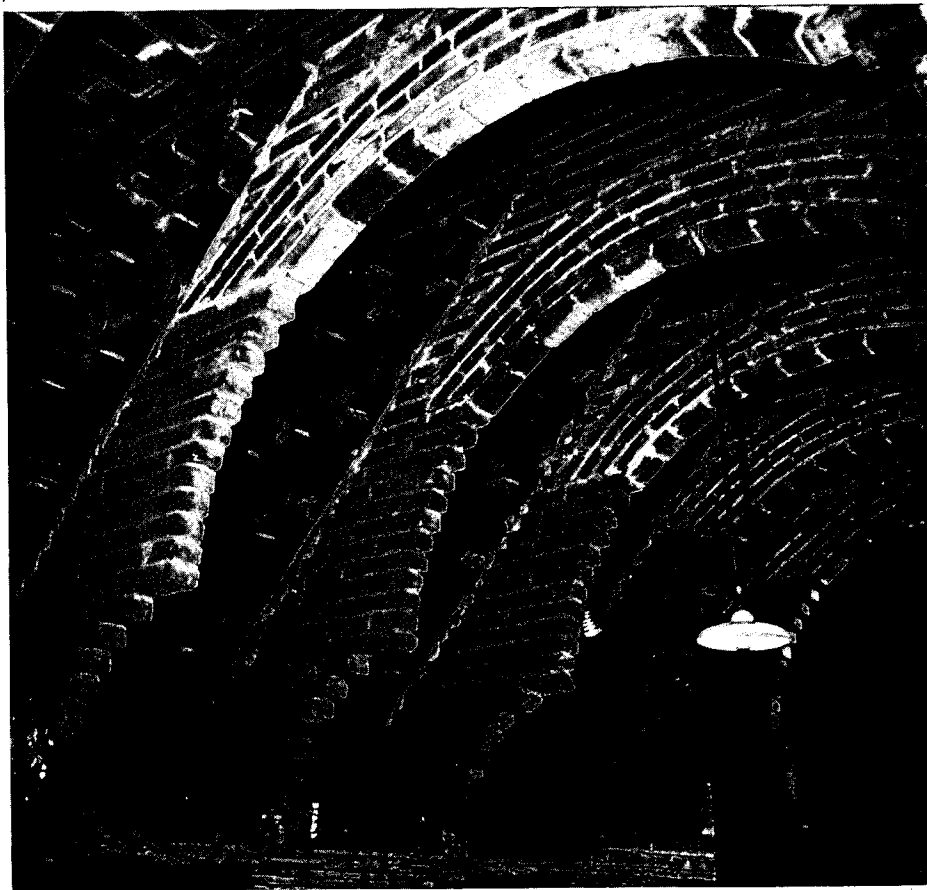
substantial after all. To accentuate the winding rays of the tiles, and to emphasize the texture of this unpretentious material, he carefully left the mortared joints rough."

Spiegel found "a veritable toyland up in the attic" at the villa Bellesguard near Barcelona. "Gaudi hated to repeat himself, thought it boring, so none of these arches is seated

quite like any other—here a seat for thrust, there another for shear—like a musician demonstrating his virtuosity. One sees, for instance, a kind of shear connection (below left) that

scares engineers like me. It wants to slide right off. But that lattice work isn't just decorative, it's working, buttressing that arch from the back and continuing over to a similar arch

opposite. That lattice isn't exactly hiding, but the eye doesn't read it at first. And I love those corbeled capitals, getting thinner, thinner, thinner—he's always exaggerating."



"The man's daring staggers the imagination. Gaudi's corbeled masonry is the best I've ever seen in my life." A brick column at Palacio Güell (left) is typically atypical: corbeled, twisted,

eccentrically shaped, "but always structurally comfortable." At the Colonia Güell chapel (right), "a very beautiful thing. The capital comes out on the right to a feather edge, making

it appear that this thin thing supports the ribs, that the vault is balanced on someone's fingertips. But when you trace the thrust lines, you see they're right over the column—this is just

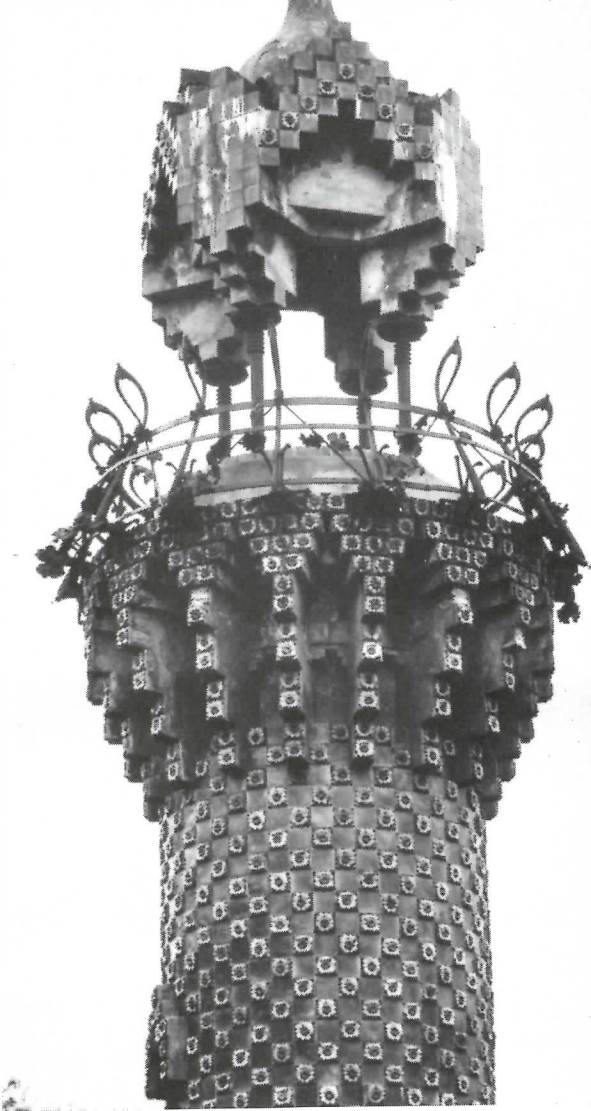
decoration. On the other side, however, where those ribs appear to go right over the collar, that heavy hammerhead capital sticking out *does* work in bearing."

G

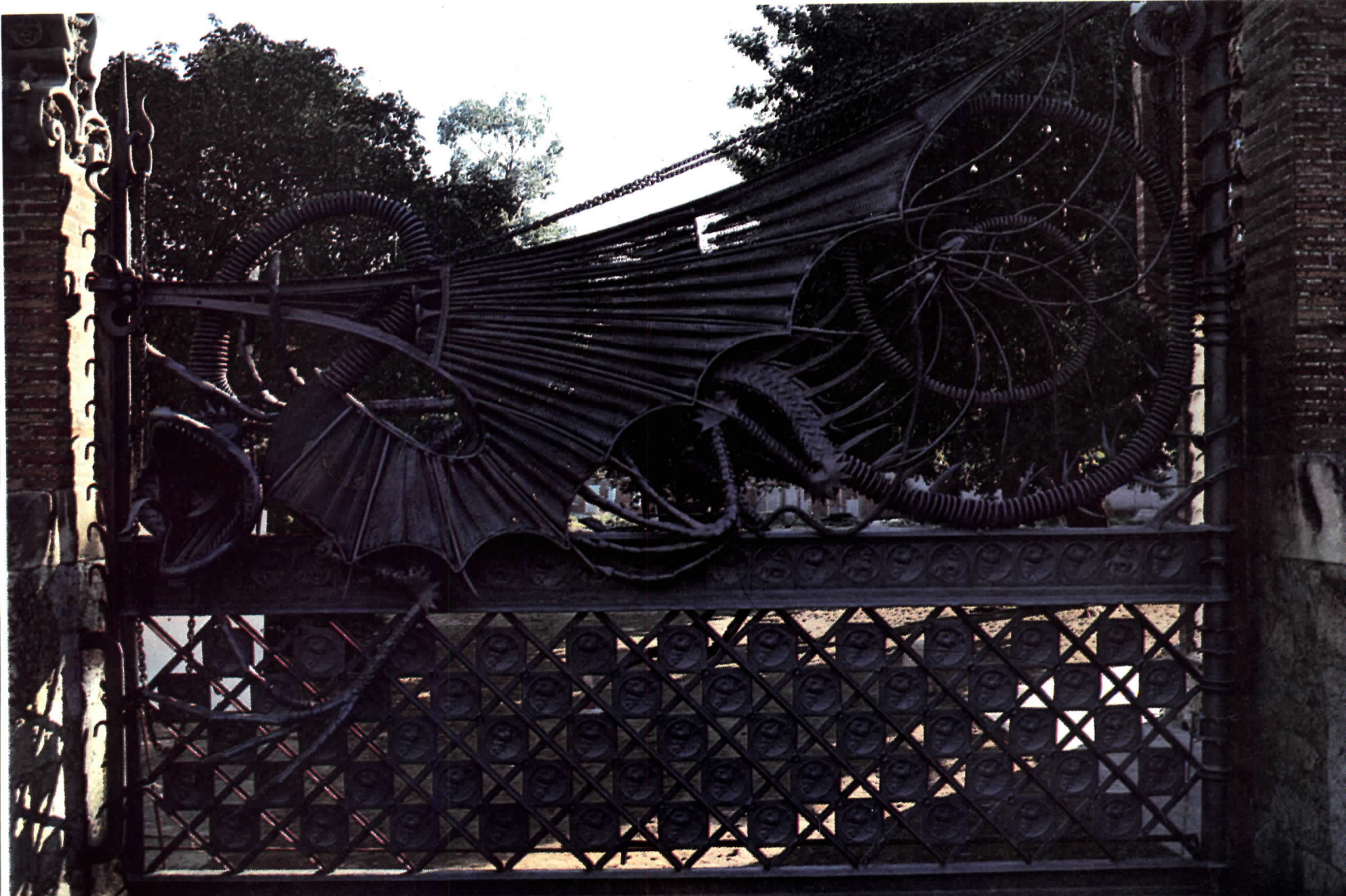


Gaudí's reliance on the parabolic arch evidenced itself throughout his career. In the stables at the Finca Güell, says Spiegel, "he showed he was a master of three-dimensional form. On the left [above]—arches; on the right, parabolic arches between those arches. So what appears to be a barrel vault is really arches in two directions. Clever! By the way, the brick configurations on the inside of the arches aren't structural—just trim. He simply didn't want to be boring." (The building is being restored as a Gaudí museum). The convent school of Santa Teresa de Jesús in Barcelona (lower left) is a four-story rectangular block with four longitudinal bearing walls. "On the second floor, Gaudí removed a bearing wall to open a corridor. The third- and fourth-floor walls come down on parabolic ribs—there are a lot of them, so no one is overloaded—and then, on the first floor, he brings the load back to the bearing wall on haunches. The corridor intrigues me—so rhythmic and beautiful." At the Finca Güell (lower right), "you see another favorite trick of Gaudí's. He toys with us by having one structural condition outside, a totally different one inside. You can see the silhouette of the parabolic arch outside, the corbeled brick arch inside."

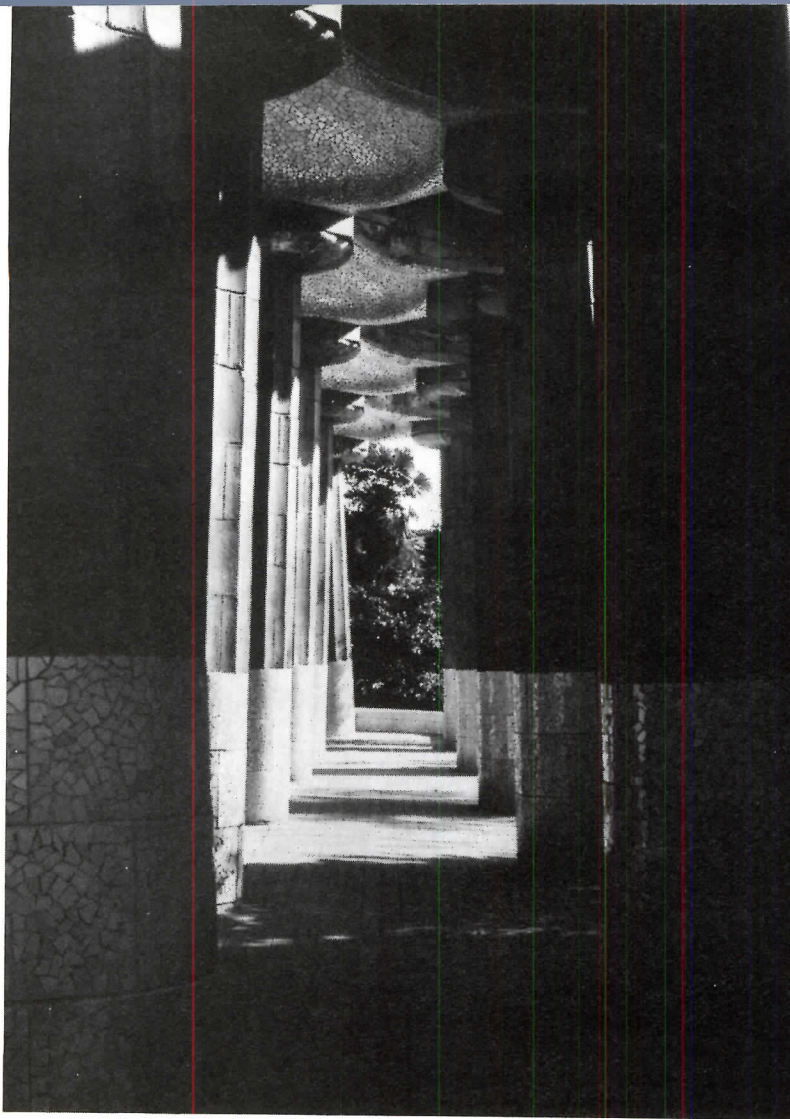




As with masonry, Gaudí was a master of iron work, and exploited craftsmanship to the full. At the villa El Capricho in Comillas, "that was an advanced technique he used, those four slender iron posts supporting the cupola," Spiegel points out. "He was always interested in new techniques, and he evidently got on to the work of a couple of English engineers who had worked out an empiric formula to determine how slender an iron post might be for any purpose. Gaudí used that, but he also buried the ends of the posts so securely in masonry that in effect he developed a moment connection—and that suggests great sophistication for the time." Of the famous dragon gate ("Gaudí had a thing for dragons") at the Finca Güell (below), Spiegel says, "I read one historian who claims that the wing of the dragon is placed so that it braces the gate and provides structural support. As luck would have it, I was out there one day when the wing was away for repairs—that gate doesn't need the wing for support. But it has so much going for it—it's magnificent—it doesn't have to be sold with structural rationalizations. The little pedestrian gate next to it [right] is good engineering: a nice simple curve coming down to hang the gate, a horizontal shear member at the bottom, a diagonal compression strut braced with rivets at each vertical—a nice clean job."

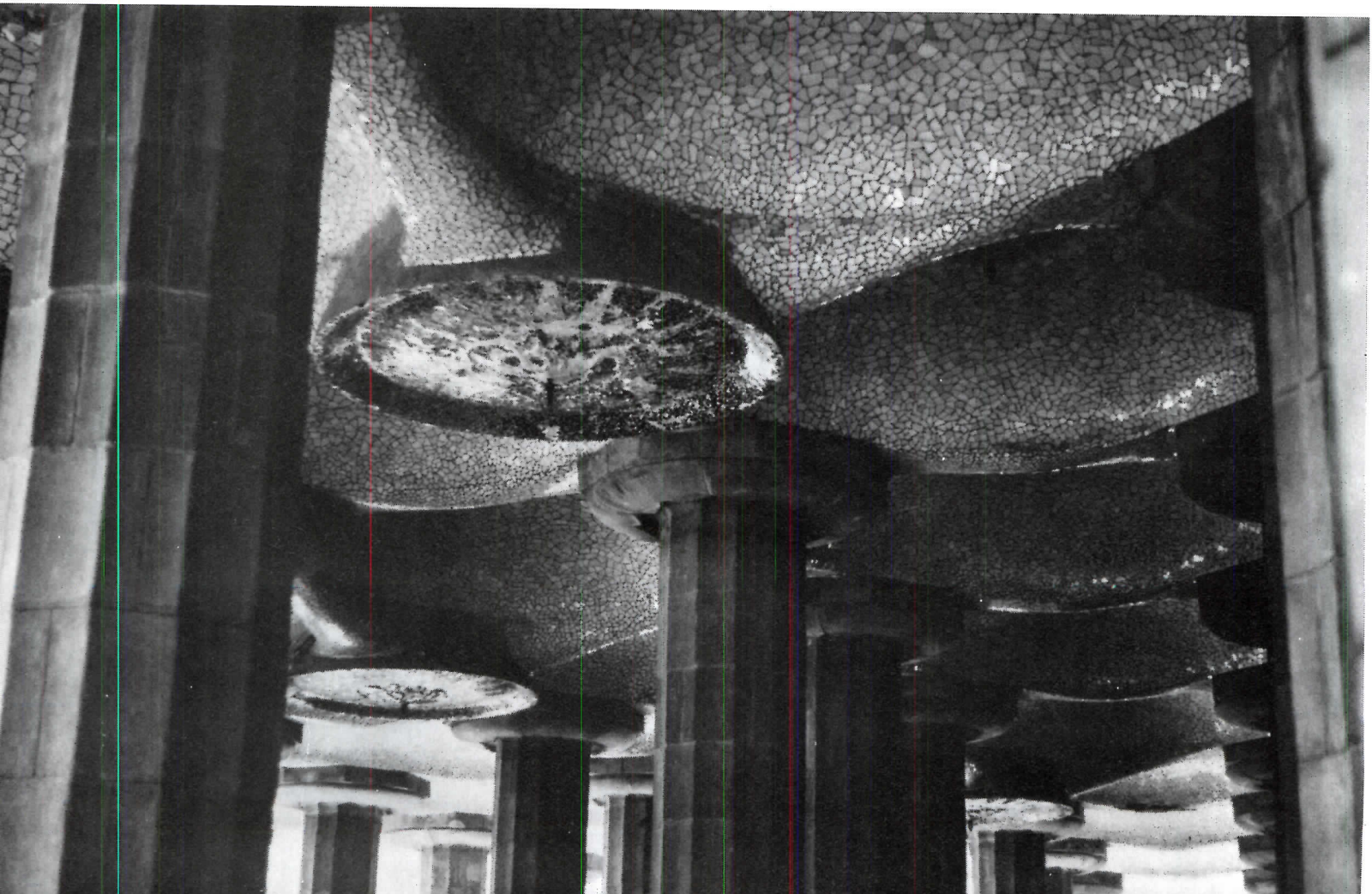


G



The Doric colonnade at Park Güell in Barcelona was intended as a market.

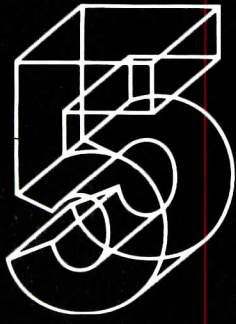
"Every so often Gaudí would drop out a column to make room for a larger stall—and then mark the place with a beautiful polychrome tile. I think Gaudí had a remarkable intuitive understanding of structure, because he *is* allowed to punch holes in the system (Corbu does it with regularity) if he keeps his stresses comfortable enough. I puzzled for a long time over those leaning columns at the ends of the colonnade, until my then 13- and 14-year-old sons came up with an answer. 'It's better,' they said. 'If it tries to fall down, they'll push it back.' It's that simple, I think. The exterior columns lean in a way that does push toward a natural hill behind, giving a very stable appearance. Of course, visually it does a lot more than that."





Variegated columns at Park Güell combine retaining walls and support for the park above. "Gaudí has designed his retaining wall so that it approaches the natural angle of repose," Spiegel observes, "—that's the frictional angle soil assumes when it slides down in a pile. Then Gaudí further helped himself out by tilting the columns in the same direction to resist the horizontal pressure, allowing him to keep the stresses in the masonry low rather than to overpower them with reinforcement. Now if the soil wants to tip that wall, it first has to lift it against the force of gravity." Spiegel concluded that "everyone finds something different in Gaudí. For some, it's the Art Nouveau, or the surrealism, or Spain's greatest Gothic architect—for me, it's a master of materials. But he's more than any of those things. He had an incredible, powerful sense of three-dimensional design. Unfortunately, Gaudí's popularity seems to rise and fall—but there's no doubt in my mind that he was a genius."





With derring-do, dash and painstaking care, designers use materials for economy and form

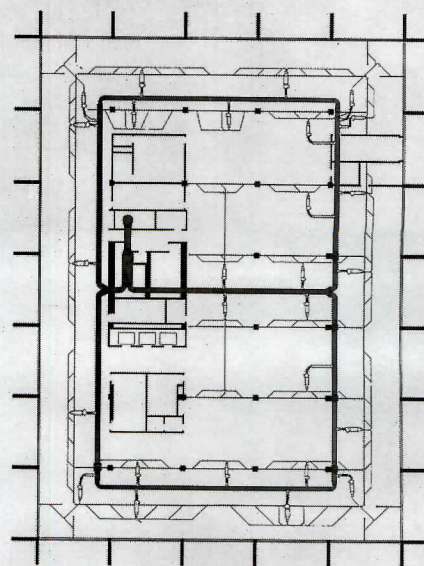
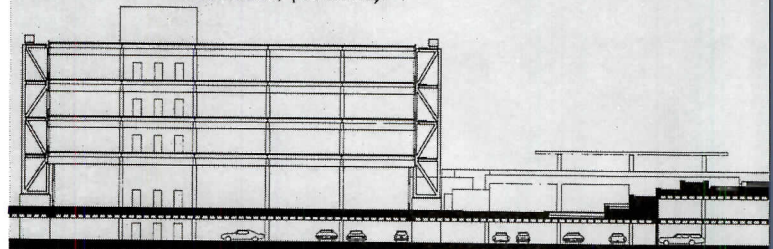
The materials represented in this section run the gamut of steel, concrete, wood, plastics. The architectural forms derive logically from the nature of materials, but more importantly, the materials often are used multifunctionally. For example, the exposed steel frame on the following three pages has as its primary function resistance to wind and earthquake, but it also provides sunshades. The precast office building on page 119 deftly integrates the services in notched beams. The plastic spandrels in the Amex building on page 122 are not only enclosure—they support the glazing system as well. Two buildings in Texas and California have steel-plate walls to take the brunt of wind and earthquake. Factory-made utilitarian trusses were given a beauty treatment so they looked good exposed (page 120). The magic qualities of glass fiber for reinforcing plastics and concrete open up many new design possibilities (page 124). And an architect and concrete consultant get the most out of concrete by showing the builder how to form it.

