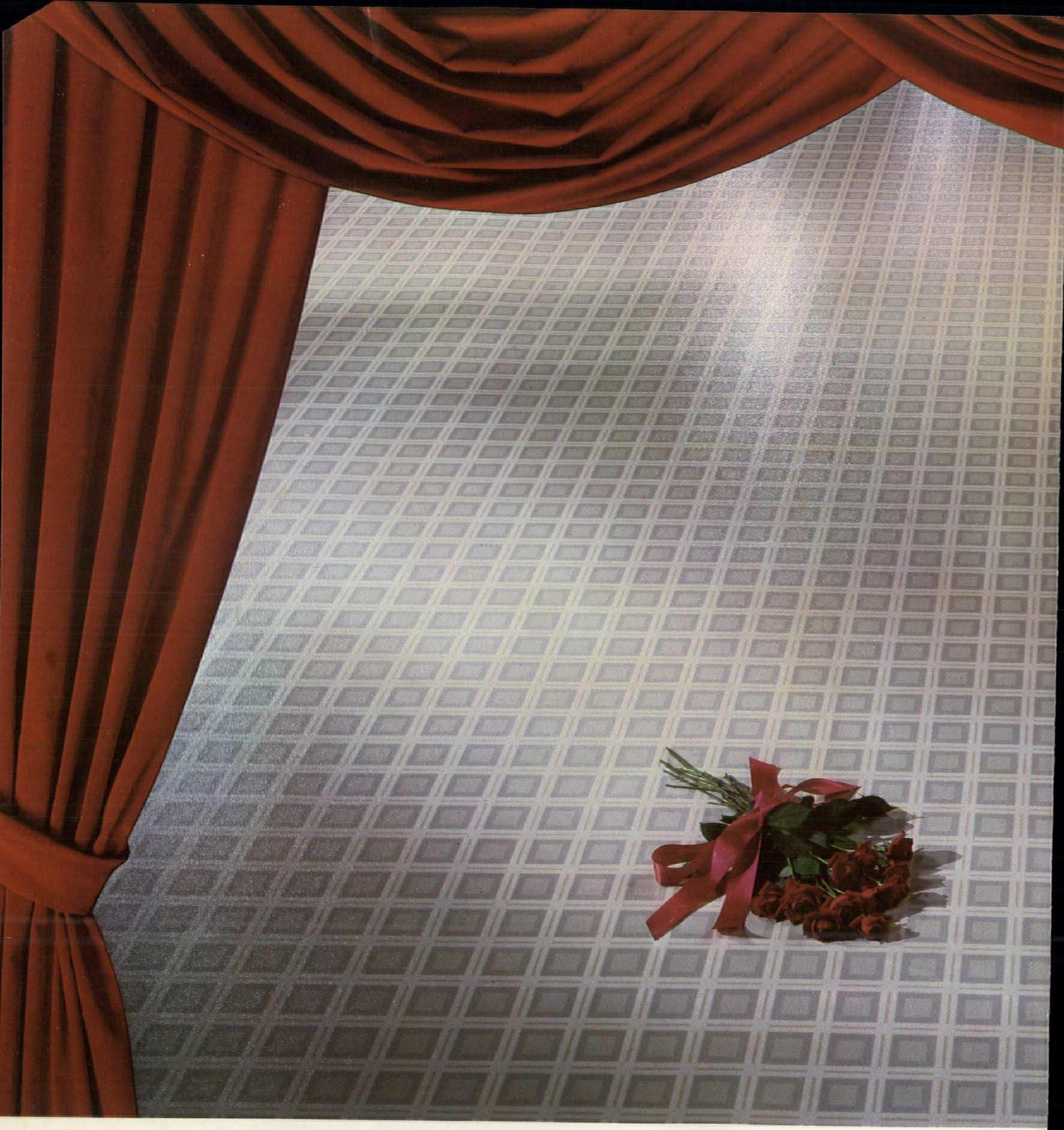
Progressive Architecture

April 1980

Energy Conscious Design



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NOW A LOW-ENERGY SYSTEM GIVES YOU HIGH-QUALITY LIGHT.

Conventional ceiling systems can give you high-quality light. Furniture-mounted systems can give you low-energy light. Now Tascon™ task lighting gives you both.

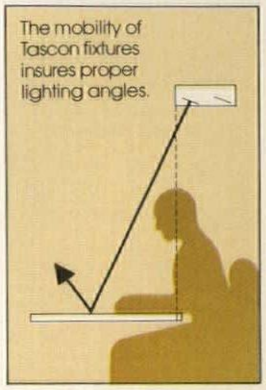
Here's a dramatic improvement in lighting systems that can cut lighting costs by over 65% in either open plan or conventional offices. (See chart below.)

The principle behind Tascon lighting is simple. The lighting fixtures, because they're moveable, can be positioned to provide light only in the areas where it's needed. So a properly positioned Tascon fixture provides ESI values of 40 to 60 on the work surface. With one fixture for every 100 square feet, Tascon provides this high-quality lighting for less than one watt per square foot. And the 120-volt fixture with optional on/off capability can cut lighting costs another 15%.

Unlike some low-energy systems, Tascon provides comfortable light.

Because the Tascon pendant fixture illuminates from both sides, as well as above and behind, it distributes high-quality light evenly without the glare, shadows, and reflections some furniture-mounted task lights create.

And Tascon directs 20% of its light upwards to create visual interest and ambient illumination.



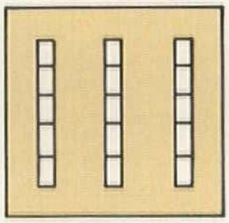
Armstrong Tascon fixtures fit most types of ceiling grids.

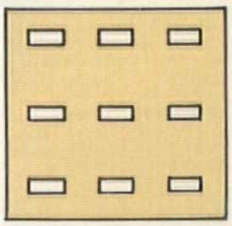
The tracks that support Tascon fit most ceiling grid systems. And you can relocate them to resposition the fixtures easily. So Tascon gives you the quality of ceiling-mounted lights and the energy savings of furniture-mounted lights along with flexibility that neither can offer.

For more illuminating information about Tascon lighting fixtures, write Armstrong, P.O. Box 3001, Dept. 04NPA, Lancaster, PA 17604.

Performance Comparison—Conventional vs. Tascon

Room size	30'x30'x9'
Reflectances	
Ceiling	80%
Walls	50%
Floor	20%
Task	#2 Pencil
Lumens/Lamp	3150





	2'x4', 4-Lamp Recessed Troffer (prismatic lens)	2-Lamp Moveable Tascon Fixture (prismatic lens)
No. of fixtures	15	9
No. of lamps	60	18
ESI (equivalent sphere illumination)	40 (80% area coverage)	40-60 (on work surface)
Classical footcandles (maintained)	95 (CU method)	90 (on work surface)
Watts/work station 100 sq. ft.	307	92
Watts/sq. ft.	3.07	.92

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Views

More awards feedback

The 27th P/A Awards issue depicts a segment of a profession gone looney—publicly illustrating a very distinct reason for avoiding the use of an architect where possible.

You and your staff can be excused only by admitting that the issue was prepared during the office Christmas party.

Conrad C. Jankowski, AIA
Jankowski Associates
Fort Wayne, In

Architecture by Appliqué dates back at least to the first primate with a wad of mud in his hand and neoclassicism in his heart, so it is ironic to find a periodical devoted to eulogizing clumsy contemporary examples and calling itself "progressive." The sophistry of Venturi and his school is embarrassed by visual comparison to the conceptual force and invention evident in the eclectic work of Maybeck and Wright. It would seem that these predecessors were inspired by something transcending next month's issue. Cancel mine.

Rik Edmonds
Architect
Tampa, Fl

The P/A Design Awards program has become a self-serving and a predictable insidious recurrence. For many years it was Moore and clones, now it is Graves and clones, with the ethic clearly being, "the more eclectic, decorative, and unbuildable, the better." What a comment!

Charles Gwathmey
Gwathmey Siegel & Associates, Architects
New York, NY

Putting arguments concerning aesthetics to the side, the really shocking thing about the projects honored in this year's awards program is the narrowness. You yourselves acknowledge it. What a poor excuse, blaming it on the "disappointing quality" of the other submissions. Perhaps your jury selection process is so poor that the narrowness lies in it. Or, architects dealing with issues other than façades and formalism have given up submitting to your awards. Small wonder considering the standard you have been setting in recent years with the pink house, inaccessible voids, and the like. Either way, the responsibility is yours. P/A is painting itself into a decorated, stage-set corner.

At the cutting edge of the profession, which is where a progressive architecture magazine should be, there are more issues to be dealt with than just "aesthetic and formal aspects." One might hope twenty awards and citations for architectural design would reflect that. The saddest outcome of this year's awards will be their effect on the architects who might look to professional journals for direction. What if we come to believe that this is architecture? P/A has a responsibility to inform otherwise.

Philip Pipal, Paula Kurgmeier,
Kim Weller, Charles Craig,
Lawrence Cheng, Laurie Putscher,
John Freeman, Steven Imrich
M. Arch candidates, MIT
Cambridge, Ma

I was mildly bemused when I received the year- and decade-end issues of the "Big Two" architectural periodicals. The theme of the magazine with "Progressive" in its name was a look backward over the past ten years, whereas the theme of "that other" magazine, the one with "Record" in its name, was a look forward.

Now arrives the January issue of P/A and "glory!," you managed to devote two whole pages to a look into the future.

And of course it is Awards time again. If one lesson can be learned from this year's collection it is that if you design and draw in the manner of Michael Graves you stand a much better chance of winning an award than otherwise might be the case.

It could even be argued that some publicity-hungry designers have learned how to manipulate not only color, form, and space, but also the press. One wonders if the Awards jury did not think in certain cases it was citing a Graves project when the project actually was done by one of Graves's imitators.

The cultural, philosophical, and emotional reasons which lie behind the phenomenon popularly named Post-Modernism are valid and should be addressed. Likewise, some of the responses to these social needs have been valid responses, even some of those by Graves. But the wholesale copying of his techniques without addressing the underlying issues in an objective way is the same kind of superficial quick-fix that lesser architects unfortunately have always been guilty of. To award such projects only compounds the problem.

P/A, you are infuriating. I know the jury made the awards selections and not the P/A editors. But, is it not possible that the selection of the jury, being an editorial function, undermines that claim for lack of involvement and responsibility?

Finally, you have changed the format and graphics of the magazine to something reminiscent of earlier years. When are you going to complete the change by renaming it *Postprogressive Architecture?*

Frank Orr, AIA
Orr/Houk & Associates Architects Inc.
Nashville, Tn

By coincidence today's mail included your January issue and the January 24th issue of *Engineering News Record.* As usual, I thumbed through P/A first and scanned a few jury comments.

It was a very short time before I picked up the *Record* as more productive reading and damned near died laughing when I read the article "Façades: Errors Can Be Expensive." The article includes the hypothesis that there are four basic causes of building façade failures: ignorance, carelessness, negligence, and greed and that ignorance is the only one we can hope to improve.

But that hope is slim as long as our schools of Architecture stress so-called "design" and as long as our major professional publications push out issues such as that of January 80.

William S. Oliver, Chairman
Architecture Department
Onondaga Community College
Syracuse, NY

Milan bank: correction

The capsule description of the Banque Bruxelles Lambert in Milan on the contents page of P/A, March 1980, could be interpreted as an adverse criticism of the work. Any such implication was purely inadvertent. P/A's actual viewpoint, as indicated in the article itself, was very favorable, and we regret any misunderstanding caused by the contents page wording.

Credit extended

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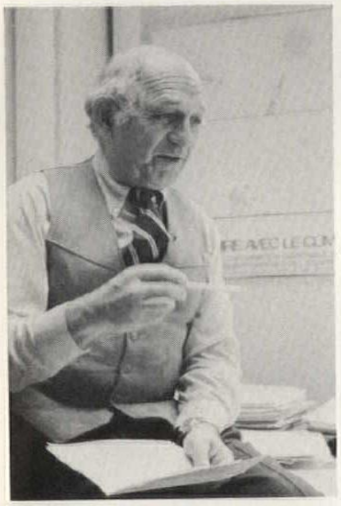
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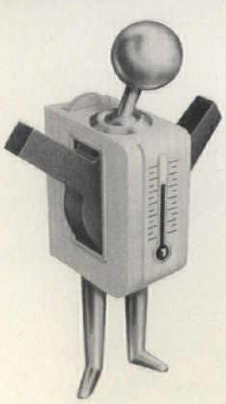
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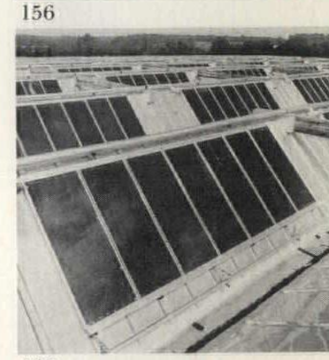
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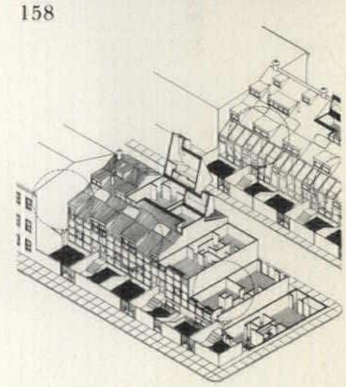
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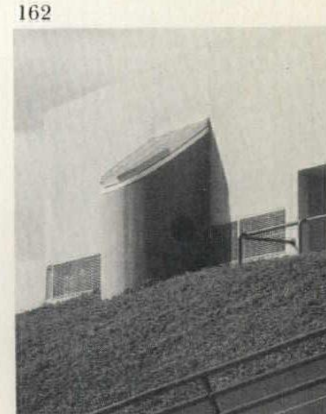
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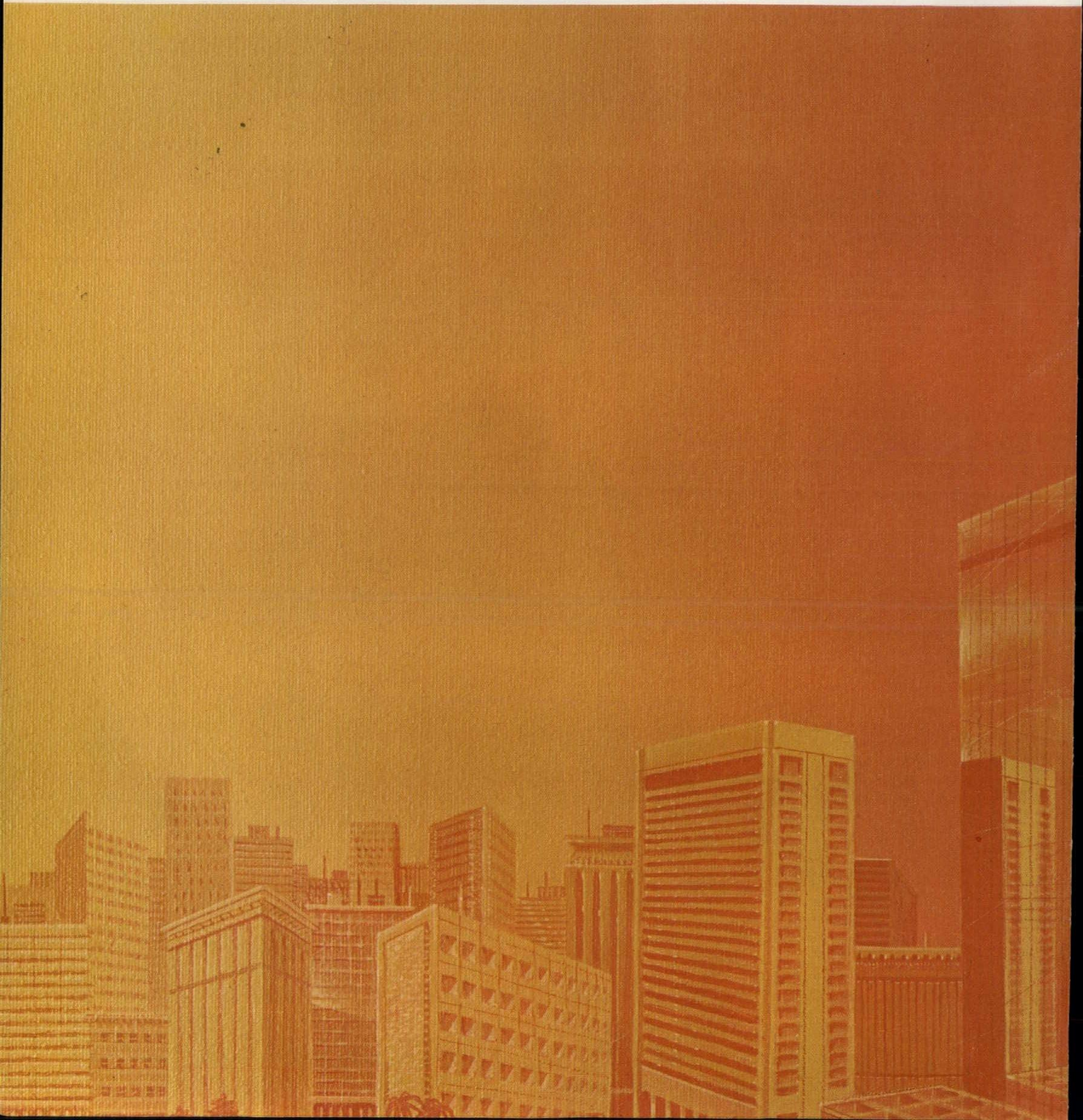

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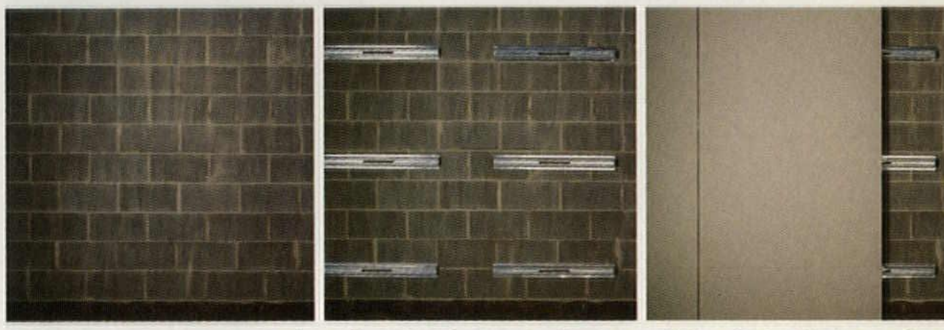

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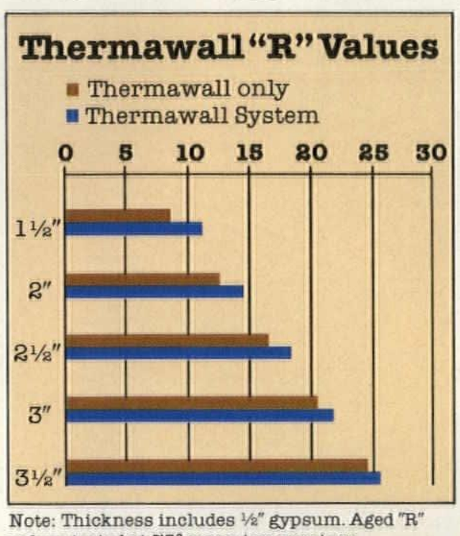

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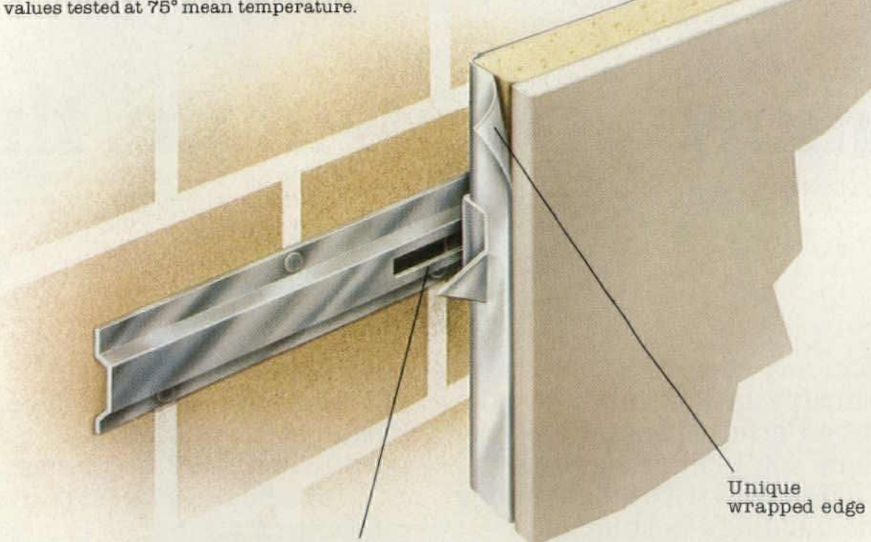

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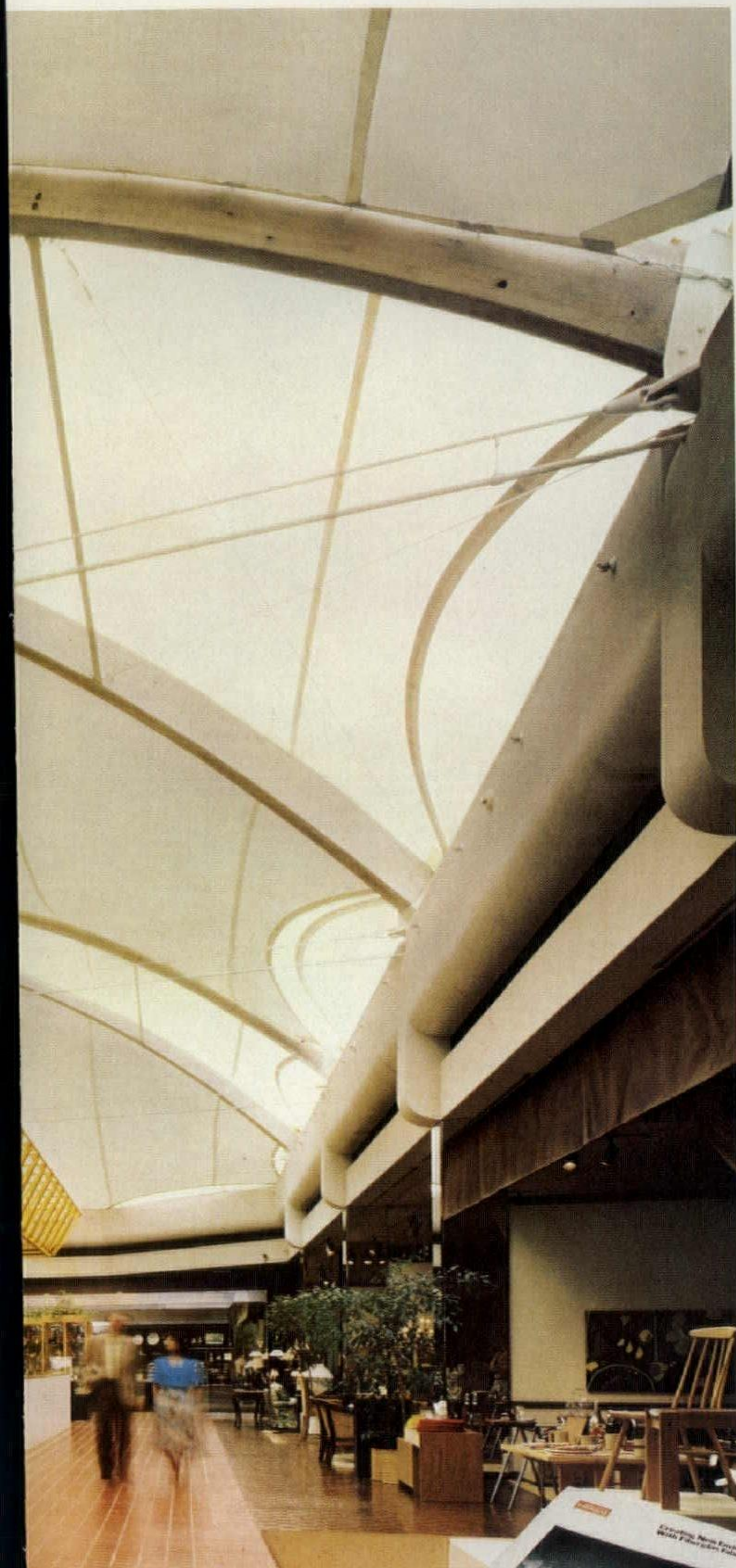

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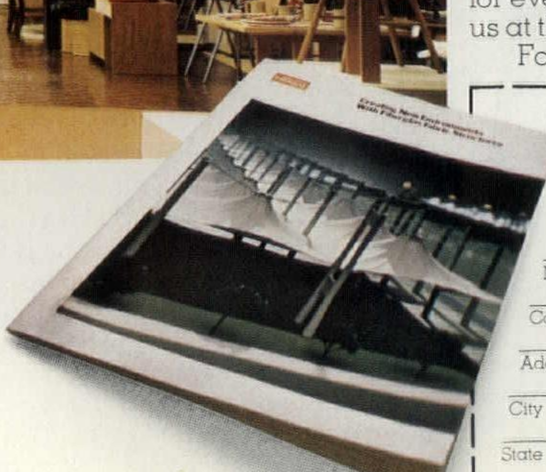

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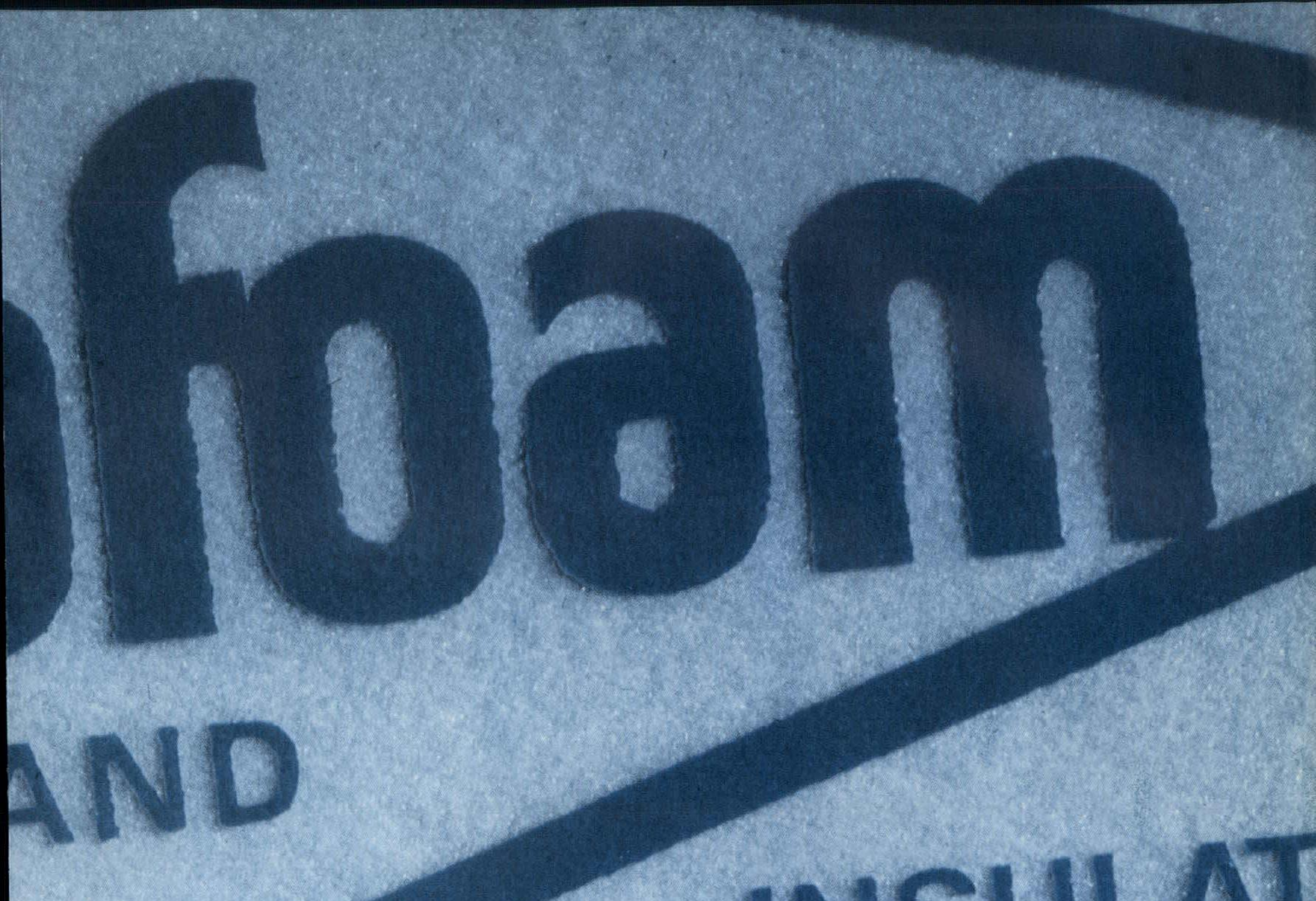

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P/A News report

Massachusetts energy code review program

The Massachusetts State Building Code Commission has established the Plan Review Assistance Program as an ongoing response to the need for communication created by the Energy Code (the modified ASHRAE 90-75). The program provides technical assistance to building inspectors and educational assistance to the professional community; the plan-review process establishes a means to assess the levels of code awareness in both the enforcement and professional communities.

The dialogue between review staff and designers fills the continuing educational and technical assistance void, since there is currently no professional organization or registration board which directly addresses energy code requirements and the related technical issues. Pre-permit analysis averts potential problems of noncompliance. Finally, an outreach seminar program addresses specific areas of the professional community's needs.

David Miller, Energy Program Manager, believes the plan "has fulfilled a dual feedback role. It told us where new construction was not complying with present energy codes, and it enabled us to devise an educational program which would facilitate the transition to new, more stringent energy codes."

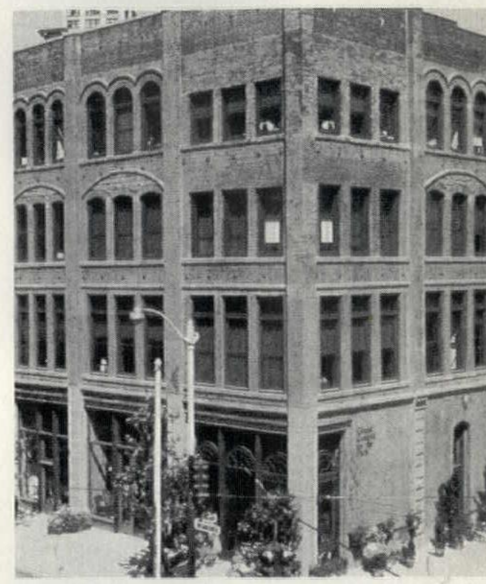
The Plan Review Program is composed of five sections. *Section 1* deals with design conditions and shows how they should be included in the specifications or as plan notation. *Section 2* on mechanical equipment establishes standards for HVAC performance which must be met and noted to show compliance. *Section 3* on OTTV (Overall Thermal Transfer Value) Calculation indicates how such calculations should be distinguished from U_0 value calculations: the former indicates thermal performance in the cooling mode, the latter in the heating mode. *Section 4* describes mechanical system sizing criteria. Finally, *Section 5* describes ventilation calculations specifying, for example, that fan schedules should note the total number of people served by each unit, the CFM per person of ventilation air and outside air, and the total circulation and outside air requirements.

The program is dynamic in character and can identify issues of particular topical interest. The data base obtained in case review of individual projects will be utilized as an internal review of the code's technical value. From January 1979 to June 1979, 136 projects were analyzed with a response rate of 60 percent supplying data on new construction. The dollar value for projects reviewed ranged from $50,000 to $12 million. Such data are useful in evaluating how well codes are presently being met and what measures must be taken to improve compliance.