Bare steel, a strong motif, resists earthquake/wind and carries overhangs to stop sun

Exposed seismic trusses—the main design motif for this building—were inspired, at least in part, by the ubiquitous gantry cranes, bridges, and other marine structures in Los Angeles harbor. The search for a nonrestrictive structural approach was stimulated by the need for an optimum area per floor of 30,000 sq ft and for a large expanse for open-office planning. The weathering steel braced frames at column lines, which are water-filled for fire protection, eliminate the need for shear walls either in the interior or in the window plane. This approach avoids the need for rigid frame construction, allowing the interior framing to have simple connections. Furthermore, the framing method permits an offset core. This, together with a continuous 7½-ft window height around the perimeter of the 10-ft ceiling, helps create a spacious feeling.

The large amount of glass used would not have been possible under the new California energy laws if steps had not been taken to shield it from the sun. The seismic frames provided means for attaching horizontal platforms to shade the glass and to permit window cleaning. This overhang is reduced to a 3-ft width on the north side so that a maximum of daylight can be utilized. On the east and west exposures, however, the full-width overhang is supplemented by a motorized shade that provides additional cutoff. Additional ambient lighting for the open-office floors is by pendant indirect HID luminaires.

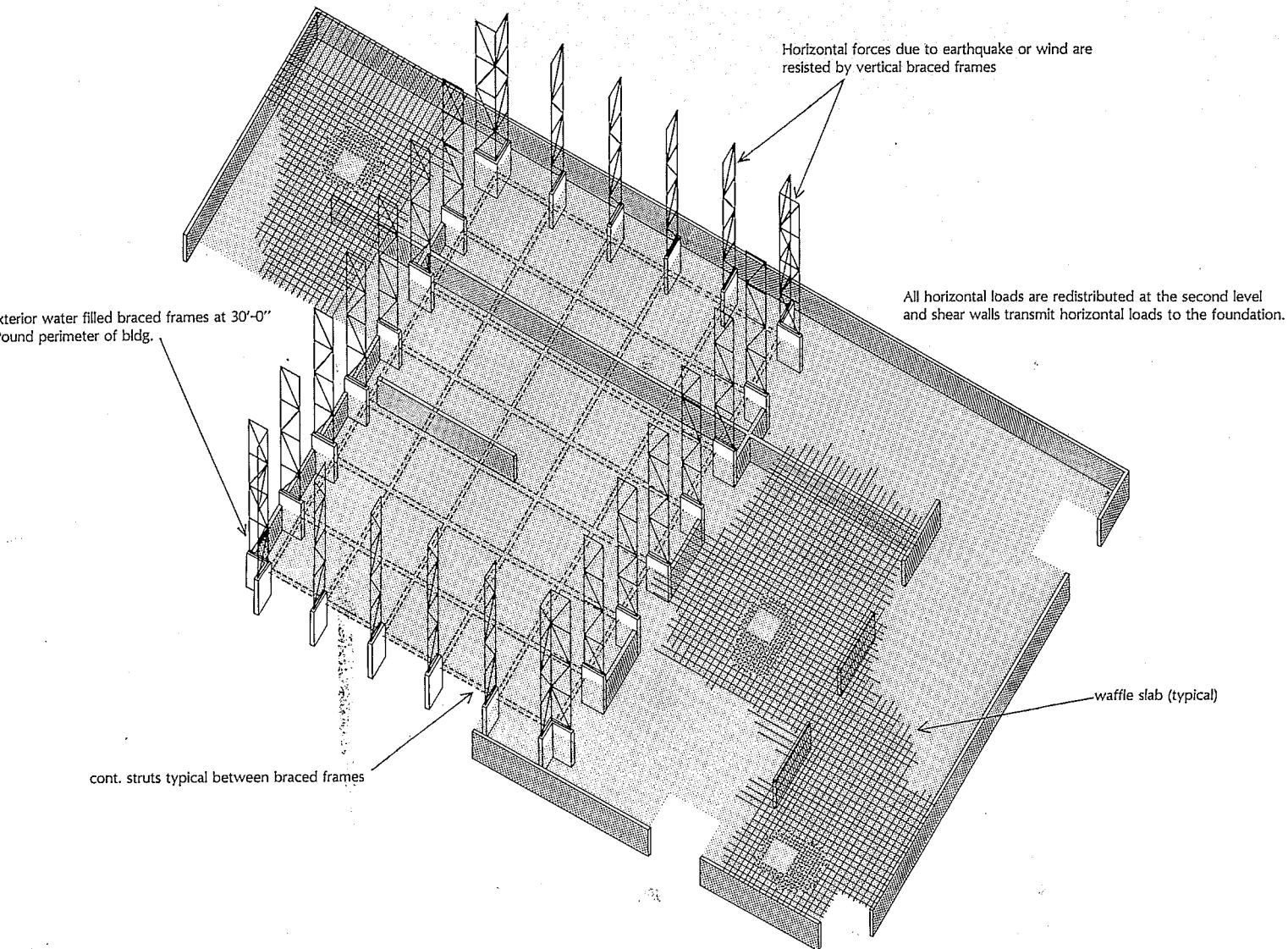
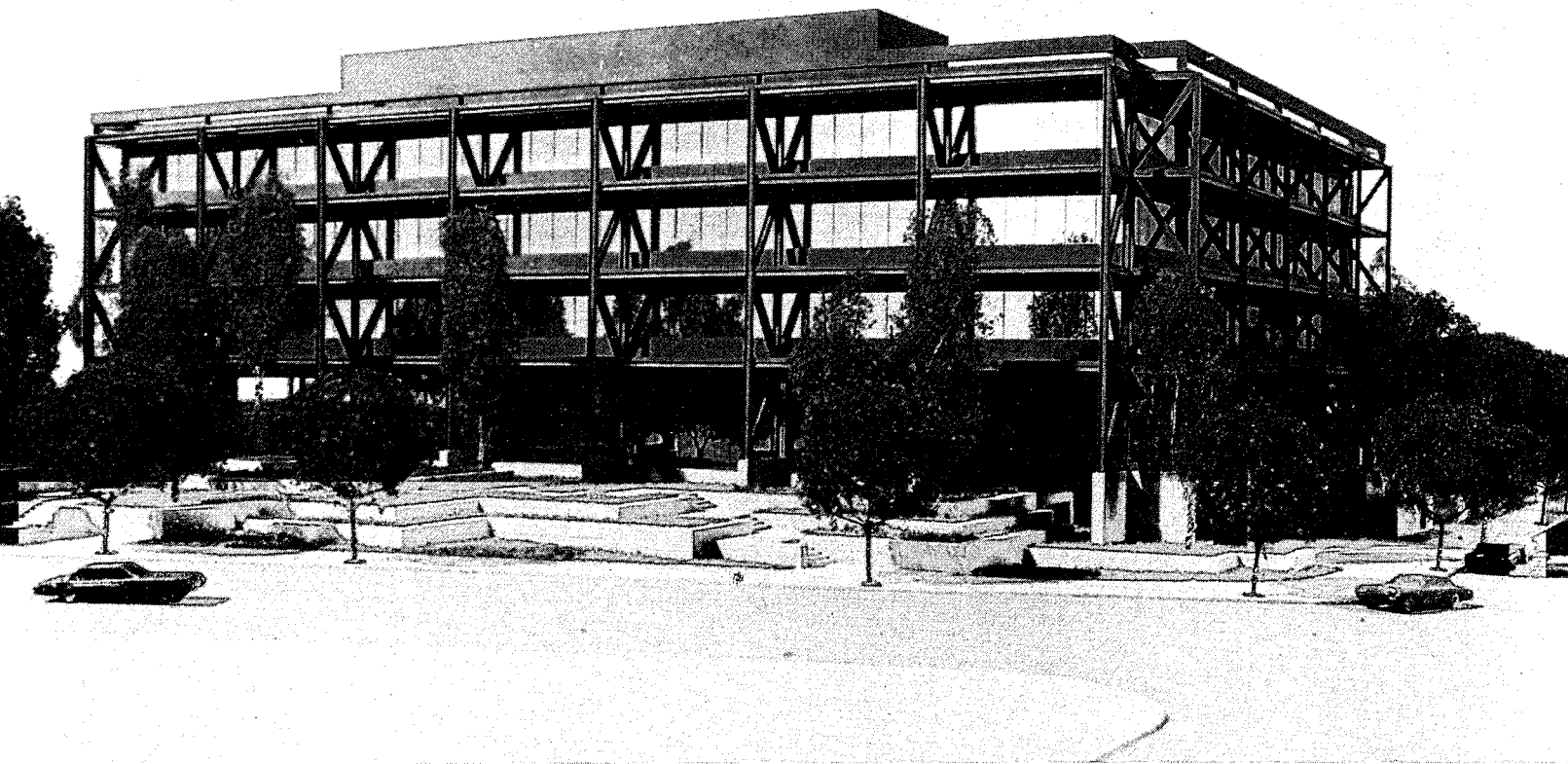
LOS ANGELES HARBOR DEPARTMENT ADMINISTRATIVE OFFICE FACILITY. Owner: *City of Los Angeles, Port of Los Angeles Board of Harbor Commissioners—Fred Crawford, general manager; Joseph Taylor, architect.* Architects: *John Carl Warnecke & Associates—John Carl Warnecke, principal-in-charge; Emilio Archaederra, project director; Edward Koester, project architect; Howard Kurushima, project manager; Edward K. Connors, Jr., project designer.* Engineers: *John A. Martin & Associates (structural); James A. Knowles & Associates (mechanical); Michael J. Garris & Associates, (electrical).*

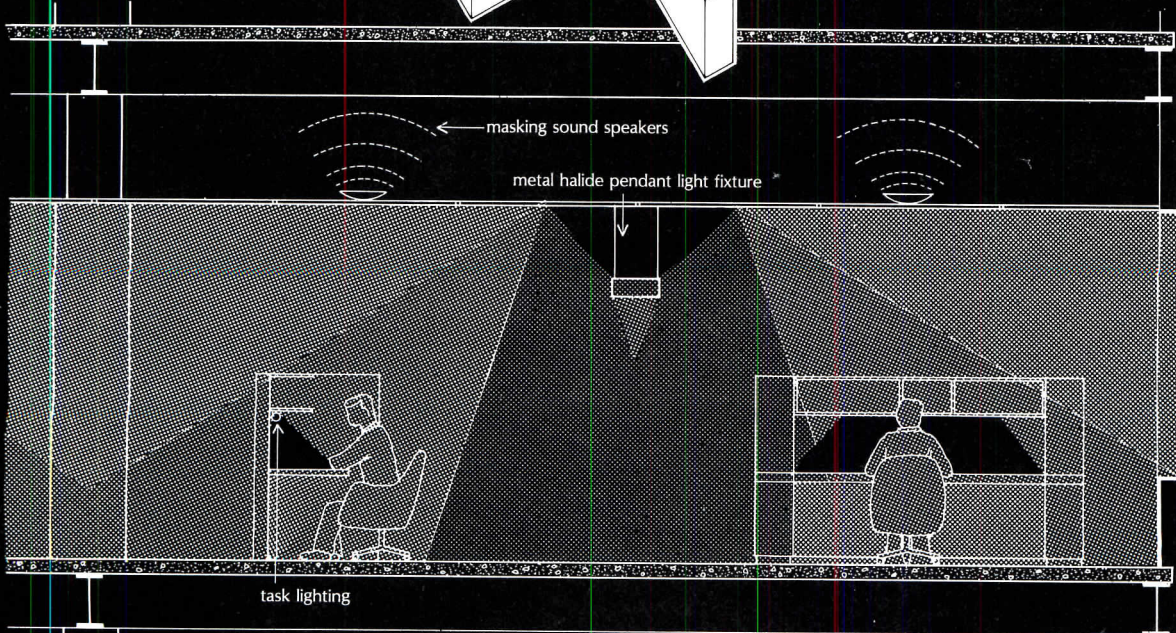
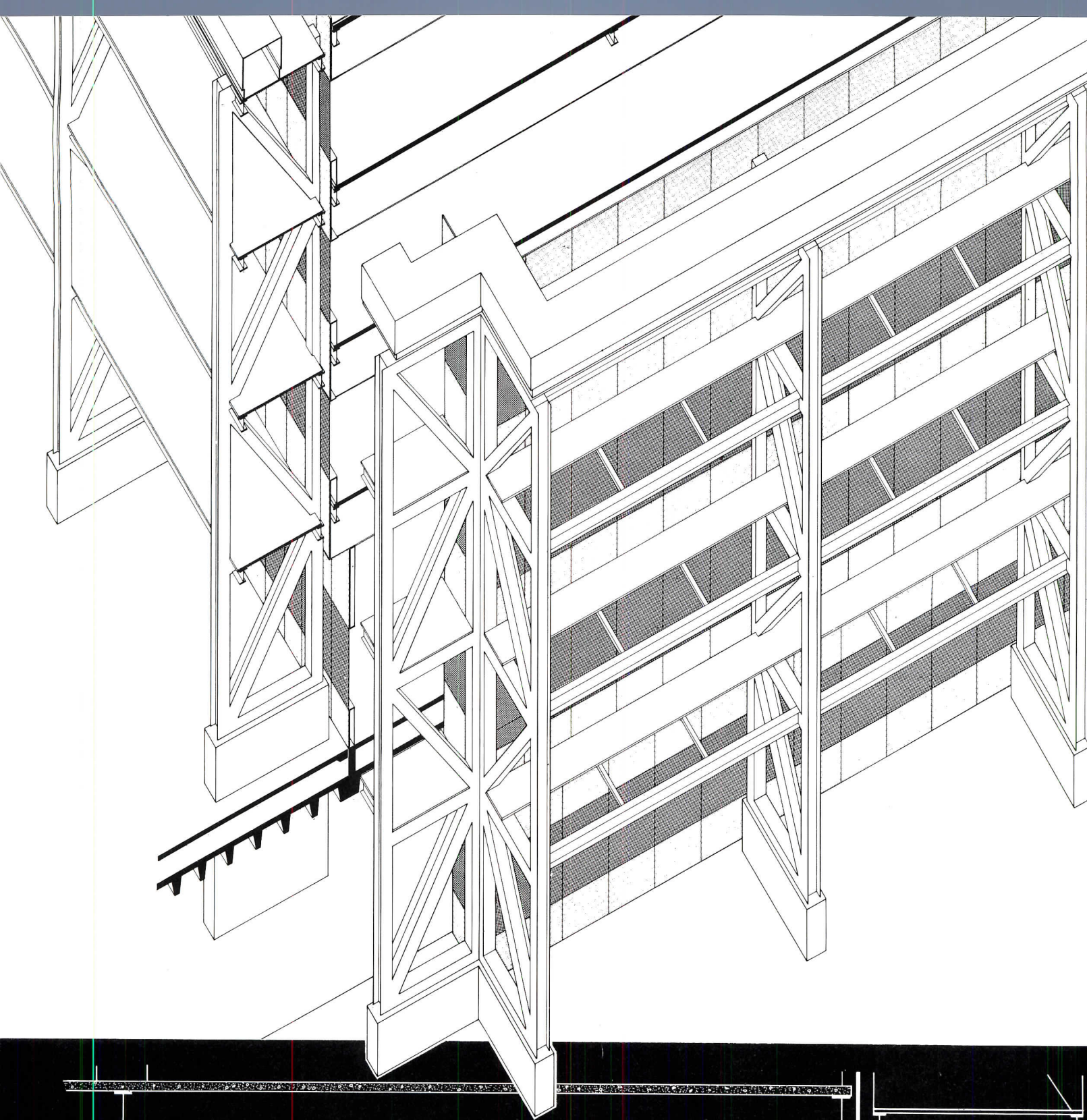


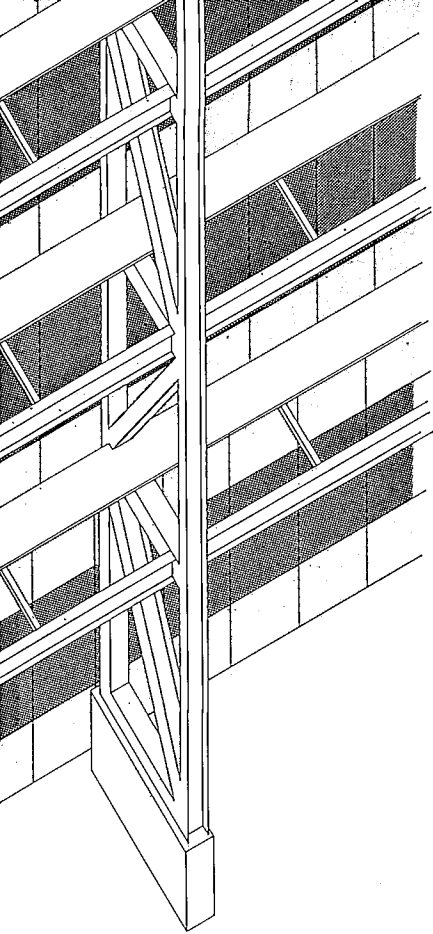
Horizontal forces caused by wind or earthquake are resisted by braced frames of weathering steel at column lines on 30-ft centers. The exposed, 60-ft long trusses, as long as could easily be transported, were welded to framing encased in concrete piers that provide plinths of varying heights, depending upon the grade.

All horizontal loads are redistributed at the second level, and shear walls transmit horizontal loads to the foundation (or reverse, for earthquake). While the office section is a steel structure, the parking garage is waffle slab.

Air distribution is single-duct vav to air-bar diffusers.

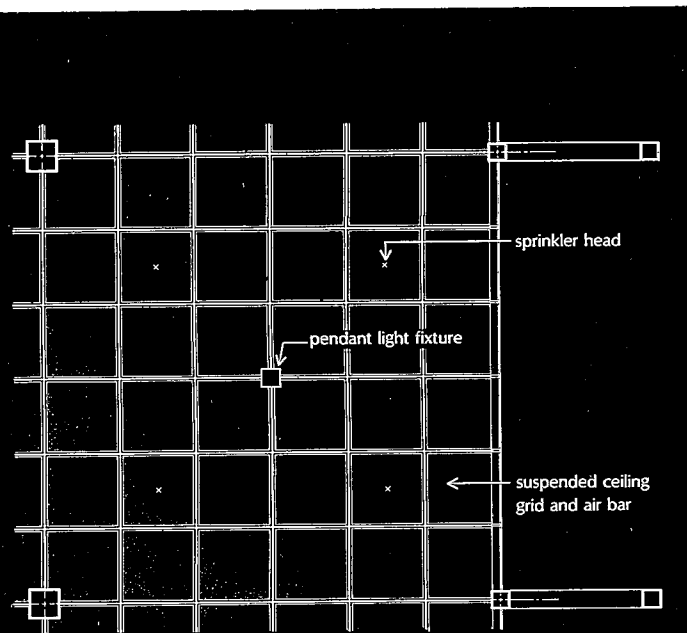




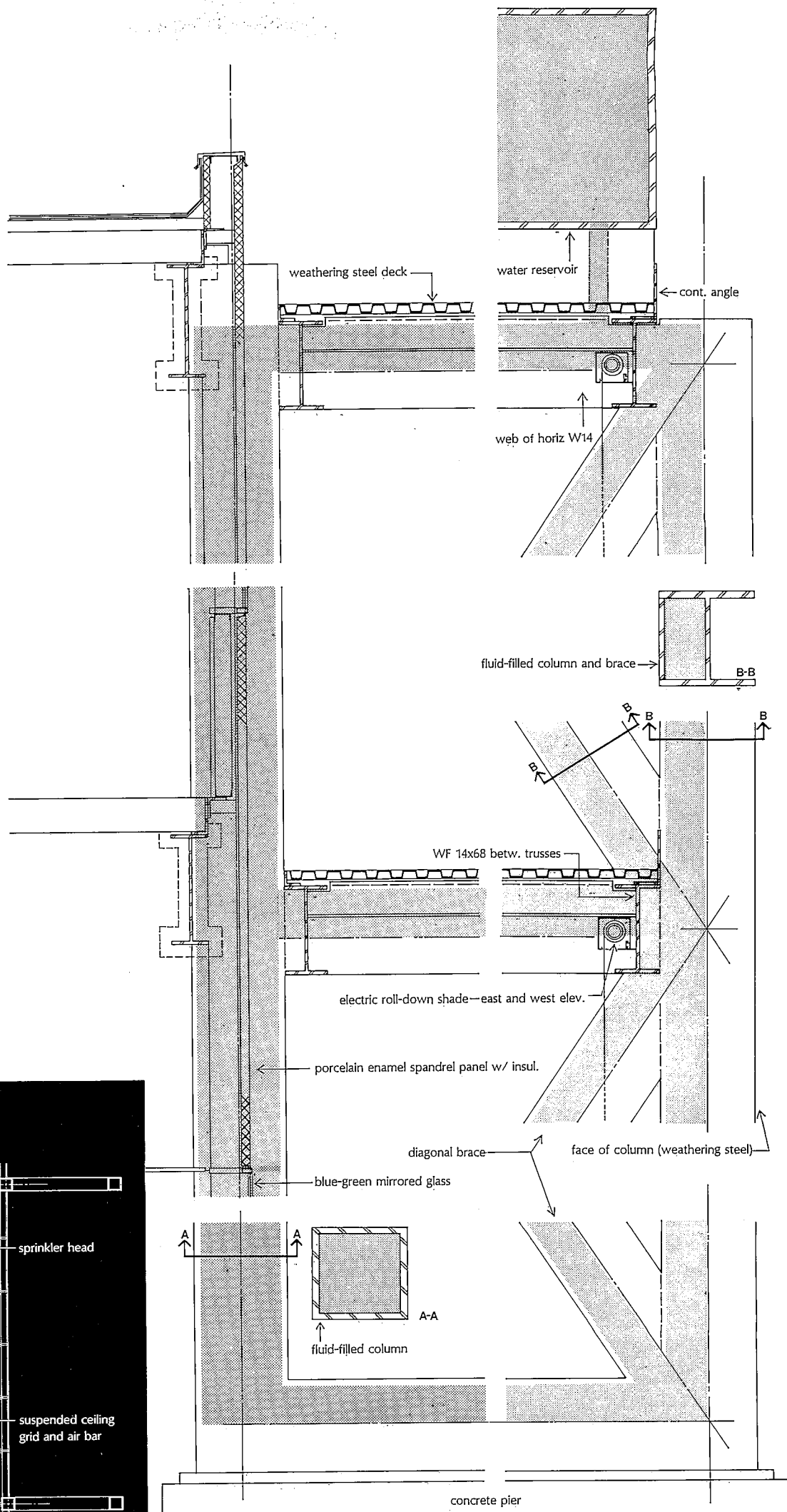


In addition to resisting lateral forces, the braced frames allowed attachment of platforms for shading glass and for window washing. On the north side, the overhang is narrowed to a 3-ft catwalk to admit more daylight. On east and west exposures, the overhang is supplemented by a motorized shade at the front edge of the overhang. The front column is a WF-section with a plate welded to the back to form a tube and to produce crisp lines.

Ambient light is produced by a pendant luminaire having wide distribution and using a 250-W metal halide lamp.



TYPICAL BAY—REFLECTED CEILING PLAN



concrete pier



Steel-plate shear walls blunt the wind's force and carry gravity load in a towered hotel

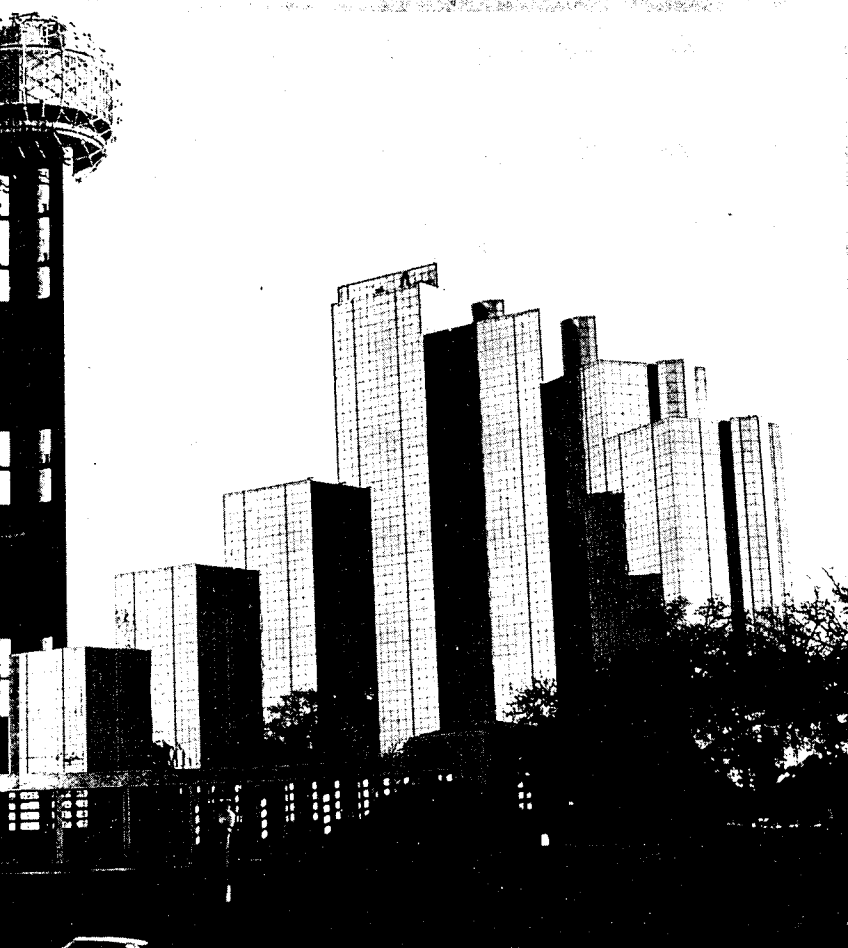
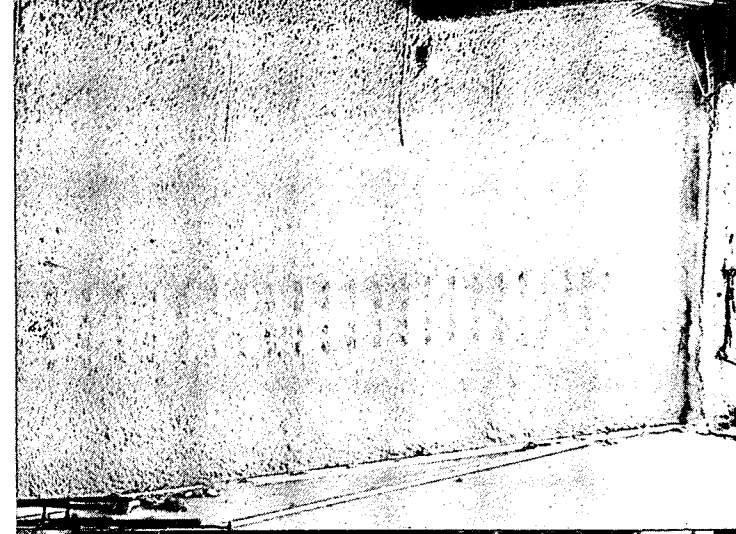
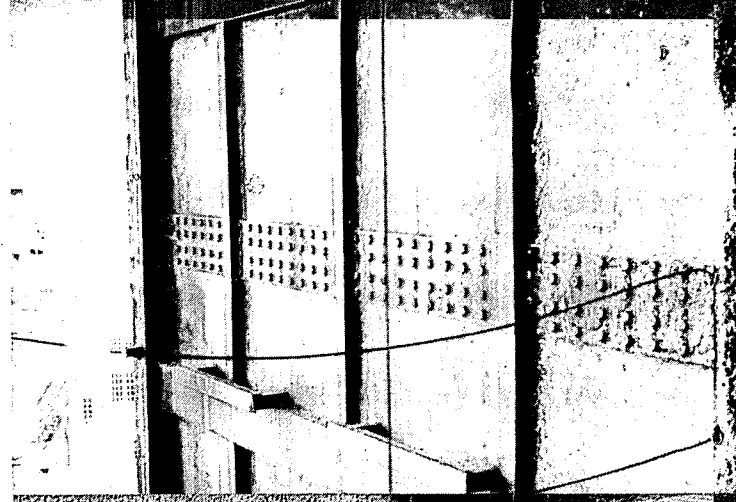
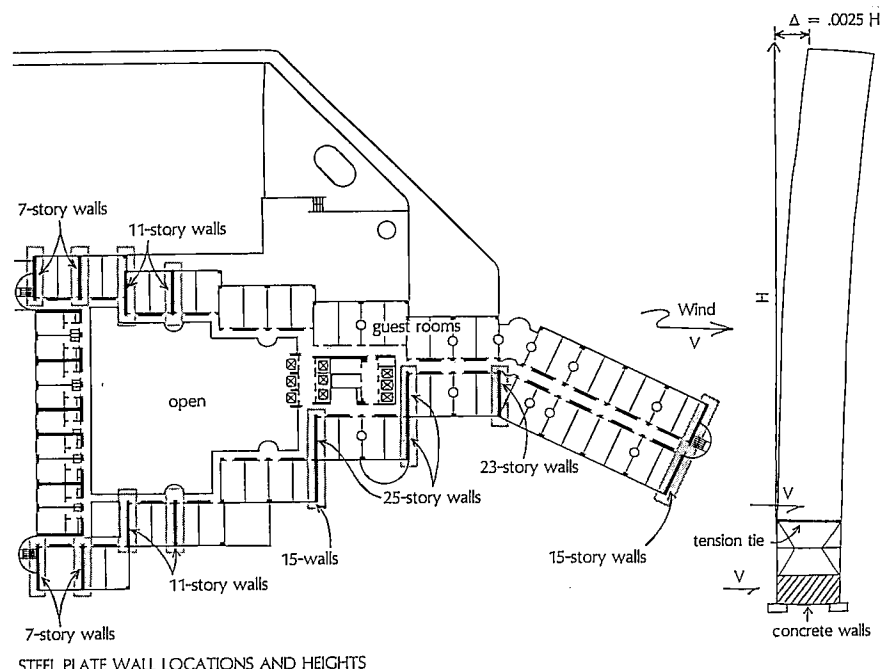
HYATT REGENCY HOTEL, Dallas, Texas. Owner: *Hunt Investment Corp.* Developer: *Woodbine Development Corp.* Architects: *Welton Becket Associates.* Engineers: *Welton Becket Associates* (structural); *Herman Blum Consulting Engineers, Inc.* (mechanical/electrical). General contractor: *Henry C. Beck Company.*

The Hyatt Regency hotel in Dallas, just recently opened, is distinguished not only for the quality of its architectural design but also for the innovative and economical way the tower structure is stiffened to withstand the wind. The shear walls are steel plates—an approach that has long intrigued structural designers—rather than steel trusses or concrete walls.

The steel plate walls are located in the narrow east-west direction, where a conventional cross-braced frame would have encroached on the interior space. Conventional diagonal bracing was used in the longitudinal (north-south) direction for it could be

encased in the walls of the corridors. Diagonal bracing also was used on the lower two levels to allow openings for architectural design reasons. Wind shear is transferred from the shear walls to the diagonal bracing, spread through the floor diaphragm, and collected in the concrete foundation walls (see diagram top opposite page).

The steel plates are 10-ft high, 25.5-ft wide and 1-in. thick, and are stacked on top of one another between columns. In some cases two panels are connected horizontally to form a broader shear wall, and depending on the stress in the wall, two or three stiffeners were added to the panels. According to



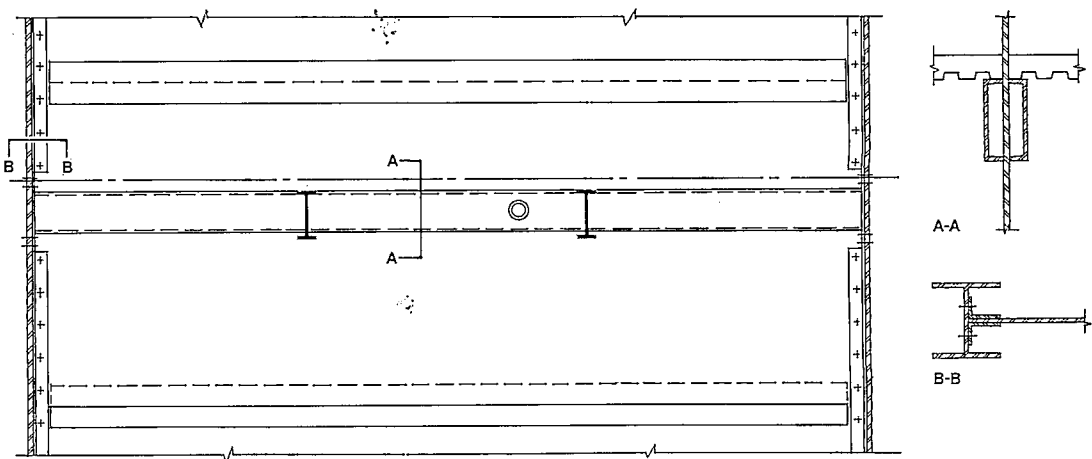
The steel plate shear walls (untreated, top, and fire-protected, center) use stiffeners according to the stress the wall

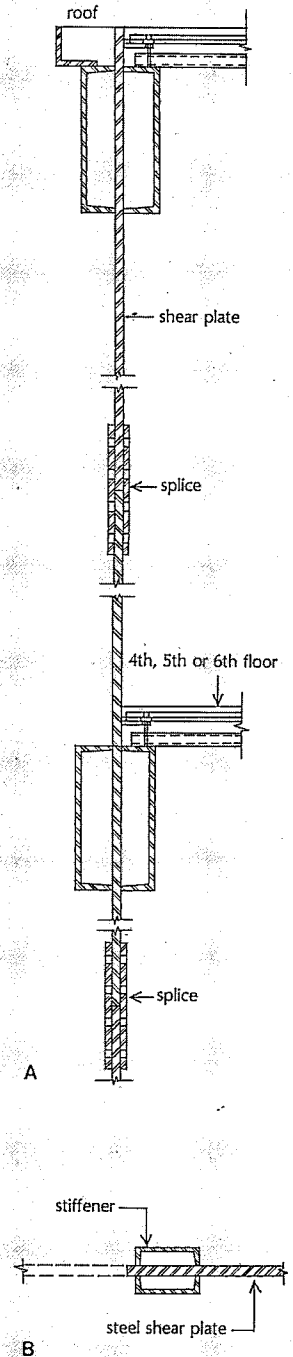
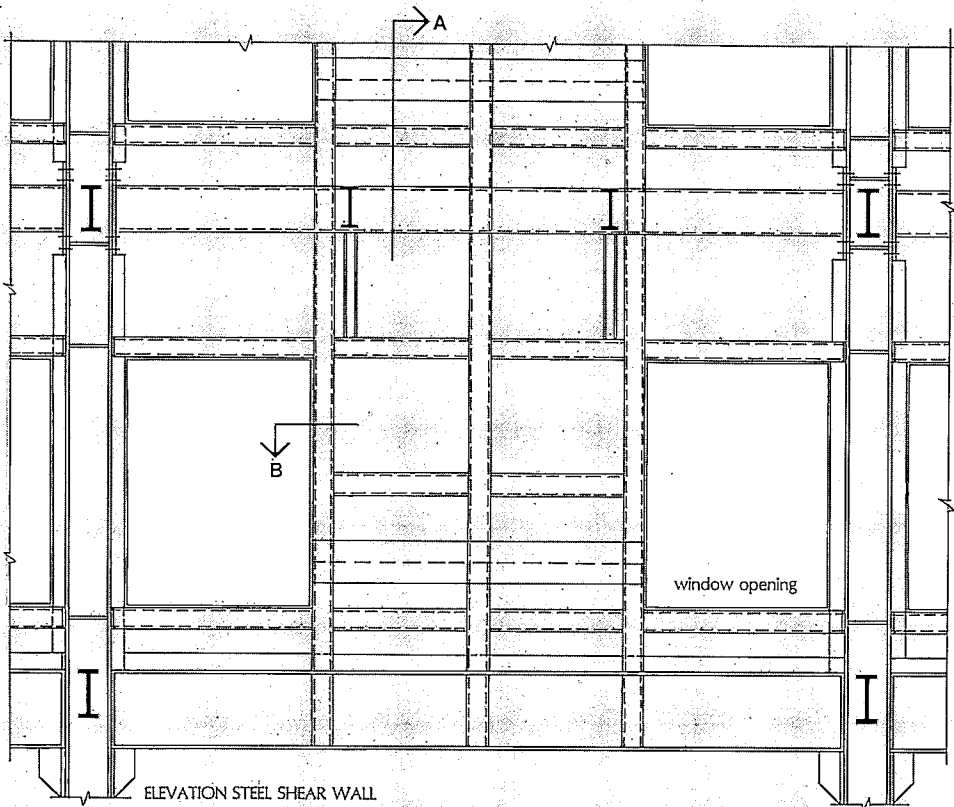
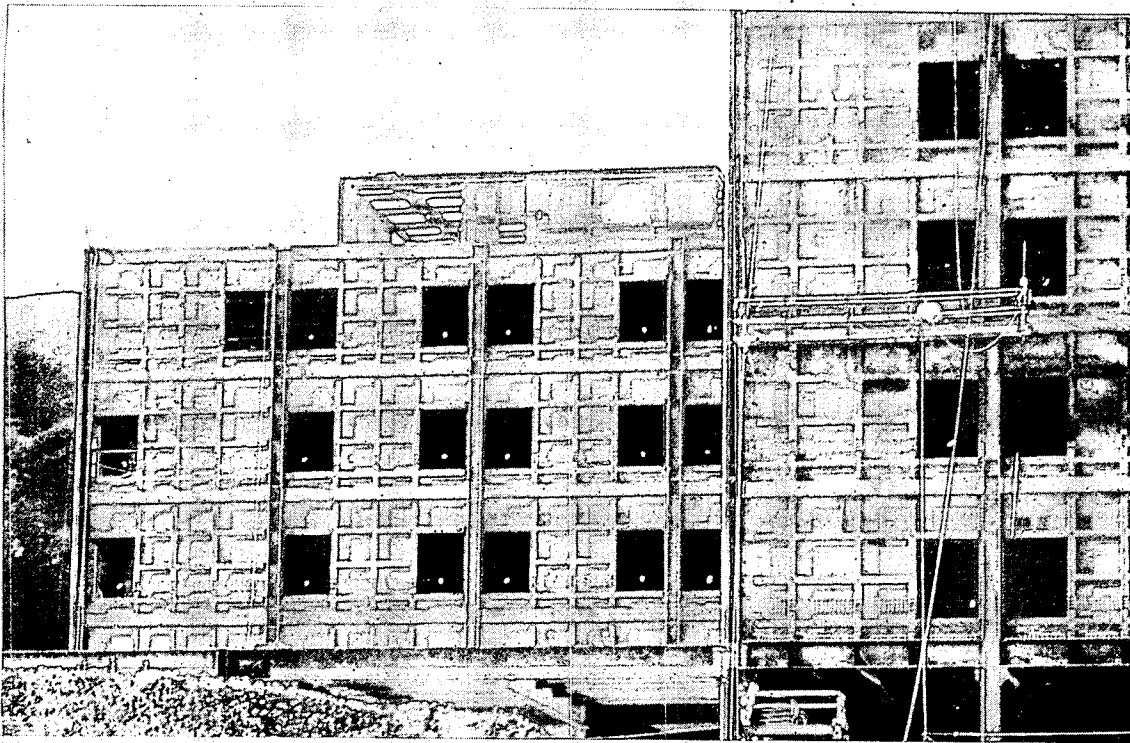
takes. Outriggers (top) are for support of reflective glass curtain wall. Diagonal bracing (above) parallels the corridors.

Richard Troy, director of structural engineering for the architect, a 270-ft-high section in the tower will deflect only 8 in. at the top under the design wind loads.

The engineers chose steel shear walls rather than concrete because the contractor felt this would lengthen the construction time, and because a steel moment-resistant frame would have required a tremendous amount of steel and large members.

Because the design accommodates both lateral wind bracing and vertical forces, steel was saved by slimming down the columns and beams. The architects estimate a savings of approximately \$2.85 million.





Hospital steel-plate shear walls were designed for a 0.69g earthquake

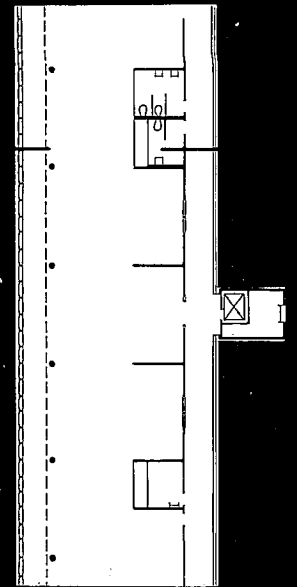
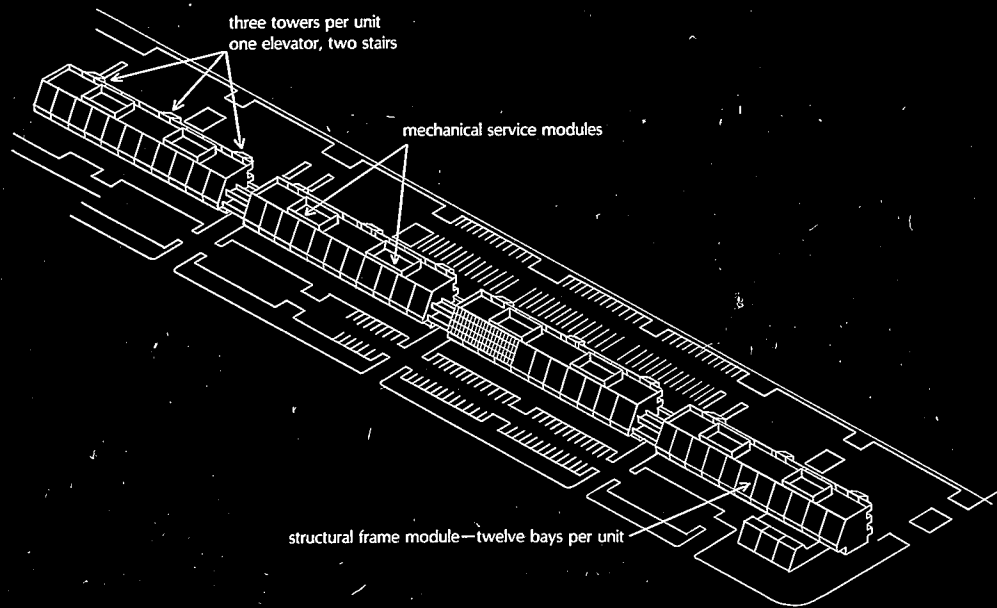
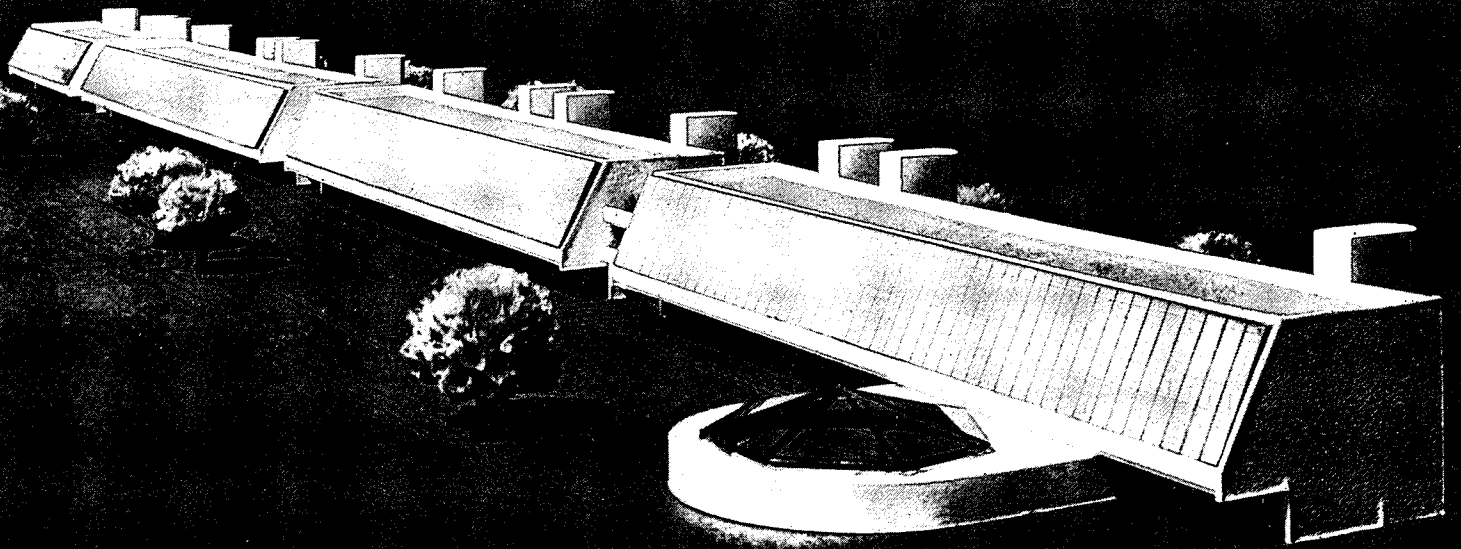
OLIVE VIEW HOSPITAL, Sylmar, California. Architects: *The Luckman Partnership—Richard C. Nilblack, project designer; Richard McKnew, project director.* Structural engineers: *Welton Becket Associates—Richard G. Tröy, director of structural engineering; Robert Flick, project engineer.* Consultant: *Ralph Richard, University of Arizona, Tucson.* General contractor: *TGI Construction Corp.*

Built to replace the original Olive View hospital that was totally destroyed in the 1971 Los Angeles earthquake (and constructed on the same site for economic reasons), the new hospital has steel plate shear walls to meet strict earthquake codes and to permit more freedom in the interior spaces.