Where currently the onus resides on the designer to maintain contact with both the technology and terminology inherent in the energy code requirements, the Plan Review Assistance Program seeks to assist the professional by first, insuring a high level of code compliance and second, providing an educational assistance program to keep the design community aware of the new energy code. The program has the potential of adoption as a prototypical model and as an example for other states interested in establishing a similar assistance program. It provides a link between the component codes (ASHRAE 90-75) and the new second-generation energy codes (e.g., the Department of Energy Building Energy Performance Standards, BEPS), which prescribe overall energy budgets. It assists designers in using and feeling comfortable with the component codes prior to the implementation of the more complex BEPS computer-aided code. [Susan Gill]

Study proves preservation energy efficient

Old buildings save energy. That assumption, long a contention of the preservation movement, can now be documented, a federal agency reports. Booz, Allen & Hamilton prepared a study, "Assessing the Energy Conservation Benefits of Historic Preservation," for the Advisory Council on Historic Preservation, an independent federal panel that advises the president and Congress.



Grand Central Arcade, Pioneer Square, Seattle.

The study points out that approximately one-third of America's total energy consumption involves buildings, their use and operation. Five percent of the country's annual consumption is invested in the processing, transporting, and putting into place of construction materials. "Replacing all existing buildings in the United States would require the entire world's energy output for about a year just for materials and construction processes—approximately 200 quadrillion Btu of energy," the study notes.

In preparing the report, three dissimiliar old buildings were used as case studies: the Grand Central Arcade in Seattle's Pioneer Square, a hotel converted to mixed use as shops and offices; Lockefield Gardens in Indianapolis, a 1935 WPA low-cost housing project—one of the federal government's first—now abandoned and threatened with demolition; Austin House, a two-story brick carriage house on Capitol Hill in Washington, DC, that was gutted, leaving only the shell, and then converted into three apartments.

The study notes that most people assume, correctly, that new buildings can be more energy efficient than old ones. In assessing whether to rehabilitate an old building or build a new one, however, there are other kinds of energy that must be taken into account. The first is demolition energy, the cost in energy terms of tearing down an old

News report continued from page 25

building. Included would be the gasoline used by the wreckers to raze the structure and haul away the debris, for example.

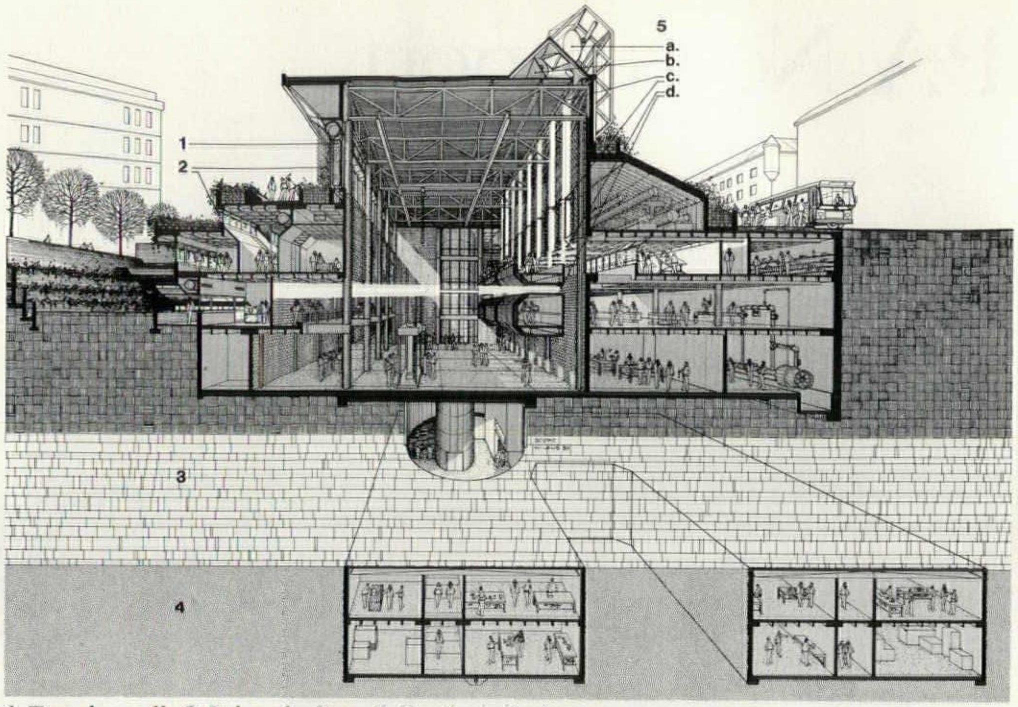
The second, and even more important kind, is embodied energy—the energy already invested in a structure. Once used it is nonrecoverable. Thus, for example, the energy in eight bricks is equivalent to one gallon of gasoline, the study reports, but that energy cannot fuel a car. Included in embodied energy is the energy used to create the bricks, steel, concrete, glass, and myriad other materials.

It was determined that the abandoned Lockefield Gardens complex represents nearly 550 billion Btu of energy embodied in its construction, equivalent to approximately 4.5 million gallons of gasoline. Austin House has 1 billion Btu of energy embodied in its shell.

In determining how to document preservation's energy savings, the researchers developed three increasingly complex formulas—the Building Concept Model, the Building Survey Model, and the Building Inventory Model. Figures derived from a study of such elements as building materials, plans, climate, and occupancy standards can be plugged into the formulas to offer either general, refined, or precise results as to the amount of energy involved in a particular project. The work can range from a single calculation for each kind of energy—embodied, demolition, and operational—to several hundred that would require the use of a computer.

Through the use of the formulas, the study concluded that rehabilitation of the Grand Central Arcade used less than one-fifth of the energy that would have been required for a new building of similar size—a saving of 92 million Btu. Despite the fact that more energy is required to operate the Grand Central Arcade annually, the savings from rehabilitation would run the structure for more than 200 years, the study concludes. Over a 30-year period, enough energy would be saved at Austin House to heat and cool a similar-size apartment building for 10 years. And Lockefield Gardens offers a net energy advantage for 50 years.

Copies of the full report, including the complex formulas, are available for $2.75 from the U.S. Government Printing Office, Washington, DC 20402 (stock no. 024-000-008-56-8). An illustrated brochure that highlights the study is available free from the Advisory Council on Historic Preservation, 1522 K St., NW, Washington, DC 20005. [Carleton Knight, III]



1 *Trombe wall.* **2** *Solar shading.* **3** *Earth sheltering.* **4** *Mined space.* **5** *Solar optical system.*

In progress

These buildings were chosen as representative of the vast body of effort known as Energy Conscious Design.

Civil/Mineral Engineering Building, University of Minnesota, Minneapolis. *Architects: Myers & Bennett, Minneapolis.* When the Minnesota state legislature mandated to the University of Minnesota that its proposed new Civil/Mineral Engineering building on the East Bank campus be an energy demonstration project, the architects dug in—way in. Currently under construction, the 142,000-sq-ft building will be 95 percent underground. A third of its volume, some 48,000 sq ft, will be mined space 110 ft below ground in a soft layer of sandstone beneath a layer of limestone.

The architects, who pioneered earth-sheltered architecture on the campus with the construction two years earlier of Williamson Hall, intend to demonstrate the potential use of mined spaces for a variety of human activities by introducing light to these spaces. Where Williamson Hall demonstrated that earth-sheltered spaces need not necessarily be cavelike, the Civil/Mineral Engineering building goes further. It will demonstrate, according to project architect David Bennett, that daylight can be projected, not just naturally filtered, to deep spaces.

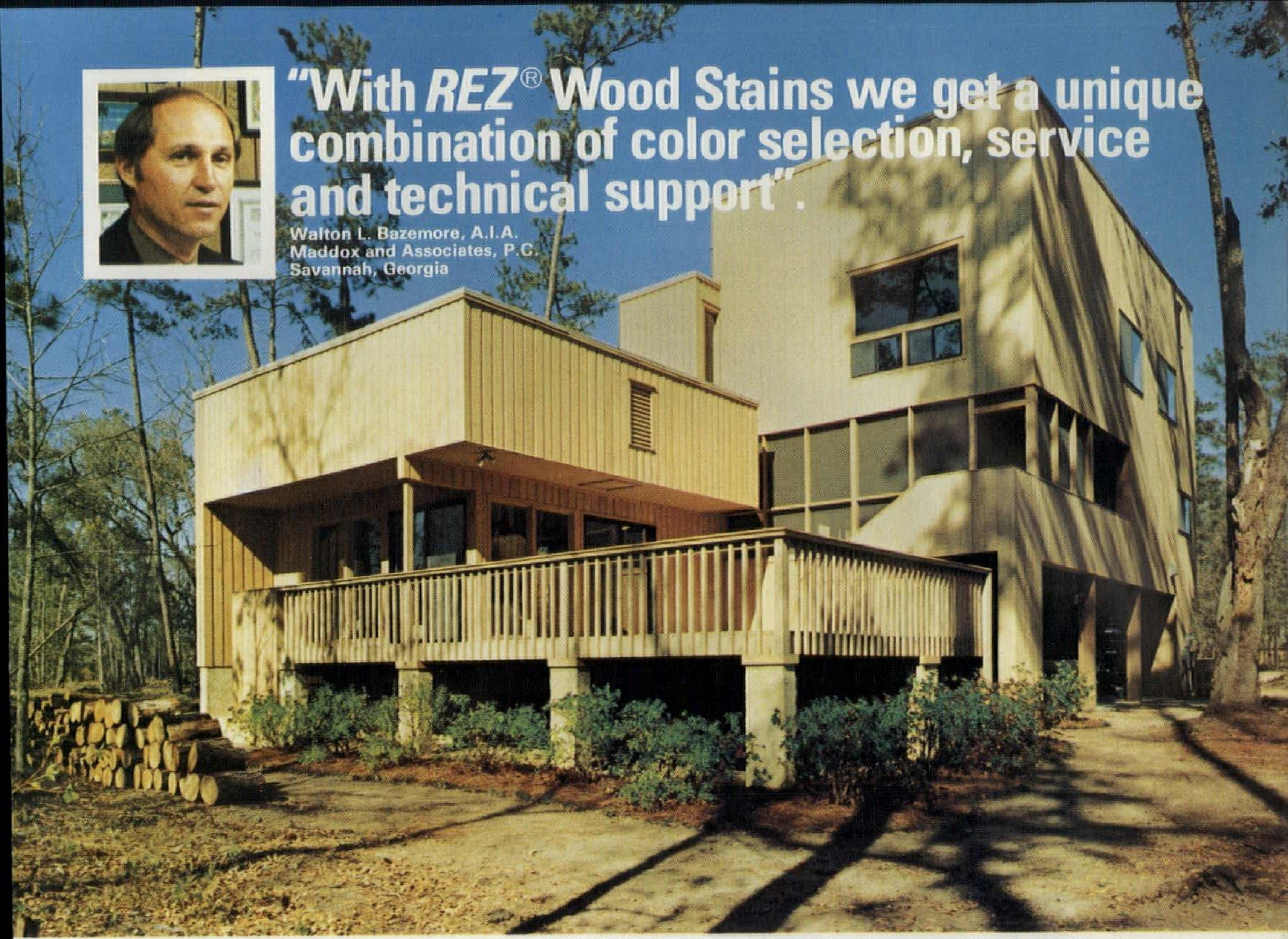
With research scientist Dr. Michael Dugay, now with Bell Laboratories in New Jersey, Bennett devised a demonstration solar optics system that collects sunlight and directs it through the building by means of an assembly of lenses and mirrors which reflect the light into deep interior spaces, including the mined space. The system optically compresses sunlight into narrow streams of light through a series of ten heliostats mounted on the roof of the building. The heliostats track the sun, reflecting it into a series of shafts which plunge into the main central space of the building, and then diffuse over targeted spaces in the structure. No transmission energy is used. When combined with conventional artificial lighting under controlled conditions, the system has the potential to reduce substantially the electrical demands for lighting interior spaces. As environmental design, it goes even further, illustrating the potential of enhancing earth-sheltered spaces as viable places for human habitation.

Solar optics aside, the new building will be a virtual energy park of passive and active energy systems working incrementally to reduce the building's energy demands; these include a system of plant screenings, called *micro/climatology,* that turn the south-facing parts of the building into a kind of Babylonian gardens in reverse (the architects call this *landscape micro/climatology*) and trombe walls. Active systems will include solar electricity generation, ice energy cooling, and planned solar heating, pending a grant from the U.S. Department of Energy.

Structural systems include cast concrete walls, columns, and floor slabs, and a structural-steel truss roof that will support a 15-ton traveling crane over the huge main structural lab. The exterior will be clad in oversized brick to match the surrounding buildings of the Institute of Technology.

Entrance to the building will be by means of a fan-shaped spiral of classrooms surrounding a rotunda. The spiral forms an entry court which begins at grade level and terminates in the main entry of the building. Because of its location near a proposed bus transfer station, the entry forms a symbolic center for this part of the campus, a focus not only for the Institute of Technology, but for the university as a whole as well. Construction costs are expected to be $12,500,000. [Joanna Baymiller]

Joint Use Public Facilities, Lincoln, Ne. *Architect: The Clark Enersen Partners, Lincoln, Ne.* The objective in this project is to take full advantage of the joint use concept in a four-phased building program. The first [*News report continued on page 30*]



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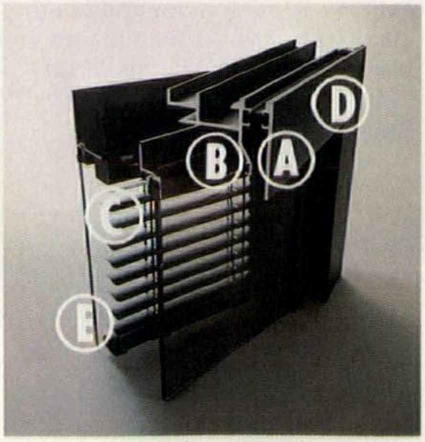

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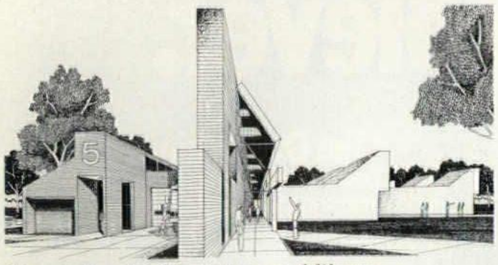


Fire station, health station, and library.

phase is the fire station; the second comprises the health station and portions of the library and park; and the third and fourth, the expansion of the library and the development of the park.

Energy conservation is achieved through the use of a circulation spine, automatic insulating shades over glazed areas, building materials and detailing, exterior planting, and the shape of the building elements. The fire station is separated from the other elements in the project by a rock-filled masonry solar heat storage wall with an adjacent circulation spine linking the various elements and the park.

Both the library and the health station are set against the spine and present a south façade, thereby maximizing the potential for solar heat gain. Post and beam construction affords ease of expansion, and the mass of the concrete structure provides added passive solar storage.

The passive solar system in the library and health section consists of Trombe wall elements on the south façade and light scoops in the roof for areas not near the Trombe wall elements. The light scoops are glazed with diffusing glass, which disperses the light and solar radiation and avoids the glare of direct solar radiation. This light will permeate most of the interior, thus minimizing the use of artificial light. Localized dark masonry floor areas and movable standing water tubes store the heat from the light scoops. Consisting of a dark masonry wall behind clear glazing, the Trombe wall both collects and stores heat. Automatic shades that roll down in the evening insulate the light scoops and Trombe wall. The fire station has a linear light scoop focusing sunlight on the masonry wall to the north in the dormitories and locker rooms.

An active solar heating system will use the masonry divider wall as a solar heat storage element to supplement the passive system and preheat domestic hot water. A low-tech, air-type collector will be constructed as part of the building using standard materials and techniques. Both the collector and the wall will be built in segments as the other elements are constructed. The collection and storage system blends effectively with the forced-air ventilating and cooling system. The air-distribution system will provide added heat storage by taking return air high and transferring heat from the warmer air near the ceiling through buried ducts to an insulated heat sink beneath the floor. Natural gas will provide supplemental heat.

When outside temperatures permit, cooling will be done with fresh air. An air-conditioning compressor will be arranged for future conversion to a heat pump, providing flexibility to use the preset lower cost of natural gas with the option of converting to an electric heat pump, depending on the availability and cost of natural gas.

Upon completion of the project, approximately 70 percent of the heating requirements will be provided by solar energy.

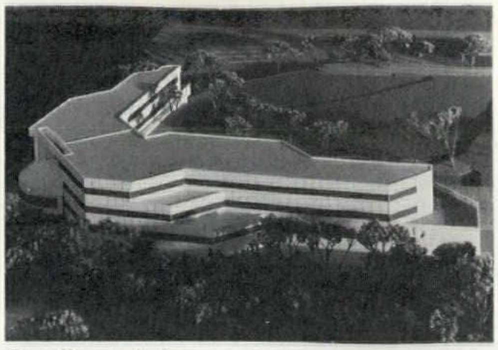
Indio Palms Park Center, Riverside County Parks Department, Rubidoux, Ca. *Architects: Paolo Soleri Associates, Scottsdale, Az.* This exhibition and leisure facility for casual visitors and research facility for longer term users is designed to demonstrate an "environmental ethic as lifestyle." Situated in an unusually harsh desert climate subject to extreme temperature variations and near two earthquake faults, the building will reflect energy conservation and autonomy, using passive solar systems, waste and water recycling, and intensive greenhouse horticulture.

Taking the form of a large solar greenhouse, the facility is sloped upward along a knoll. The main entrance to exhibitions and public space is at the top level, and three lower levels, sheltered to the east and west by bermed earth, contain dormitories, classrooms, laboratories, an intensive horticulture greenhouse, and other facilities. Access to the lower levels is via a continuous ramped gallery housing displays of native plant life. The lowest level includes a pond which serves as a catchment for rainwater runoff from the greenhouse membrane and is used for plant irrigation and as a heat sink.

Indio Palms Park Center.

The greenhouse structure acts as a solar chimney, drawing solar-heated air up through the building by means of natural convection. Insulated louvers beneath the greenhouse roof provide shade from extreme daytime heat and hold the heated air inside on cold desert nights. Irrigated pads on the upper level aid evaporative cooling. The projected cost of the buildings, displays, and equipment is $1,300,000.
[Barbara Goldstein]

Cray Research, Inc., Headquarters Facility, Mendota Heights, Mn. *Architects: Architectural Alliance, Minneapolis, Mn.* Architects for a new headquarters office building for Cray Research, in a St. Paul suburb, proposed to the client the installation of a centralized ice storage system at an initial investment of $80,000 above the cost of conventional air-conditioning systems, but with an annual saving of $8400 and a seven-year payback period. The estimated cost saving was based on comparable fuel costs for conventional systems plus tax savings from the recent tax incentives contained in the National Energy Act.



Cray Research, Inc.

The system is one of several which the architects expect will considerably reduce energy use and subsequent energy costs in the new facility.

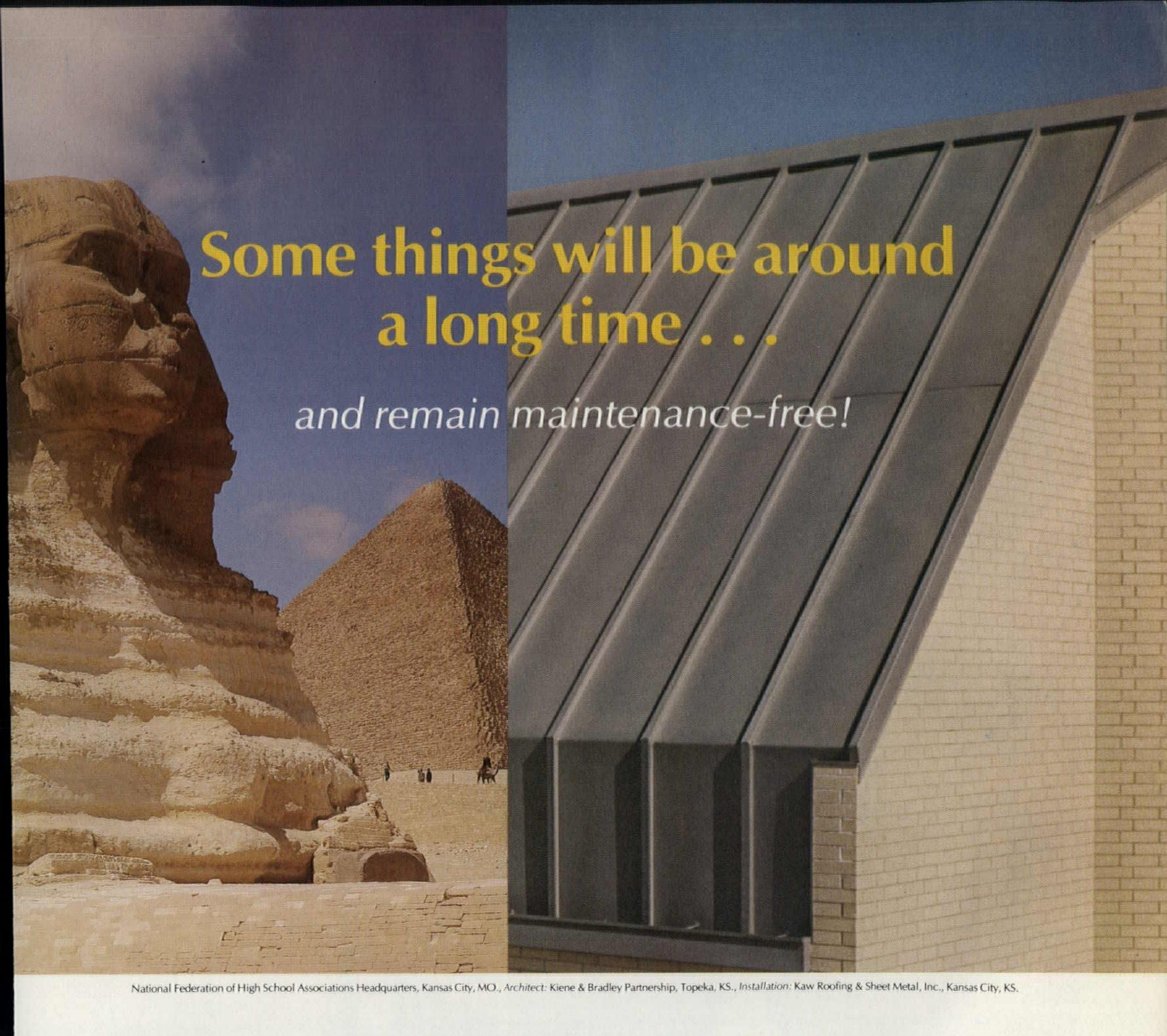
Cray's new headquarters is a two-phase project: a 25,000-sq-ft original headquarters building for the company, a three-year-old, fast-growing computer designer-manufacturer; and a 40,000-sq-ft addition, being designed before the first building was ever completed.

The graceful, narrow wings of the three-story, tiered stucco and reflective glass building wrap either side of a promontory of land on a partially wooded site overlooking the Minnesota River Valley to the southwest. A central glass entryway and a bilevel dining space with access to an outdoor deck afford employees access and views to the spacious outdoor site.

In determining energy requirements for the building, the architects identified two major areas of potential energy savings in addition to the air-conditioning requirements: lighting and operation of the company's computer. To reduce loads in the all-electric building, the mechanical engineers, Dunham Associates of Minneapolis, cut the number of fluorescent tubes from the conventional four to three and relied on photoelectric control of perimeter lighting to maximize the effects of natural sunlight.

The building's heating requirements will be handled entirely by a heat recovery system that will recapture the 2.4 million Btu per hour of excess heat generated by Cray's in-house computer, which operates 24 hours a day. Back-up systems will be installed for use in the event of computer failure.

In recognition of impending "time of day" rate structures from the local utility, the architects realized the value of shifting some of the major electrical loads to off-peak or nighttime operation. They implemented an innovative ice-storage system which relies on cooled air produced from circulated ice water. Water cooled by two ice-making heat pumps is stored in a 15,000-cu-ft tank and distributed to fan coils which are placed at various intervals in the ceiling plenum. The heat pumps produce ice at night, from which cooled air is generated for air conditioning the following day. Storage capacity of the system can provide approximately four days of peak air conditioning if required. Subsequently, energy use will be dis-
[*News report continued on page 34*]



National Federation of High School Associations Headquarters, Kansas City, MO., *Architect:* Kiene & Bradley Partnership, Topeka, KS., *Installation:* Kaw Roofing & Sheet Metal, Inc., Kansas City, KS.

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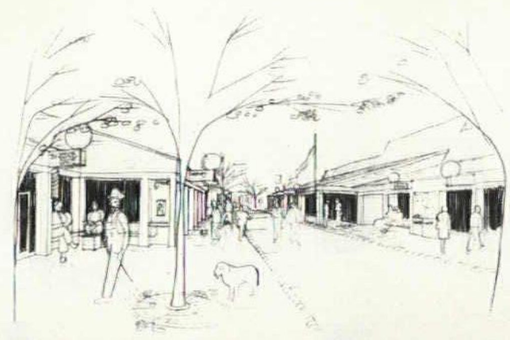
News report continued from page 30

tributed over a 24-hour period, greatly reducing peak period use and the resulting high demand charges. The implications of widespread use of this system, say the architects, would be considerable if substantial numbers of commercial and industrial buildings were converted to a similar system. Fewer power plants would be necessary, and expenditures by utilities would be reduced, resulting in fewer rate increases to consumers. [Joanna Baymiller]



Pedestrian street flanked by shopping arcades.

Plan for the Relocation of Soldier's Grove, Soldier's Grove, Wi. *Architects and Planners: The Hawkweed Group, Chicago.* Devastated by flooding several years ago, the entire town of Soldier's Grove (population 514) will soon relocate on higher ground away from the flood plain. Many town merchants and residents will move into the new town as the old one is demolished. When they do, it will be to a setting that—while not quite a complete haven from Wisconsin's harsh winters—may serve as a model of energy-conscious planning. Rodney Wright of Hawkweed says that the town fathers sought a plan that would emphasize energy as an issue for nonurban communities: "They want the town center to be rural in appearance. It was a small country town and the new town will be, too, right down to the building materials."

Hawkweed has done a planning scheme for the town center and has designed a number of public and private buildings for the site. A series of design guidelines and standards resulted from the planning effort, including a heat-loss standard of 4 Btu per sq ft per degree day for building exterior surfaces and a restriction against flat roofs. The standards also call for a solar contribution of at least 50 percent of the total heating requirements of individual buildings, but, in fact, the buildings are emerging with a solar contribution closer to 90 percent. The plan calls for maximum use of renewable building materials, which, in Wisconsin, means wood. Even oak railroad ties are being used as columns in some of the town center buildings.

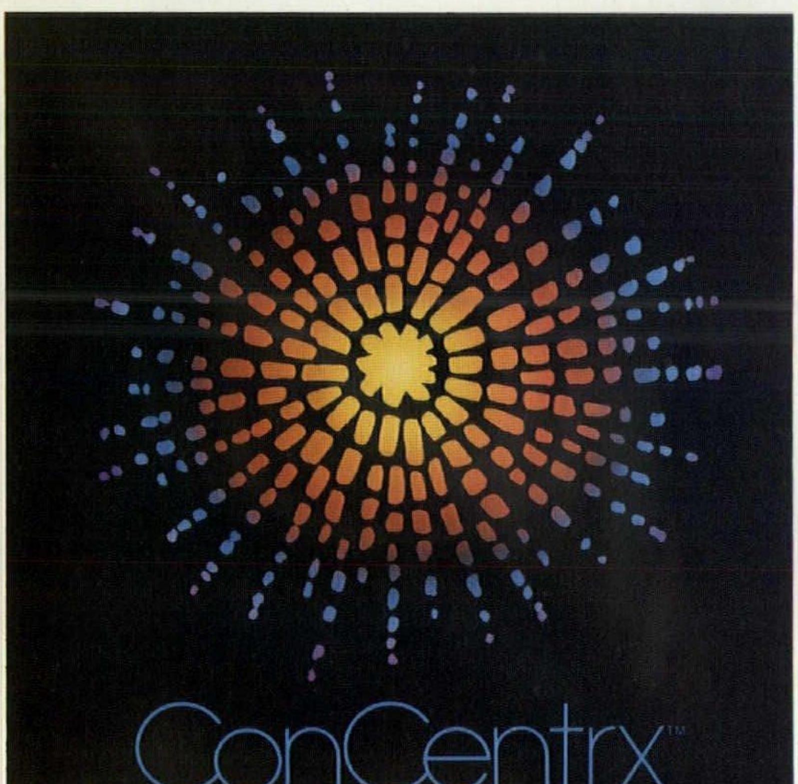
The site analysis for the town center involved examination of solar and wind movement, existing vegetation, and the microclimatic effects of terrain. A building area was defined by these considerations with solar access a key concern for the winter months.

Hawkweed's landscape design also involves relocation of trees. The 190-acre parcel now owned by the town—of which the town center involves 19 acres—will have large windbreaks to the north and northwest. Near-mature pines and other indigenous plantings will be moved for this purpose. Deciduous trees will serve to block summer sun, letting winter sun pass through as their leaves fall.

Concern with solar access is also evident in Hawkweed's suggested designs for buildings in the town center. Along the south side of the main pedestrian thoroughfare, buildings will be limited to a single story, so as to ensure adequate sunlight for the street and for buildings on the north, which will be higher. Roof and balcony overhangs are also used, along with earth berms—some extending to roof level.