The four-story, cruciform-shaped building, set atop a two story rectangular base, was designed to meet a maximum credible earthquake ground acceleration of 0.69g. While a concrete building could have met this force, it would have required thick shear walls, usurping valuable interior space, and requiring an elaborate layout of reinforcing

steel around windows. On the other hand, a steel moment-resistant frame would have used 40 psf of steel.

The structural system consists of steel plate walls bolted to columns and girders, becoming an integral part of the structural frame (see detail) on the upper four stories, and concrete panels encasing the columns and beams on the lower two levels (so construction could keep pace with a fast-track schedule). Conforming to stress criteria computer-developed by a consultant for the steel plate walls, the walls at levels 3 to 5 were made 3/4-in. thick, and at levels 5 to 6, 5/8-in. thick.

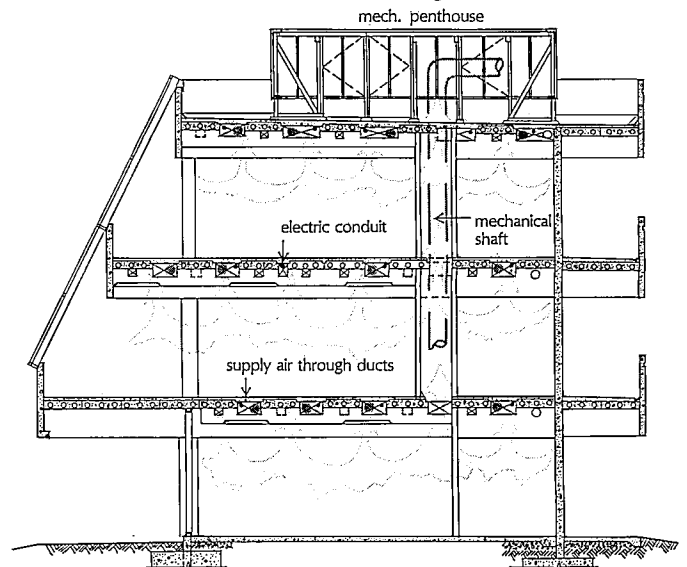


Sloped glass plus shallow service space produces roomy "studio" offices

Lofty ceilings and a long sloping wall of glass create a spacious studio atmosphere in this speculative office complex 50 miles south of San Francisco. The north side of the Oakmead office complex, which is nearly a quarter-mile long, looks out over a lake in the Oakmead Village Industrial Park. Because of its orientation, architects were able to sheathe this entire side of the building in bronze glass, to allow a view and use of daylight without negatively affecting the air conditioning. The inclined glass extends office space out past the main ceiling, creating a skylight effect inside, and reflects clouds rather than wavy mirror images of nearby buildings outside. The complex is served by a single-loaded open corridor on the south side whose overhangs block solar gain.

To raise the ceilings and provide flexibility in air distribution, standard precast concrete beams were notched to provide room for ductwork within the beam. By using this method, and by raising the ceiling above the bottom of the precast beams for visual interest, ceiling heights of 9 ft 8 in. were possible. Cost was projected at \$32 per square foot.

Construction combined concrete that was site precast, factory produced, and cast-in-place. The south, east and west walls, which must resist high seismic loads, were panelized, allowing erection of one story at a time with a minimum amount of bracing.



OAKMEAD OFFICE CENTER, Sunnyvale, California. Developer: *Holvick, de Regt, Koering*. Architects: *Jacob Robbins and James Ream*. Engineers: *Ketchum Konkel Barrett Nickel Austin (structural); Climate Engineering (mechanical); Valley Electric (electrical); WTW Inc. (civil)*. Contractors: *L. E. Wentz Co. (general)*.



Ed Stewart Photography & Associates, Inc.

Light truss sections in splayed configurations produce different spaces for different activities

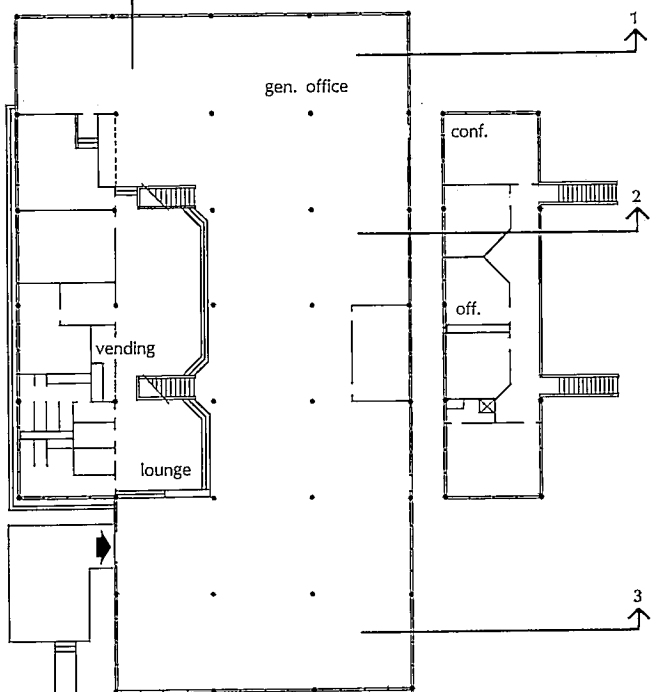
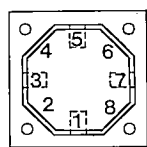
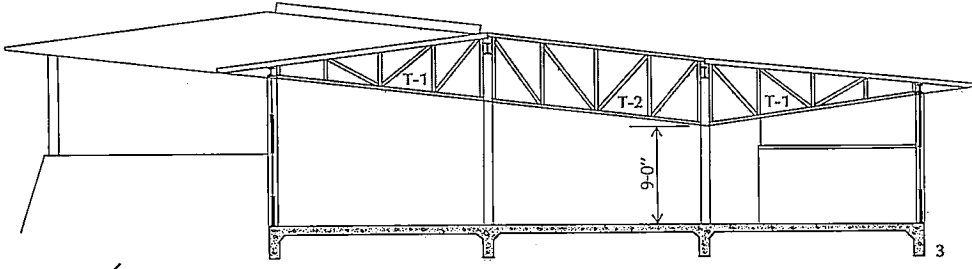
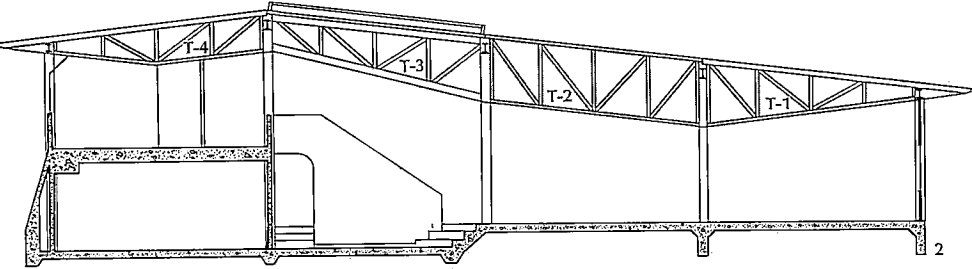
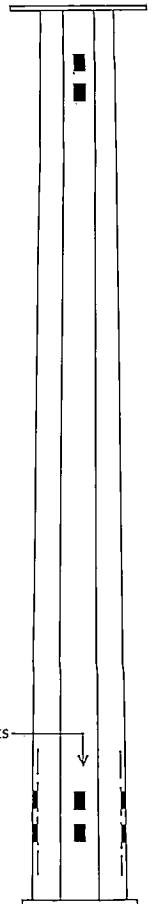
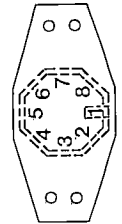
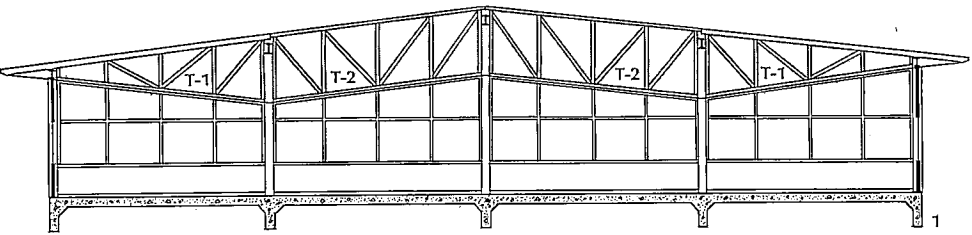
AMERICAN POLE STRUCTURES OFFICE BUILDING, Houston, Texas. Owner: American Pole Structures, Combustion Engineering, Inc., Linn Tranquilli, liaison. Architects: Clovis Heimsath Associates—project team: Clovis Heimsath, Kerry Goelzer. Interiors: Clovis Heimsath Associates. Engineers: Nat Krahl & Associates (structural); Rex Bullock (mechanical). Contractor: RAYKO Construction Company.

"A building with personality" was the instruction the client, a manufacturer of steel utility poles, gave architect Heimsath for their 8,000-sq-ft home office building in Houston. He responded with a building that neatly disposes three different types of space, giving prominence to the employees' lounge/refreshment area, and privacy for executives in the upper portion of the split-level space.

Because he thought splayed wood trusses would suit the building program, Heimsath showed the client a golf clubhouse in which he had used prefabricated wood trusses for visual interest in roof and ceiling lines, and for creating skylighted space (RECORD, September 1975). They liked what they saw, so the architect developed the three ceiling configurations shown across

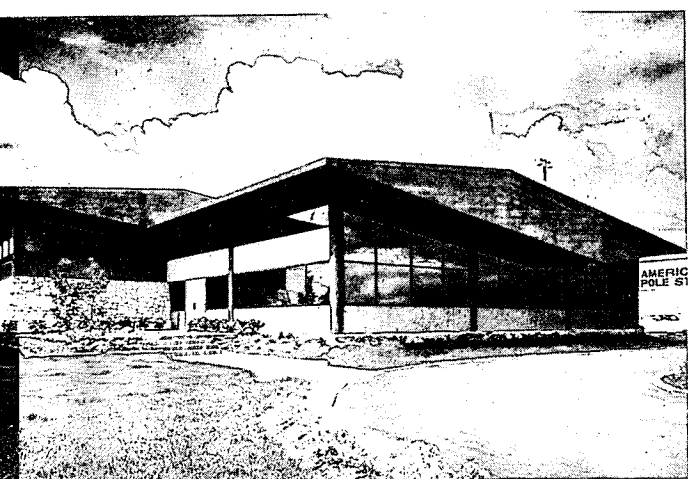
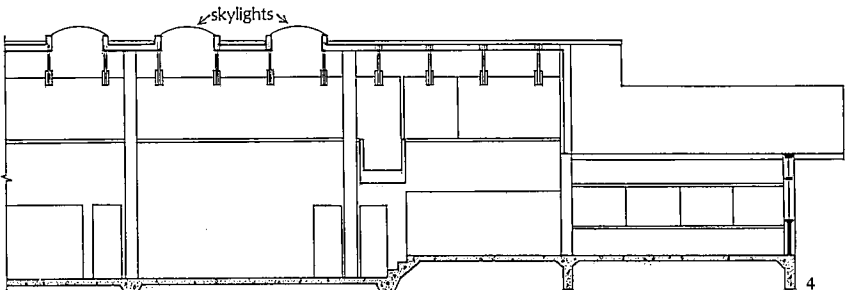
page. All of the wood trusses were factory fabricated with *Gang-Nail* connectors fastening the webs and chords, most of which are only 2 by 4's. The trusses are supported by steel beams and octagonal shaped utility poles *made by the owner*. Though the owner wanted to display their product, the poles neatly serve as chases for wiring.

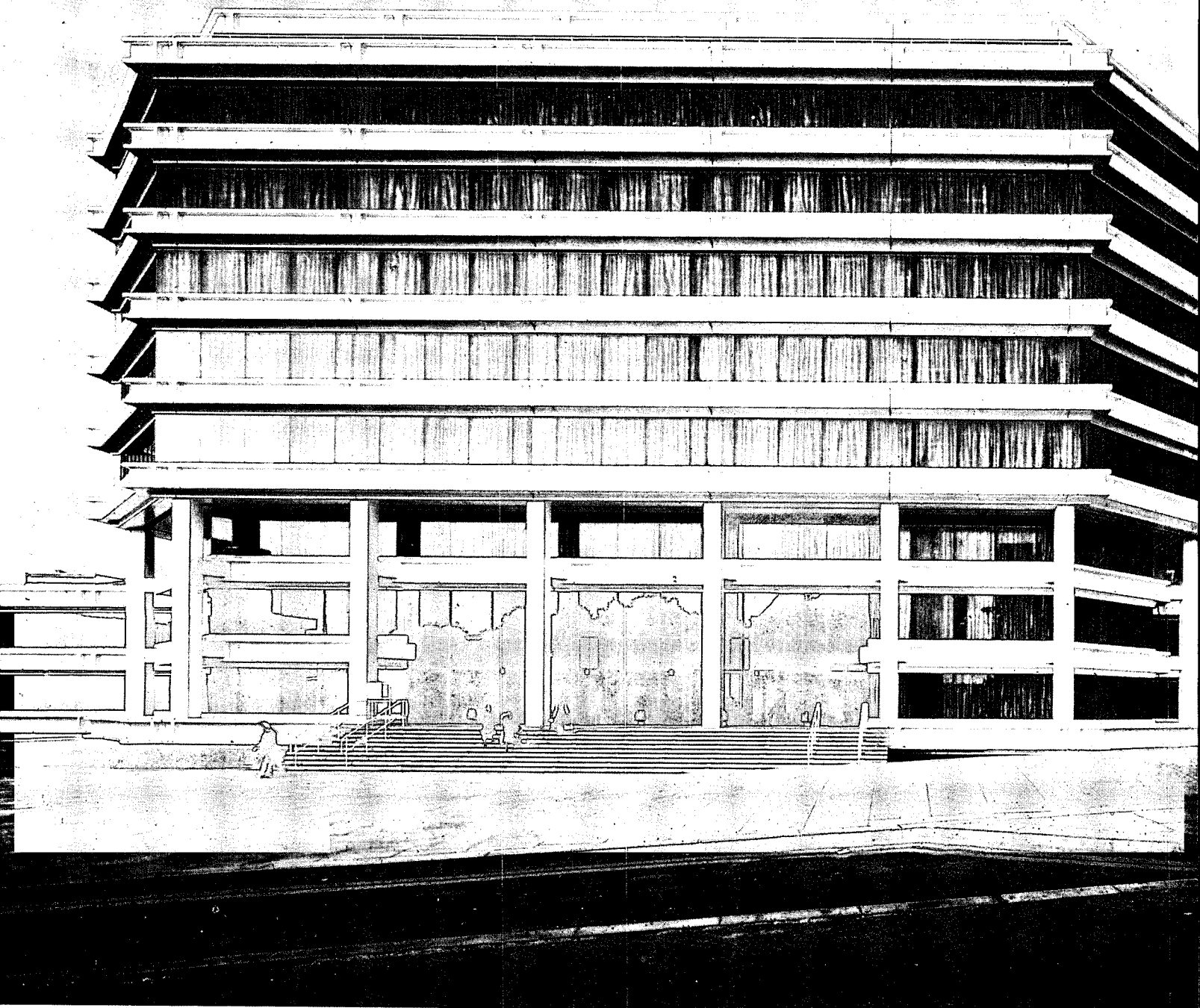
The building cost only \$28 per sq ft, and the architect attributes this to use of low-cost materials, exemplified by the trusses and by finish materials such as plywood and prefinished siding. Where the trusses are exposed over the lounge, care was taken in selecting lumber for appearance, and the bottom chords have 2 by 6's on either side to give a heftier look, to partially conceal the nail plates, and to provide a chase for wiring.



Only four different truss sections were required to produce the unusual roof/ceiling configurations shown above. All the trusses are enclosed (gray tone) except the ones over the lounge/refreshment area (see below).

Steel utility poles made by the building owner support the roof. The hollow space was conveniently used as a chase for wiring. Receptacles on the columns supply power to the open-plan furniture, which has integral raceways.





American Express builds on the English Channel in gleaming white plastic

AMEX HOUSE, American Express Headquarters Europe. Owner: American Express Company—Alun Price, project design and construction manager; Arthur Goodwin, project coordinator. Architects: GMW (Gollins Melvin Ward) partnership in association with Peter Wood Partners. Engineers: Zinn Burgess and Associates (structural); F.C. Foreman and Partners (mechanical/electrical). Consultants: Building Programs International; Peter Hodge and Associates (FRP panels); Cushman & Wakefield; Peter Corsell Associates (curtain wall).

Sheathed in sparkling white ribbed panels of plastic and bands of marine-blue glass, American Express' new European headquarters sits on a podium overlooking England's famed resort on the English Channel at Brighton, and in its palette and detailing reflects some of the ambience of this centuries-old resort. The broad plaza in front offers a large public space, and this, combined with the building's siting and landscaping, provides a transition to the surrounding clusters of row houses. Further, the form of the building allows maximum office space without blocking sun and daylight from the surrounding buildings. The tower was splayed at the corners to enhance daylighting.

Amex House, which opened last September, is the company's largest facility outside

the U.S., bringing together operations of their three main travel-related services, which were handled formerly by a number of offices in the county of Sussex, as well as in London. Reasons for selection of the Brighton site were the availability of skilled personnel, good telecommunications, and its proximity to London—only an hour's train ride.

The spandrel panels, most of which span about 24 ft between columns where they are supported by corbels, not only look structural, with their rib and flange sections, they are, carrying the 6½-ft-high glazing system of butted lights of blue glass—laminated to obtain the blue color the architect wanted. The spandrel materials were selected to withstand the exposure of the sea-coast air, and to maintain a pristine whiteness.

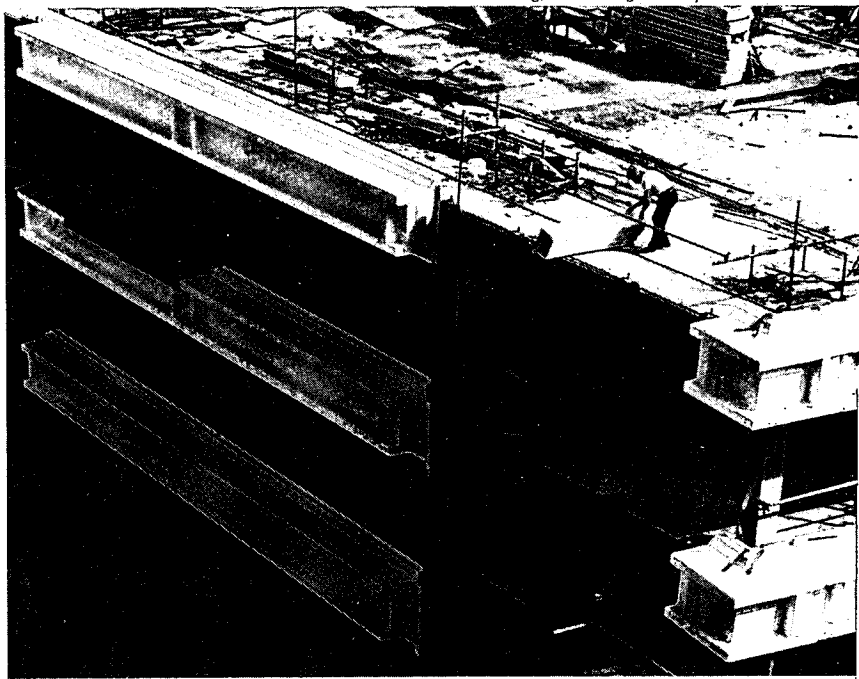


Richard Einzig, BrechtEinzig Limited photos

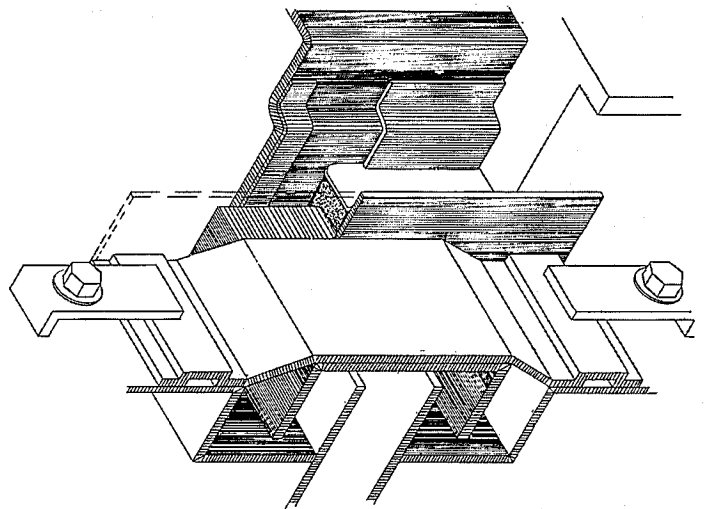
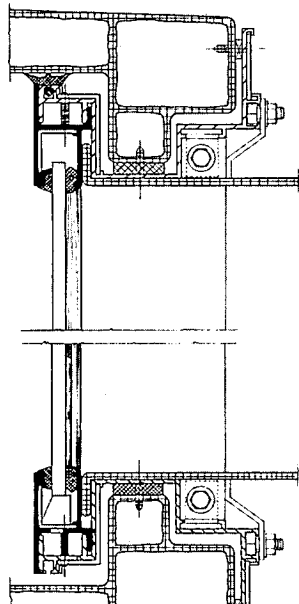
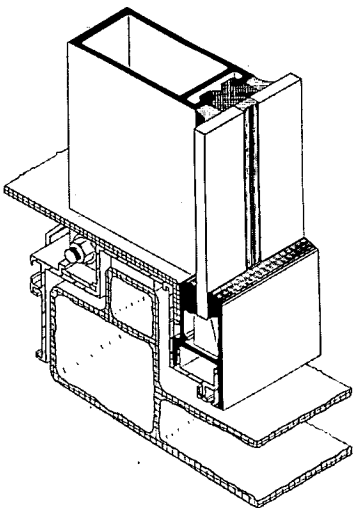
The spandrels are stiffened by the ribs and by box sections formed in the flanges. The elegance of the spandrel section is enhanced by the vertical board effect on the webs. The flanges, which work as beams, are connected by 4-in.-square preformed tubes on the rear side used to clamp the panels to the reinforced concrete corbels.

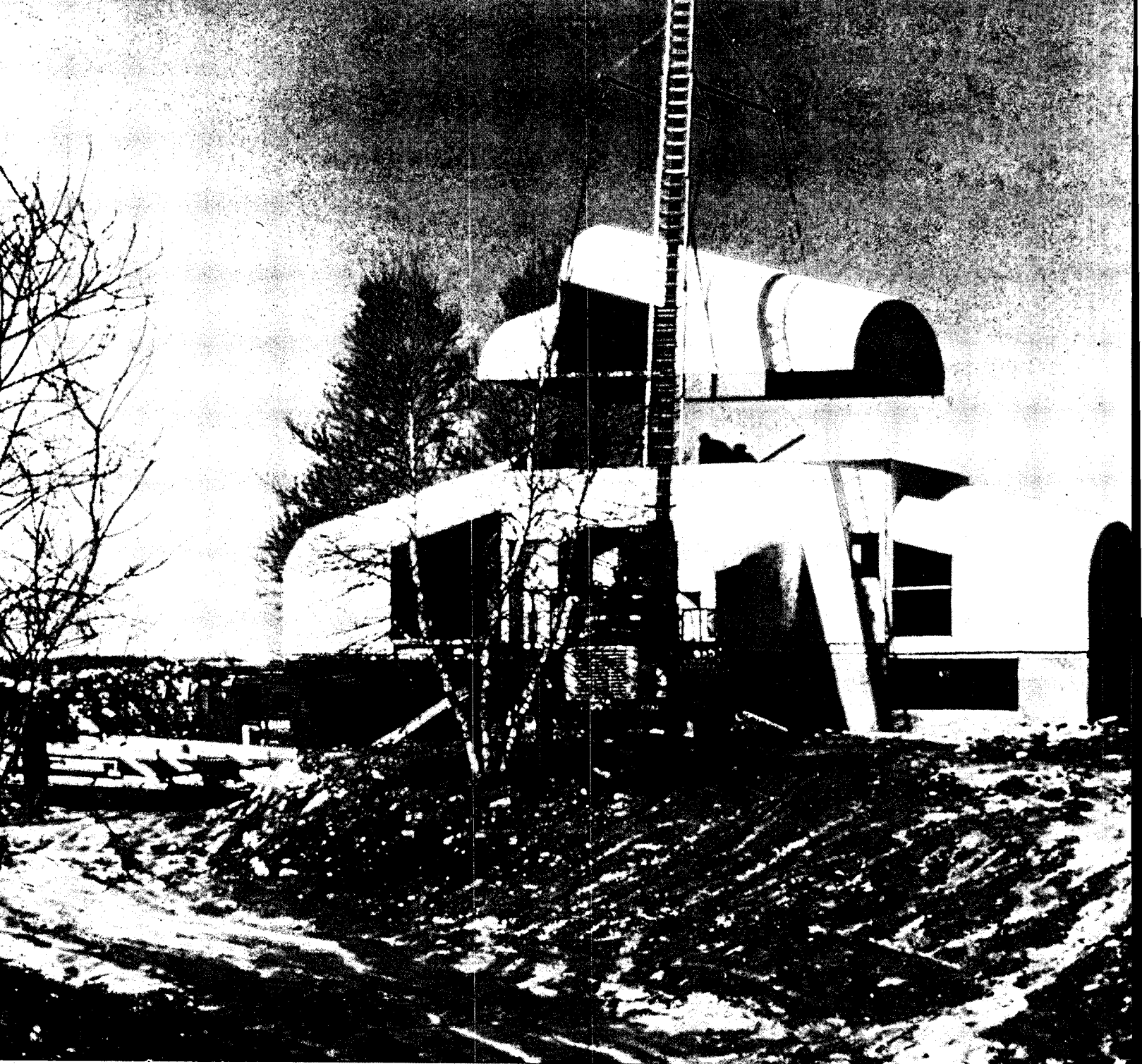
The material for the spandrels is glass-reinforced polyester (GRP, as it is known in England). The backs of the panels are separated from the occupied space by means of fire-resistive insulating panels.

A butt-glazing system with structural silicone sealant has been used, with sealant bonding to a neoprene spacer attached to the mullion. Details show glazing and the rain baffle at the spandrel joints.



Drawings: Peter Corsell Associates





“Plastic” shapes in architecture made from glass-reinforced plastics and concrete

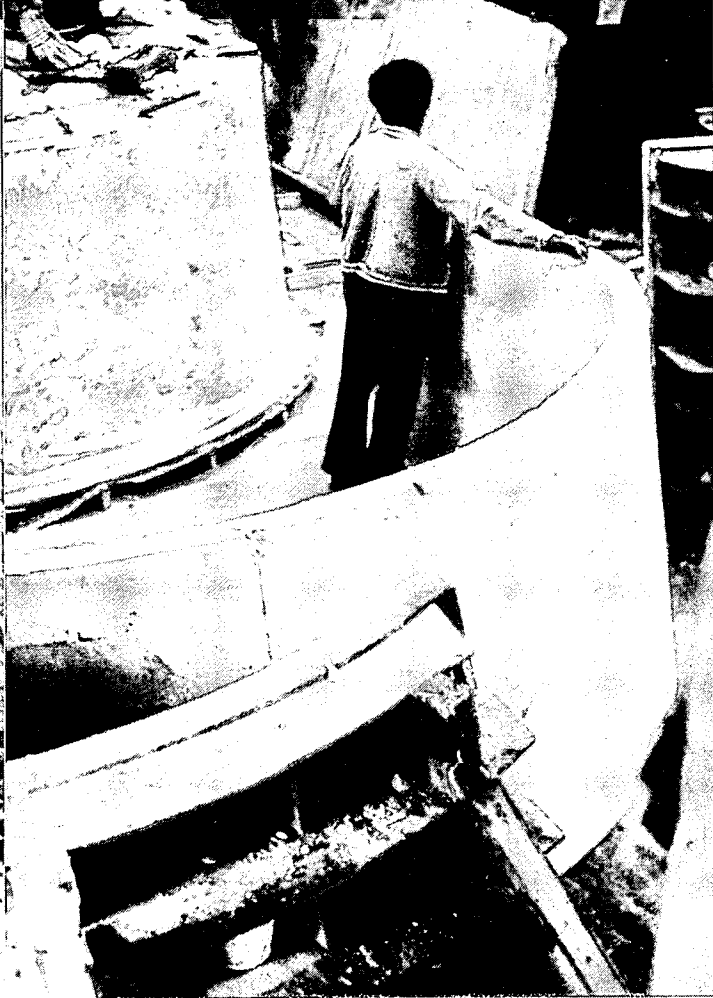
For several decades, the technological glamor and the unique physical properties of plastics have intrigued architects, but not until the last few years have they been used in architectural ways—taking on forms that mirror their structural characteristics and that are possible with accepted production methods. The spandrels of the Amex building in Brighton, England, made of glass reinforced polyester (GRP) are a notable exception. This compo-

nentized plastic house near New Haven, Connecticut, designed by Yale architecture graduate Valerie Batorewicz is another rare example of exploiting these materials. Dismayed by the quality of much of the housing she had seen both in Europe and in the U.S., she traveled the country in the hope of discovering an up-to-date technology that could lead to new forms and more interesting spaces. When she saw what was possible with the fiberglass-reinforced plastic (U.S. terminology) used for auto bodies, Valerie determined that, for a new approach, “this was the only way to go.”

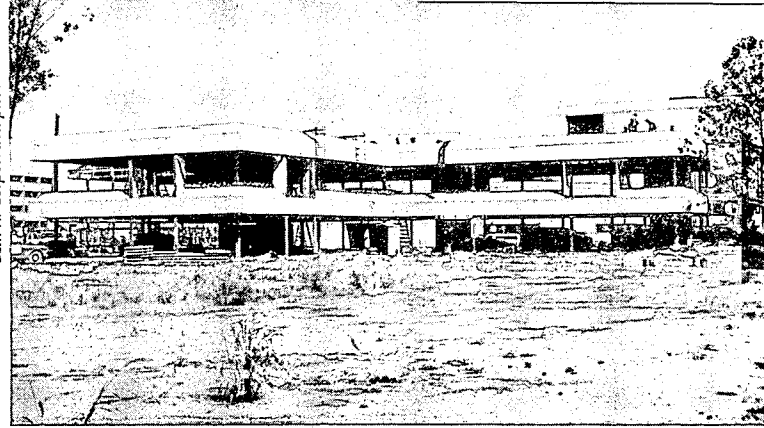
Thus inspired she found financial support privately, a client, and a factory to fabricate the house shown here for a site near New Haven. Up until 1975, the cost of this construction, called “Environ A,” for which she has a mechanical patent, was about \$22 per sq ft, she says. The construction was 3½

in. of isocyanurate foam with ¼ in. of FRP on the outside and ¼ in. FRP inside, both given a mineral coating as a fire retardant that looks like plaster, all painted with acrylic latex. The bathroom/kitchen cores, the floors and the end panels of the FRP sections were framed in wood (the end panels were framed in wood in order to speed field construction). To obtain approval from the state, Spiegel & Zamecnik, structural engineers for the building, conducted load tests.

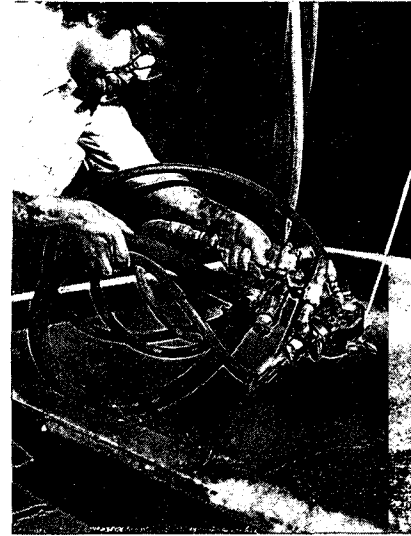
Because of higher petrochemical prices after 1975, a fabricator of FRP components, also in Connecticut, who built two dozen single-story houses with FRP, at a price competitive with “nicer homes,” has been investigating the possibilities of fiberglass-reinforced concrete (FRC)—used for some time in England and increasing in acceptance in this country (see photos across page showing fabrication methods and two examples).



Cam-Fil Corporation photo

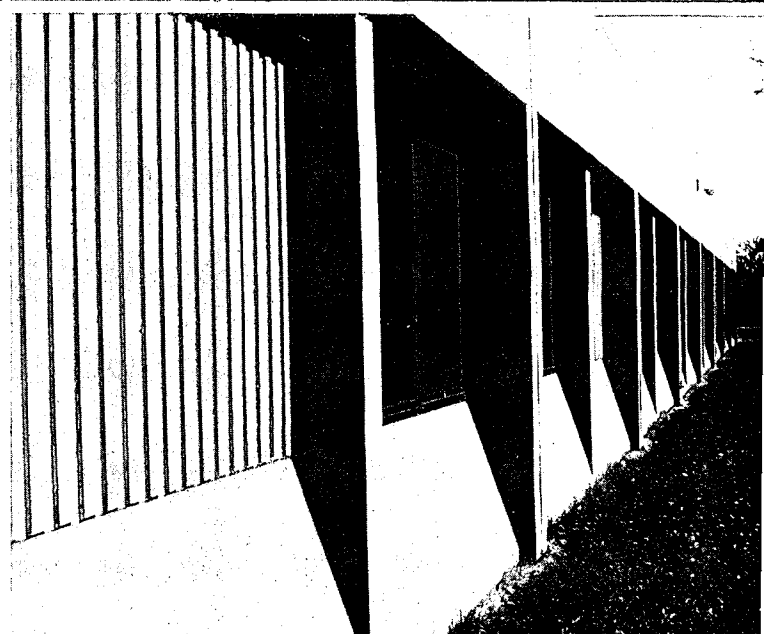
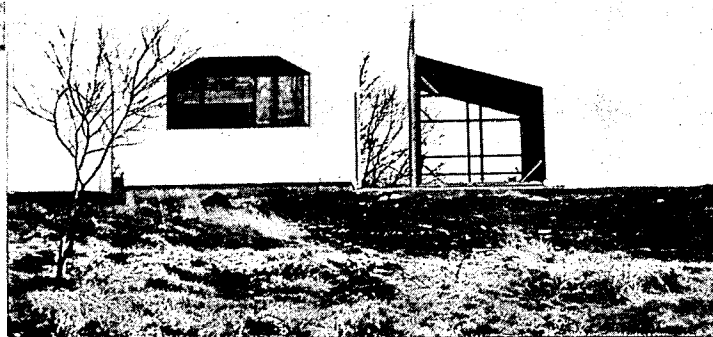
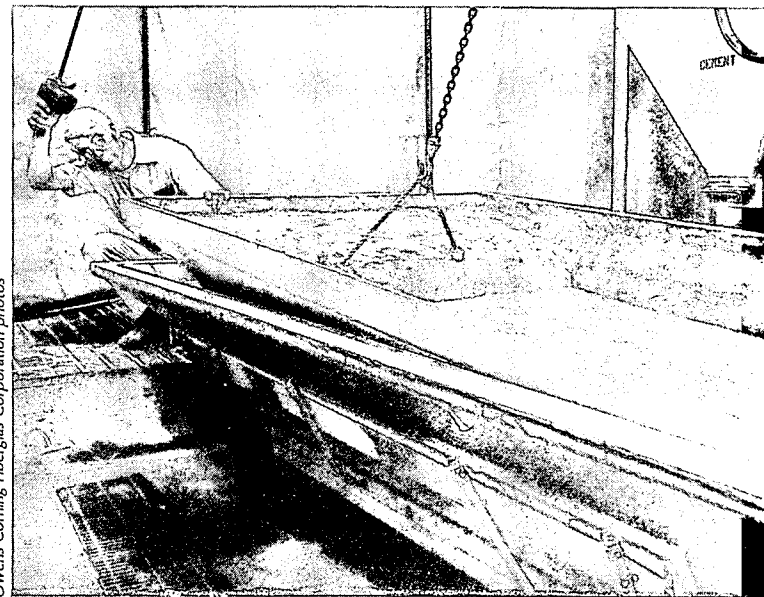


As the cost of resins has risen following the OPEC price jump in oil, interest has mounted in fibreglass-reinforced concrete (or glass-reinforced cement, as it is known in England, and to some extent here). Such a composite was not possible until an alkali-resistant glass fiber was developed by an English glass manufacturer. The building at top is a suburban office building of GRC in Nashville. The one at the bottom is the Lutheran Social Services Center in Minneapolis. Center photos show fabrication of FRC panels in molds at Concrete Technology, Inc., near Dayton, Ohio.



Sandwich construction for the 'plastic' house shown across page and below comprises a 3½-in. isocyanurate core for insulation with structural skins of fibreglass-reinforced plastic. The shell components were fabricated using molds of FRP braced by wooden wales. After the core was molded, the FRP layers were sprayed on.

Owens-Corning Fibreglass Corporation photos



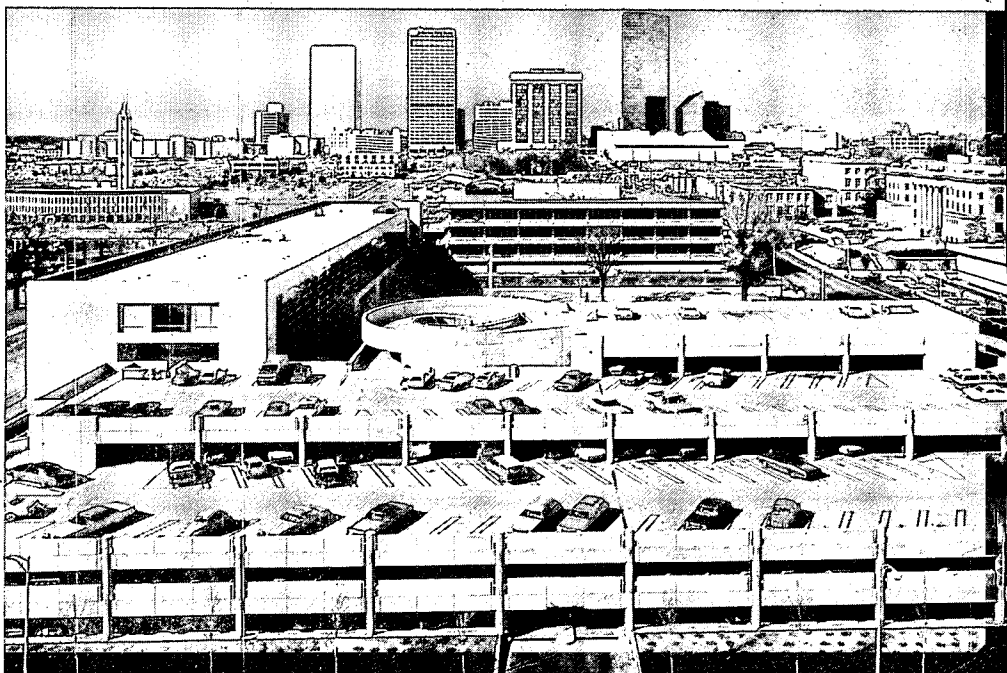
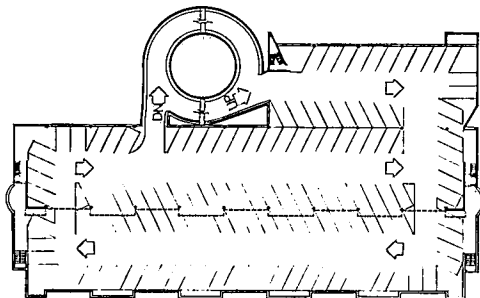
A thorough elucidation of forming technique underlies deft detailing for a concrete garage

The architects for this publicly owned garage in Charlotte chose architectural concrete as a finish material because it could serve as structure while also matching, at low cost, the buff-white facades of the adjacent county court house (limestone) and the facing county office building (precast concrete). Concrete also was a logical material for the helical drum that provides access to the second through fifth levels, and that, moreover, because of its turret shape and location on the landscaped courtyard, signals visitors to the court house where to park their cars.