Although the initial scheme is for the town center only, two residential areas are planned for future development, and Hawkweed is now planning an industrial park that will be situated across a major road. The designers hope to see many of the same concepts applied to these neighboring developments. Sitework and landscaping will not be completed by spring, but there should be some completed buildings by then. [Thomas Vonier]

The Phoenix House, residence for Mr. & Mrs. Robert Kiefer, Phoenix, Az. *Architect: Robert F. Augustine, Boston, Ma.* In this design for a hybrid solar house, the goal was to avoid tacking on an energy system as an afterthought and instead to integrate art and technology in a self-sufficient, minimal [*News report continued on page 39*]



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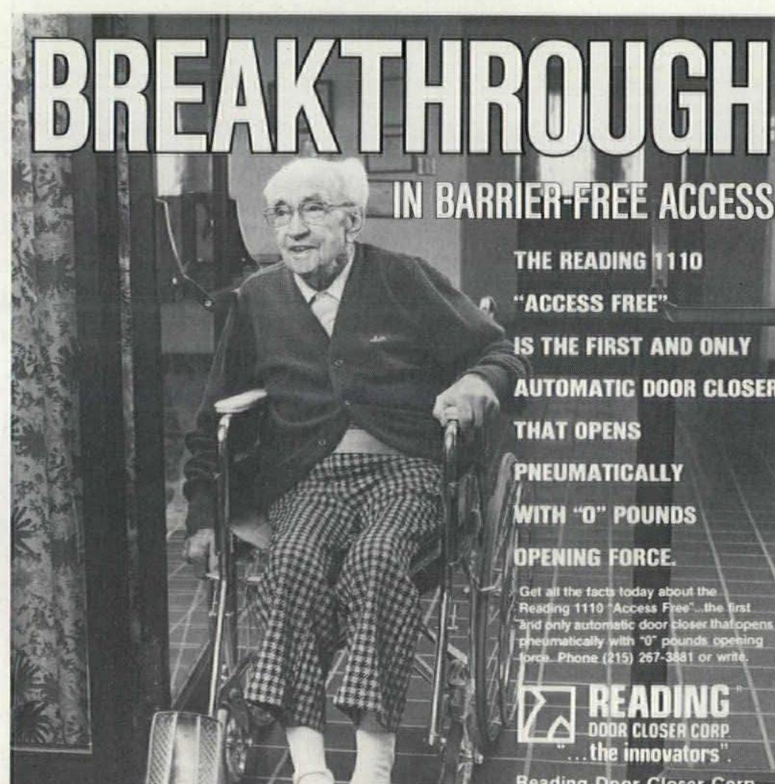

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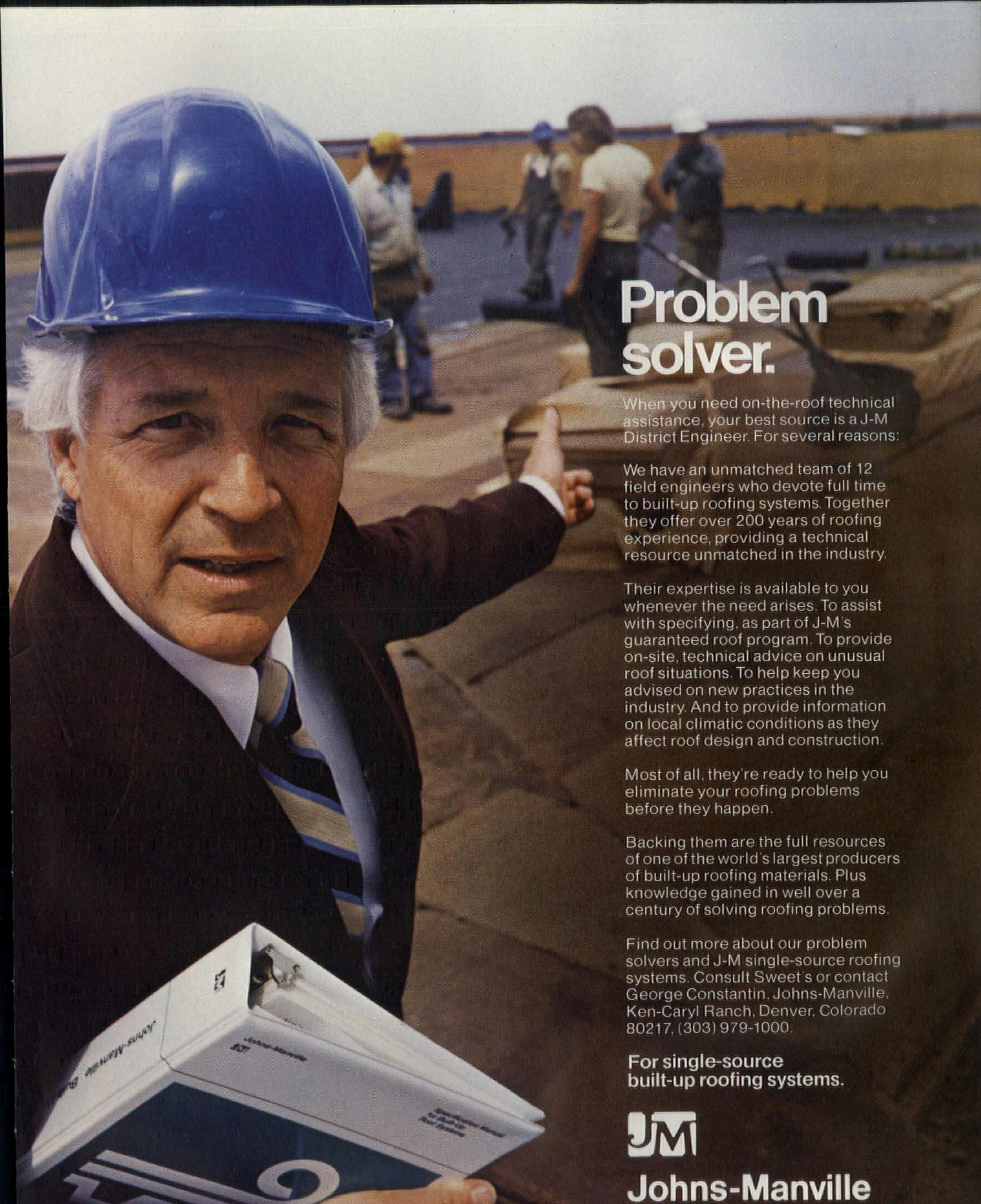
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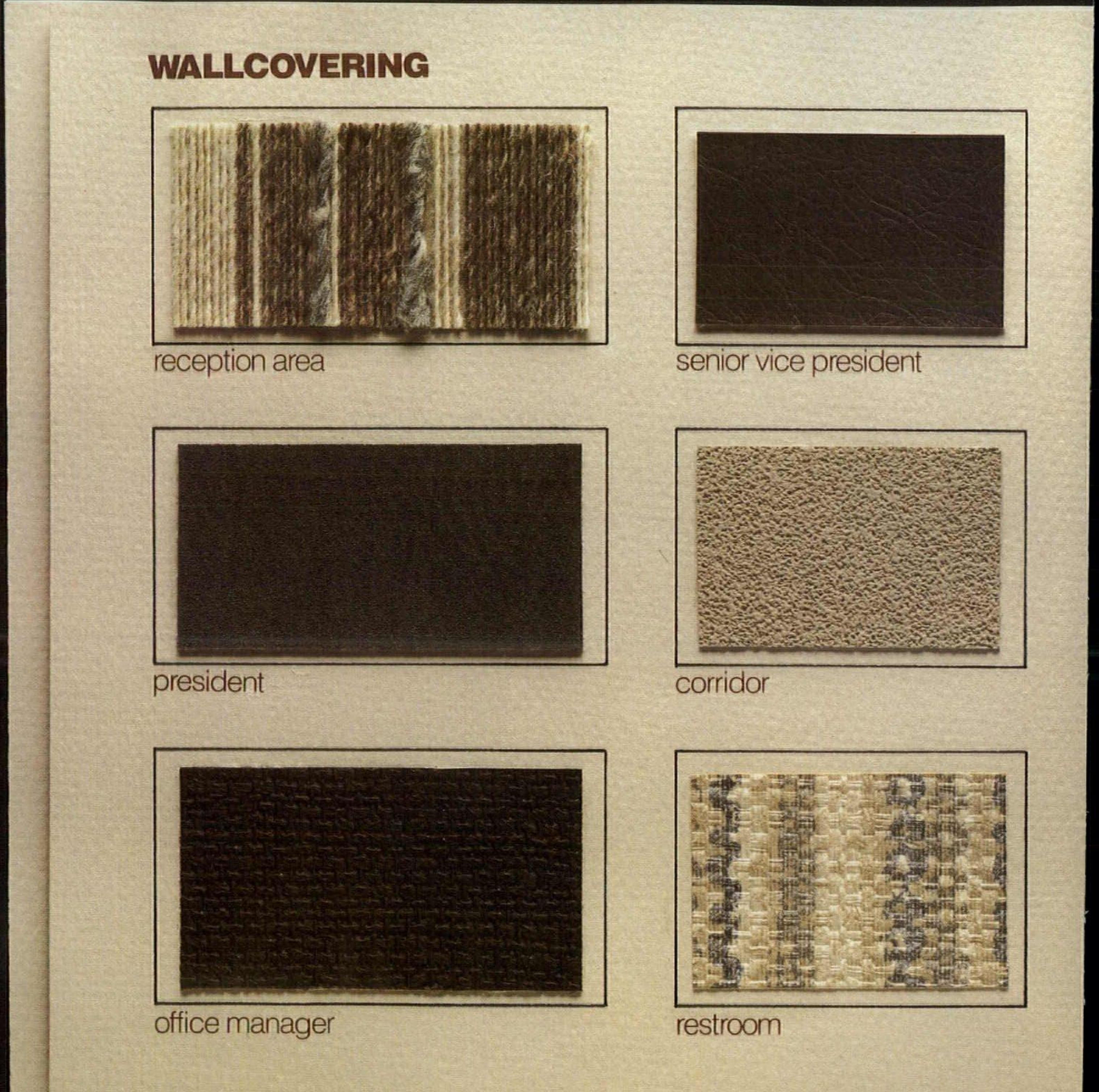

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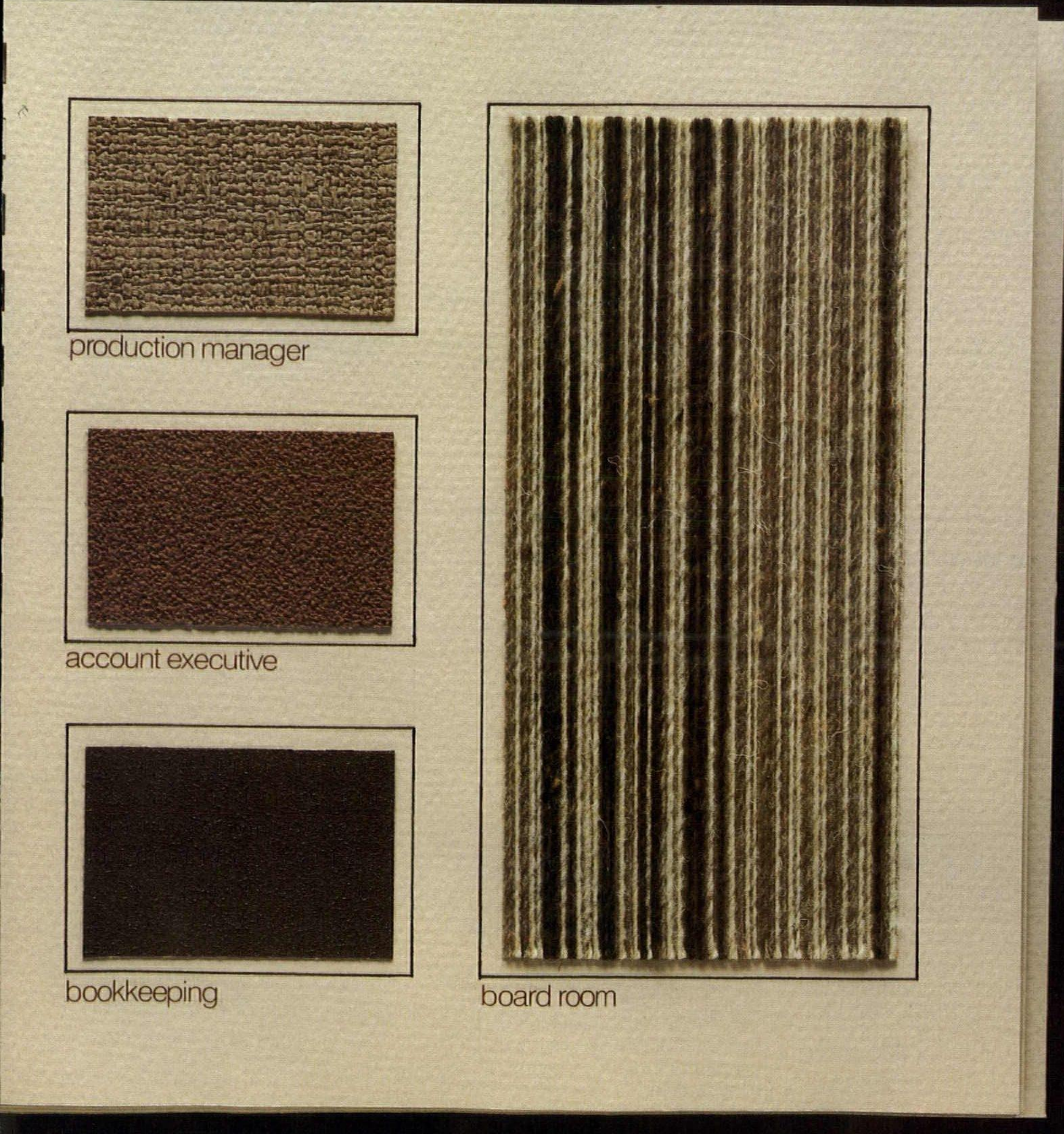

Now you can have the world's finest roof on any building.

THE MR-24® ROOF.

The MR-24® roof—the only true, double-lock, standing seam metal roof system on the market—is now available for use on virtually any structure: conventional, pre-engineered or a combination.

That means you get design freedoms not associated with other metal roofs, plus quick installation with a minimum of labor.

And, because it is today's finest roofing system, the MR-24 roof will change the way you measure the performance of all roofs.

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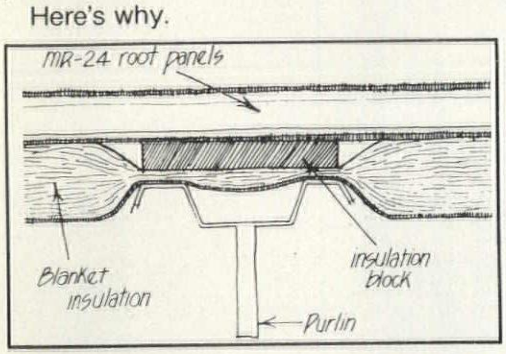


Unequalled energy efficiency.

No built-up or metal roof can come close to the MR-24 roof in energy efficiency.

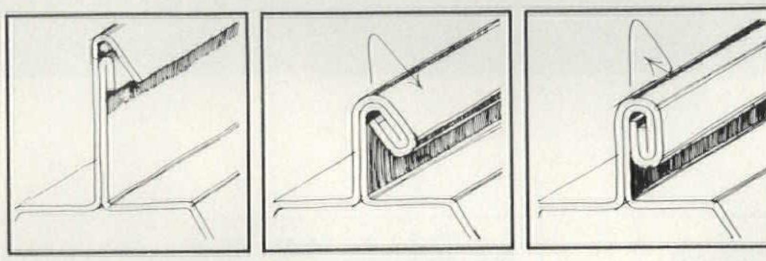
Just 4 inches of insulation, plus special insulation blocks at the purlins, give the MR-24 roof an exceptional tested U value of .08. A fact that can mean lower utility bills, and savings for years to come. (See "Comparative U values" chart.)

Eliminates roof decay.

Built-up roofs use organic materials. But the MR-24 roof uses aluminum-coated or Galvalume* steel, which won't crack, peel or decay.

To your client, that means virtually no maintenance. . . and big savings.

*A Trademark of Bethlehem Steel Corp.



Keeps elements out.

With over 150 million square feet of MR-24 roof installed, we have never had a reported leak through our double-lock seam.

Not one.

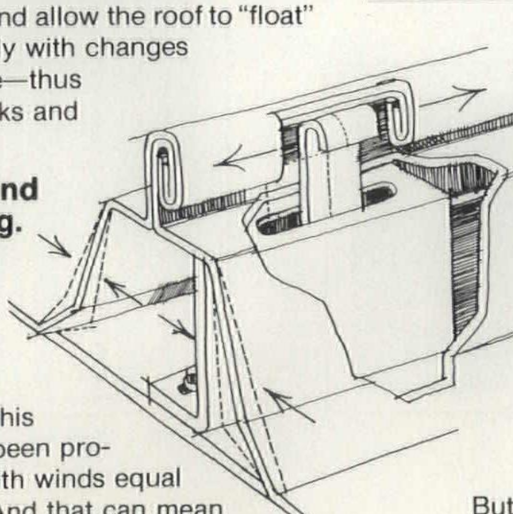
Our exclusive Roof Runner® machine is one reason. It automatically compresses and locks the roof panels into a single, continuous membrane . . . on the job site.

And, because the MR-24 roof eliminates a substantial number of the usual penetrating fasteners, it eliminates a major cause of roof leaks.

Allows for roof movement.

Built-up roofs, and most metal roofs, don't provide for normal thermal expansion and contraction. Therefore they are highly prone to leak.

But the MR-24 roof is attached to the structure by unique clips formed into the standing seam. These eliminate penetrations and allow the roof to "float" —moving freely with changes in temperature—thus preventing leaks and cracking.



Highest wind uplift rating.

The unique design of the MR-24 roof gives it a U.L. Class 90 wind uplift rating. This means it has been proven in tests with winds equal to 200 MPH. And that can mean substantial insurance savings in some areas.

Energy-efficient, durable, weathertight, adaptable, easily installed and maintained.

Only one roof system can back all those claims with a record of proven performance: the MR-24 roof. Shouldn't it be on the next building you design?

Comparative U values.

Roof System	*Calculated* U value	Butler tested *Actual* U value
1. Built-up roof with metal deck		
2" insulation	.15	*
4" insulation	.07	*
2. Industry standard metal roof		
2" insulation	.12	.19
4" insulation	.06	.12
3. Butler MR-24 Roof System		
2" insulation	.12	.12
4" insulation	.06	.08
6" insulation	.04	.07

*No tested U values available.

To find out more about the MR-24 roof, contact your local Butler Builder.®

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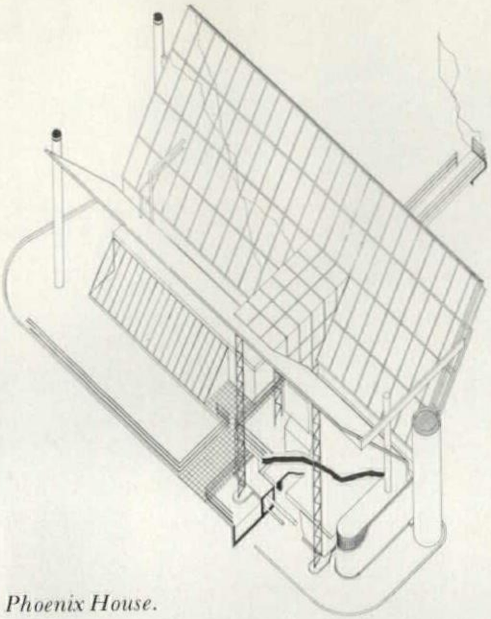
News report continued from page 34



Phoenix House.

aesthetic. The plan epitomizes both functional simplicity and formal elegance.

On the south side of the house the pool evokes the medieval imagery of moat and drawbridge, while serving as an energy reserve, stabilizing the house temperature by heat transfer in either direction. The southern living quarters are sheathed by a glass-enclosed "interstitial" space, the inner skin of which is made of etched glass which reflects and diffuses sunlight. Heat is trapped in this plenum during cold weather; at other times temperature variations are mediated by means of air circulated within this interstitial space. Adjustable awnings control the admission of daylight into this area.

A 432-sq-ft greenhouse constitutes the remainder of the southern exposure, serving both as a visually attractive transitional space and as a trap for passive solar heat gain. These southern layers of the house are aligned with the mechanical service spine, which extends the length of the house. The northern exposure aligns service functions against this central, mechanical spine which services all spaces in the house. By designing this mechanical spine as an opaque barrier between the north and south functions of the house, the architect has missed an opportunity to establish a visual link between the greenhouse and the service spaces on the north side of the house: the bath, laundry, and kitchen. The dining room, which might have been more directly associated with the southern exposure of the living room, is also on the north side, separated from it by the mechanical spine.

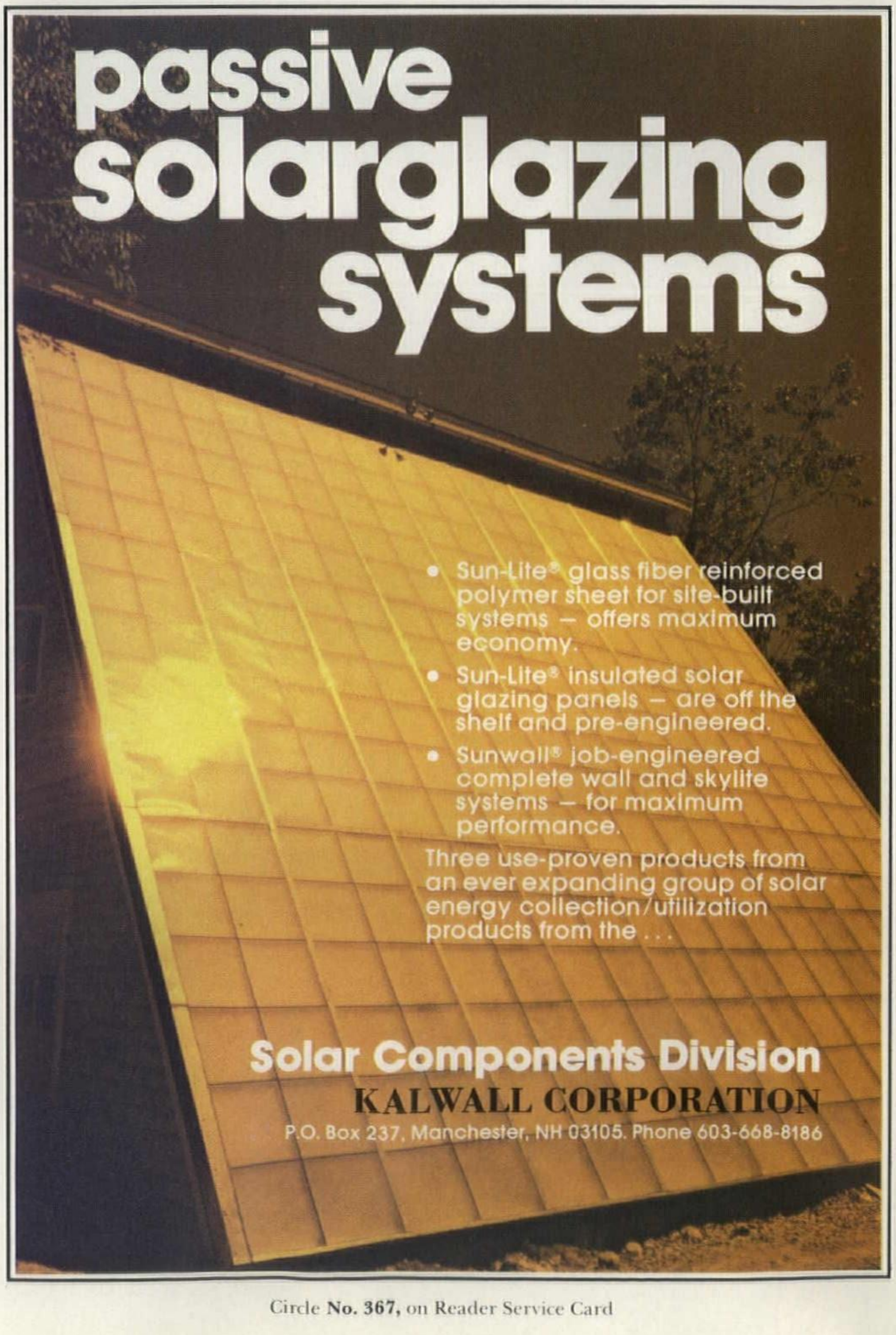
The roof umbrella is half an array of water-filled solar collectors (1656 sq ft at 45-degree tilt) on a metal frame facing south and half a steel grid with translucent fiberglass panels, oriented north. This solar umbrella absorbs solar heat energy at the same time that it shields the house from unwanted insolation. The collector panels are used for domestic hot water, for space heating, and for an absorption chiller air-conditioning system. Electricity is supplied by a wind-powered electric generator. Beneath the solar umbrella, a roof deck with an outdoor sculpture court overlooks the valley from behind adjustable awnings. These movable sun screens control radiant energy at the exterior, while adjustable metal blinds, positioned in the interstitial space and greenhouse, control incoming energy. The house rests on a concrete pad base. The building skin is glass and aluminum with a structural metal frame and floor joist system used throughout.

To achieve this design subtlety in a project of 2304 sq ft conditioned floor area demanded careful integration of functions by the architect. The design is so tight that no space is wasted, and every element is used to both aesthetic and energy-conserving advantage. The house is scheduled for construction beginning in the spring of 1980 on a four-acre site in the Verde Valley near Phoenix. [Susan Gill]

Montessori School and Administrative Building, St. Paul, Mn. *Architects: Ralph Rapson & Associates, Minneapolis, Mn.* An irregular, multilevel grid of hard and soft landscaped terraces pierced by triangular roofs constitutes one's first impression of a proposed Montessori School and Administrative Offices facility for the Montessori Foundation of Minnesota.

The building was planned for a small, sloping urban site bounded on the south by a residential street in a moderate-income residential neighborhood in St. Paul.

Both the architects and the client shared economic and energy concerns. Those factors, and the site, led the architects to a low-profile building, a "nonbuilding," almost entirely underground. The plan puts classrooms, commons areas, cafeterias, and lecture halls just below ground on the south side of the building, and administrative offices one level below, on the north. The triangular roofs which poke through the surface house skylights and solar collectors—16 banks of the latter, irregularly spaced, with the highest reaching 60 ft from the entry level at its highest point. Skylights [*News report continued on page 42*]



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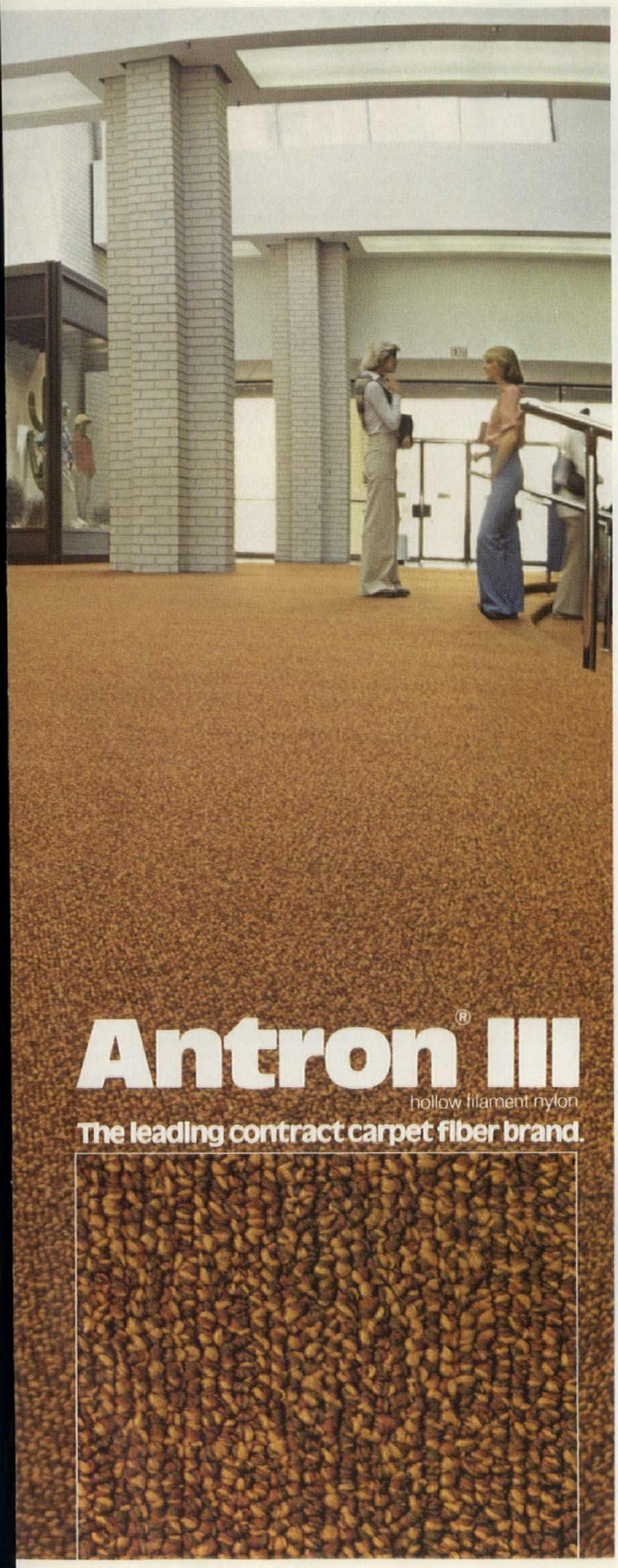

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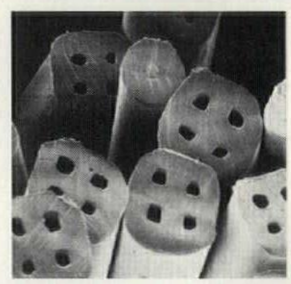

Magnification 250X of Antron® III nylon showing hollow filaments and round, anti-static filament.

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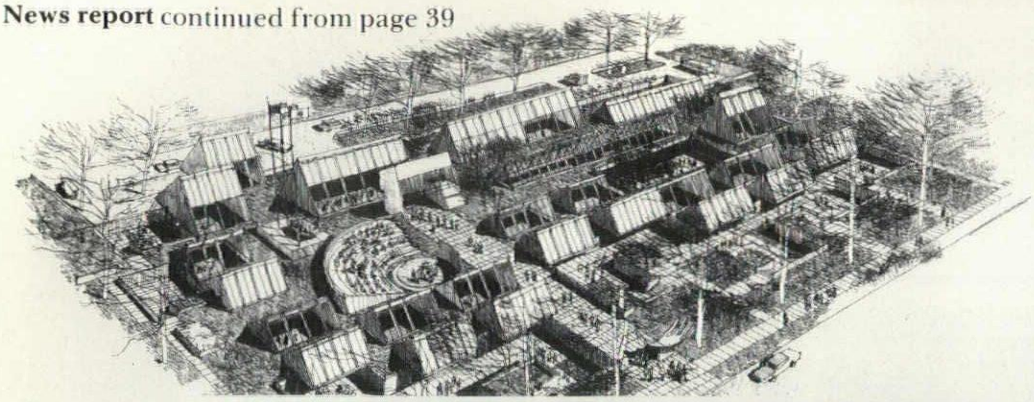

Montessori School & Administration Building.

bring light into classrooms and circulation spaces immediately below them; solar collectors are mounted above storage and mechanical spaces.

The terraced, sunken, south-facing play courts on the building's roof provide 4000 sq ft of controlled play area immediately accessible from every classroom, meeting the school's request for outside play space equal to or greater than indoor classroom space.

The courts form an irregular grid of landscape and stone, breaking the expanse into a series of play courts and mazelike walkways. A greenhouse and an open, semicircular garden court have been designed to provide functional integration of the natural and man-made elements of the building.

After initial designs had been approved, the promised site was included in a major industrial development project planned by the city, leaving building plans temporarily suspended until an alternative site can be selected. [Joanna Baymiller]

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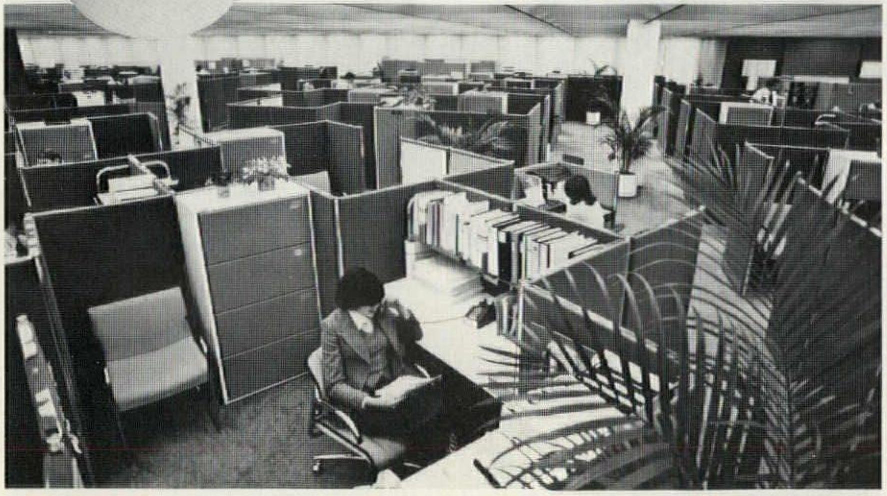

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Central Pre-Mix Concrete Co., Spokane, Wa. *Architects: Walker McGough Foltz Lyerla, Spokane, Wa.* Electrically powered hydronic heat pumps are the basis of the energy-saving system for this earth-covered building. The conservation potential of the building envelope is enhanced through the maximum utilization of internally generated heat from people, lights, and equipment—mostly a computer—and passive solar energy from an exposed south-facing wall.

Wrapping the building with an earth berm on all but the south side answered the client's requests for a two-story structure with a daylighted basement and access to a major traffic artery along the south side of the site.