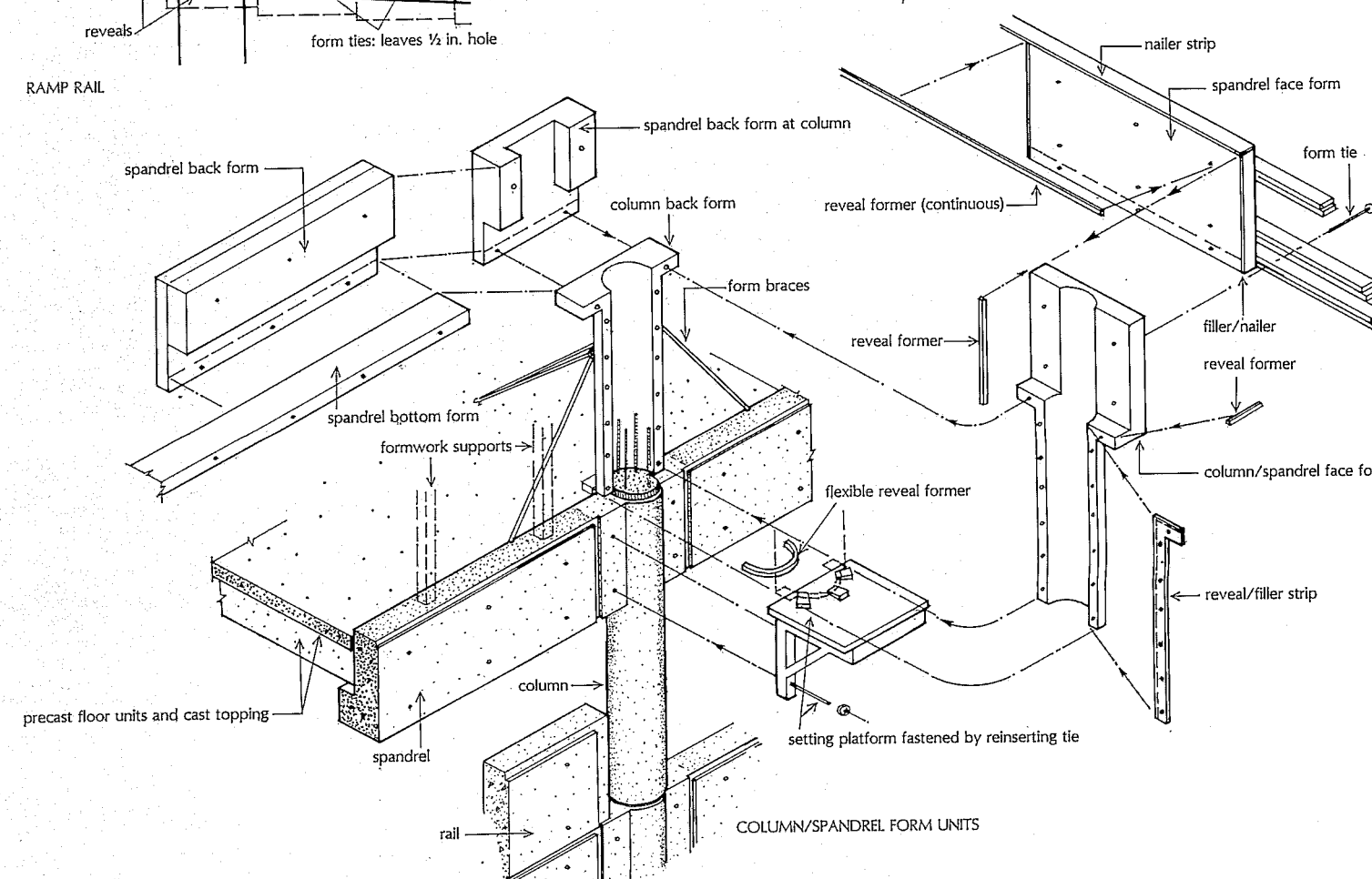
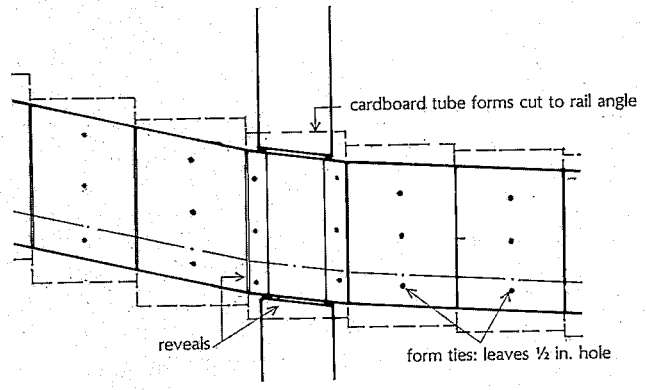
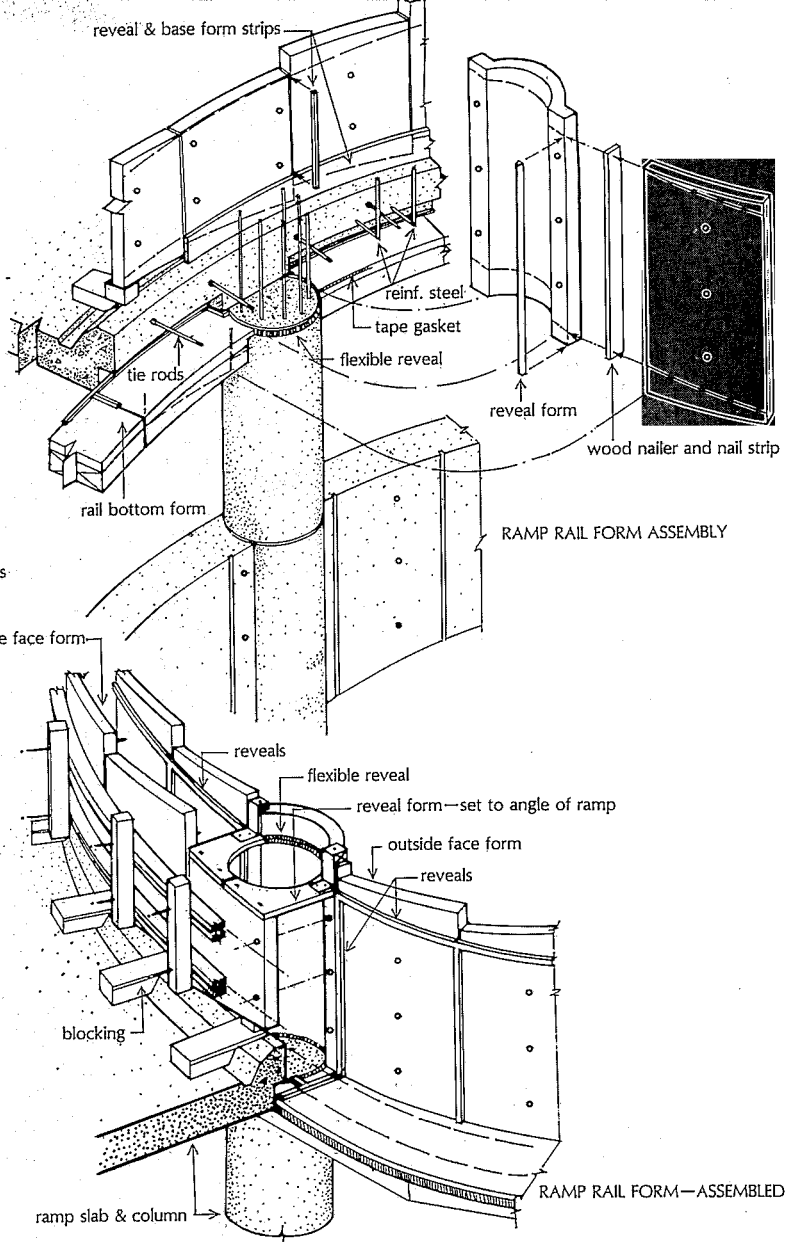
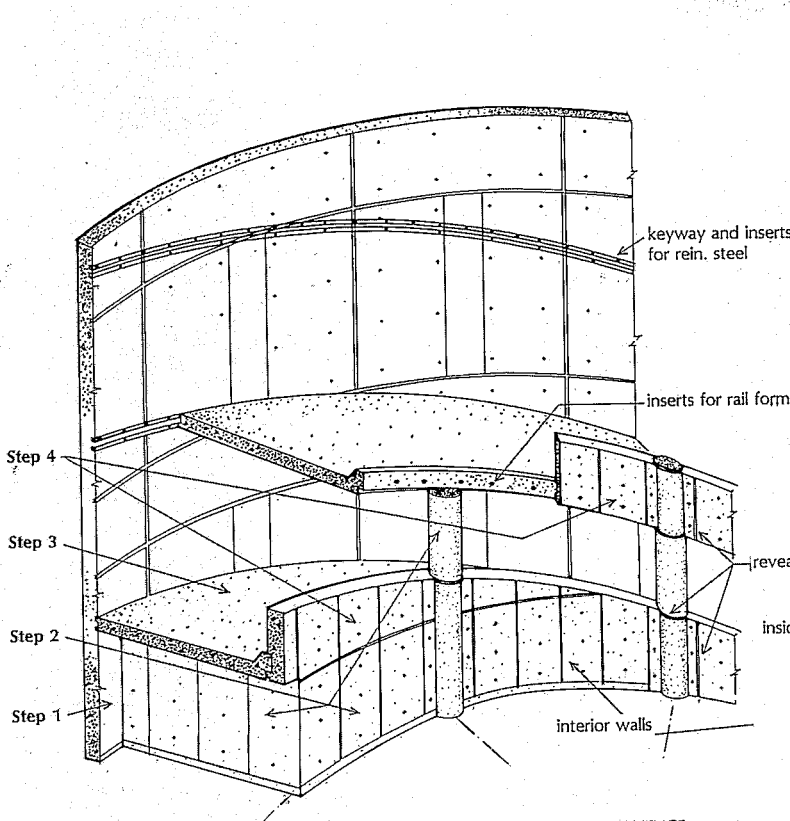
According to Gerald Li, partner-in-charge for the architects, the expression of the exterior grew out of their massing scheme for the structure: a series of three steps providing a smaller scale on the street side and rising to the four-story height of the other two buildings on the courtyard. The designers wanted to expose the columns so the tiers would "read" as a series of table-like units. The remaining articulation of the facade followed in logical progression. Because it would have been difficult to butt spandrel and column forms, the fiberglass (FRP) column forms were provided with haunches. This established a vertical reveal. The rail panels atop the spandrels were stopped short of the columns to show they are not structural, and have a reveal matching that of the haunch. Spandrel and rail forms were divided into three sections between columns for ease of handling, establishing remaining reveals.

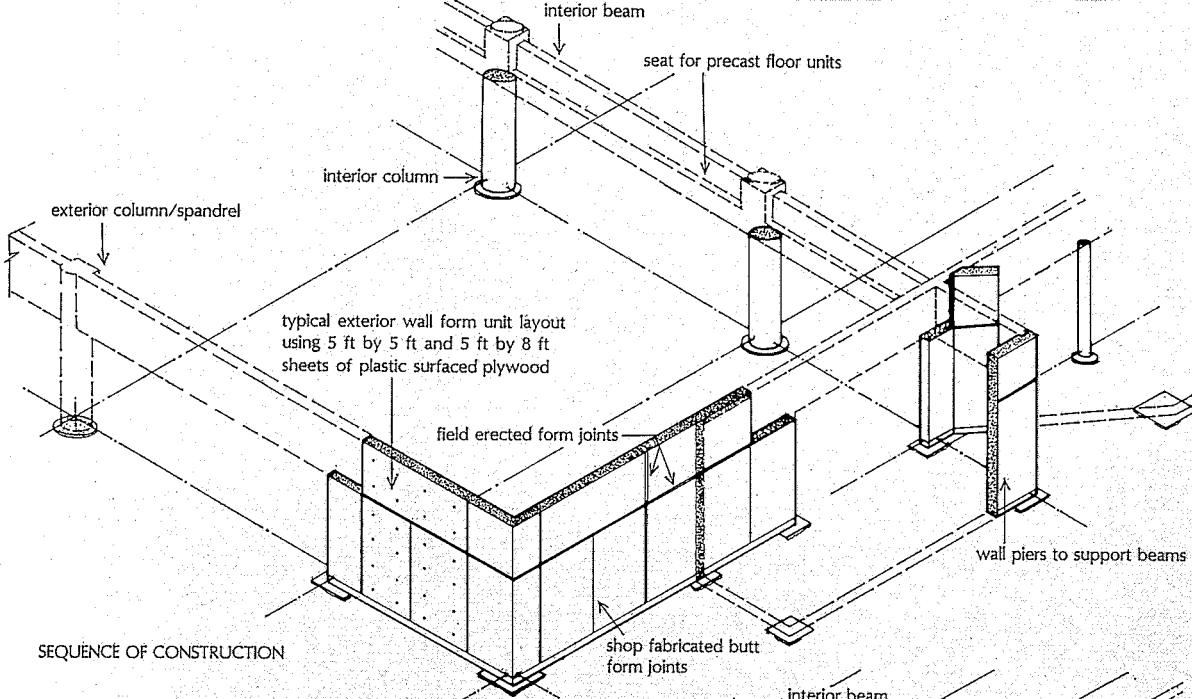
To ensure quality and to expedite construction, the architects engaged consultants Kelly/Hough, who not only developed a series of construction procedures and forming techniques, but, in a step unusual in construction circles, produced explanatory drawings to assist the contractor.

MECKLENBURG COUNTY PARKING STRUCTURE, Charlotte, North Carolina. Architects: *Clark Tribble Harris and Li, P.A.*—*Gerald Li, partner-in-charge; Roger Hinton, project designer; Thomas D. Byrum, job captain.* Engineers: *Clark Tribble Harris and Li (structural); Geotechnical Engineering Company (soils).* Consultants: *National Planning, Inc. (parking); Kelly/Hough, Inc. (concrete).* Contractor: *Hickory Construction Company.*



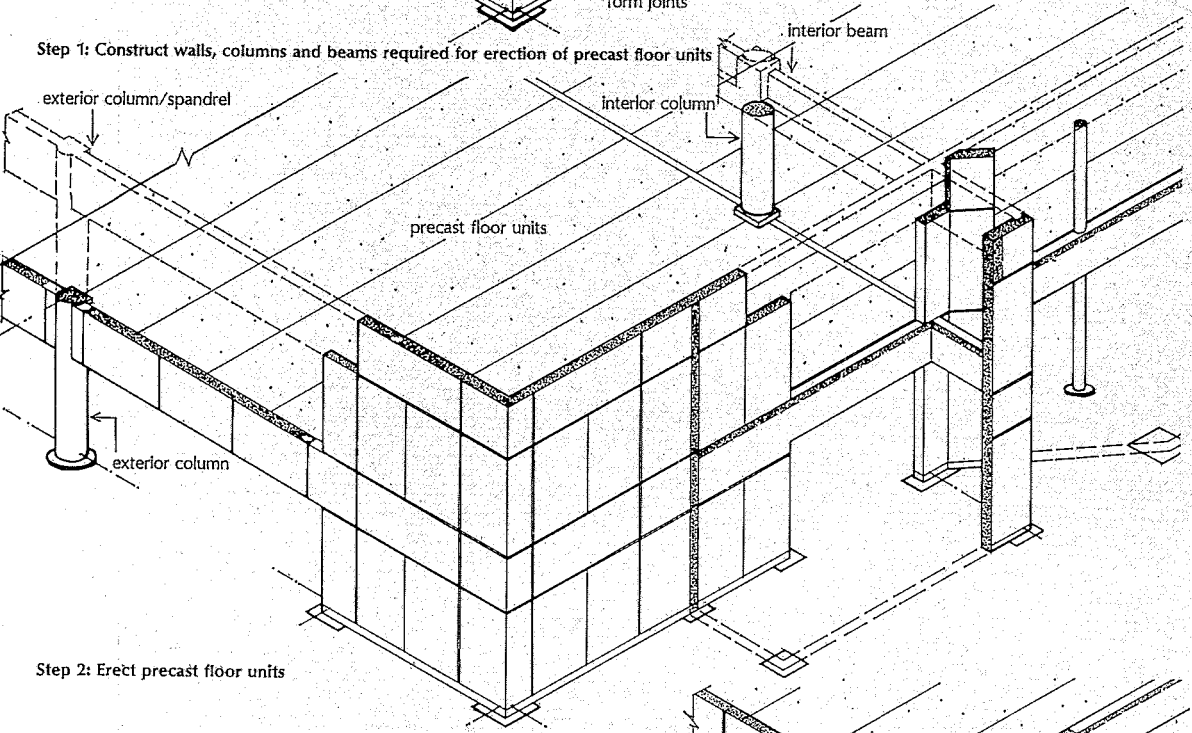
Rich L. Alexander photos



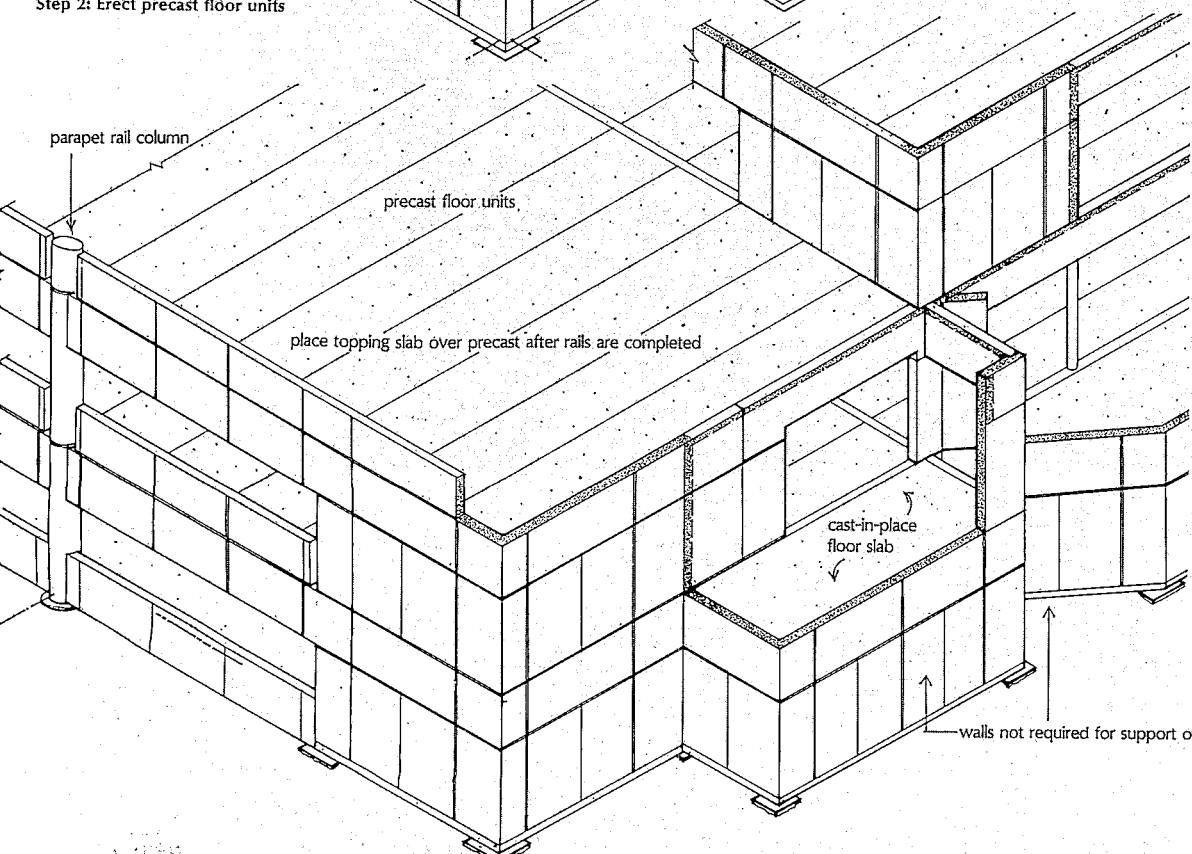


SEQUENCE OF CONSTRUCTION

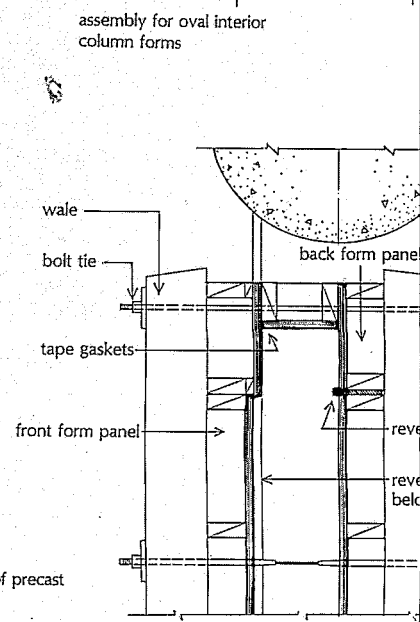
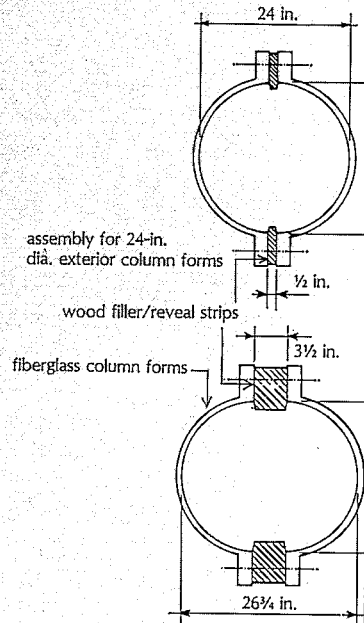
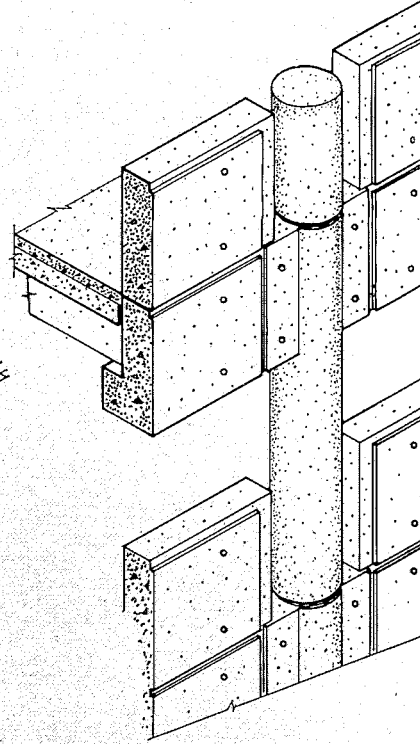
Step 1: Construct walls, columns and beams required for erection of precast floor units



Step 2: Erect precast floor units

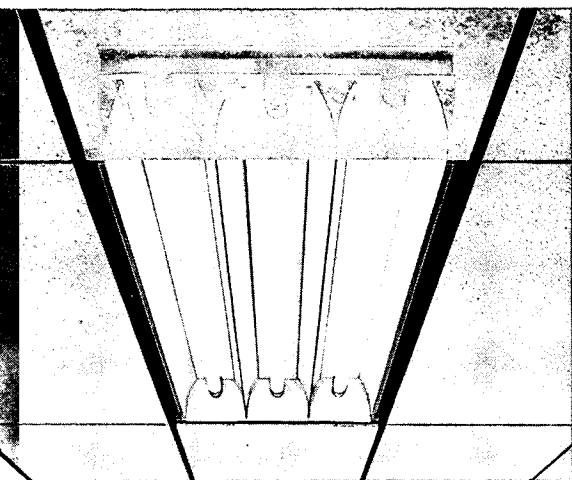


Step 3: Construct wall not required for the precast units; construct rails and place topping slab



RAIL FORMWORK

For more information, circle item numbers on Reader Service Inquiry Card, pages 169-170