One floor is situated above grade and the other slightly below, thereby providing both levels with generous amounts of natural light through continuous bands of south-facing windows. Exterior precast sunshades screen unwanted direct sunlight during the warmest months. Combining the building's structural mass with an earth cover insures minimum heat gain or loss through the building envelope. When outside temperatures exceed even 15 F, the occupant load will generate more heat than necessary. Only during periods when the building is unoccupied in the winter will heat loss through the south wall require use of the HVAC system to counteract reduced night temperatures.

To condition the usable 15,200-sq-ft floor area, the HVAC system will collect heat from the internal sources mentioned, including the lighting fixtures, the majority of which are extraction fluorescent troffers that return air to the heat-pump units. If the total heat produced exceeds that needed to maintain a comfortable temperature, the heat-pump units will reject the heat into a water loop system that includes a 3000-gallon storage tank.

The piping and storage tank will store enough heat to counteract the losses for approximately a 24-hour period during cold weather. Most of the time, the excess heat produced will be used at night and on weekends. When more heat is generated than can be used during unoccupied periods, outside air will be introduced into the ceiling plenum and into the heat-pump units. If the cooling effect of the outside air is inadequate, resulting in mechanical refrigeration within the heat-pump units, a tower fan will be actuated to reject the excess heat. When the temperature of the water in the storage system can accommodate additional rejected heat, introduction of outside air will be minimal.

If heat losses exceed available stored heat,

[*News report continued on page 44*]

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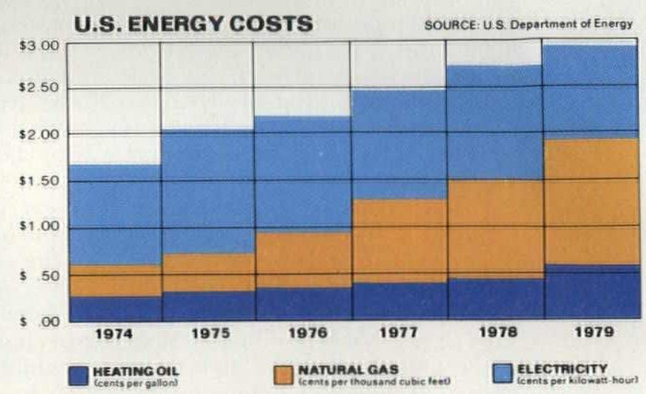
It won't cost you a penny. and it could save your clients thousands.

StarTherm insulated roof and wall systems are so remarkably energy efficient we think they'll out-perform almost any conventional construction materials. And we're willing to prove it with a free StarTherm Energy Efficiency Analysis.

Just give us the location and specifications of your proposed building project and your Star Builder will ask our computer to determine the energy savings you could realize with a StarTherm building of the same size. The results can be dramatic.

The StarTherm system's remarkable insulating properties will significantly reduce operating and maintenance costs, which account for about 50% of the total life cycle costs of any building. (The rest is initial construction and finance costs, plus improvements or building additions.)

You'll find it pays impressive dividends to build with StarTherm insulated panels.



$1,839 Annual Savings in Chicago.

In one example, the computer compared a 100′ wide by 150′ long by 20′ high structure with 4″ normal density blanket insulation in the roof and 12″ corefilled concrete block walls, with a building of the same size equipped with StarTherm roof and wall panels.

Our energy savings calculations were based on heating loads only. We told the computer that our example buildings were located in Chicago, and we specified that each building had two 3×7′ walk doors, two 10×10′ insulated overhead doors and two 3×6′ thermal pane windows. We assumed gas heating at $3.50 MCF.

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The StarTherm building consumed 68% less energy than the conventional building, resulting in an annual dollar savings of at least $1,839. And when you consider the current rapid inflation in energy costs, this savings will be even more significant to the building owner 20 years from now.

Remarkable but not surprising.

StarTherm insulated panels offer some of the lowest U factors money can buy: 0.043 for roofs, an even lower 0.040 for walls. They have no through fasteners or compressed insulation points. Joints form a positive energy tight seal, and, according to ASTM-E-283 testing procedures, allow no detectable air infiltration.

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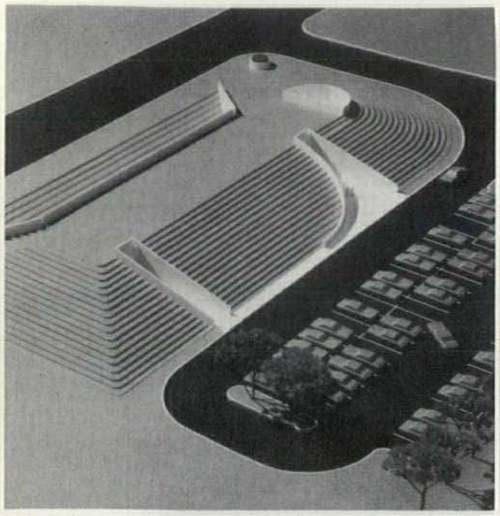
News report continued from page 42



Central Pre-Mix Concrete Co.

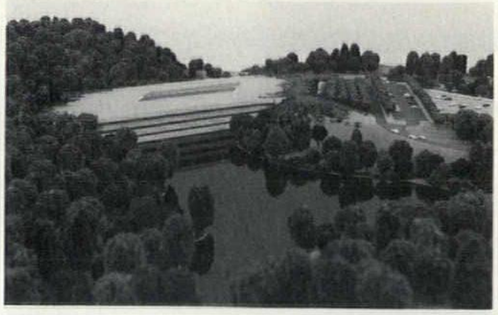
a supplemental gas-fired boiler will add heat to the loop. When the heat-pump units are mechanically cooling, heat will be rejected into a closed-loop water system via a water-cooled condenser subsequently to be redistributed or stored.

Compared to a similar, conventional above-grade building with a standard system, this structure has been calculated to reduce costs by about 50 percent. The payback period has been conservatively estimated at eight to ten years although the actual time should be less because of the gradual warming of the earth around the building. The total initial building cost for this 16,000-sq-ft structure is projected at $840,000. [Sally Woodbridge]

Alabama Operations Center, South Central Bell Telephone Company, Jefferson County, Al. *Architects: Crawford, Giattina & Associates; Joe Giattina, architect in charge, Birmingham, Al.* Although energy conservation was a strong design charge, many of the energy-conscious features of this 450,000-sq-ft headquarters building seem to be more a result of the owner's and architect's concerns for the attitude of the building toward its natural setting.

The winning solution in a statewide competition, this building is covered with insulating earth fill topped by native vegetation. Like other aspects of the project, this decision was not wholly the product of energy concerns. The ground level of the site is nearly 100 ft below the level of surrounding roadways. The building is mostly office space (or *office warehousing,* as Giattina describes it, referring to the client's need for large, flexible open areas). Internal stairs are a central element of the design, both formally and from an energy-saving standpoint. Use of elevators will be minimal. Since the building is only three stories high, stairs are emphasized as the major building transportation system.

The client's concern for environmental systems also led to development of a complete, self-contained waste-water treatment facility. Innovation in the project was extended beyond the mechanical, electrical, and plumbing systems. Faced with a re-



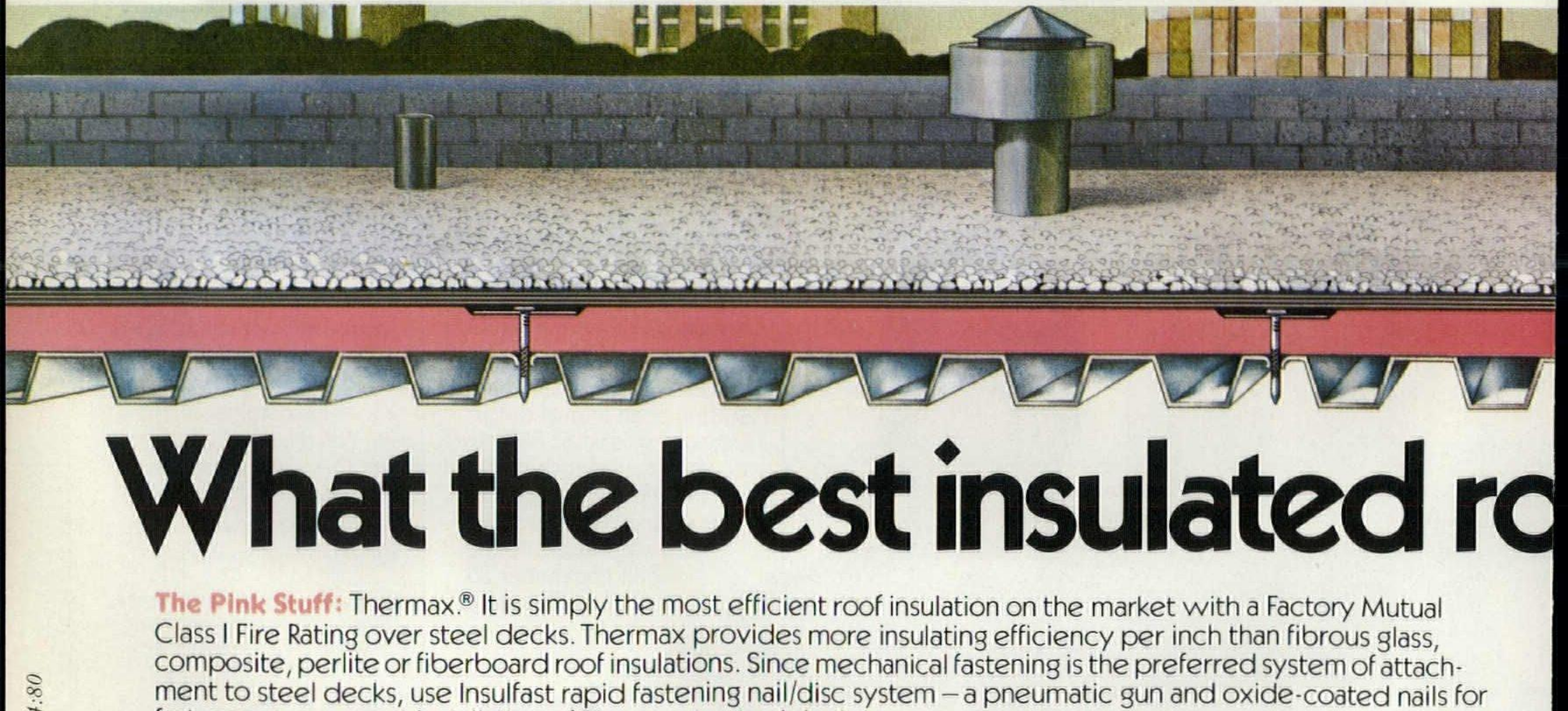
Alabama Operations Center.

quirement for large open spans, the architects and engineers devised a post-tensioned concrete frame and steel deck structural system, which, to the best of their knowledge, is the first such application in a building of this scale. Architect Joe Giattina explains, "it was really a problem of site-blending, as most of the major views of the building would be out over the roof level. The side benefits from an energy standpoint were substantial."

A man-made lake, in part a design gesture to the company's desired corporate image, serves several important energy and environmental functions. In service as a thermal pond, its waters become a cooling medium when temperatures permit. Irrigation for the roof planting comes from the lake; as the water is recirculated, it is purified and oxygenated. The lake also serves as an area for storm-water retention and accommodates the building runoff.

The building form provides shading for all major glass areas. In the architect's words,

[*News report continued on page 48*]



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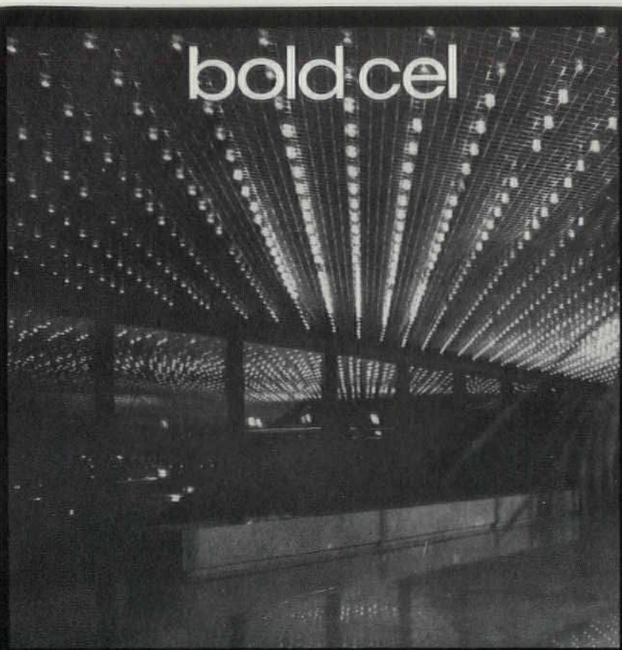

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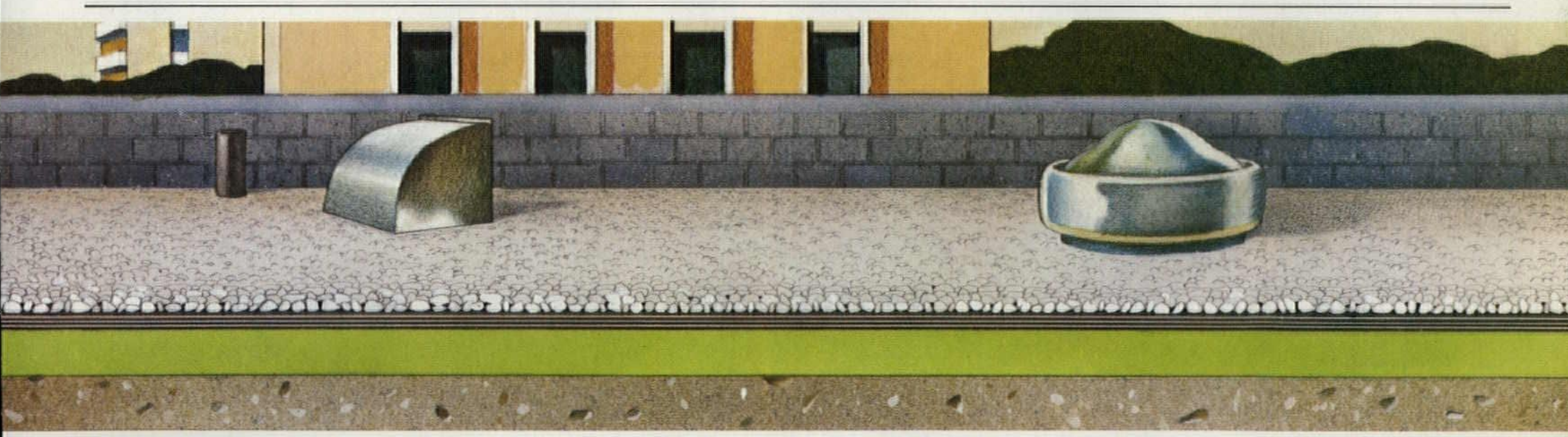

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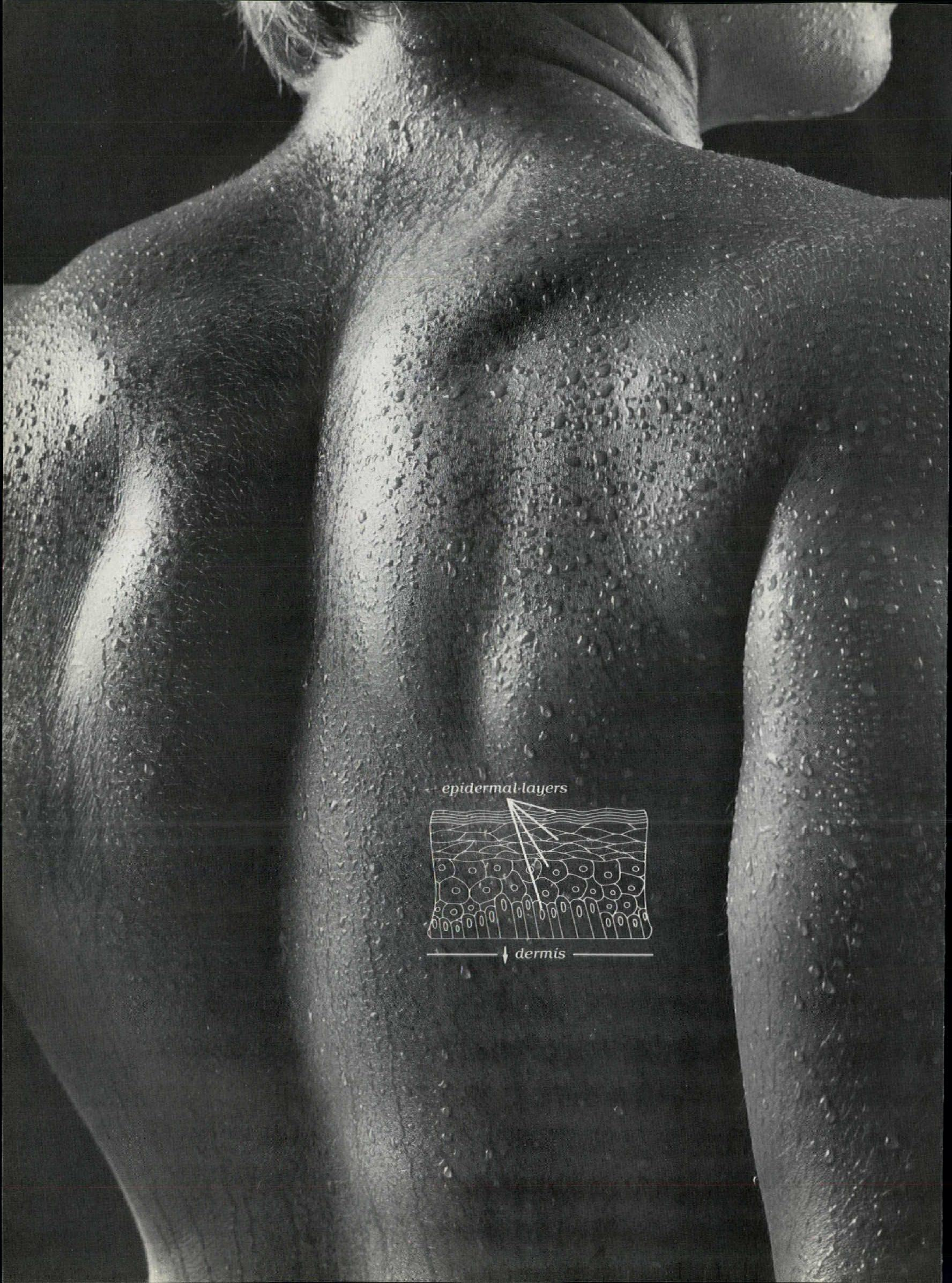
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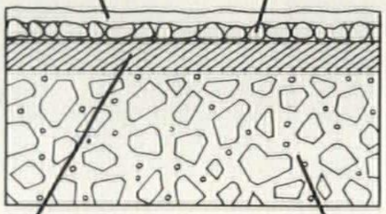

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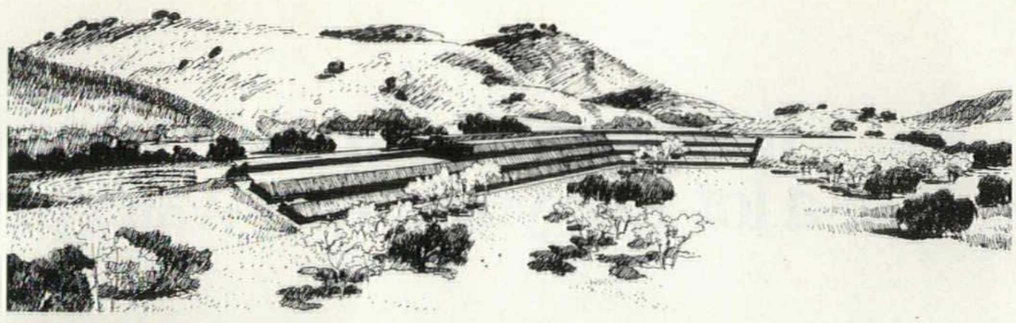
News report continued from page 44

"This is primarily a location where cooling is the problem; we're exhausting heat 95 percent of the time." A reclamation system uses that heat for domestic hot water in the bathrooms, kitchens, and cafeteria. Augmented by storage tanks and 6000 sq ft of solar collectors, the hot water system can also provide the building with adequate space heat, when needed, for brief holiday periods. This also saves considerably at "start-up" time when the staff returns.

One element seems to run against the conventional energy conservation wisdom: there are few provisions for task lighting. Constrained by the requirement to accommodate Southern Bell's existing furnishings, which were not compatible with task lighting, the architects had to devise a flexible ambient illumination scheme in the ceiling. "The results are very nearly as good as those we'd see with task lighting," says Giattina, noting that zoned switching and a perimeter photocell system helped greatly.

The firm compared the expected energy performance of its design against that of a 1970 office building of a similar size in a similar climate. The computer-assisted analysis put the Alabama Operations Center at 40 percent below its earlier counterpart in calculated annual energy use. Construction of the project is now about 30 percent finished with a projected completion date of October 1981. [Thomas Vonier]

Prudential Insurance Company Corporate Headquarters, Thousand Oaks, Ca. *Architects: Albert C. Martin & Associates (Senior Project Designer, Michael O'Sullivan), Los Angeles, Ca.* The headquarters occupies an environmentally sensitive hilly site, and the architects have designed a building which will take full advantage of the landscape's natural beauty. The three-story, stepped-back building is sited in an "earthen saddle" against the bottom edge of a hill and canted to follow the natural contours. The angle of the setback echoes the slope of the hill, and additional berming will visually reduce the building's bulk as well as screen parking and service areas. Faced with alternating bands of glass and earth-colored granite, the building reflects the colors of the surrounding countryside. Site development included design of a 49-acre landscaped master plan, extensive parking, internal access roads, and protection of an oak arroyo storm channel. Office space constitutes 286,000 sq ft and auxiliary functions, another 100,000 sq ft.

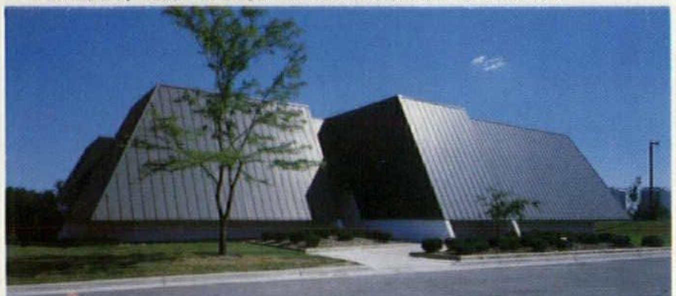

Prudential Center.

A continuous three-story atrium along the building's axis terminates at both ends in carved-out amphitheaters. Three staggered north-light monitors along the atrium's length admit daylight into the core of the building; smaller porthole skylights facing south balance the light. Daylight is directed to the atrium floor by a system of reflective panels and motor-operated blinds. Along the building's long façades, continuous bands of double-glazed windows provide views of the distant mountains and an additional source of natural light, while 6-ft overhangs protect the offices from direct solar penetration and heat gain. Both the skylit atrium and band windows will reduce the daytime artificial lighting requirement. The project is scheduled for completion early in 1981. [Barbara Goldstein]

California Farm Bureau Federation Headquarters, Sacramento. *Architects: Pflueger Architects, San Francisco.* Since the major problem in the Sacramento Valley is cooling, many of the energy-saving devices incorporated in this building address this problem. To reduce the energy input to the refrigeration chiller of the air-conditioning system, water is cooled in evaporative cooling towers at night and stored in four underground tanks for use the next day. On mild days the towers send water straight to the air-conditioning system, bypassing the re-
[*News report continued on page 52*]

What do this Japanese restaurant, furniture store, and office building have in common?

Top — Kyoto Steak House — and right — Barr Office Building, both by Rossen/Neumann Associates, Southfield, Mich. Lower left — Art Van Furniture by Robert L. Ziegelman/Architects, Birmingham, Mich.



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1980 OWENS-CORNING ENERGY CONSERVATION AWARDS: CALL FOR ENTRIES.

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Owens-Corning would like to honor those specific architects and engineers responsible for conceiving and creating the most energy-efficient designs of 1980.

Registered architects or professional engineers practicing in the United States may enter as individuals or in teams. The building entry must be a commissioned project: new or remodeled, in the design process, under construction or completed.

A panel of proven professionals in architecture and engineering will act as jury. Entries must be submitted by August 29th, 1980. Winners will be notified in early October.

The Call for Entries has full details. For your copy, write today to Mary Reinbolt, Department 124, Owens-Corning Fiberglas Corporation, Fiberglas Tower, Toledo, Ohio 43659. Or call her at this number: (419) 248-7419.

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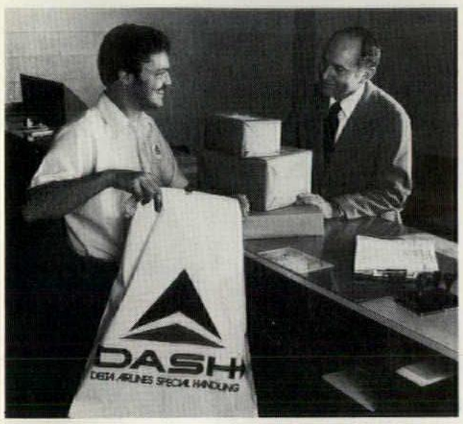

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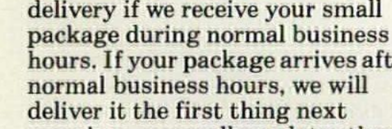

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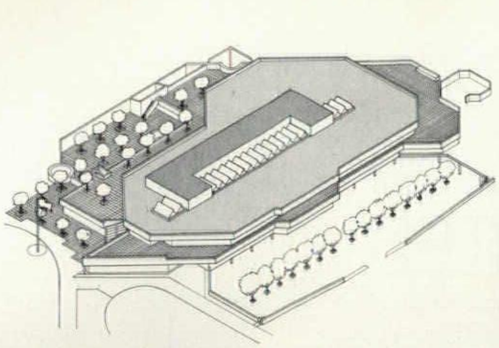
News report continued from page 48



California Farm Bureau Headquarters.

frigerator chiller. The chiller can be run in off-peak hours at lower rates to prechill water for storage in the underground tanks. An economizer cycle in the air-conditioning system reduces the electrical consumption of the fans and conditions the building with outside air when the weather permits. Louver window draperies and panels below the windows provide the occupants with some control over the micro-climates in different parts of the building.

The major equipment in the building is an electronic data-processing facility that requires 24-hour air conditioning for its operation. Heat rejected from this system is stored in two underground tanks and used to heat the building in winter and also for hot water.

The central part of the roof has a monitor section with north-facing skylights providing natural lighting and south-facing collectors supplying hot water for the kitchen, showers, and lavatories. When solar energy is insufficient, the control system switches to natural gas.

The building will require no heating or cooling for approximately 315 days of the year. Based on an interior design temperature range of 68 F to 78 F, it is estimated that the building will consume about 74 percent less heating and cooling energy than a comparable conventional structure.

The building is sheathed in Dryvit, a foam paneling with a cementlike appearance that has a number of advantages over stucco: reduced weight resulting in reduction of structural steel; simple, speedy construction; and no maintenance problems from cracks caused by expansion, as well as good insulating characteristics.

An energy-saving earth berm up to the second-floor level of the building on the west side minimizes its height and bulk from the point of view of the neighboring tract and provides a sunken terrace for the employees. The berm is well landscaped and the vegetation maintained by recycled or gray water. Parking is provided in an underground garage that also serves to transmit the cool night air under the building to the first-floor concrete slab where it is stored in the structural mass. [Sally Woodbridge]

Joanna Baymiller is a freelance journalist specializing in architectural subjects.

Susan Gill, M.Arch., Harvard, is a principal of the firm ABRI (Architecture, Building, Research, and Innovation) in Boston.

Barbara Goldstein, formerly of RIBA Jour-
[*News report continued on page 56*]

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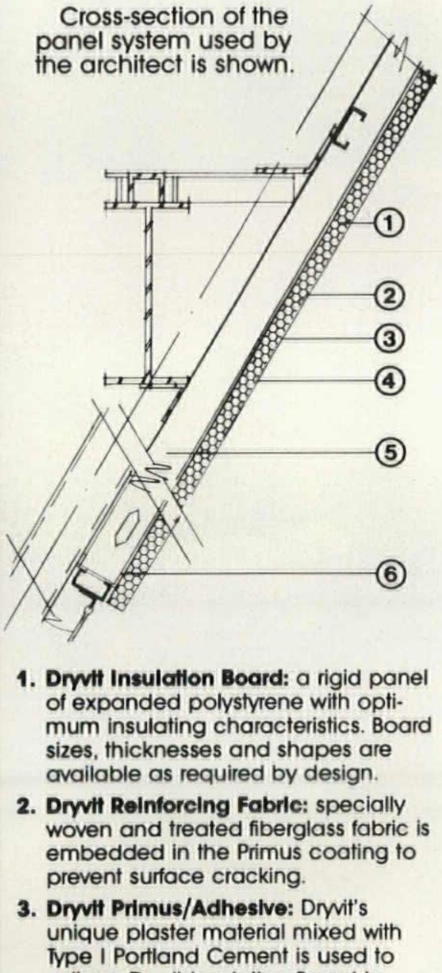

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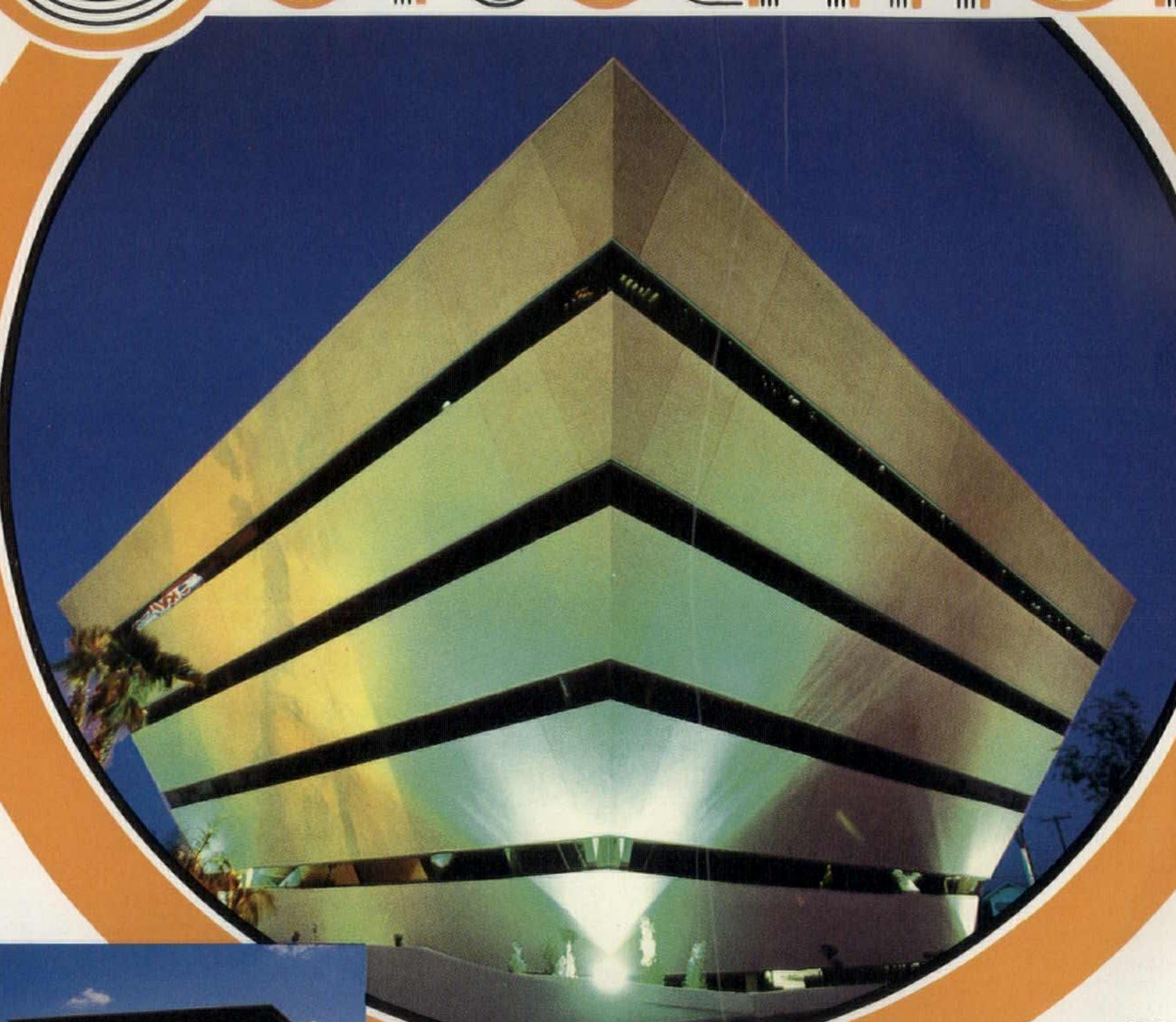

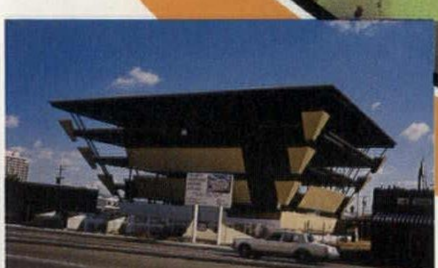

ARCHITECT
Tom Hite
Denver, CO

The pyramid is ancient history. But in this Phoenix, Arizona building, the pyramid is a dichotomy. On one hand, its inverted shape creates a mood of modernity. On the other hand, it was erected by using some good old fashioned work methods. The building which houses the offices of Security Mortgage Corp. and its lessees, stands four floors high. Each floor carries an overhang of more than 10 feet. In all, a total overhang of 44 feet. A 30 foot tree could grow within its shelter.

Another remarkable feature about the structure is the time it took to build. Just two and a half months from start to finish.

Unique methods were used. The Dryvit System was prefabricated on steel stud panels which were constructed on an adjacent lot. The block and tackle method was used to hoist the panels into position. And it needed only a crew of 3 lathers, 2 plasterers and a plaster tender to put up the 16,500 square feet of walls.

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All winners share equally in the Design Awards. There are no specific categories. In addition, for the first time in the Awards Program, the jurists presented a Special Award for energy conservation.

A CRSI Design Awards Program V brochure is now available. It details the structural systems and illustrates design features of all the Award winners. For your copy, write: Concrete Reinforcing Steel Institute. Attention: Victor A. Walther, Jr., Vice President, Marketing and Promotion.

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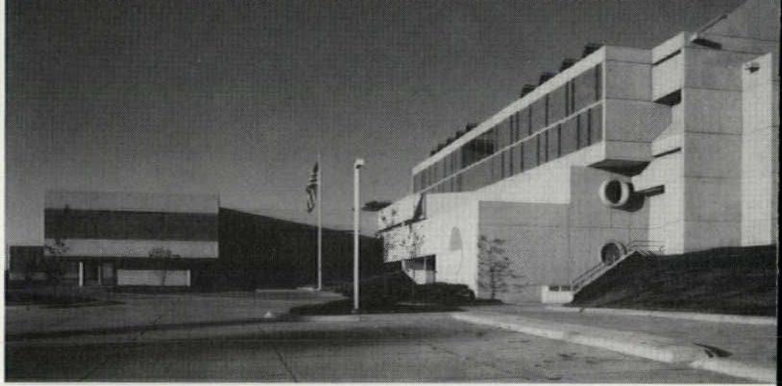
SPECIAL ENERGY CONSERVATION AWARD



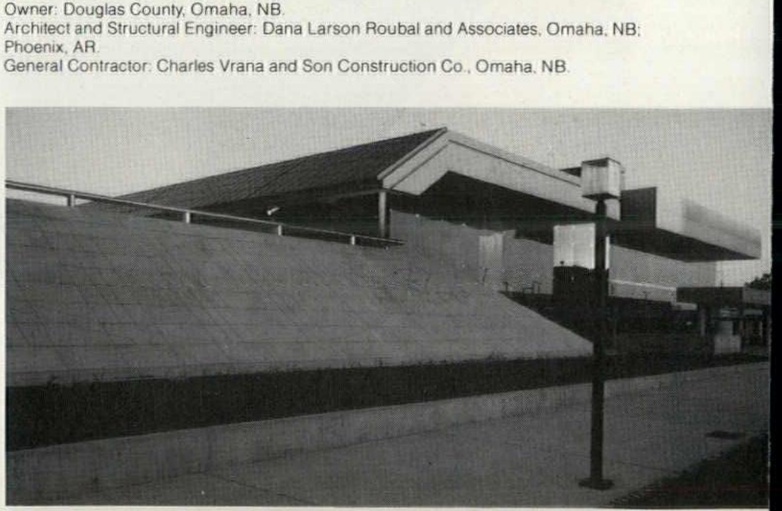
"Well-ordered intermix of elements."

Douglas County Correctional Center, Omaha, NB.

Jury Comments:
"This building says what it is. It uses basic forms in a well-ordered intermix of construction elements—reinforced concrete, masonry and brick. These contribute to a definite warmth so desirable in a correctional facility."

Energy Conservation Award.
Solar panels on the roof integrated solar energy into the design in more than just a visual sense. An altogether unique and economical solution to special design problems.

Owner: Douglas County, Omaha, NB.
Architect and Structural Engineer: Dana Larson Roubal and Associates, Omaha, NB; Phoenix, AR.
General Contractor: Charles Vrana and Son Construction Co., Omaha, NB.



"Visual excitement, great flexibility."

Baltimore Convention Center, Baltimore, MD.

Jury Comments:
"This building projects a dramatic image of what it is. Extensive use of glass infill permits one to see the people and activity inside the convention center contributing to the visual excitement of the project. A most innovative reinforced concrete framing system frames each of the four major exhibition halls and provides great flexibility for conventions of various sizes. The dominant concrete roof spandrels provide visual strength."

Owner: City of Baltimore.
Architect: Naramore Bain Brady & Johanson, Seattle, WA.
Associated Architect: Cochran, Stephenson & Donkervoet, Inc., Baltimore, MD.
Structural Engineer: Skilling, Helle, Christiansen, Robertson, Inc., Seattle, WA.
General Contractor: The Whiting-Turner Contracting Company, Baltimore, MD.

CRSI DESIGN AWARD

FOR
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in
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"Innovative, enthusiastic."

Reunion Tower, Dallas, TX.

Jury Comments:

"A successful solution to a unique structural problem. An innovative structure that capitalizes on modern slip-forming methods to provide both speed and economy. This enthusiastic reinforced concrete structure should have high appeal to the patrons of the observation decks and the revolving restaurant at the top."

Owner: Woodbine Development Co. (subsidiary of Hunt Investment Corp.), Dallas, TX.
Architect and Structural Engineer: Welton Becket Associates Architect, Los Angeles, CA.
General Contractor: Henry C. Beck, Dallas, TX.

"Functional, practical, overall economy."

Mecklenburg County Courthouse, Charlotte, NC.

Jury Comments:

"A very functional, practical, and distinguished solution for a government building. Everything is done with a purpose. Reinforced concrete was an excellent example of a very natural material for a high-quality building. The unique glass facade provides visual penetration both in and out of the building. One feels comfortable in this environment. The straightforward design provided overall economy for the client."

Owner: Mecklenburg County, Charlotte, NC.
Architect: Wolf Associates Architects, Charlotte, NC.
Structural Engineer: King-Hudson Associates, Charlotte, NC.
General Contractor: Larke Construction Company, Charlotte, NC.

"An exciting place to be."

Chapel of Thanks-Giving Square, Dallas, TX.

Jury Comments:

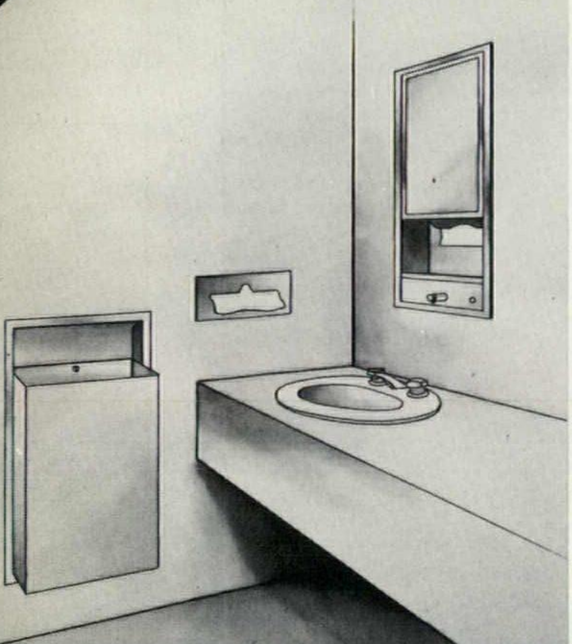
"A fun place for people. A real surprise in a busy, congested downtown area. A multi-leveled, well-ordered, exciting place to be. A tribute to the dedication of open space for use by people."

Owner: Thanks-Giving Square Foundation, Dallas, TX.
Architect: Philip Johnson & John Burgee Architects, New York, NY.
Structural Engineer: Datum Structures Engineering, Inc., Dallas and Austin, TX.
General Contractor: Manhattan Construction Co., Muskogee, OK.

washroom directions

The Space-Saving Men's Room–

For Office Buildings



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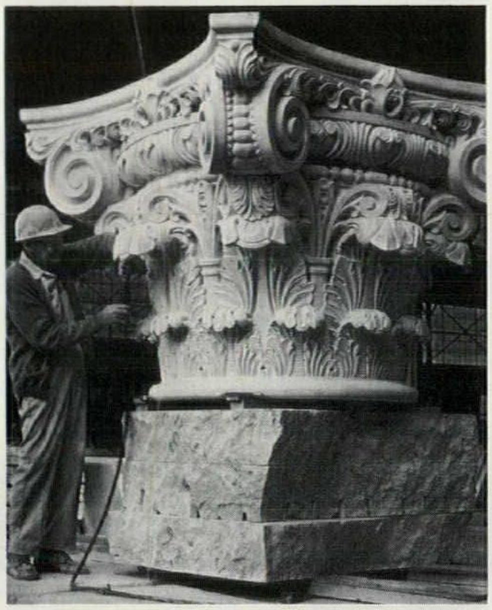
News report continued from page 52

nal *and* Architectural Design *in London, now teaches at the University of Southern California, Los Angeles, and is a West Coast correspondent for P/A.*

Thomas Vonier, AIA, is president of Thomas Vonier Associates, Washington, DC.

Building Stone Institute architectural awards

The 1980 Tucker Awards for architectural excellence in the use of natural stone have been announced by the Building Stone Institute. Presented at BSI's annual convention in San Francisco in February, these awards recognize outstanding concept, design, and construction in several categories.



Corinthian capital, First Church, Boston

Singled out among contemporary nonresidential buildings was the new portico of the First Church of Christ Scientist in Boston, completed in 1975 under direction of project designer Araldo Cossutta, then a member of I.M. Pei & Partners of New York (now principal of Cossutta & Ponte, New York). Among the several applications of stone in this addition to a monumental 1906 structure, the most striking are ten 42-ft columns of Indiana limestone with six-ton Corinthian capitals—each of which required 500–700 man-hours to carve (P/A, Mar. 1976, p. 81).

In the category of residential design, a single award was presented for a residence in Armonk, NY, by architects Robert A.M. Stern and John S. Hagmann of New York (P/A, Feb. 1977, p. 58). Among the notable features of the house are the fieldstone retaining walls of its terraces, which extend into the landscape, and the bluestone terrace paving, which continues into the interior.

Recognition for use of stone in buildings 25 or more years old was shared by two landmark structures designed by [*News report continued on page 61*]

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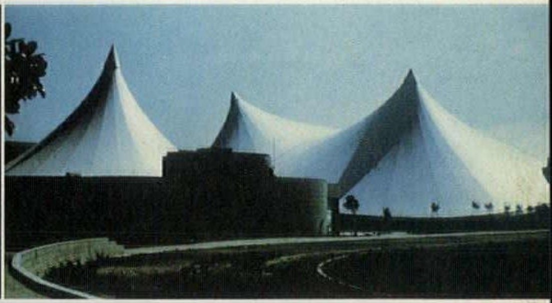
Although the roof weighs 200 tons, the spectators inside never notice the slight increase in air pressure that supports it.

Tension structures with steel cables carrying the load, such as this LaVerne College drama lab and campus center, offer an attractive alternative to air-supported structures.



In addition to low construction costs, fabric structures coated with TEFLON offer easy and economical maintenance. The coated fabric resists sunlight, dirt and aging, and rain helps keep it clean because of the non-stick surface of TEFLON.

Fabrics coated with TEFLON have high reflectivity, which helps minimize energy expenditures for cooling in summer. They also provide relatively high solar transmission for natural illumination and can be insulated to minimize heat loss in winter.

Architectural fabric structures are strong. When properly specified, they easily withstand the stresses of wind and snow. And Fiberglas® coated with TEFLON does not support combustion—exhibiting exceptionally low values for flame spread and smoke generation.

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Find out more about the advantages of architectural fabrics coated with TEFLON for permanent buildings. For a free 16-page full-color brochure, write: DuPont Company, Room 37050A, Wilmington, DE 19898.

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97 years of craftsmanship.

The Heltons of Terre Haute, Indiana. Three generations of craftsmen, and proud of it.

Elza Helton is on the left. He's been laying brick since 1919. Jim, on the right, has been a mason since the late 1940s. Rick is a relative newcomer with five years of journeyman experience on top of his three-year apprenticeship. Every time he lays a brick, Rick brings to the task the accumulated skills, experience and pride of three generations; and every wall he builds reflects those attributes.

Masonry is a unique building system. The inherent quality of the materials—of brick, block, stone, or tile—is one reason. Men like the Heltons are the other.

Their craftsmanship is what gives a masonry wall its beauty, permanence, and durability. Their skill is what makes a masonry wall air-tight, water-tight, sound-resistant and fire-safe. Masonry craftsmen build walls that save money, cut heating and cooling bills, and need virtually no maintenance.

It's a winning combination—the best building materials ever devised, and human skill and pride in using them well.

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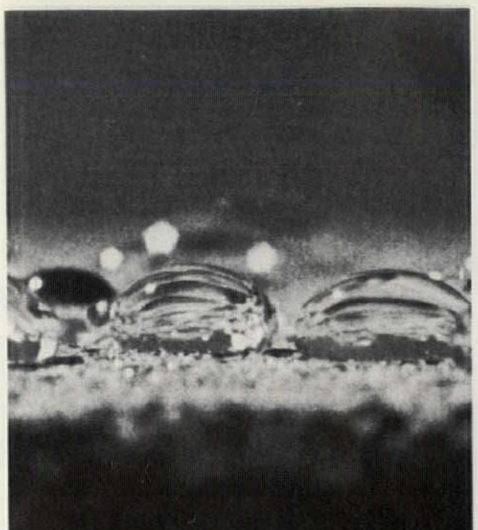

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News report continued from page 56

the Detroit firm of Smith, Hinchman & Grylls: the 42-story Penobscot Building in Downtown Detroit, a limestone-and-granite-clad exemplar of 1920s skyscraper form and the Rackham School of Graduate Studies at Ann Arbor, also of granite and limestone, with other fine materials.

Awards for landscape architecture went to two contemporary works by Robert Murase of EDAW, Inc., Portland, Or, for two projects in Japan—the Myodo Kyo Kai and the Aichi Green Center—completed when the designer was resident there.

The jury for this year's Tucker Awards included: Harry C. Wolf, FAIA, principal of Wolf Associates, Charlotte, NC; Gerald Allen, architect with Peter L. Gluck & Associates, New York, contributing editor of *Architectural Record*, and coauthor of *The Place of Houses* and *Dimension: Space, Shape and Scale in Architecture;* Charles G. Hilgenhurst, architect, of Boston (see obituary, P/A, March 1980, p. 56); William H. Livingston, Jr., AIA, of the firm of H2L2, Philadelphia; F. Thomas Schmitt, AIA, principal of his own firm in New York, until recently an associate of I.M. Pei & Partners, where he was Project Designer for the East Building of the National Gallery (P/A, Oct. 1978). [JMD]

Architectural awards for steel structures

The Architectural Awards of Excellence Competition, sponsored by the American Institute of Steel Construction, granted 14 awards for architectural excellence in its 19th annual competition. The jury also cited two other structures for "Special Mention." A total of 103 designs were entered in the competition.

Although clear, sharp details demonstrating design control are important, increasing emphasis is being placed upon energy utilization as an essential criterion in developing an award-winning structure. In addition, the jurors looked for an inviting environment for those using the building.

The following AAE award winners are listed alphabetically by architect: John F. Kennedy School of Government, Harvard University, Cambridge, Ma; architect: Architectural Resources Cambridge, Inc., Cambridge, Ma. Indiana Bell Telephone Switching Center Columbus 37XESS Addition, Columbus, In; architect: Caudill Rowlett Scott, Houston, Tx; associate architect: Boots-Smith & Associates, Indianapolis, In (P/A, July 1979, p. 66). Michigan City Public Library, Michigan City, In; architect: C.F. Murphy Associates, Chicago, Il (P/A, July 1978, p. 62). Rust-Oleum Corporation International Headquarters, Vernon Hills, Il; architect: C.F. Murphy Associates, Chicago, Il. Hickory Hollow Mall, Nashville, Tn; architect: Cooper Carry & Associates, Atlanta, Ga. Fournou's Ovens Restaurant

[*News report continued on page 64*]

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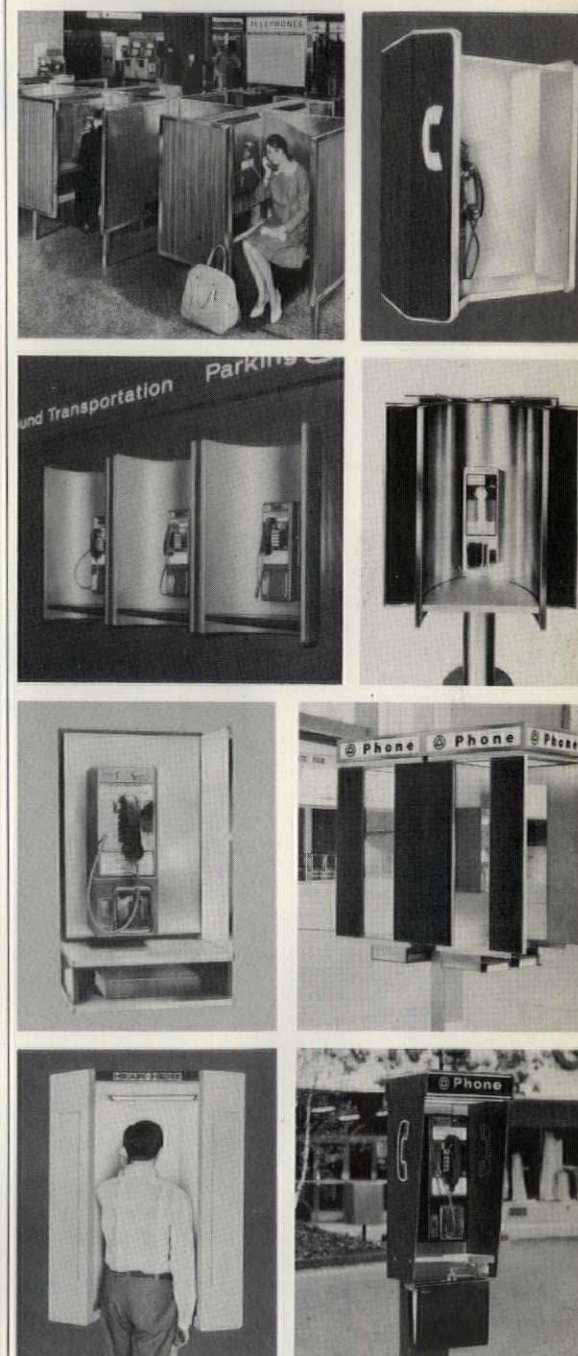

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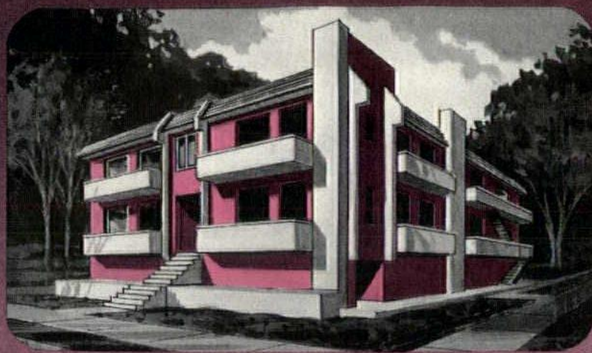

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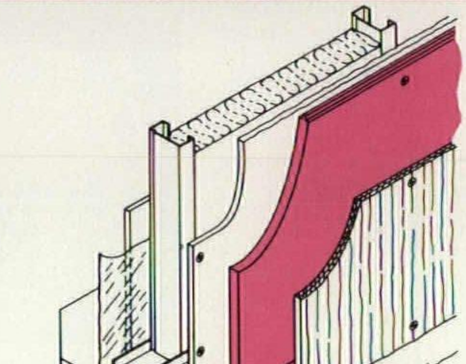

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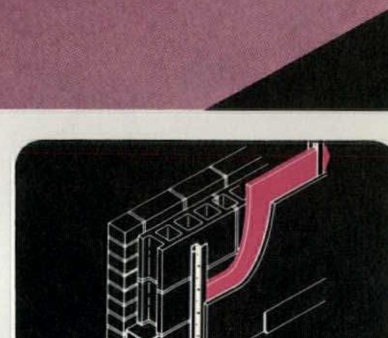

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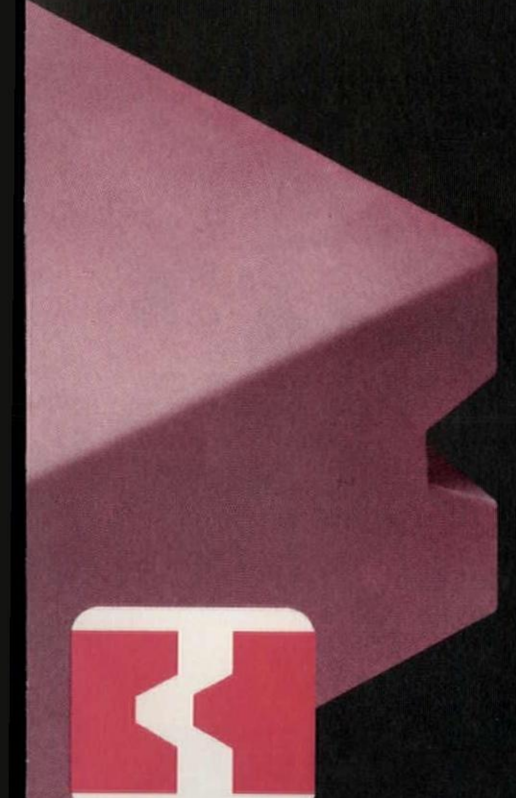

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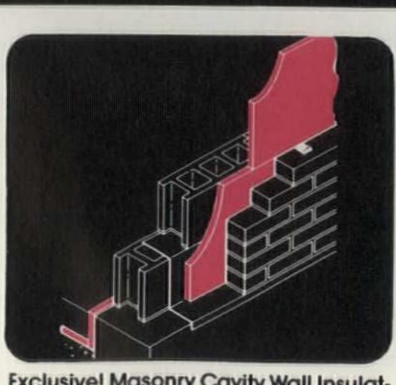

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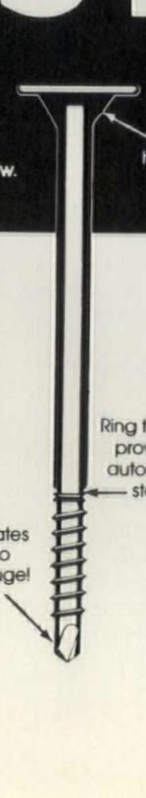

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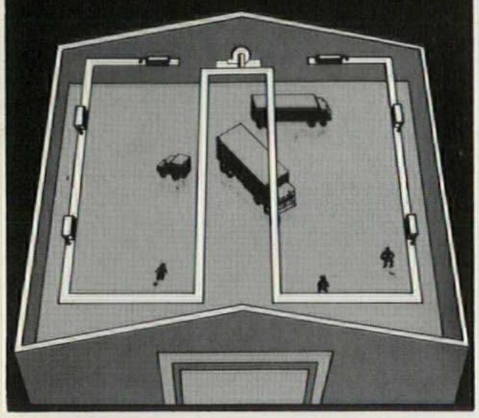

The 17 year old vented radiant heating system that a lot of people don't know about.

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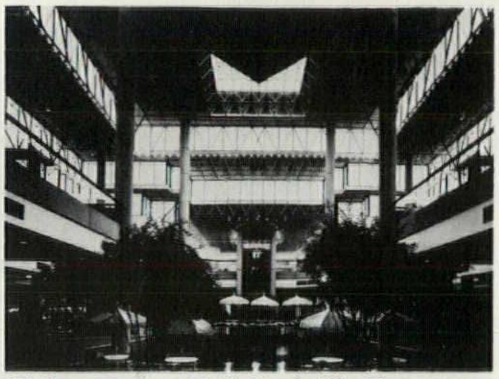
News report continued from page 61



Hickory Hollow Mall, Nashville, Tn.

& Lounge Expansion, San Francisco, Ca; architect: Esherick Homsey Dodge & Davis, San Francisco, Ca. The Calvary Baptist Church, Detroit, Mi; architect: Gunnar Birkerts & Associates, Birmingham, Mi. Environmental Health Laboratory, St. Louis, Mo; architect: Holabird & Root, Chicago, Il (P/A, Apr. 1979, p. 118). Deere and Company West Office Building, Moline, Il; architect: Kevin Roche John Dinkeloo & Associates, Hamden, Ct. Citibank Satellite Banking Building, New York State; architect: Landow & Landow Architects, Commack, NY. The Atheneum, New Harmony, In; architect: Richard Meier & Associates, New York, NY (P/A, Feb. 1980, p. 67). Federated Building, Cincinnati, Oh; architect: RTKL Associates, Baltimore, Md. Mid America Center, Hot Springs, Ar; architect: Stuck Frier Lane Scott Beisner, Little Rock, Ar; design architect: E. Verner Johnson & Associates, Boston, Ma. West Portal BART Station—MUNI/METRO System, San Francisco, Ca; architect: Tallie Maule and Reid & Tarics Associates, San Francisco, Ca.

The two buildings that received "Special Mention" are: Pavillion for Pope John Paul II, Boston, Ma; architect: Glaser/de Castro Associates, Boston, Ma. Sixty State Street, Boston, Ma; architect: Skidmore, Owings & Merrill, Chicago, Il.

The six jurors praised AISC for again sponsoring the awards as an effective means of promoting steel-framed buildings and steel as a construction material. Citing the institute for its promotion of fine architectural design, the jury noted that such a competition encourages designers to create buildings that not only have an aesthetic value but also fit the needs of the owners and relate effectively to their environment.

The jury was composed of: Sarah P. Harkness, FAIA, The Architects Collaborative, Boston, Ma; Philip H. Hubbard, Jr., president, Reinhold Publishing, Div. Penton/IPC, Stamford, Ct; George E. Kassabaum, FAIA, Hellmuth, Obata & Kassabaum, St. Louis, Mo; Ehrman B. Mitchell, Jr., FAIA, Mitchell/Giurgola, Philadelphia, Pa; J. Albert Paquette, FASCE, Paquette & Associates, San Francisco, Ca; Daniel H. Shahan, Albert Kahn Associates, Detroit, Mi.

[*News report continued on page 68*]

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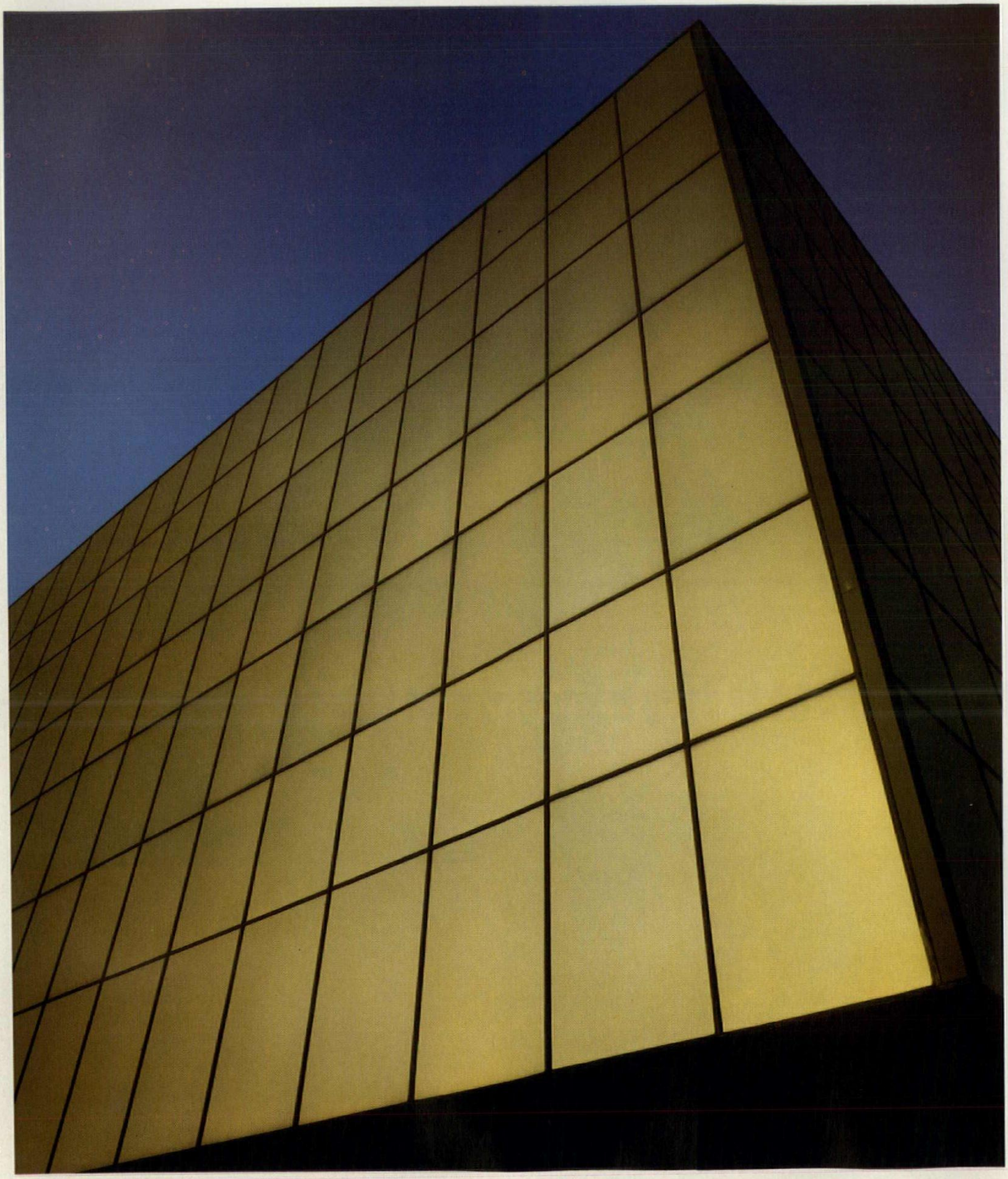

The Midland Life Insurance Building, Sioux Falls, South Dakota. The centerpiece of a far-reaching urban renewal program. And a triumph in modern center city architecture.