Parabolic luminaire with new design

Called "X-Parabolic," this new luminaire is claimed to produce a higher light output than any other light fixtures and to be more energy efficient. The new unit has two major design departures: 1) it uses an open configuration without louvers or baffles which can absorb and waste light energy, and 2) its reflectors completely surround the fluorescent lamps, yielding maximum light distribution and an extra wide

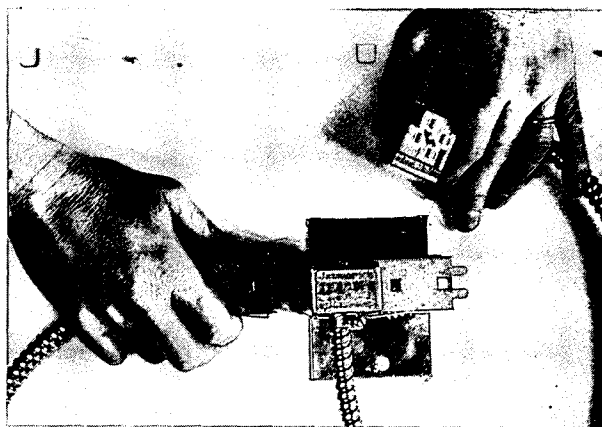
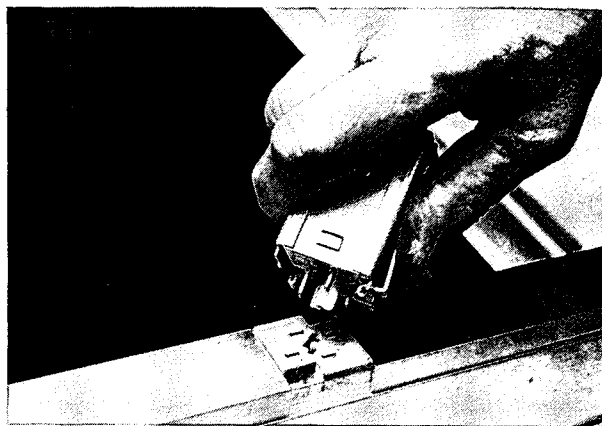
light beam pattern. The developers believe that because of this wide light beam pattern the luminaire may be used on 9- by 12-foot mounting centers while maintaining 70 foot-candles between rows at 1.4 to 1.8 watts per sq ft. The unit is available in one-, two-, and three-lamp fixtures with recessed, surface or suspended mounts. ■ Lighting Products, Inc., Highland Park, Ill.

circle 300 on inquiry card

Increased flexibility in office layout achieved with electrical raceway system

Now available from 3M Company's Electro-Products Division is an improved electrical raceway system, called "Power-T-Duct," to provide complete freedom for relocating lighting fixtures, receptacles, power poles and switches. The PTD system utilizes a series of extruded aluminum raceways that are available factory-attached to the main runners of a T-Bar suspended ceiling. Ceiling fixtures and "Communi-Power" poles (top right) may be plugged into the nearest outlet in the PTD raceway. A Jumper Cable system (right) is another improvement. Cable sets are totally metal enclosed and can be used with either the PTD system or hard wiring. Equipped with a positive-locking latch, power heads and receptacles are color coded and keyed to prevent voltage mismatch. Receptacles have feed-through circuit and ground wires for greater reliability of the system. ■ 3M Company, St. Paul, Minn.

circle 301 on inquiry card



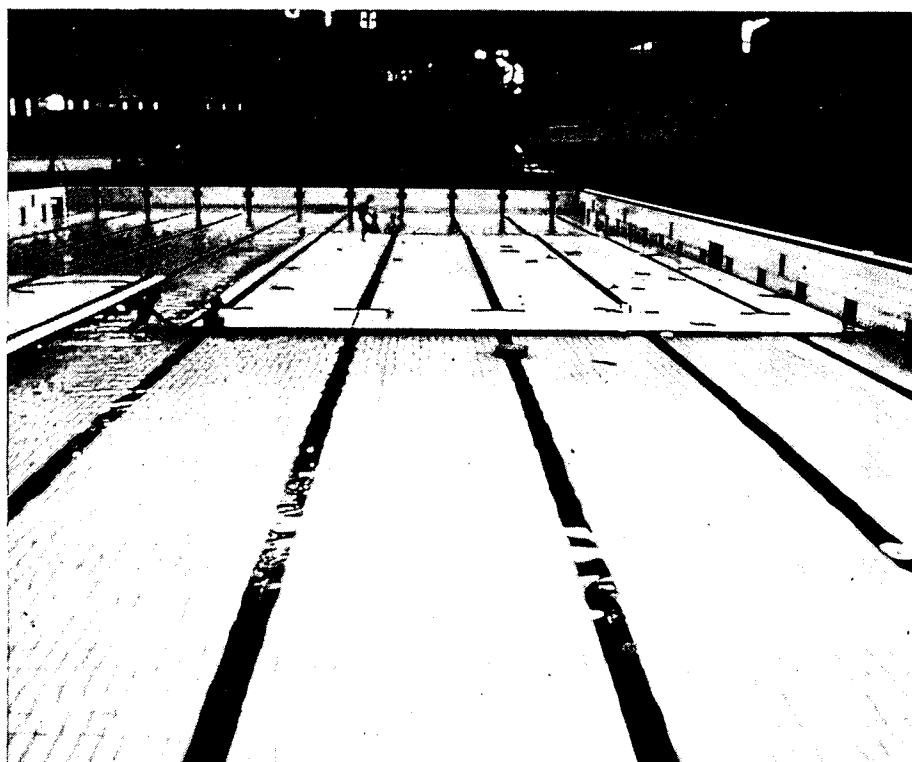
Adjustable-depth flooring available for pools

An adjustable-depth fiberglass floor for swimming pools has been designed to add versatility to pools used by competitive racers, every-day swimmers and instruction classes. The "floating floor" consists of two large main sections joined together in the center by a foot-wide grillework. The two sections are composed of smaller rectilinear modules, each containing a special casing with PVC piping hung underneath. The floor operates along the same principles as a submarine. To raise the floor, water is evacuated from the PVC piping by a positive displacement pump, and air is forced into the piping, raising the floor to the surface. Aluminum telescopic legs underneath each module are adjusted and secured, and the air in the piping is replaced by water, thus lowering the floor to the desired level. Following

the opposite procedure, of course, will lower the floor to its deepest level of 6 ft 2 in. (a depth meeting the Olympic competitive standards). Raising or lowering the floor can be accomplished in 20 minutes. Safety features include: the design of 30 legs for 500 sq meters of flooring for durability; a 6-in. metal grate along the perimeter of three sides of the floor that allows water to pass through but prevents a person's foot from becoming jammed between the wall and floor. Non-skid surfaces also cover the floor. The new floor can be retrofitted to existing pools without any drilling, attachment or modification to existing equipment because the flooring is a totally independent system. ■ Roski Ltd., Roxton Falls, Quebec, Canada.

circle 302 on inquiry card

more products on page 138



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ARCHITECT
ENGINEER
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MECHANICAL CONTRACTOR
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Don't let lackluster finned-tube enclosures spoil an imaginative interior.

Sterling custom enclosures are made to order to enhance your design.

Finned-tube enclosures don't have to be a dull afterthought. Or a necessary eyesore. In fact, they can be an aesthetic plus.

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At Sterling, we build custom enclosures that really look customized. Rugged and functionally efficient. Yet with a respect for form

that preserves the integrity of an imaginative design.

The range of Sterling's metal fabrication capabilities is unsurpassed in the industry. Enclosures of meticulously finished reinforced steel as thick as 14 gauge, as well as stainless, aluminum, anodized aluminum, and vinyl-clad assemblies are all everyday fare at Sterling.

But we love a challenge, too. You'll find that Sterling people aren't afraid to explore innovative concepts and designs. We won't blunt your imagination, either, by telling you that what you want is "unavailable."

At Sterling, we build enclosures to meet your needs—not ours.

So go ahead. Let your imagination run wild. Drop us a line and we'll send you more information on Sterling custom enclosures along with some recent application case histories to help you get started.

We think you'll find them anything but dull.



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For more information, circle item numbers on Reader Service Inquiry Card, pages 169-170

KEYED SWITCH SECURITY / Keyed electric switches are secured by lock cylinders with an interchangeable core; a control key permits removal and replacement of locks in seconds. This masterkey system is suitable for lighting panels, elevators, lifts, overhead doors, machinery, etc.; an illustrated flier lists circuits, pole types, voltages, amperage, and on/off variations ■ Best Lock Corp., Indianapolis, Ind.

circle 400 on inquiry card

PLAIN-PAPER COPIER / A dry toner copier with an automatic paper cassette feed system, the "Model 1620" table top machine also has an "Express" by-pass feeder for making copies on unusual size and shape paper, even letterheads, without changing paper cassettes or adjusting the unit in any way. Product literature describes the "1620" 's advantages to architects, draftsmen and other users who routinely handle oversize originals. ■ Océ Industries, Inc., Chicago, Ill.

circle 401 on inquiry card

ENGINEERED WOOD TRUSS DESIGN / A loose-leaf bound manual provides both technical and general information for use in the design of proprietary roof and floor structural systems. It includes residential, commercial, industrial and agricultural applications in a presentation designed specifically for use by architects and engineers. The "Alpine Truss Architectural and Engineering Manual" is available for \$15.00, plus \$2.00 shipping and handling, from Alpine Engineered Products, Inc., P.O. Box 2225, Pompano Beach, Fla. 33061.

SPLIT SYSTEM AIR CONDITIONERS / High EER split system units, available in capacities of 2 to 30 tons, are offered with a choice of 10 blower coil units and 12 air cooled condensing units. Units can be operated in 40F ambient weather to provide mechanical cooling. Complete mechanical details, selection, performance and application data is given in a 48-page product manual. ■ ITT Nesbitt, Philadelphia, Pa.

circle 402 on inquiry card

LARGE-SCALE READOUTS / A color brochure depicts some of the commercial applications of the *Digilite* large digit electronic clocks and displays. These indoor uses include, bedside time/temperature data, scoreboards, monitors and silent paging, transit information, etc. An optional multi-color and pulse feature enables the user to have an automatic visual alarm capability: i.e., changing from green to red with or without flashing display in emergency situations such as a security alert in department stores. Design and construction information is given, along with options and complete mounting dimensions for both displays and clocks. ■ Tele-Signal Corp., Hauppauge, N.Y.

circle 403 on inquiry card

CERAMIC PAVERS / Fully illustrated with close-up and on-site color photos of individual ceramic pavers, two product brochures introduce *Paverstone* and *Normandie* thin pavers. Flame-fired in a range of brown, red and burnt umber tones, these ceramic tiles are available natural or glazed for a variety of commercial or residential uses. Standard sizes up to 10- by 20-in are available nationally. Technical data and installation suggestions are included in the brochure ■ Metropolitan Ceramics, Canton, Ohio.

circle 404 on inquiry card

WINDOW TREATMENTS / An illustrated product catalog features the "Westwood" window blind, a 1-in.-narrow slat blind made of premium California cedar. The "Westwood" and other custom wood window coverings are available in a variety of stains. ■ OHLinc Corp., Gardena, Calif.

circle 405 on inquiry card

FASTENING SYSTEMS / Written specifically for architects and engineers, a 46-page handbook provides complete information on the features, applications, selection criteria and other pertinent details on powder-actuated fastening systems and expansion anchors. Code approvals and field and lab test data are included for each system. ■ Ramset Fastening Systems, Brandford, Conn.

circle 406 on inquiry card

CALIBRATION SERVICES / A completely revised catalog of "Calibration and Related Measurement Services of the National Bureau of Standards" is now available from the U.S. Printing Office. The catalog, last updated eight years ago, presents detailed descriptions of all currently available NBS calibration services as well as other measurement-related services, including the new Measurement Assurance Programs. Typical entries include not only the type of instrument accepted for calibration, but also the test methods that will be used, references to the applicable industry standards, and a selected bibliography of technical references for further information. Current price lists and changes in service will be published in an appendix, published every six months. SP 250 may be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for \$3.00. Request Stock Number SN-003-01916-0.

SIGNS AND PLAQUES / Standard and custom sign systems are featured in a full-line catalog. Other products listed are memorials, awards, directories, control panel faces and nameplates. Materials used include fiberglass, wood, glass, marble, aluminum, stainless steel and brass. ■ Best Sign Manufacturing Co., Kansas City, Mo.

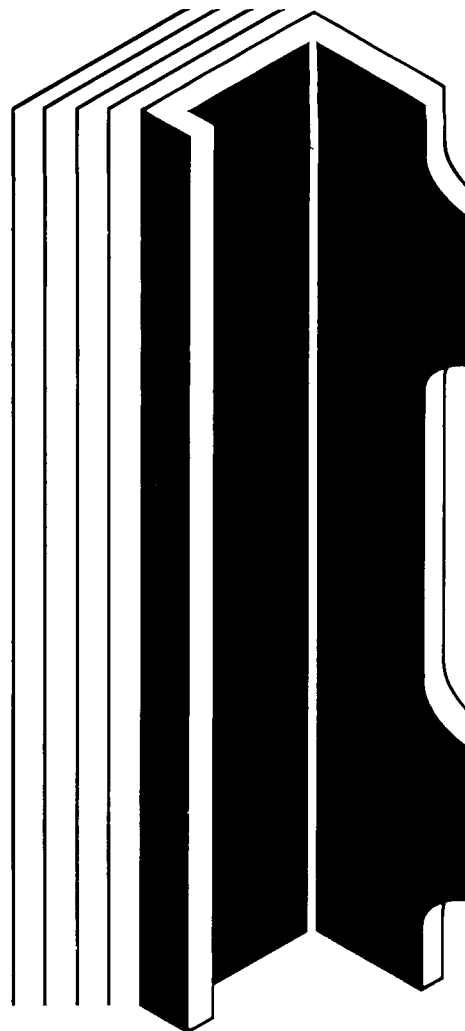
circle 407 on inquiry card

PARK SHELTERS / Three shelter styles suitable for parks, golf courses, rest areas, recreation centers, institutions and private homes are shown in a color brochure. Available in a pre-fabricated package, the wood structures have supporting columns and fascia, which have been pressure-treated with preservative chemicals for protection against termites and decay. Shelters range in size up to 50- by 84-ft. ■ Koppers Co., Inc., Forest Products Group, Pittsburgh, Pa.

circle 408 on inquiry card

ADJUSTABLE FOCUS LUMINAIRE / Said to allow the architect to create a coordinated environment from the walls of buildings to pole-mounted areas, the *Paracyl* luminaire has an adjustable focus for precise cutoff control; the glare-free units have a large number of mounting variations. A 12-page color brochure suggests several applications of the luminaire, including a hospital and surrounding parking areas, urban area lighting, and mass transit and highway uses. Photometric and dimensional data are given; options and accessories are also included. ■ Moldcast Lighting, Pine Brook, N.J.

circle 409 on inquiry card



IS GAGE ENOUGH?

When you specify 16 gage material for a light gage load-bearing steel stud, you might assume that you'll get the same stud—no matter who your supplier. And if gage were the only consideration, you could be right.

But it isn't. You know that the yield strength of the steel is just as important. For example, members of the Metal Lath/Steel Framing Association form 16 gage and heavier members from high strength steel with a minimum yield point of at least 50 ksi. *Not commercial quality steel that looks the same but won't carry the load.*

Is gage enough? Be sure. Write for a copy of our *Light Gage Steel Framing Specifications*.



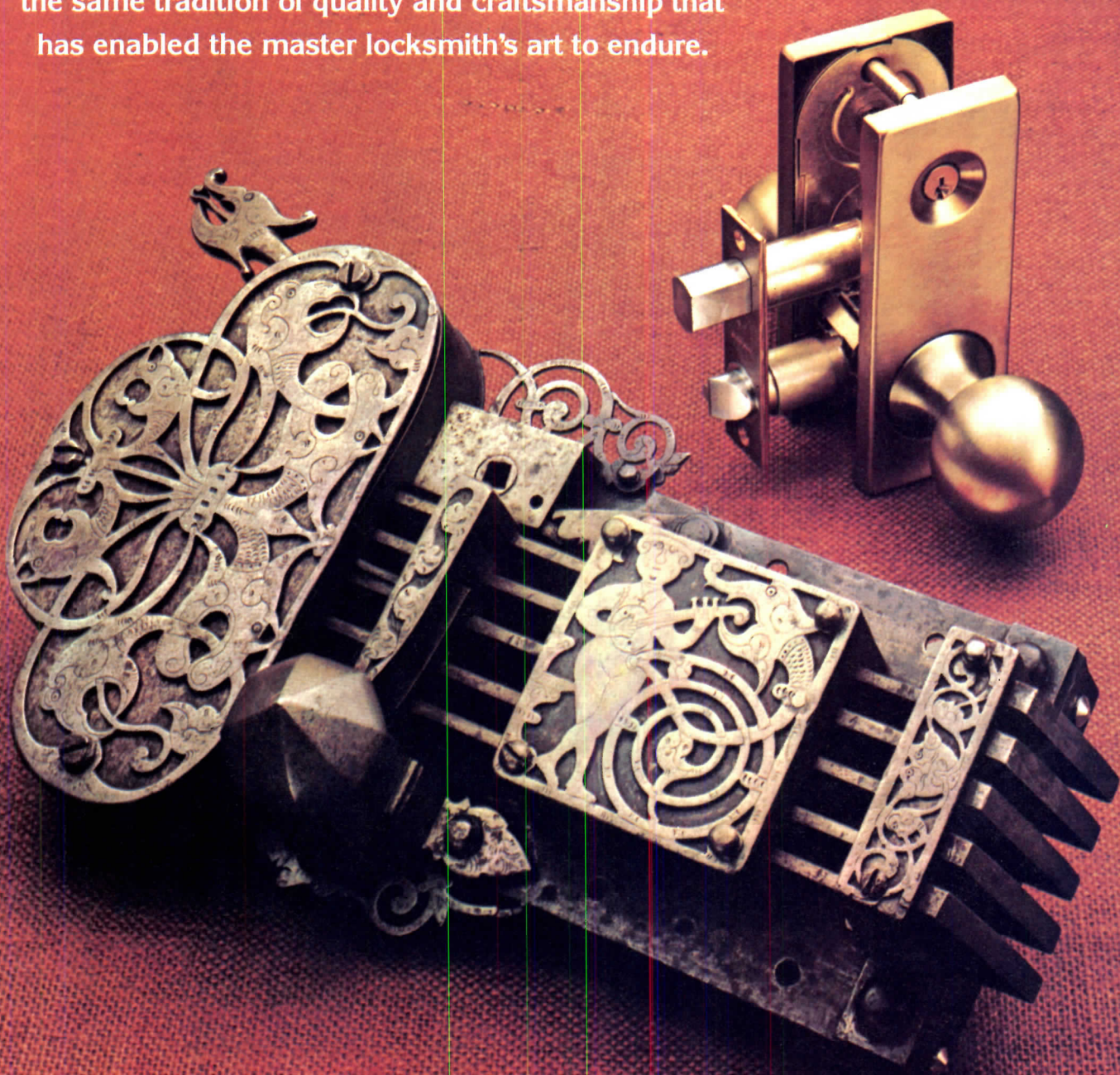
**Metal Lath/
Steel Framing Association**
221 North LaSalle Street
Chicago, Illinois 60601

For more data, circle 53 on inquiry card

Quality Endures

In 1600 it took a German craftsman more than a year to create this unique five-bolt castle lock.*

Schlage's Double Security "G" Lock is built in the same tradition of quality and craftsmanship that has enabled the master locksmith's art to endure.



SCHLAGE

The World's Most Respected Name in Locks!

*Courtesy of the Schlage Antique Lock Collection.

For more data, circle 54 on inquiry card

DOCUMENT SHREDDERS / Confidential documents, as well as all types of office trash, computer cards, printout sheets, carbon paper, and general refuse are reduced to unintelligible scraps by the hopper-type shredders described in a product data sheet. Said to operate quietly without producing dust, the shredder can be combined with a compactor to reduce the volume of shredded material 50 to 65 per cent. No hoods or special power are required. ■ Kleco Shredder Systems, Inc., Brecksville, Ohio.

circle 410 on inquiry card

CONCRETE FORM / An extensive range of end use projects, including water treatment plants, is described in an eight-page illustrated brochure on *FormGuard* high-density overlaid plywood concrete form panels. The lightweight forms normally produce 50 to 75 re-uses, according to the brochure, which also includes information on design procedures and considerations for forming fabrication. ■ Simpson Timber Co., Seattle, Was.

circle 411 on inquiry card

CART CONVEYOR / A four-page brochure describes the *ACT* (automatic cart transportation) system, a power-and-free conveyor that moves material and supplies horizontally and vertically throughout a hospital. Photos show the conveyor in use; a typical installation is diagrammed. ■ American Chain & Cable Co., Inc., Bridgeport, Conn.

circle 412 on inquiry card

LAMINATED CONSTRUCTION PANEL / A low-maintenance panel designed to overcome problems caused by moisture and humidity, *Korelock* walls have two exterior panels laminated to a core. An illustrated brochure explains how this core design ensures that the natural impact of temperature variation will be equally dispersed throughout the laminated panels, reducing or eliminating the need for separate insulation materials. ■ Marlite Div., Masonite Corp., Dover, Ohio.

circle 413 on inquiry card

RESIDENTIAL SIDING / Before and after drawings of five home styles illustrate a "Re-siding Styling Guide" featuring *Colorlok*, *CypresSide*, *Woodsmen* and *Stuccato* brand hardboard sidings. ■ Masonite Corp., Peoria, Ill.

circle 414 on inquiry card

DECENTRALIZED HVAC / A 12-page brochure lists the advantages to building owners, tenants, architects and contractors of Climate Master series decentralized air conditioning and heat recovery systems. EER ratings and cooling performance data are listed; the brochure is illustrated with drawings of building projects using these packaged terminal units and water-to-air heat pumps. ■ Friedrich Air Conditioning & Refrigeration Co., San Antonio, Texas.

circle 415 on inquiry card

REPLACEMENT WINDOWS / Custom-fit residential, light commercial, and high-performance replacement windows are shown in a 16-page catalog. The booklet includes brief product specifications and cross sectional drawings of over 30 double- and triple-hung, slider, and picture replacement windows and insulating panel frames. Featured units are new gothic and circle-top windows with operating top sashes; a stacking and joining system that permits installation of multiple units in large window openings is also discussed. ■ Season-all Industries, Inc., Indiana, Pa.

circle 416 on inquiry card

RECORDS STORAGE / "How to unboGGLE your records storage & retrieval system" is a 24-page booklet that describes the "Filing Cycle," and suggests areas to reduce the labor involved in filing and finding needed material. A complete line of document handling products, from simple file folders to electrically-operated track-mounted shelving, is described in text and pictures. ■ Sperry Univac/Office Equipment, Blue Bell, Pa.

circle 417 on inquiry card

EPOXY FLOORING / Said to be more durable and less expensive than terrazzo surfaces, *Dur-A-Quartz* flooring combines 100 per cent liquid epoxy with uniform-size quartz aggregates. The non-porous, 1/8-in.-thick floor can be applied and ready for use overnight; *Dur-A-Quartz* resurfacer is USDA-approved and meets OSHA requirements.