One reason for the building's success is 26,000 square feet of energy-conserving PPG *Solarban*® Gold *Twindow*® reflective glass. A breathtaking building skin that, literally, has earned its way into this design.

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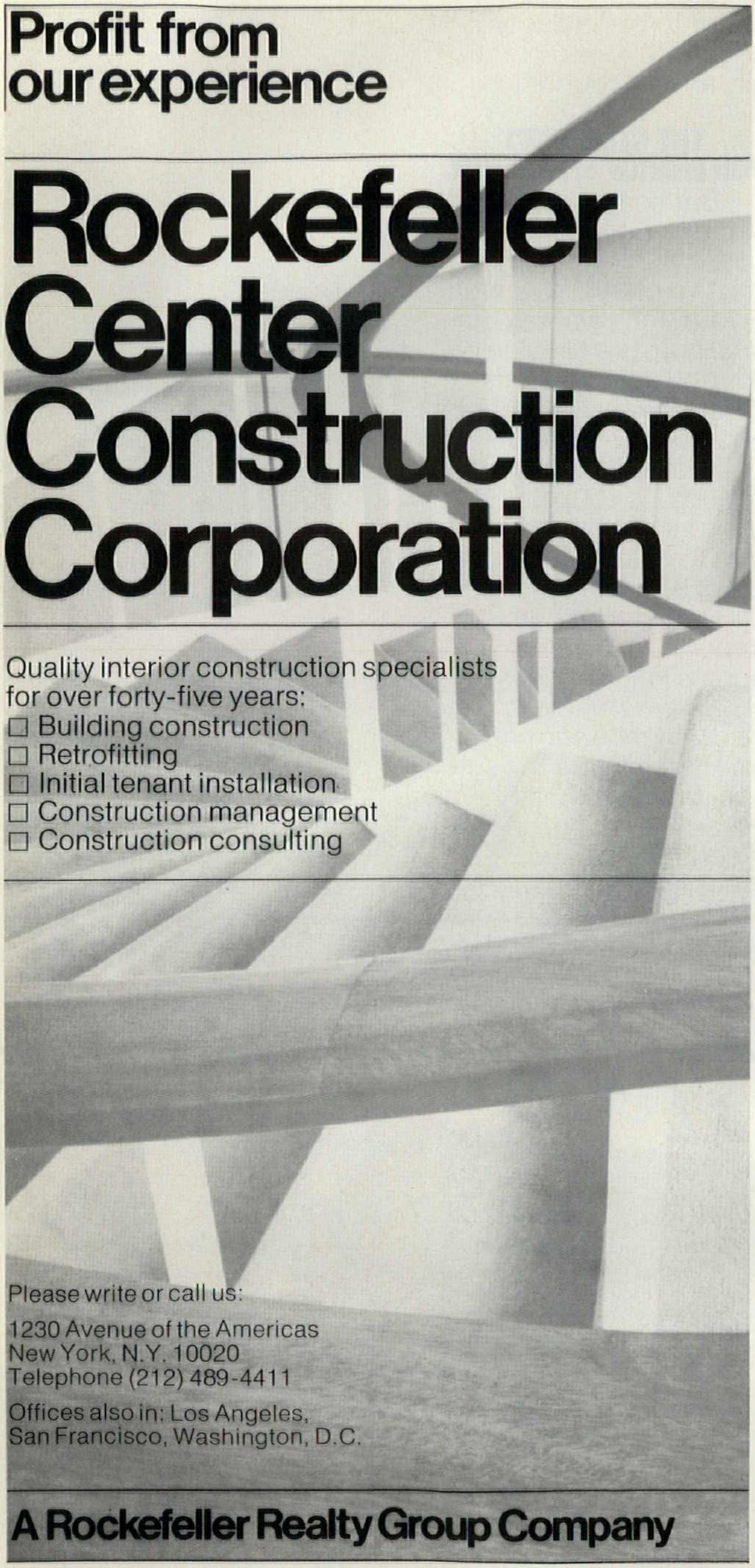

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News report continued from page 64

Promotions on P/A staff: McCarthy, Desimone, Rose

Three key members of the P/A organization have assumed greater responsibilities as part of a program to expand and strengthen the magazine's staff.

Barbara McCarthy, previously Administrative Editor, has been named Managing Editor, with broad responsibilities for planning of editorial subjects and management of editorial expenses. A graduate of Sacred Heart University, she joined P/A in 1971 as an editorial assistant.

Daniel Desimone, who joined the P/A Production Department in 1960, has been promoted from Managing Editor to Business Manager of P/A. In this newly established position, he will work closely with the Publisher in all areas affecting the magazine's revenues and costs.

Harrington A. Rose, who has been associated with P/A since 1962, has been appointed to the new position of National Accounts Manager. Until recently P/A's Eastern Sales Manager, he will represent P/A with major producers and trade associations nationwide and at building industry conventions.

Calendar

Workshops

May 13–14. Workshop on Seismic Performance of Low Rise Buildings. Contact: Ajaya K. Gupta, Department of Civil Engineering, Illinois Institute of Technology, Chicago, Il 60616.

Conferences

June 2–5. 7th Ocean Energy Conference, Washington, DC. Contact: Robert J. Scott, Gibbs & Cox, 2341 Jefferson Davis Highway, Suite 1020, Century Bldg., Arlington, Va 22202.

June 19–20. National Conference and Exhibition on A/E Firm Productivity, Hyatt Regency O'Hare, Chicago, Il. Contact: Carol Gosselin, *The Paper Plane,* Box 11316, Newington, Ct 06111. (203) 666-9487.

June 19–21. 1st Solar Retrofit Conference, Princeton University, Princeton, NJ. Contact: MASEA, 2233 Gray's Ferry Ave., Philadelphia, Pa 19146. (215) 963-0880.

June 22–26. 1980 Annual FIDIC Conference, San Francisco, Ca. Contact: American Consulting Engineers Council, 1015 15th St., NW, Suite 802, Washington, DC 20005.

Conventions

June 1–4. American Institute of Architects convention, Cincinnati, Oh.

June 11–13. NEOCON XII, The Merchandise Mart, Chicago.

June 16–18. Construction Specifications Institute convention, Anaheim, Ca.

Deadline April 11. Registration for May 12–16 study tour to Helsinki, Finland, sponsored by Institute for Urban Design, State University of New York at Purchase.

Here are two of the best elevator operators in the world.

In their day, white gloved elevator operators were the best way to get from one place to another. Times changed. So much so, that even the mechanical programmers designed for the first automatic elevators became inadequate.

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Today, Schindler Haughton is part of the world's second largest elevator company with a full line of geared, gearless and hydraulic elevators and escalators. Each supported by systems that dramatically improve passenger service and reduce operating expenses.

Times have changed. And so have we. But we're still committed to delivering white glove service in a push button world.

We're #2 in the world and going one better.

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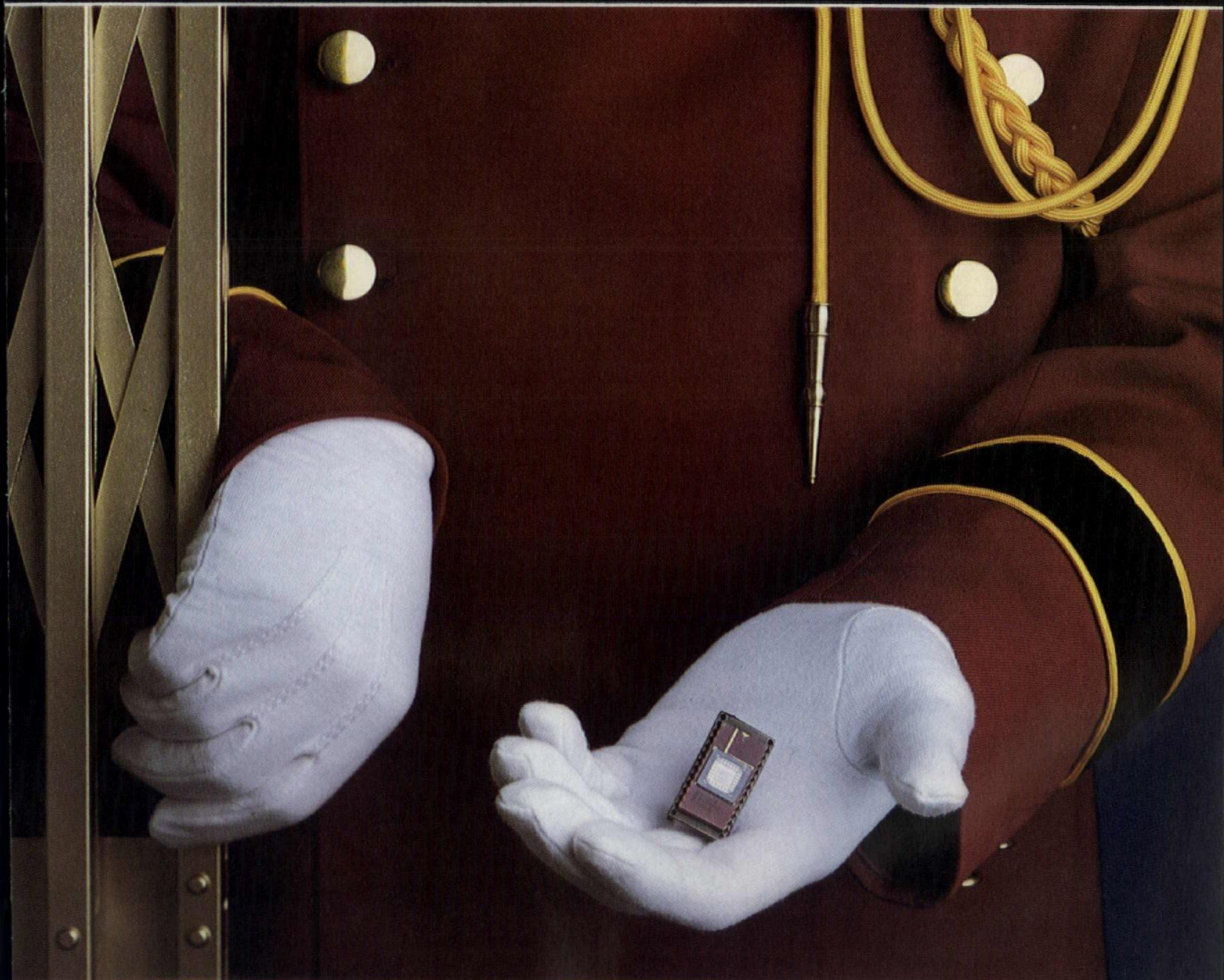

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Coreroof is a new, complete, one-step roof system that does everything the built-up roof does. Except give you trouble.

A factory-finished insulated panel 2½ inches thick, Coreroof is so lightweight (only 2½ pounds per square foot), that primary and secondary structurals can be lighter.

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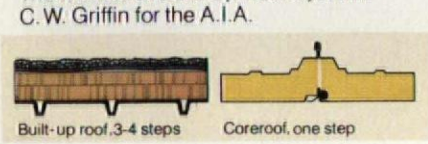
*The Manual of Built-Up Roof Systems C. W. Griffin for the A.I.A.



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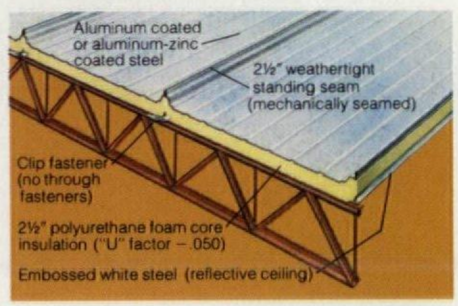

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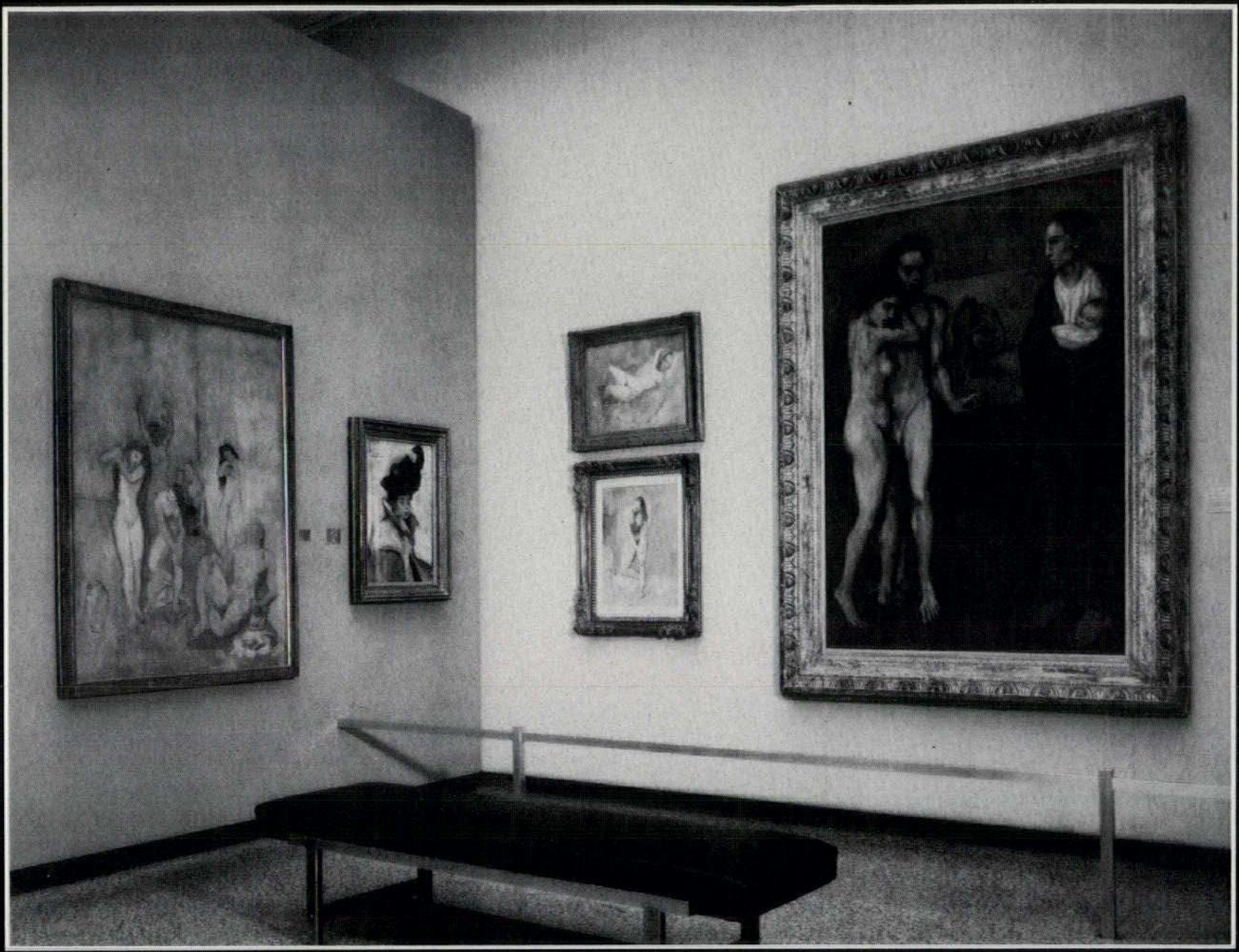

Photo courtesy Cleveland Museum of Art.

Who protects the Picasso after the museum closes?

Kinnear does.

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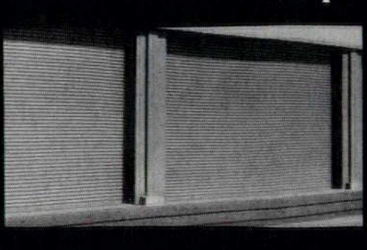

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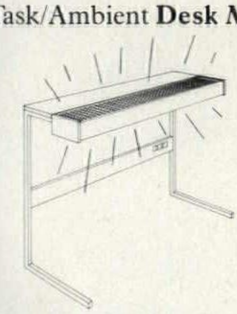

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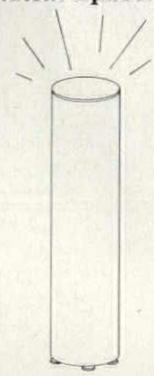

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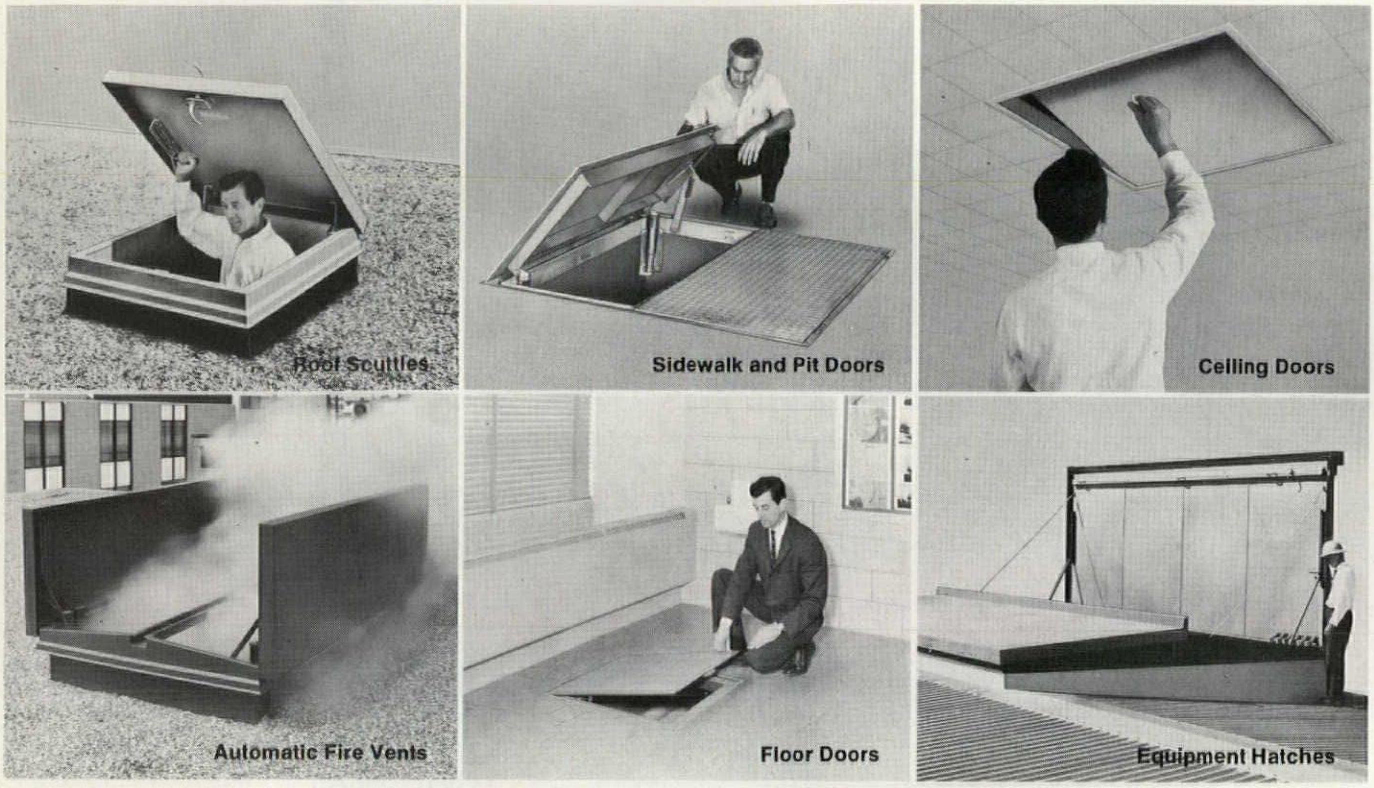

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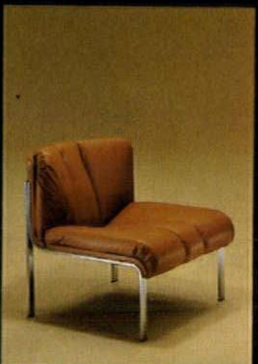
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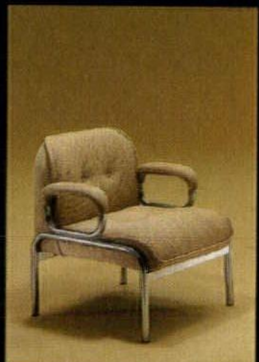
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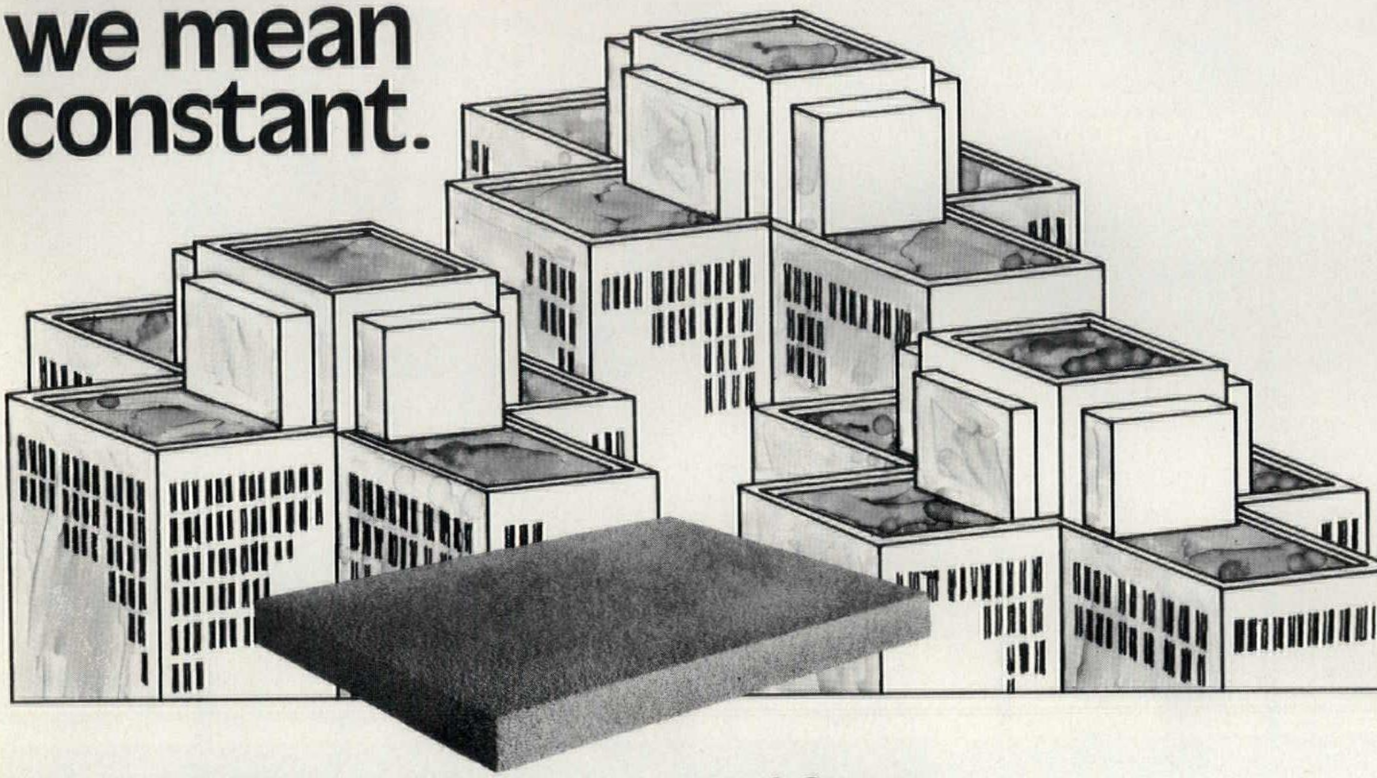

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Physical Property	Published Rating 1952	Test Result 1978*	A.S.T.M. Test
Thermal Conductivity (k)	0.40	0.42	C 177
Density (lbs/cu ft)	9.0	9.52	C 303

*Tests conducted by Pittsburgh Testing Laboratory, an independent testing laboratory located in Pittsburgh, Pennsylvania. Copies of the test results may be obtained by a written request to our Marketing Department.

From 1952 to 1978 the insulation had withstood, without deterioration, ambient temperatures ranging from highs in the 90's (99°F, July, 1974) to lows in the minus teens (−18°F, January, 1963).

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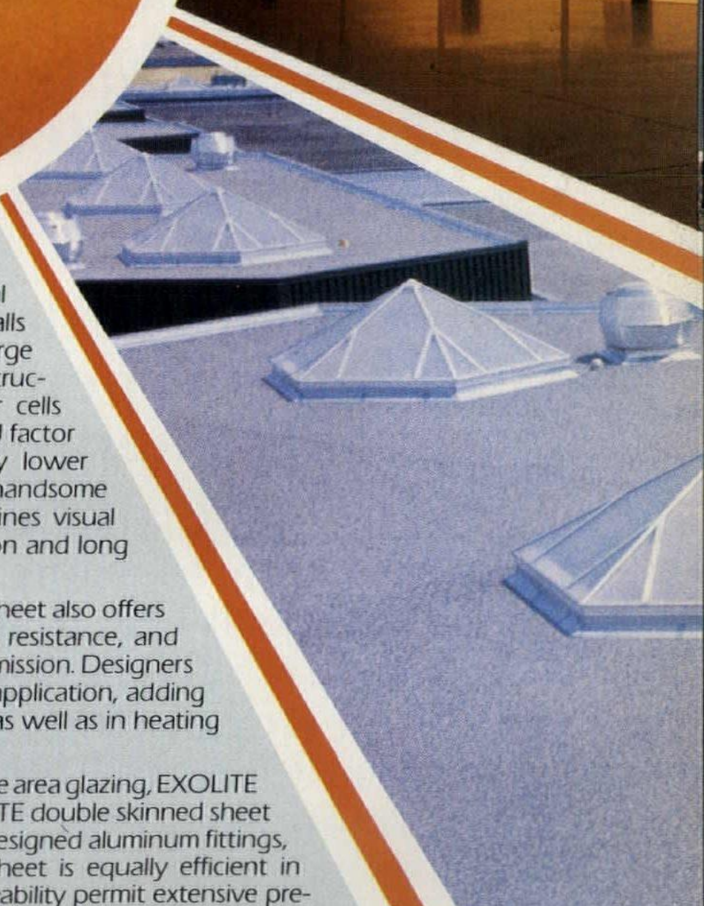

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Especially well suited for passive solar applications and large area glazing, EXOLITE sheet and its special mounting system, consisting of EXOLITE double skinned sheet in 47¼" width and lengths graduated to 20', and specially designed aluminum fittings, provide fast, efficient glazing on 48" modules. EXOLITE sheet is equally efficient in custom designed units. Light weight, high strength and workability permit extensive prefabrication, and easy handling and transportation.

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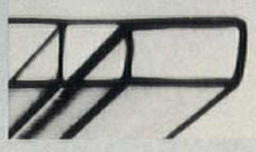

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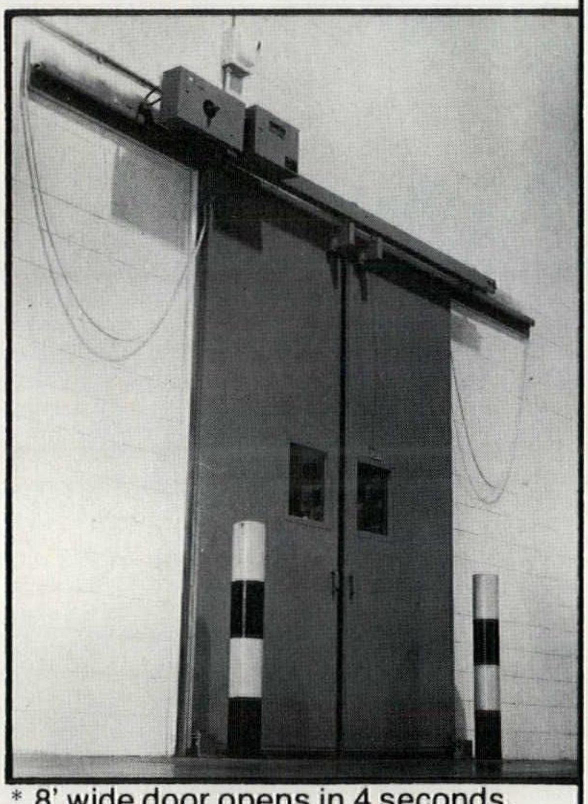

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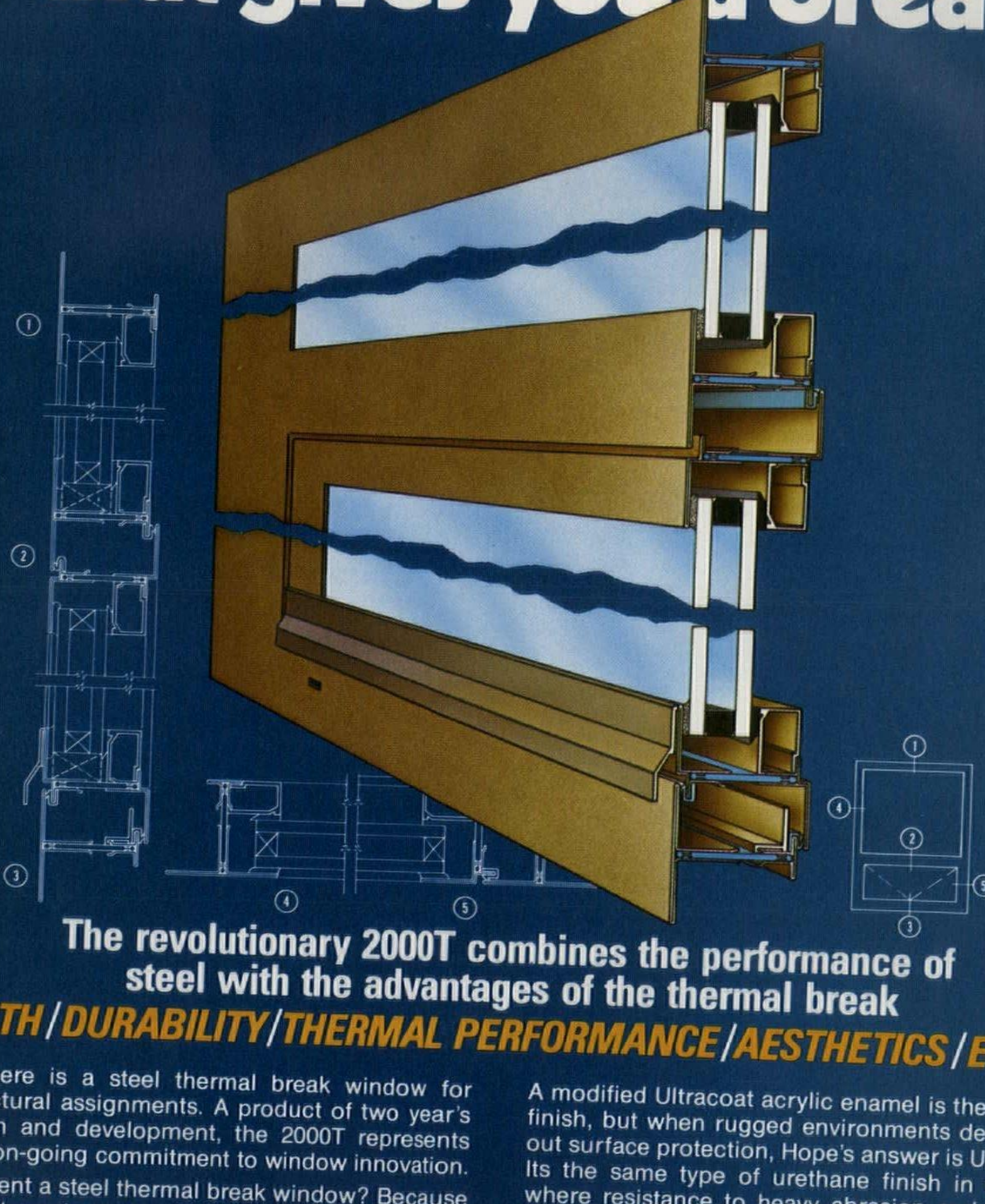

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Big problem, small world

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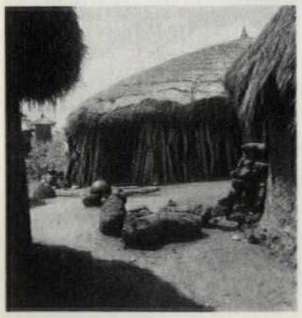


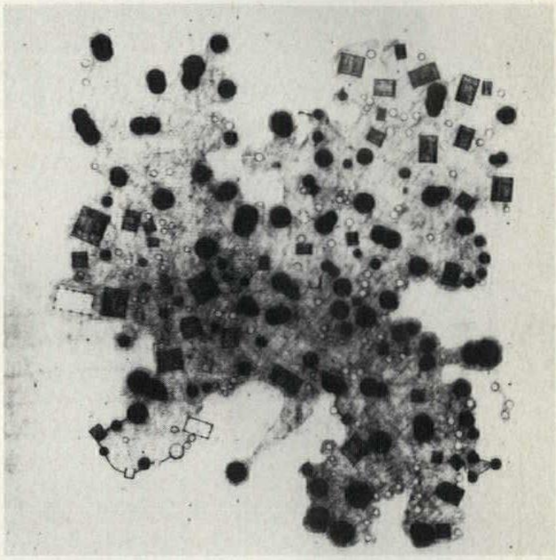
The Senufo farming village of Fakaha has never lost its energy balance with the natural world. Photos: Richard Rush.