■ Dur-A-Flex, Inc., Hartford, Conn.

circle 418 on inquiry card

REPLACEMENT WINDOWS / Specific solutions to energy loss in windows are given in a 16-page catalog of custom-fit residential, industrial, and commercial replacement windows. Specifications and cross section detail drawings of more than 30 double- and triple-hung, slider and picture windows and insulating panel frames are included; installation procedures are illustrated. ■ Season-all Industries, Inc., Indiana, Pa.

circle 419 on inquiry card

WRITING BOARDS / A color guide and product specifications are contained in a brochure describing porcelain-on-steel *WhyteBoard* writing boards for business, schools and industry. Also included are photos of various installations including a functional wall, a wall-mounted unit, an easel model, a mobile board, and custom fabrications.

■ Alliance Wall Corp., Alliance, Ohio,

circle 420 on inquiry card

Granite.

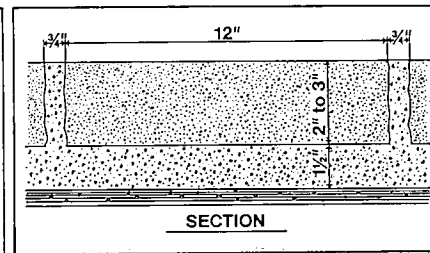
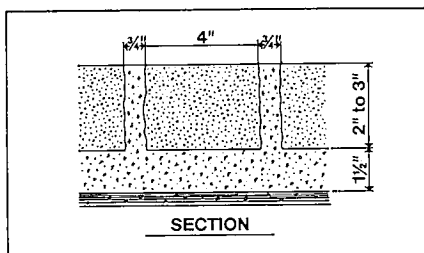
Beautiful for heavy traffic areas.



Architects: Lawrence Halprin & Associates



Architect: Joe Karr & Associates, Chicago, IL



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WASHERLESS FAUCETS / Twin-handle sink faucets, lavatory, bath and shower fittings have been added to this manufacturer's line of washerless faucets. The washerless cartridge is interchangeable among all fittings. The "Riviera" style shown is offered in either polished chrome or antique brass finishes; handle designs include clear or smokey acrylic as well as the brass or chrome.

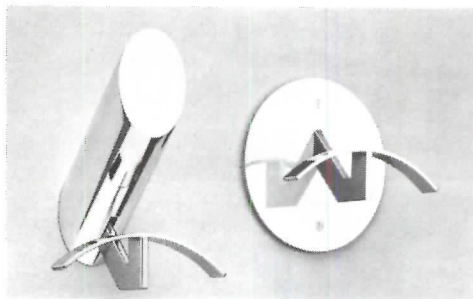
■ Crane Co., Plumbing Div., New York City.

circle 303 on inquiry card



CONTRACT SEATING / The "9000 Series" guest and conference chairs are now available with a Gyron sled-type base as shown. The smooth chromed runners are easily moved on carpet, and serve as glides on hard-surface floors. ■ Cramer Industries, Inc., Kansas City, Ka.

circle 304 on inquiry card



COAT HOOKS / Made of polished chrome steel, the contemporary design pictured is one of 23 different coat hooks offered for office use singly or grouped. Ornate brass hooks, clear plastic cylinders, panels of coat hangers, and slatted shelf designs are included in the line. ■ Vogel-Peterson, Elmhurst, Ill.

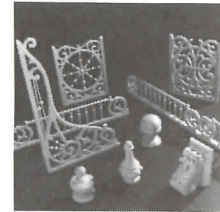
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FLUORESCENT LIGHT FIXTURE / The "BV48/48" fixture uses standard 2- by 4-ft lay-in acoustical ceiling panels for its vaulted sides; the splayed sides of the vault provide 46 per cent more sound absorbing surface than an equivalent 2- by 4-ft lay-in fixture. The prismatic lens is said to produce high lighting efficiency with reduced brightness. The UL-listed fixture includes lens, 20 gauge steel housing and end caps; the "BV48/48" is designed to fit a 48-in-sq module using standard inverted T-bar suspension installation. ■ Conwed Corp., St. Paul, Minn.



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MILLWORK / Authentic Victorian designs in kiln-dried hardwoods are available for commercial and residential applications. The line includes solid wood fretwork, privacy panels, brackets, turnings, wainscoting, special moulding and trim. Each item is manufactured using a combination of machine and handwork, said to provide faithful reproductions at costs well below those of genuine artifacts. Custom designs may be supplied to individual specifications. ■ Cumberland Woodcraft Co., Carlisle, Pa.



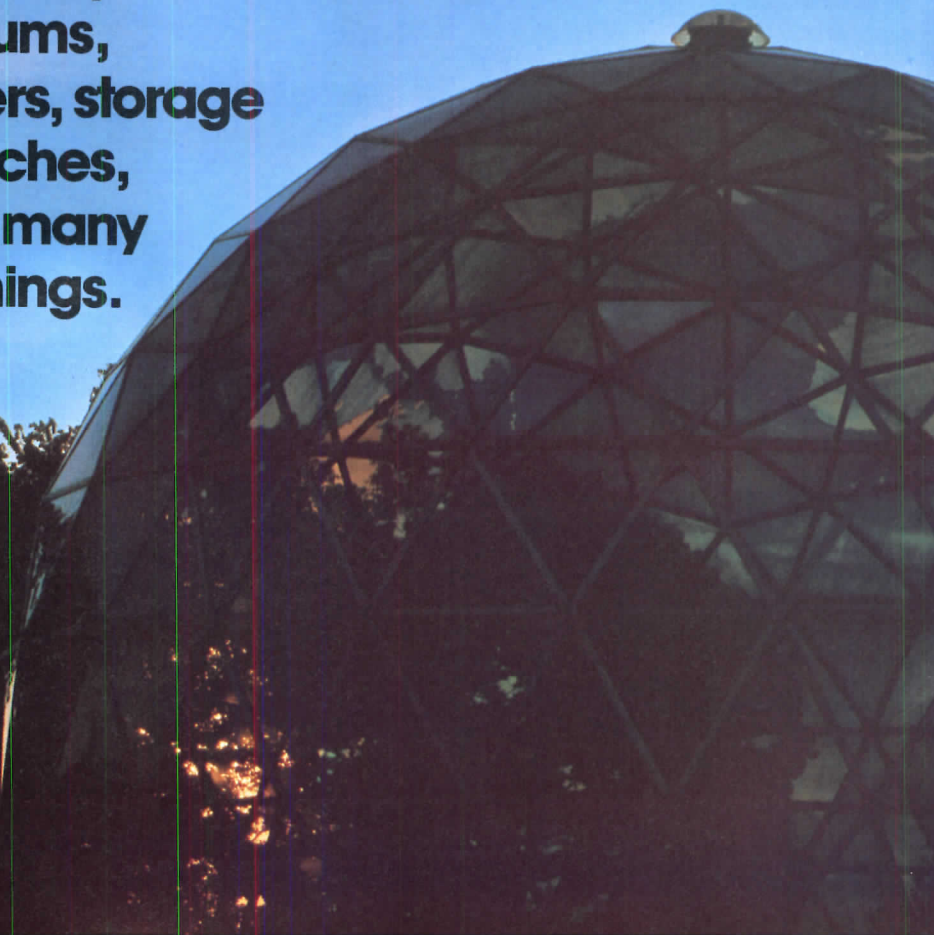
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CABINET LATCHES / The *Toolhead* cabinet security latches are very tamper resistant: they operate only with the special screwdriver-size tool shown here. The conical steel head of the latch has a smooth, rounded interior wall: only the driver, with its triple eccentric key design, fits into the head with enough torque to turn the latch. The *Toolhead* latch is installed through a single hole in a sheet metal door. ■ Southco, Inc., Concordville, Pa.

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LANDSCAPE FURNITURE / Constructed of mahogany hardwood and designed for outdoor use all year, the table and barrel chairs shown here are part of a line of furniture for residential and contract use in gardens, terraces, recreation areas, etc. Left outdoors, the pieces will weather to a silvery gray; for indoor use, a handrubbed oil finish is provided to keep the wood from soiling. Designs offered include lounge and dining chairs, benches, tables, decorative pools and fountains, flooring, and screen seating for privacy in landscape planning. ■ CI Designs, Inc., Medford, Mass.

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LIGHTING FIXTURES / *Trilux* is a European line of architectural specification-grade lighting fixtures for commercial interiors characterized by sharply defined white acrylic diffusers with small radius edges and corners devoid of windowing. The opalescent diffusers produce soft, uniform illumination; all fixtures are sealed against dust and insects. As supplied, units satisfy UL and local electrical codes; graphics may be applied to the diffusers, and the rectangular housing may be ordered in any color as desired. ■ Litecontrol Corp., Hanson, Mass.

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SOLAR HEAT CONTROLS / Applicable for both air and liquid solar systems, the "Energy Managers" series for domestic water, space and pool heating handle all differential temperature control and performance monitoring functions. The line starts at a two input/one output differential thermostat, and culminates in a space conditioning control with 6 temperature sensors, 6 thermostats, and 16 solid-state outputs. Models offer brown-out and lightning protection, freeze protection, standard and custom temperature thresholds, factory calibration, and computer performance-testing. ■ Independent Energy Inc., East Greenwich, R.I.

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ELECTRIC STRIKES / For architectural security applications, the "700 Series" line of electric strikes will fit standard ANSI cutouts, and conventional, modern or narrow stile aluminum hollow metal frames and wood frames. UL-listed as a burglary protection device, the line includes strikes approved as fire door accessories, for use with single-swing fire doors having a 3-hr (A) rating, or less. The strikes may be energized continuously; are reversible; and have built-in strain relief to keep wires from pulling loose. ■ Folger Adam Co., Joliet, Ill.



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more products on page 143

Temcor doesn't believe a dome is a dome is a dome. In fact, it's a Geodesic, a PolyFrame, a Crystogon. It's part of a sphere, a true hemisphere, or approaching a full sphere. A structural paneled dome or a frame braced one—the optimum space enclosure.

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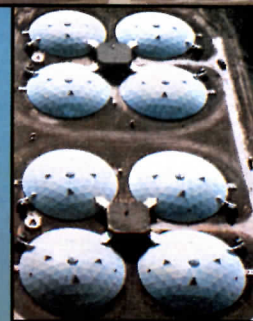
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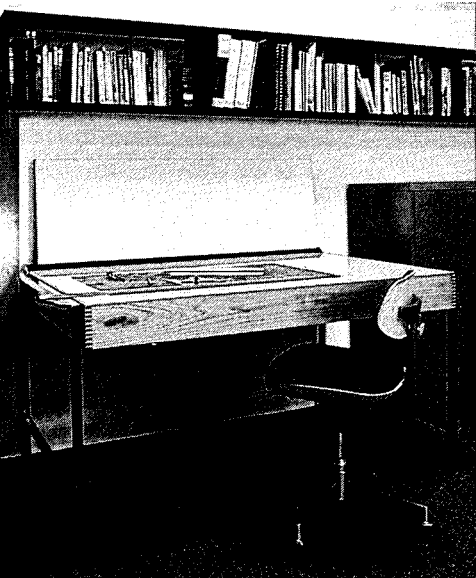


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ILLUMINATED DRAFTING SURFACE / The *Versa-Table* is a multiple-use, desk-height drawing or drafting table, with a 35- by 49-in. plate glass surface illuminated by eight fluorescent tubes. As a light table, it can be used for viewing overlays and transparencies, for tracing through bond paper, etc. An accessory contact printing platen can expose exact size prints or multiple overlay check prints and composites. With an oak cabinet and galvanized steel chassis, the *Versa-Table* costs about \$1,000. ■ *Versa-Table Co.*, Lexington, Ky.

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CONTRACT CARPET / Manufactured by a four-step process of heat-setting, plying and tufting of the continuous filament nylon yarns, "Series 88" contract carpets are soil-hiding, anti-static, and will not pill or fuzz. Intended for heavy-traffic areas in offices, stores, and schools, the line consists of three patterns in 13 colors that coordinate with the manufacturer's solid color "Election" carpets. Shown in "Metropole," installed with a solid-color border. Suggested retail price: \$14.99-\$15.99 a sq yd. ■ *Armstrong Cork Co.*, Lancaster, Pa.

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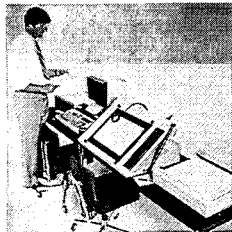
DISPLAY CASES / *Acrylite FF and GP* acrylic sheet is used in the manufacture of the octagonal display case shown. The three door locks on the case make the unit particularly suited for more valuable merchandise such as jewelry and art objects. ■ *Egan De Young Co.*, Brockton, Mass.

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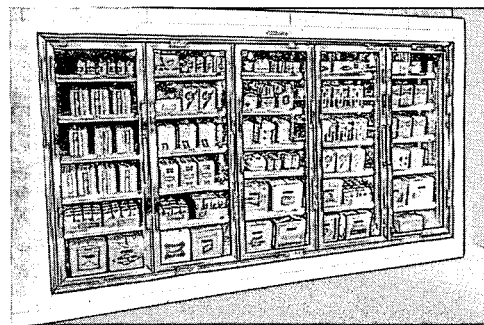
HOSPITAL SOAP DISPENSER / An elbow-operated hospital-type soap or lotion dispenser, this surface-mounted unit delivers a measured amount at each operation of the lever. Metal components are 18-8 stainless steel; the container is polyethylene. Projection of the lever from the well is 6½-in. ■ *American Dispenser Co., Inc.*, Carlstadt, N.J.

circle 317 on inquiry card

PORTABLE DIGITIZER / Simplified operation with greater user comfort and productivity are said to be features of the "work station" design of the "HP9874" portable computer digitizer. The unit also has a tiltable working surface, rear projection capabilities, a cursor vacuum system, built-in self test, automatic document alignment and axis extension, microprocessor control, and multiple function user keyboard. Suggested industrial and engineering applications include computer models of pipeline networks, surveying and mapping, and electronic design. The price of \$6,200 includes a stylus, cursor, computer test cartridges and manuals. ■ *Hewlett-Packard Co.*, Palo Alto, Calif.



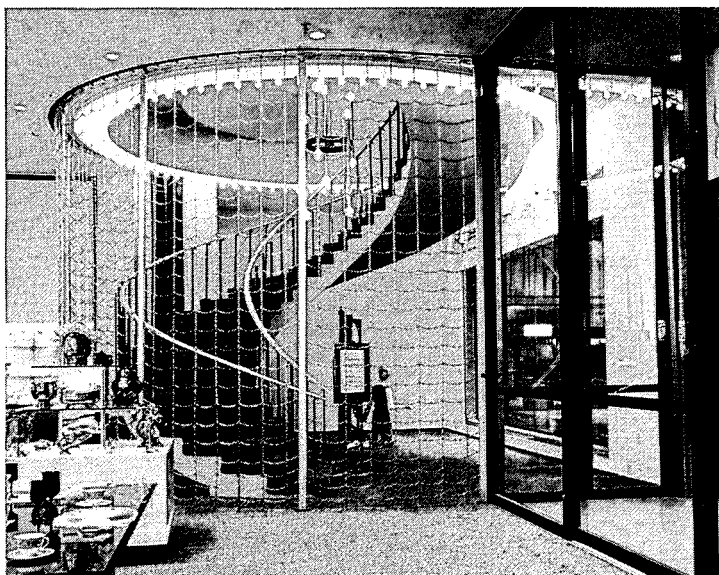
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REFRIGERATED DISPLAY CASES / Coolers and freezers are fully insulated with 4-in.-thick urethane, and provide an upright display of refrigerated products for full-view customer selection. The unit is stocked from the inside, with additional space available for product storage. ■ *The Vollrath Co.*, Sheboygan, Wisc.

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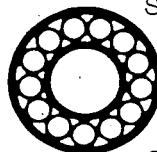
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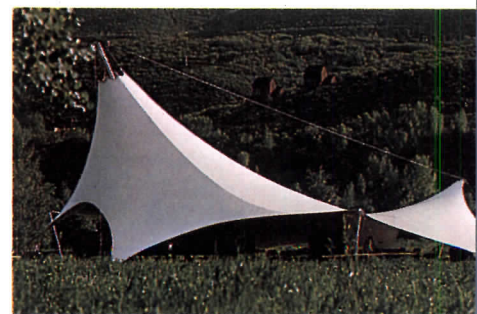


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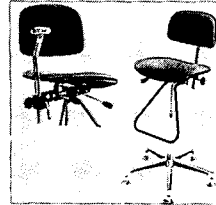
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DRAFTING STOOL / The Flex drafting stool has



several features intended to promote user comfort. Both seat and back are posture contoured to avoid fatigue; the seat height adjusts 10½-ins by gas-operated lift. The seat also can be tilted forward to relieve leg pressure. The stool is mounted on a five-leg polished cast aluminum base, and is offered with either dual wheel casters or chrome nylon-footed glides. Back and seat are upholstered in *Dralon* fabric or COM; chair weight is 26 lbs. There is a five-year guarantee on all parts.

■ Loewenstein, Ft. Lauderdale, Fla.

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WATER SAVING SHOWER / The Water Pincher

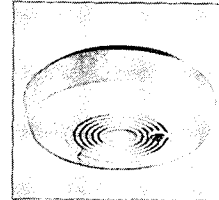


shower head automatically limits water flow to a rate of 2.7 to 3.2 gallons per minute, regardless of water pressure. The wide spray pattern can be adjusted from a fine, needle spray to a rain-like one. The

-*Water Pincher* is said to be priced competitively with other flow restricting devices. ■ Zin-Plas Corp., Grand Rapids, Mich. 49501

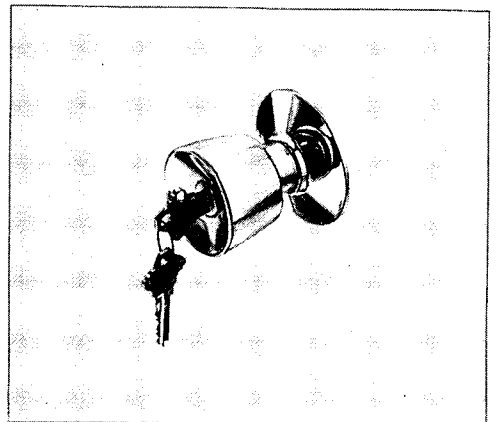
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MULTI-STATION SMOKE DETECTORS / Low-



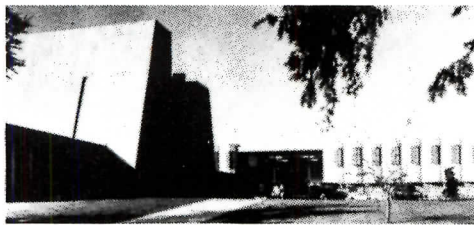
cost, low-voltage Class 2 wire may be used to interconnect up to six smoke detectors; the wiring does not have to be run in BX or conduit unless specified by local code. Designed primarily for new construction, the "77T/77TR" units are ionization type detectors, and meet UL Standard 217 for sensitivity. The "77" series units operate in a temperature range of 30 to 120F, with a relative humidity range of 20 to 95 per cent; each detector will protect areas up to 900 sq ft. ■ BRK Electronics, Div. Pittway Corp., Aurora, Ill.

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PIN TUMBLER LOCKSET / The "F51PD" combines an economical chassis with a precision-pin tumbler lock cylinder in a residential lockset said to be both high-quality and low cost. Knob and latch springs operate independently; any one of the "F" series knob designs and finishes may be selected. The "F51PF" may be keyed alike with a number of ½-in.-throw anti-shim deadlocking latches. ■ Schlage Lock Co., San Francisco, Calif.

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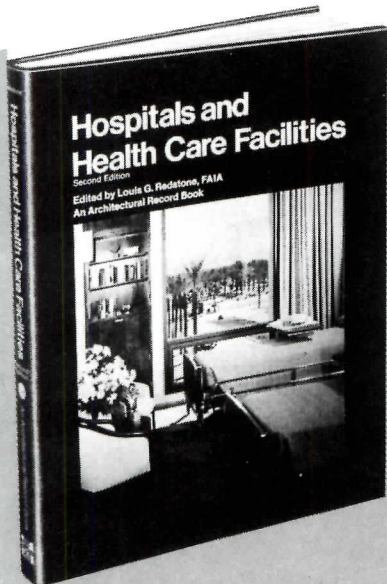
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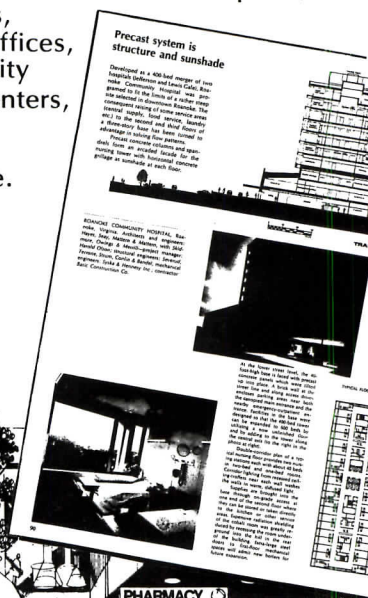


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