As individuals, we realize that our bonds to the energy problem per se are voluntary. We can within a matter of hours fly to another country where oil and the inflation it causes are quite remote. We can ride a horse, chop wood, barter or farm for food, and live a quiet if lonely life.

In rural India, for example, it is rare for people to have the forms of commercial energy to which Americans have become enslaved. Humans and animals provide the work; wood, crops, and dung supply the fuel. In some African bush locations commercial energy is not only unused, it is unknown. In large portions of Africa, South America, and the Far East, people still rely on wood for fuel, and the stove may literally be a placement of stones on the ground. In such remote corners of the earth where the roads are still too narrow for cars, the people probably inhabit a strikingly "energy efficient" home.

Ten years ago, I served in the Peace Corps in such a place, the Korhogo region of the Ivory Coast. The village was called Fakaha. To the Senufo inhabitants of that village, a bicycle was high technology. The mud houses were clustered together like mushrooms in an open field, the thick walls keeping the heat out in the day and warming the house at night. The rounded house exteriors reflected the heat and presented minimal areas to the sun. The conical thatched roofs miraculously kept rain from coming in but let the heat escape. There was no energy crisis in Fakaha in 1970 and there is probably none there today.

Modern society not only bit from the energy apple in the garden of Eden, it supplies that apple 25,000 feet in the air wrapped in cellophane in coach class. Some people who have never lived in a village setting worship the simplicity and oneness of place which can be found there. They might even question whether this complex organism which we call civilization is worth the trouble.



VILLAGE PLAN, FAKAHA, IVORY COAST

The most gas-guzzling, moon-landing, grandaddy of them all is the United States of America. Downtown Manhattan couldn't be further from Fakaha. The World Trade Center would hold dozens of villages. Many New Yorkers would like to have the peaceful setting of Fakaha at the other end of the subway or for that weekend retreat and 18 holes.

Modern society has traded quality of life for quantity. In Fakaha, people don't live very long. Sometimes, as close as the next house, they don't even get born. In the U.S., death is removed to the nightly news between soap commercials or may be switched off. The fact is, in spite of all the junk in the air, the water, and the food, we have a better chance of being born in this country and a better chance of dying of old age.

The Senufo village pays a price for its self-sufficiency. It may be a different price, but so will we. In a sense the modern world is desperately seeking what Fakaha has never been without (and doesn't know it has).

The energy crisis in this country is heavily rooted in faraway places. Some of them have been the cause of the problem, others have found good solutions. Our purpose in the pages that follow is to provide an overview of what energy problems other countries face and to explore some of the directions which they have found fruitful.

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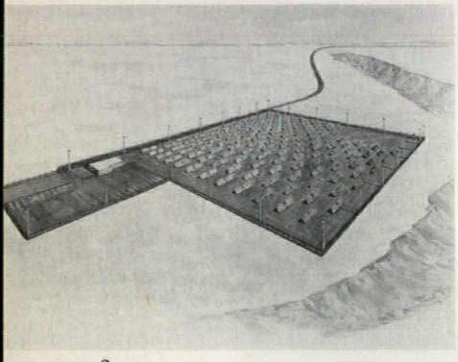
Photos: Consulate General of Israel



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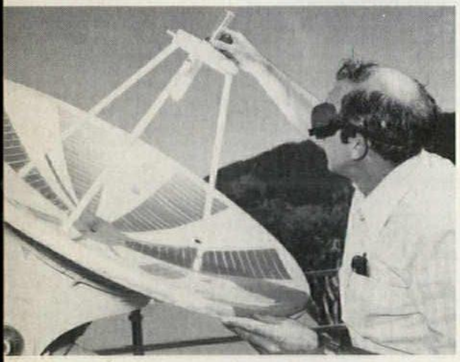
SERI



4

Australian Information Service

1 Solar water heaters have become an integral part of the roofscape in Israel. **2** *The solar pond is an Israeli invention and holds great promise for electrical generation in the Dead Sea region.* **3** *A SERI project for Saudi Arabia uses a photovoltaic field to power two villages.*
4 *Researchers at the Australian National University in Canberra are experimenting with ammonia-filled chemical heat pipes.*

Israel
The energy news from the Middle East has not been all bad. The Israelis have set a solar example and possess a blossoming solar-collector business that exports to two dozen other countries. Its precarious position in the region militarily and its dependence on oil of course make development of alternative energy sources vital. Today, 20 percent of all the homes in Israel have incorporated solar water heating, a saving of about 100,000 barrels of oil per day. As impressive as that sounds it constitutes only 2 percent of the country's energy consumption. Israel's goal is to reach between 8 percent and 15 percent total consumption by solar by the 1990s.

The man most responsible for Israeli solar progress is Dr. Harry Zvi Tabor, head of the Scientific Research Foundation in Jerusalem. His work in solar dates back to the mid-1950s, and he is in the forefront with the emerging technology of the "solar pond" which holds so much promise for the future electrical needs of Israel.

Solar ponds: A normal body of fresh water which is acted upon by wind and surface irregularities underwater is not a very efficient collector of solar heat. The underwater turbulence tends to even out water temperature. Tabor's solar pond contains salt water which is left undisturbed and stratifies, with the hottest, most saline solution at the greatest depth. Working with Dr. Rudolf Bloch, Tabor built a black-surfaced water container filled with a saline solution and recorded near boiling temperatures at its depths. When this solar heat energy is passed through heat exchangers, power turbines can then be linked into the system to produce electricity.

The Dead Sea region of Israel offers a particularly abundant natural resource of relatively tranquil salt water. Israeli energy experts have been busy trying to improve the economics of electrical generation using solar ponds in the Dead Sea region. One 150-kilowatt power plant has been constructed for experimental purposes adjacent to the Dead Sea. Within three years, a five-megawatt power station will be built in the region, using a one-square-kilometer pool. Still larger projects are intended by 1985. At the moment the cost of solar electricity is between 25 and 30 times that of fossil fuels. By 1985 the large installations are expected to compete with expensive hydroelectrical energy. If progress and technology improve normally, it is conceivable that the Dead Sea region could meet all of Israel's electrical needs by the end of the century.

Japan
A full 90 percent of Japan's energy resources must be imported. Three-quarters of that imported energy is foreign oil and 15 percent is imported coal. To make matters worse, over half the electrical power is oil generated. Another unique energy factor is that kerosene, a refined petro-product, is the primary home heating fuel. What are the Japanese doing about it?

At the moment, long range plans include nuclear energy supplying 30 percent of Japan's power requirements by 1990. Three Mile Island has had its effect on the Japanese, however, and it is expected that energy supply volumes for both nuclear and oil will be revised downward in favor of importing more coal. This means business for such trading partners as Australia, the U.S., and Canada. Japan is actively investigating alternative energy sources. Although the goals are much higher, it is estimated that solar energy will comprise little more than 1.6 percent of the total energy consumption by 1990.

There are two long-term government projects which have been underway in Japan since the beginning of the energy crisis: the Sunshine Project and the Moonlight Project. The Sunshine Project is for the development of new energy sources, and the Moonlight is for energy saving technologies.

Project Sunshine was begun in 1974 and has the goal of developing technologies for making use of solar and geothermal energy as well as coal liquefication and gasification and hydrogen production. The goal of the program has been to supply 10 percent of Japan's energy using such methods by the year 2000.

Geothermal energy has great promise in Japan. Underground steam and hot water have already been put to use producing electrical power. Six geothermal power stations are operative today in Japan with an output of 168,000 kW. Three times that output is expected in the next decade.

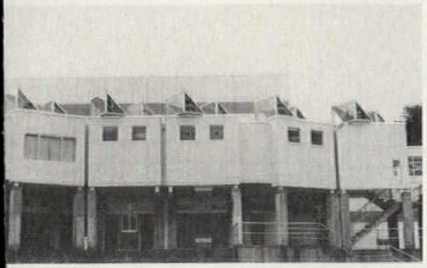
Two 1000 kW solar power towers are now under construction. A field of mirrors surrounding the tower will focus solar heat to a point and eventually drive a turbine generator of electricity. The Japanese Science and Technology Agency is also constructing series of eight small wind-powered generating plants.

The Moonlight Project has three areas of concentration: 1) development of large-scale technologies for energy conservation; 2) development of pioneering, basic technologies for energy conservation; and 3) development of energy-saving technologies for devices used in the household and commercial sectors. Part of the conservation program is voluntary. Television stations close down earlier, gasoline stations close on holidays, and entertainment establishments shut doors early.

Japan's historic sensitivity to nature and the natural processes will no doubt turn up some ingenious technological solutions. Solar access is at the other end of the scale, but the Japanese can traditionally serve as an example to the Western world. A recent article by Gail Feingold Takagi in Volume 10:123 of the Connecticut Law Review traces the history of solar access in Japan back nearly 400 years. Property owners were expected to compensate a neighbor when a new house shaded his property. Most recently, The


Consulate of Japan

5


Saburo Takama

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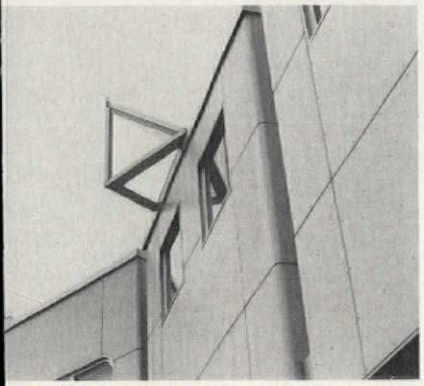
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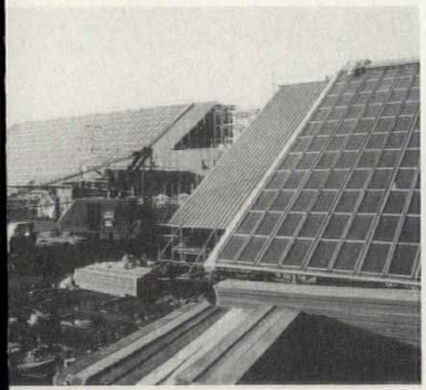

Saburo Takama

8

5 Solar collectors cover the roof of a bank in Japan. **6, 7** *In the Naoshima Citizen Gymnasium, Architect Kazuhiro Ishii and solar consultant Saburo Takama collaborated to combine solar water heating and daylight control.* **8** *Solar heating, cooling, and pool water heating are accomplished in the Doho Park Gymnasium. The architects Masato Ohtaka Associates were assisted by solar consultant Saburo Takama.*

Building Standards Law (BSL) in Japan prescribes a strict procedure for assuring solar access. At one point Takagi describes the standards process for Tokyo: "The developer or contractor shoulders the burden of conformance with the BSL by obtaining a permit of construction from the building review council of the appropriate governmental authority. In Tokyo, the developer must in addition provide notice to the residents of the site vicinity by erecting a sign thereon which sets forth the dimensions of the proposed structure, the anticipated date of commencement of construction, and the name of the developer. The posted notice also directs any residents with complaints to file their objections with either the local administrative unit or the developer. As evidence of compliance with the notice requirement, a photograph of the sign must be appended to the architect's drawings at the time they are submitted to the building review council of the administrative unit."

Australia

Like the United States, Australia has rich coal resources. Unlike the U.S., Australia generates most of its electricity from coal. In addition, about 70 percent of the country's oil requirements are met with domestic crude oil resources. Although it actually exports energy, it must still rely on imported oil for the remaining 30 percent of its oil needs. Uranium, steaming coal, and liquefied natural gas are abundant enough to export. The major thrust for Australia's energy future is to increase the use of its coal. At this time about 47 percent of its energy needs are met by oil and 37 percent by coal. By 1990, coal is expected to top 41 percent and oil will be reduced to 39 percent.

Solar energy is not given much near-term potential in Australia, although non-oil fuel space-heating appliances including solar devices are exempt from sales tax. Solar has been found to be competitive in powering microwave radio systems in Australia and replacing diesel-fueled generating systems.

Heat pipes: A team of researchers at the Australian National University in Canberra has pioneered in high-pressure and two-phase chemical heat pipes. By using high-temperature parabolic tracking solar collectors, the sun's heat can be concentrated on a small container of ammonia to decompose it into nitrogen and hydrogen. The gas then is transferred to a cold pipe where it reforms ammonia. On a large scale, the energy released in the process can be used to make steam and power an electrical generator. Because of Australia's large expanse of bush country, such devices hold great promise for providing electricity to remote areas.

SERI's international programs

In addition to second-hand international experience, there have been formalized programs of cooperation between the U.S. and other countries. At the center of many of these cooperative programs is DOE's Solar Energy Research Institute located in Golden, Co (see p. 126). SERI is currently involved in millions of dollars of research with numerous countries. Here are just three examples:

Mexico: In February of 1979, the presidents of the United States and Mexico signed a Memorandum of Understanding of Science and Technology Co-operation. In that context, SERI is participating in seven joint projects: 1) Mexican information specialists will be given training in the use of SERI's Solar Energy Information Data Base (SEIDB). 2) Cooperative work will attempt to establish a comprehensive network of instrumented stations in Mexico to map insolation availability throughout the country as well as formulate accurate solar prediction models. 3) Following a series of information exchange meetings, the two countries will perform a detailed study of passive heating and cooling principles which will culminate in the construction, instrumentation, and monitoring of two passive solar buildings, one in each country. 4) A cooperative program between the University of Delaware and the University of Mexico will center on the optimal usage and testing of photovoltaic devices. 5) The two countries will jointly participate in the preparation and characterization of "selective surfaces," i.e., coatings and chemical treatments which improve surface solar properties of materials. 6) Laboratory testing of solar refrigeration components and subsystems will be followed by field testing in both the U.S. and Mexico. 7) The village of Ajuchitlan, near Cuernavaca, Mexico, will be made energy self-sufficient through uses of energy-conserving technology. Mexico will supply the 20 houses and the community center; the U.S. will provide photovoltaic cells, solar hot water systems, and bio-gas systems to produce methane.

Italy: SERI will play a role in a three-pronged program of joint energy research with Italy involving coal, electric power transmission, and solar energy. A \$4.5-million jointly sponsored multiyear project will involve R&D, design and construction, and information exchange on a broad range of solar technologies, both passive and active. Solar systems will be installed near Catania, Sicily, varying from photovoltaics to concentrating liquid collectors. Further projects will be cosponsored which will involve designing, building, and monitoring passive solar buildings.

Saudi Arabia: Late in 1979, SERI signed a \$16.4-million agreement with Martin-Marietta for that company to design, build, construct, and operate the world's largest photovoltaic power system for the villages of Al Uyaynah and Al Jubailah, 30 miles northwest of Riyadh, Saudi Arabia. The 350 kW system will provide the complete electricity needs for nearly 3500 people. The photovoltaic system will be situated on a hilltop between the two villages. It is part of a five-year, jointly funded project under the auspices of the United States-Saudi Arabian Joint Commission on Economic Cooperation, which is expected to cost over \$100 million. The purpose ultimately is to demonstrate the economic and technical feasibility of solar technology in both the U.S. and Saudi Arabia. [Richard Rush]

United Kingdom

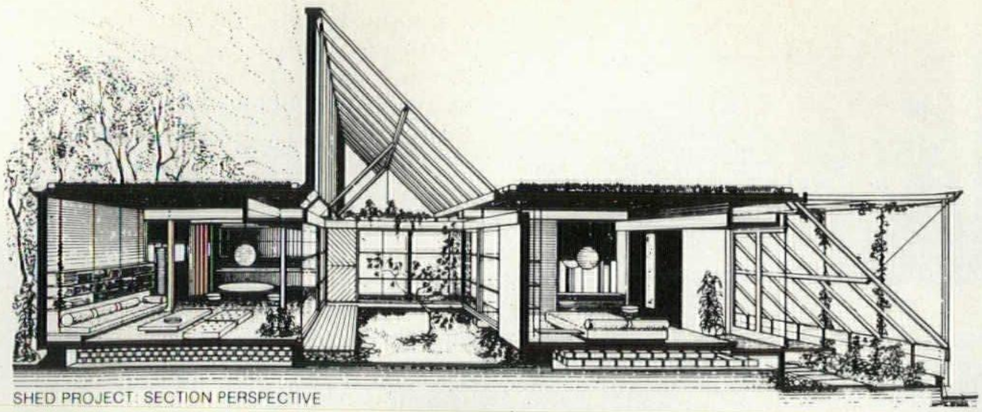
George Kasabov

For an American to understand the context of energy-conscious design in the U.K., he has to remember that Britain is a small, densely populated, damp island situated at the same latitude as central Canada. While it is not subject to extremes of either hot or cold, comfort standards have been traditionally lower than in the U.S. United Kingdom buildings consume just over 50 percent of all U.K. energy, 35 percent going to housing, and it is important to remember that 32 percent of housing is publicly owned. Also, most housing is made of masonry not timber as it is in the U.S. The damp climate produces major problems of condensation. The high latitude means that solar-energy schemes are only marginally successful. Given these conditions, what has been achieved?

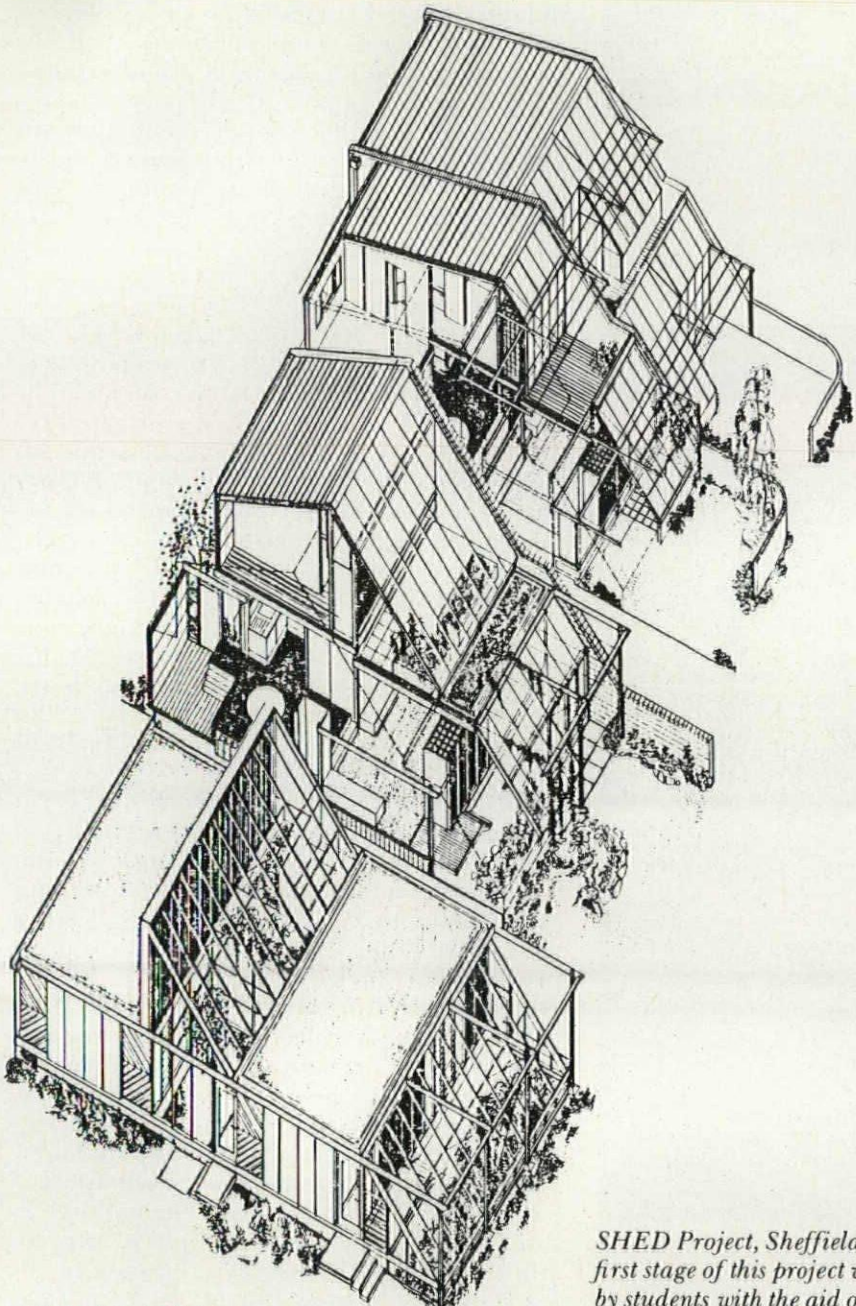
Government action: First, a reduction of temperature standards in public buildings has lowered thermostats to 68 F, and the proposal is to reduce them further to 66; second, financial incentives cover two-thirds of the cost of insulating dwellings, up to a maximum of £50, which is $110; third, there is an energy survey scheme which allows £75 for a one-day energy survey of buildings in order to evaluate what can be done. Eighteen thousand buildings have been surveyed so far and the program can be extended with more money for half the fees for a more extensive energy audit. The fourth program is conservation in industrial buildings. So far, $12 million has been spent out of a total of $25 million which has been earmarked for the four-year period from 1976. There is also a demonstration scheme, again started in 1976, which allows 25 percent reductions toward demonstrations of new technology, and here a lot of work has gone into heat recovery, some into heat pumps, and a lot into energy management and automated energy control. The total, however, is only $2 million spent so far out of the $20 million for the purpose. Funding for this sort of work is also available through the European Economic Community (EEC). This source has not been used extensively as the loan of up to 49 percent is to be paid back out of the savings made.

New building regulations were also instituted in 1976, but these really are dealing only with insulation levels and window sizes. The 1976 regulations which are for houses were extended in 1979 for other buildings.

Education: Some money has been made available by the government for courses in energy management and also in design. The design courses have been implemented by the RIBA Energy Group, which was formed in 1976 specifically intended to 1) initiate the training of practitioners and students in



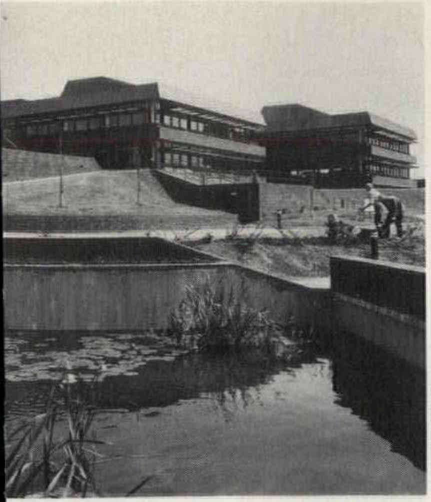
SHED PROJECT: SECTION PERSPECTIVE

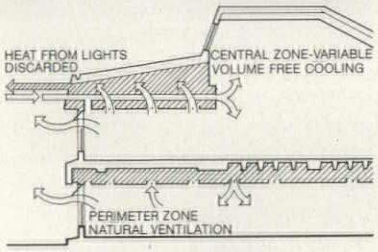


SHED PROJECT: AERIAL VIEW

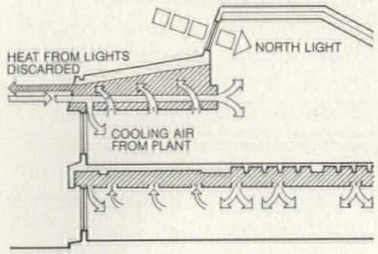
Photos and drawings courtesy of George Kasabov

SHED Project, Sheffield: The first stage of this project was built by students with the aid of grants from the Manpower Services Commission. The test SHED consists of a highly insulated room with a conservatory running the full length of the south side. Three types of vertical air solar collectors are being tested: a natural thermosyphoning collector, trombe wall, and 'hypocaust' heat store (containing sealed bottles of water). It was designed by Cedric Green and a project team from the University of Sheffield.

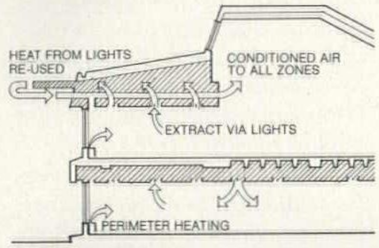

Richard Bryant



SPRING/AUTUMN 195 DAYS/YEAR



SUMMER 51 DAYS/YEAR



WINTER 120 DAYS/YEAR

Hereford and Worcester County Hall: As shown in the diagrams above, the building was designed with heat recovery in mind for the appropriate season. Over 18,000 sq m of space provides a working environment for 710 people. A high thermal mass, double glazing, automated lighting controls, and air-handling light fittings all contribute to the energy efficient design. Architects: Robert Matthew, Johnson-Marshall and Partners.

George Kasabov is in private architectural practice in London, England. He has taught at various universities in England as well as at Princeton and Harvard in the U.S. He has concentrated on energy design since 1971.

energy-conscious design; 2) provide information and tools of the profession; and 3) collect examples for the profession. This group operates through about a dozen regional groups scattered around the U.K. and is also sponsored by industry and the profession.

With respect to training, the first point, so far over 3000 practitioners—that is about one-eighth of the profession—have already attended courses throughout the U.K., and 22 courses are planned for the next few months. These generally take the form of 2–3 day seminars with the initial run-through of theory and materials, followed by a number of case studies, and culminating in a choice of design exercises.

The second point, information, is provided both for the public and for professionals, the former through home energy advice centers which have been pioneered by the gas industry, and the latter by the building centers which are an organization devoted to collecting and comparing building materials. The committee created an energy conservation handbook and library of materials and components that are particularly related to energy conservation. The library has been sent to each architectural school in the U.K., and product information has also been filed in a computer for further access. An energy center is planned in London in the next few months and will serve to inform the architectural profession.

The other point, information and tools, relates to a programmable calculator program which has been developed and is being widely used. Another aim of the group is to provide examples of what has been achieved by holding exhibitions and conferences such as the Building for Energy Conservation conference last year.

Research: Projects are being sponsored partly through the government department of energy, and partly through the Science Research Council, the Department of the Environment and again the EEC, as well as the building materials industry and, very important, the fuel supply industry. Projects in this category can cover large comparative programs to evaluate changes in construction methods such as the Better Insulated Housing Program, or the Liverpool Energy Study. Then it proceeds from passive and active solar heating to monitoring of heat-pumps.

Government buildings: Surprisingly, the largest, longest-running and best-documented program of energy conservation in buildings has been that of the Property Services Agency of the Department of the Environment: It has achieved a 30 percent saving of energy in its existing building stock since 1972. Principally this has been achieved by improvement in plant management, but also by material improvement in buildings.

Office buildings: The building type which has shown the most spectacular changes is the office building, governmental as well as private. Not only were easy savings made by reducing environmental standards from unnecessarily high ones, but also its regular pattern of occupation makes the office building particularly susceptible to automated mechanical controls. Moreover, the projects are large enough to justify the high fees involved in producing a sophisticated design analysis. The most interesting examples combine natural and artificial ventilation with careful design of the envelope and the thermal mass of the building to optimize seasonal variations.

Commercial: In the commercial sector, the most successful involvement of conservation is shown by a firm called Marx and Spencer, a chain of clothes and food stores. In the past seven years they have spent £1.5 million and saved £9 million by a simple mixture of good housekeeping and attention to critically wasteful equipment. This company, together with only a handful of other firms, stands apart from the general run of industry and commerce. Most have done very little because of the low priority energy conservation gets through the use of normal accounting procedures involving very short payback periods. Retrofitting pales in significance in terms of effectiveness when compared to more careful management, and that idea is starting to get around. People realize that if they just fire the pump at the right time, they're going to get tremendous savings for very little extra money. And obviously that's the first thing they're going to do.

Housing: In housing the picture is much more diverse, for the greatest interest is in designing for passive solar collection. Active solar heating is generally considered too expensive in this climate even though there are a number of houses built with active systems and even some proponents who claim that they will become cost effective within the next five years. Solar water heating, by contrast, is slowly gaining ground through lower interest rates for borrowed money of between 15 and 20 percent. The cost equation is still not encouraging, and there are no financial incentives for grants for such installations as in the U.S. There are also a small number of heat-pump systems, but not nearly as many as in France, Germany, Holland, and Scandinavia, all of which had extensive monitoring programs to test in-use reliability of heat pumps.

Summary: Significant developments for the future will reflect energy conservation in both the building stock nationally and the individual building. Production of total energy will, to a large extent, depend on more careful use by a better educated population, and on a much better system of monitoring and control. We can also expect a much larger proportion of new buildings to be designed for energy efficiency. Up to now, several thousand architects have developed some expertise in the field. As energy-conscious design becomes the norm, more careful matching of energy strategies to buildings will help to obtain the maximum efficiency in the use of fuel. □

Denmark

Kathy Goss and Per Madsen

Although Denmark enjoys one of the highest standards of living in the world, it is almost totally dependent on imported oil and coal for its energy needs. This fact, coupled with the country's northern location (at a latitude of 56 degrees, about the same as Juneau, Ak) and cool temperate climate (winter temperatures 20–40 F, summers 50–70 F), has made the Danes habitually energy-conscious.

Space heating accounts for nearly half of Denmark's energy consumption, with 59 percent of the nation's dwellings utilizing central heating, generally oil-fired. Another 29 percent use direct heating, which makes Denmark the world's highest per capita user of district heating systems. These systems, utilized in subdivisions as well as in urban areas, carry water by underground pipes to individual dwellings to supply domestic hot water and radiator systems. One-third of Denmark's district heating systems operate on waste heat from electric power plants; major efforts are currently underway to increase such cogeneration of electricity and heat—an energy-conserving measure that is still in its infancy in the United States.

Of the approximately two million dwellings in Denmark, about 60 percent are single- or two-family houses, with the average size of a dwelling being about 1345 sq ft. Because Denmark is only sparsely forested, the traditional building material has been brick. Cavity walls came into use around the turn of this century, mainly to save brick, although it did not become common practice to fill the cavity with insulating material until the 1950s, when the Danish government began formulating insulation requirements for new construction. The latest of these government building regulations, BR 77, which was enacted in 1977 and went into effect in February 1979, represents an approximate doubling over the previous requirements of 1972, with specified R-factors of 14 for heavy-wall construction, 19 for light-wall construction, 29 for ceiling and roof, 19 for floors over basement or ground, and 2 for windows.

The new building regulations are only part of an overall government energy plan which calls for a reduction in the growth of energy consumption, and for the development of alternative resources. The large space-heating sector is receiving special attention, with the government aiming to hold energy consumption for space heating in the year 1995 to the same level as in 1975—a reduction of over 30 percent as compared with projections based on traditional trends.

The Danish Ministry of Commerce is sponsoring an energy research and development program which includes the promotion of energy savings in buildings, as well as the testing of active solar components and systems and the development of renewable energy sources such as geothermal and wind energy. The government is further encouraging conservation by offering subsidies and tax incentives for all sorts of energy-saving measures in new and existing buildings. Energy consultants, recruited from the engineering and building professions and licensed by the government after completion of a special course, provide required consultation services to those wishing to qualify for certain of these subsidies.

Low energy houses: Hjortekaer

In a research and development project sponsored by the Danish Ministry of Commerce under the direction of the Thermal Insulation Laboratory of the Technical University of Denmark, six prototype "low energy houses" were constructed in 1978 in suburban Hjortekaer outside of Copenhagen. Each house was built by a private development group, who assumed fiscal responsibility for its own project, with additional funding provided through a government grant.

The purpose of the Hjortekaer project was to demonstrate that it is possible to build a single-family model house of about 1300 sq ft whose energy requirements for space heating, ventilation, and hot water were about 500 kWh per year—less than a third of the energy consumption of buildings conforming to BR 77. Energy use in these houses is being monitored during two heating seasons, to end in spring of 1980; they are sealed from public access, and habitation of the buildings is being simulated while detailed measurements are taken. The houses will later be sold, with monitoring to continue under conditions of actual human habitation.

The low energy consumption of the houses is achieved through a combination of technical solutions, including super-insulation, tight construction, insulating shutters, solar heat, heat pumps with ground heat exchange pipes, thermal storage mass in the building construction, controlled fresh-air injection systems with recuperation of waste heat from exhaust air, and utilization of the heat emitted by persons, lighting, and appliances, as well as solar heat gain through the windows.

'Low Energy 1979' at Skive

At an exhibit in the city of Skive in September 1979, the public was able to tour a total of 53 low-energy dwellings, including 34 apartment units, 9 single-family houses, 9 identical linked houses, and 1 remodeled older house. The result of a competition sponsored by the city and county of Skive, in collaboration with Byggecentrum (a building industry institute)

1 *The apartment building shown was part of "Low Energy 1979" at Skive, Denmark. The citywide exhibit provided a tour of energy-conserving dwellings of all kinds. Brick cavity walls are 16 in. thick with 4 in. of mineral wool insulation. The heating system is solar hot water (1377 sq ft of collectors), water-to-water heat pumps, air-to-air heat recovery, and district heating back-up. Architect: Børge Kjaer.*

2 *Low Energy House C: The Hjortekaer project was designed to demonstrate that it is possible to build a single-family model house of about 1300 sq ft whose energy requirements for space heating, ventilation, and hot water were about 5000 kWh per year. House C uses heavy insulation and triple glazing. The heating system, consisting of plastic tubes in the concrete floor, is supplied by a combination of solar and electric heat. Architect: Vibe-Hansen & Lomborg Ltd.*

3 *Sambo Low Energy House is also located in Skive. The heavy part of the house uses a 13¾-in. brick cavity wall insulated with 5 in. of mineral wool. The light construction utilizes prefabricated load-bearing building material consisting of ½-in. waterproof plywood and ⅜-in. tempered hardboard inner membrane sandwiched around a core of glass fiber that is cut into blocks and stacked with the fiber perpendicular to the membranes. Insulation can be varied to R 40. Architect: Erik Berg.*

4 *Roslev Houses, Inc., is a manufacturer of prefabricated building systems who supplies turnkey housing projects ranging from a single house to a whole town. The row-house version is shown here. 140 sq ft of solar collector is built into the south-facing roof surface on each dwelling. The heating system is a combination of solar and district heating. Designer: Roslev Houses Inc.*

Kathy Goss is a free-lance writer and editor, specializing in scientific subjects. Per Madsen is an engineer, born and educated in Denmark, who is working in solar product development and manufacturing in California. They are married and live in San Francisco.

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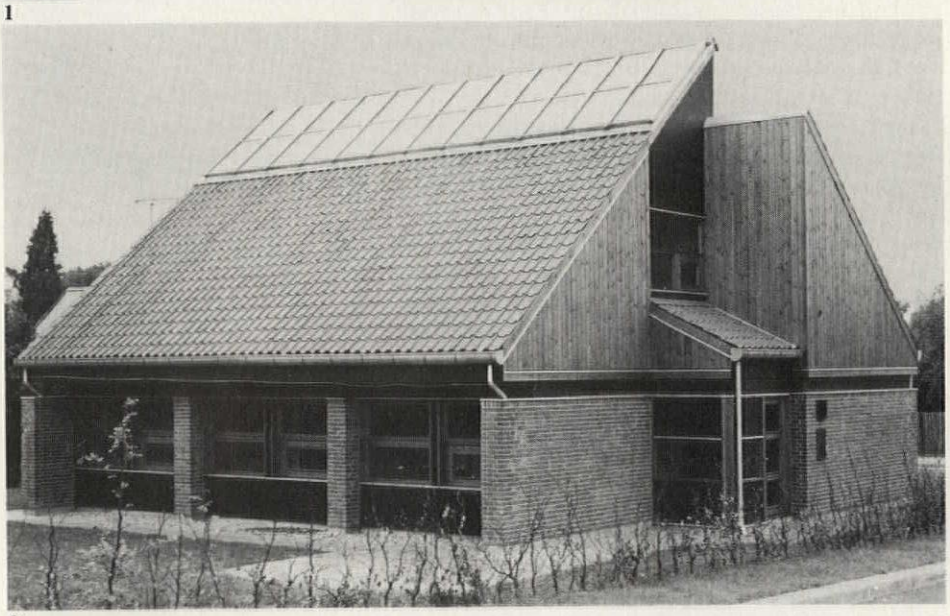

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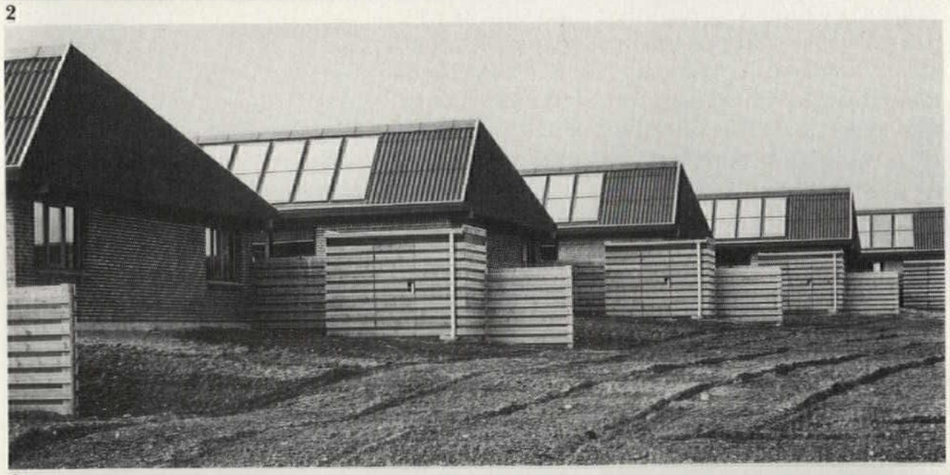

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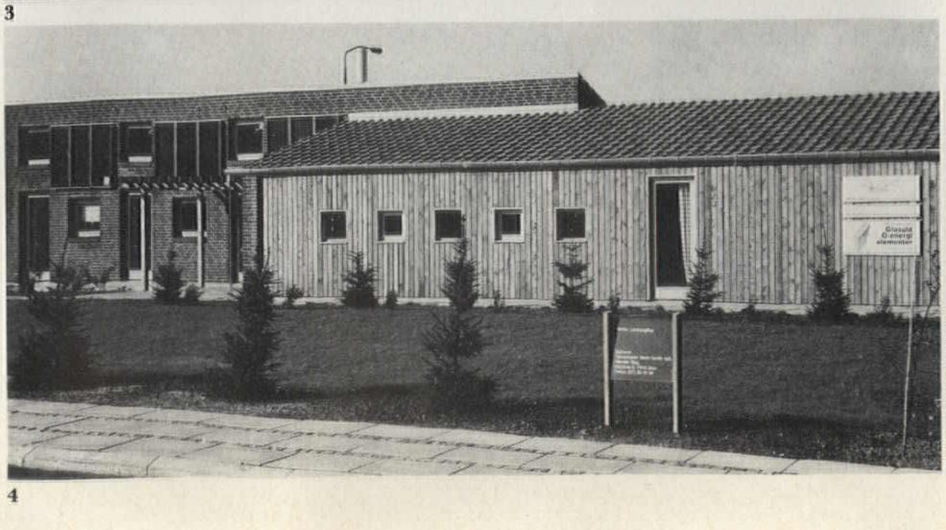

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Photos: Goss & Madsen

and a number of research organizations, the event was the second of its kind in Skive, and was accompanied by a supplementary exhibit of energy-saving building components, materials, and equipment. The participating contractor/design groups were required to hold the energy consumption of the houses to within 60 percent of the maximum permitted by BR 77, and the use of oil for heating was discouraged. The buildings, integrated into a subdivision in Skive, were to be sold or rented after the exhibit. Although they utilize the same kinds of energy systems as those at Hjortekaer, the buildings at Skive represent a wider range of design choices.

Roslev Houses, Inc.: A manufacturer of prefabricated building systems supplies turnkey housing projects ranging from a single house to a whole town; it also has community and regional planning capabilities. The nine single-level Roslev houses are arranged in a row-house layout, attached by the carports. The exterior walls are of brick veneer anchored to a load-bearing back wall with a 2½-in. ventilated cavity. The highly insulated back wall is constructed of special rock-wool insulated studs covered on both sides with chip board, and the complete wall is insulated with a total of 8 in. of mineral wool (R-29). The floor is 4-in. concrete slab on an insulating layer of 2 in. of hard mineral-wool batts and 10 in. of loose slag clinkers (R-23–26). All windows are triple glazed (R-3). Ceilings are insulated with 12 in. of mineral wool (R-40) and the roof is covered with corrugated fiber shingles and pitched 15 degrees towards the north and 56 degrees (equal to latitude) towards the south, with 140 sq ft of solar collectors built into the south-facing roof surface. The heating system is a combination of solar and district heating. The controlled fresh-air injection system is equipped with a recuperator which transfers 76 percent of the heat from the exhaust air to the fresh intake air. In comparison with construction conforming to BR 77, these low-energy versions of the Roslev homes realize a net energy saving of about 43 percent.

Conclusion: Denmark's continued prosperity hangs by the slender thread of energy conservation. The Danish government, as well as the private sector, early recognized the urgency of the situation and is well on the way toward implementing sophisticated measures to improve the energy efficiency of buildings. Besides the obvious use of passive design elements—heavy walls for thermal mass, the orientation of the buildings along an east-west axis, the minimal use of glass on all but the south sides—Denmark's experimental low-energy houses demonstrate the importance of tight construction, added insulation, and state-of-the-art energy systems whose present relative costliness will be more than offset by the resultant energy savings in the years to come. □

France

France's energy resources or, more accurately, her lack of them, place her in a rather precarious position. The nation depends upon imported energy for 70 percent of its energy needs. The French get their oil from OPEC and their coal from Poland, the U.S., and developing countries in Asia and Latin America. Although France's Energy Policy aims to cut its imported energy figure to 60 percent by 1985, it is clear that other measures must be taken. The near-term answer is nuclear energy.

France's objective is to produce more than half its electricity and 20 percent of its total energy requirements with nuclear energy within ten years. This program is the largest nuclear energy project in the world. Instead of buying enriched uranium from the U.S. or the Soviet Union, the French are attempting to produce it themselves.

The French government has great plans for solar energy, but not in the immediate future. It is hoped that 5 percent of the energy supply by the year 2000 will be solar. As modest as the goal sounds, over $100 million has been spent by the French in the last two years on solar research and development. The government is conducting a competition for the design of solar houses, with the objective of 5000 units in three years. It is expected that within the next 10 years nearly 200,000 solar water heaters will be installed; France now allows homeowners a $230 grant towards the cost of installing them.

France is also currently the second largest (after the U.S.) manufacturer of silicon photovoltaic cells. Experiments with photovoltaic generators in the early 1960s produced a 100-watt experimental photovoltaic generator at La Turbie in Southern France. As much as 90 percent of France's photovoltaic output is exported. Over 100 French generators have been constructed in the Third World.

Recent interviews in France—one with a pioneer in the area of solar-heated buildings, one with a young team of designers—reveal some of the more promising accomplishments in energy-conscious architecture now emerging with French government support.

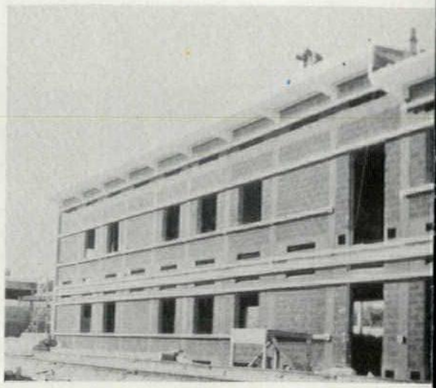
From his office on the outskirts of Paris, architect Jacques Michel maintains contact with numerous solar energy building projects in France, in Italy, and as far away as Montreal and Baja California. An associate of Le Corbusier before earning his M.Arch. at Harvard in 1958, Michel was impressed by the potentials of energy-conscious design while working on projects in Chandigarh and Ahmedabad. In 1966, he began working with physicist Felix Trombe, of the Centre Nationale de la Recherche Scientifique, on development of the Trombe-Michel collector wall. (After referring to the system by its dual name, Michel himself lapses into the more familiar term "Trombe wall.")

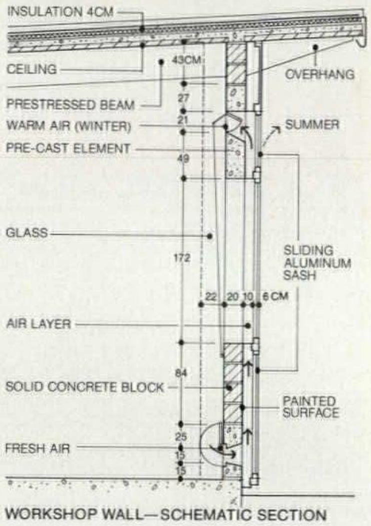
Most of Michel's practice involves the application of ever more refined collector wall systems. At the latitudes of France, he points out, vertical collectors are almost as efficient during the heating season as canted ones and offer great advantages in structural simplicity and compatibility with interior requirements. In most of his numerous houses, collector walls are combined with windows in the south wall, while more solid north wall recalls local traditions (as in houses at Odeillo, opposite).

Michel points out the particular suitability of collector walls for larger-scaled buildings without precise heating demands. At the new technical school at Beziers, a sunny location in the far south of France, Michel has designed 11 workshop structures (shown here) with 1600 sq m of collector wall serving all heating needs for a total floor area of 4000 sq m. In this classic version of the Trombe wall, air is heated in a narrow vertical gap between dark-painted concrete block wall and an outer layer of sliding sash.

For the heating of a gymnasium at St.-Peray, in Eastern France, Michel has installed a more sophisticated version of the Trombe wall (patented by Michel-Diamant-Durafour) designed to minimize loss of stored heat by transmission back out through the glass skin. Here, incoming sunlight strikes a honeycombed wall of black, expanded-aggregate concrete, which is backed up by a storage wall of more massive concrete. A current of air rises by convection between this inner layer and an interior baffle to heat the gym itself. Using strictly the solar source, the temperature inside the gym is maintained at a minimum of 12 C except for an estimated 10 days per winter, when it may fall to 9 C—when the outside temperature is −6 C.

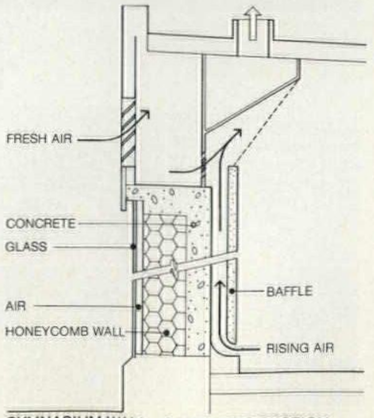
One of Michel's innovative current projects is a window-wall system now being designed for a retrofit installation on 450 sq m of façade on buildings of the Milan Fair. Tentative plans call for installation of three-layer glass sandwich panels. Using the outer layer of glass and the void behind it primarily for insulation, he plans a combination of reflective (catadioptric) plastic sheet and fluid in the inner void. The faceted plastic will be almost totally reflective when dry, almost completely transparent when fluid fills its cavity. Thus injection or withdrawal of fluid can control transmission of sunlight. Backing the panel assembly with a dark, absorptive surface can convert it from a window to a solar collector, similarly controllable with fluid. The potential of such a device for mass-produced window-wall systems is obvious.





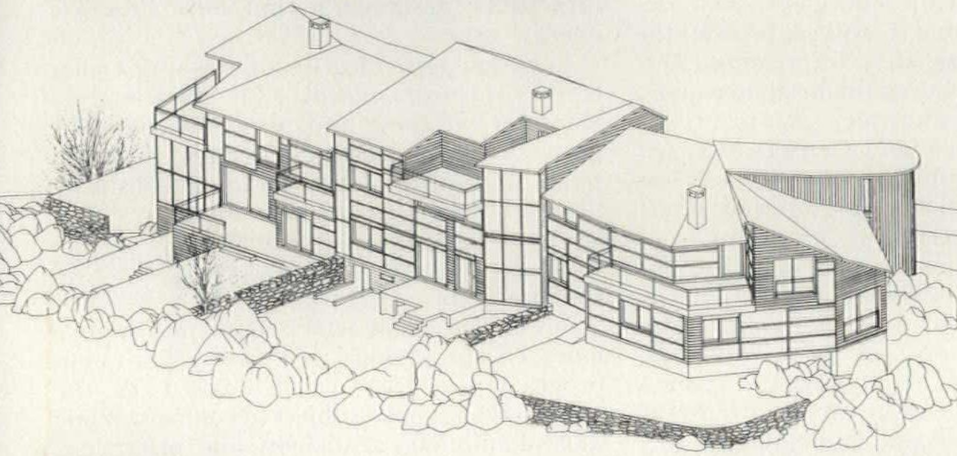
WORKSHOP WALL—SCHEMATIC SECTION

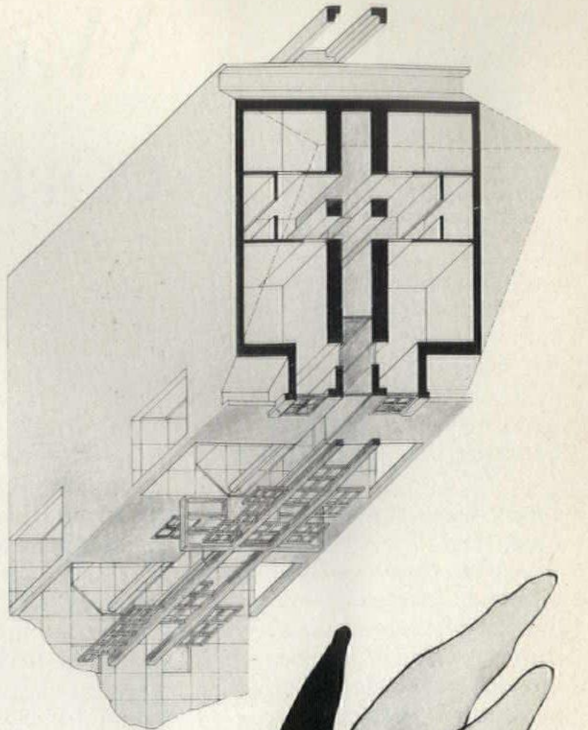
Glazed south walls of workshops at Beziers (above) by architect Jacques Michel conceal concrete collector walls pierced by vents and windows. Collector surfaces are painted red or blue, almost as efficient as black. More complex wall now under construction in Gym at St.-Peray (section below) has more storage capacity, reduced reradiation loss.

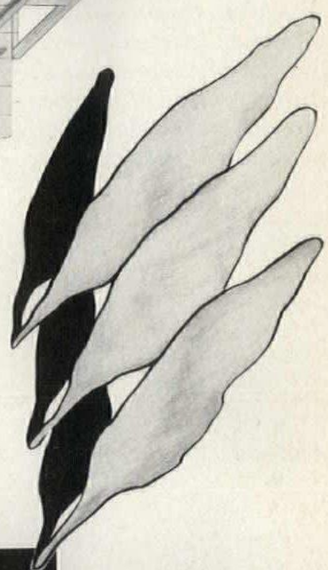


GYMNASIUM WALL—SCHEMATIC SECTION

Three attached houses at Odeillo in southern France, by architect Jacques Michel, have vernacular forms, closed north fronts (photo left), and arrays of windows and Trombe walls to the south (drawing below). Completed in 1974 (one for Felix Trombe), they have yielded fuel savings of 60–70 percent compared to conventional houses.

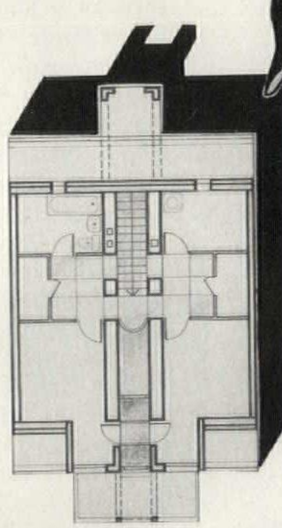




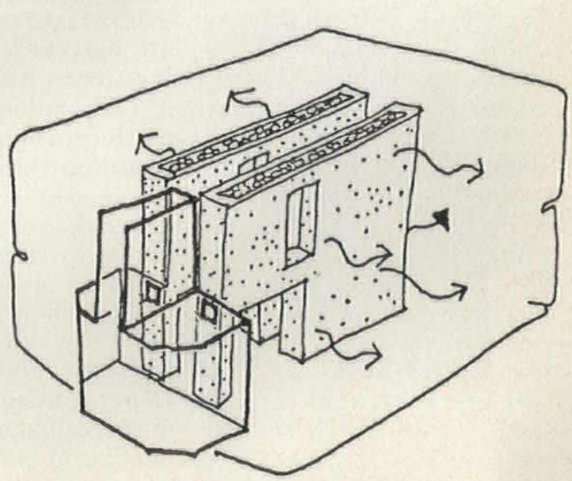


Michel looks forward to the industrialization of collector wall systems, using licensed manufacturers. Mass production, he hopes, will finance the testing required to make such walls acceptable for widespread use. He is particularly concerned about answering the doubts of insurance and building code authorities regarding performance of assemblages under unusual thermal stress. Without standards that such authorities can depend upon, says Michel, the market for collector walls will remain limited.

At the very beginning of their practice in Paris, the young international team of Baczko, Jann, Jordan, Taponier, and Zakrzewski has taken one of the four top prizes in the "HOT 5" residential design competition, held in 1979 by the French Ministry of Environment. Their proposal is based on a duplex dwelling unit that can be lined up in rows and/or stacked in four-story structures to meet urban or suburban planning needs. Its combination of a south-facing greenhouse with a central two-story void and massive thermal storage walls is estimated to reduce demand on the conventional heating system (oil- or gas-fired) by 40–50 percent; roof-mounted solar collectors would provide 77 percent of water-heating demand. Interior spaces surrounding the thermal core could be laid out in a variety of ways. Showing a rare combination of simplicity and sophistication, their design was said in the jury report to "demonstrate that it is possible to reconcile architecture of quality with thermal preoccupations." [John Morris Dixon]



Winner in a 1979 residential design competition sponsored by the French government, a multifamily housing scheme by Baczko, Jann, Jordan, Taponier, and Zakrzewski (right) is based on a prototype duplex unit. Energy-saving performance is based on a two-story, north-south core, bounded by concrete-block walls with rock-filled cavities. During the heating season, heat from a south-facing greenhouse is transferred to these wall masses, which also recapture heat from piping, vents, and chimney passing through them; at night, roll-down screens isolate the greenhouse from the interior. In summer, greenhouse is shaded by overhangs and greenery on trellises; through ventilation and chimney effect in tall core, along with thermal inertia of its flanking masses, help keep the unit comfortably cool.



Washington's commitment

Senator John H. Chafee

Federal energy measures have tended more to conservation than developing alternate energy sources; but they have coordinated public building, tax regulations, and lending policies in the effort.

Senator John H. Chafee (Republican, Rhode Island) is a member of the Finance Committee. The Senator would like to acknowledge researcher Phillip W. Sawyer for his contributions to this article.

As architects develop energy-efficient designs, the government will approach the energy crisis in three ways: by creating effective programs, providing financial incentives, and setting a good example.

The Energy Policy and Conservation Act was signed into law in December 1975. It was designed to help states develop and direct state energy conservation programs, and called for $50 million a year in grants for three years, 1977–1979. The act required them to set standards for lighting efficiency, restrict the open hours of public buildings, and set insulation requirements. Federal agencies were required to develop ten-year programs along the same guidelines.

The Energy Conservation and Production Act, signed in August 1976, calls for enactment of building performance standards, state-level information programs for homeowners, a $200-million grant program to aid low-income people in weatherizing their homes, and a $200-million demonstration program to educate homeowners about the benefits and techniques of energy conservation programs. The Act authorizes $105 million to be allocated to states which have education programs, foster energy audits, and coordinate local, state, and federal programs. The Act also calls for federal energy standards which the Department of Energy and Department of Housing and Urban Development have been working to develop.

The Energy Tax Act, signed into law in November 1978, encourages homeowners to install energy-saving items in their homes by offering a 15 percent tax credit up to $300. The Act also provides for income tax credits of up to $2200 for installation of solar and geothermal energy devices and increases by 10 percent the investment tax credit for businesses which purchase this equipment.

The National Energy Conservation Act is the most comprehensive law promoting conservation thus far. It increases funding for low-income weatherization programs, and requires utility companies to offer energy audits to consumers and to advise them of loans for energy-saving devices. It authorizes $100 million for solar equipment in federal buildings and $98 million over three years to purchase photovoltaic devices for them. It requires existing federal buildings to retrofit a percentage of their total space for maximum efficiency and requires new buildings to be designed to minimize life-cycle energy costs.

Congress passed legislation creating a solar bank to provide subsidies for below-market loans for purchase and installation of solar devices. The consumers' savings could be significant. And by encouraging consumer demand, the solar bank is expected to stimulate growth of the solar industry.

De-regulation

There is one factor which alone may induce more energy savings than any government program: the price of oil. Since 1973, the price of oil has been subject to controls. While well-intentioned, artificially low prices encouraged consumption and discouraged conservation. Alternate sources of energy remained uncompetitive. And U.S. companies were less inclined to look for new oil supplies.

In June 1979, we took a significant step: decontrol of oil prices, with controls to be phased out until eliminated in October 1981. Congress also has agreed to phase out price controls on natural gas by 1985.

Oil price decontrol will result in domestic oil costing many times what it did previously. In order to redirect some of the revenues, Congress passed a "windfall profits tax." A portion of the price increase will be collected by the government and used for purposes such as development of alternate energy sources. Revenues will also be used to fund a near doubling of the existing credit for homeowners who make use of solar and other renewable resources, raising the maximum from $2200 to $4000. The 10 percent energy investment tax credit for business owners will be increased to 15 percent. Though these efforts are worth while, I personally believe that a greater portion of the revenues should be dedicated to development of alternate sources and conservation.

The bottom line

The statistics so far reveal that American energy consumption, if not tumbling, is at least dropping slightly despite some population growth. Americans used 10,302.93 trillion Btu in their homes in 1973, 10,283.31 trillion in 1977. The commercial sector used 8083.11 trillion Btu in 1973, 7972.94 in 1977. According to statistics provided by the Internal Revenue Service, since 1977 approximately 214,000 housing units have been affected by the government's low-income weatherization program. And, according to IRS, of the 89 million tax returns filed for 1978, 5.84 million demonstrate some form of structural change to the home in accordance with the Energy Tax Act's provisions. Of those, only 70,000 reflect changes with regard to renewable energy sources (solar and wind). The IRS does not yet have any meaningful statistics on commercial use of the energy investment tax credit.

Conserve by example

Numerous federal programs have been devised to reduce energy consumed by the federal government. The Federal Energy Management Program, started in 1973, sought to reduce projected federal energy use by five percent, and the General Services Administration devised guidelines for federal office buildings. Since 1976, HUD has helped install solar heating systems in approximately 23,000 apartments and houses at a cost of $26 million. The department also has developed its Minimum Performance Standards for federally funded housing and published a host of fact sheets for consumers. Its Solar Heating and Cooling Information Center can be reached by telephone toll free.

Incentives

The federal government can do a great deal to influence energy-conscious design through tax incentives and direct subsidies. The Energy Tax Act represents a step in the right direction, but the relatively low level of response indicates that greater incentives should be seriously considered. In a time when initial costs are of greater concern to building owners than life-cycle costs, significant incentives are required to encourage investment. The Report of the National Energy Project of the Harvard Business School argues: "The speed with which retrofit can deliver substantial savings argues for a much more stimulative public policy, with tax credits up to 50 percent. Such a policy would signal the importance of retrofit and would encourage homeowners, entrepreneurs, and manufacturers. It would make retrofit economically attractive for homeowners, and not only attractive but possible for others."

Another way to encourage investment in energy-saving items is to accelerate depreciation. The current laws allow write-offs of machinery over an average of 11 years and buildings over 20 or more. A bill halving these times would allow businesses to write off major changes to buildings in ten years and install energy-saving equipment such as solar heating devices in five years. The point of depreciation is to encourage businesses to replace old equipment and buildings with new, more efficient pieces. It is an incentive that entrepreneurs understand well.

Direct subsidies for weatherization are called for to help those who are most hurt by the rising price of energy and least able to undertake measures themselves: people with low incomes. The Department of Energy and Community Services Administration programs which provide weatherization assistance are vital to the 14 million households with incomes below $9800. Almost half of all low-income households are in the Northeast and North Central regions, where winters are especially severe. Of the approximately 10 million lower-income homes, only 590,000, or .5 percent, have been weatherized. With 9.4 million houses to go, there is a clear need for a concerted, aggressive effort.

Lending policies

The federal government must also do more work with existing institutions which generally have not encouraged conservation measures. For example, revision of lending policies of banks could encourage the American public to conserve energy and to consider life-cycle costs more than initial costs. A statement concerning the energy efficiency of a particular building, either through a comprehensive listing of utility costs or through a listing of energy-saving devices in the home, might be required in a transaction involving a financial institution. It is reasonable to assume that a building that is energy efficient would command a higher price than one which is less energy efficient.

By working closely with banks, the federal government could help assuage the fears of normally conservative lending institutions. Some banks, for example, fear lending money to people who want to buy homes that are built partially underground. Such homes can be extremely energy efficient, and yet because the idea is new and the market untested, many banks balk at financial backing. The Department of Energy has worked to convince banks that such investments are wise, that underground homes can be both attractive and efficient, and that as a result, they are bound to increase in value.

The government's contribution to winning the energy battle must include strong incentives for conservation, research, and development of alternate energy sources, and energy-efficient building design and construction. In the long term, research and efficient design will produce the energy sources and energy-efficient buildings needed to make the United States an energy-independent country.

There is a great energy future in solar power, synthetic fuels, and alternate energy sources. But the harsh truth of the energy crisis is that, in the 1980s, we are not likely to find a meaningful replacement for oil and natural gas. Those new sources may be refined in the latter part of the decade. But with government incentives and energy-efficient design, conservation will provide the light at the end of the tunnel. □

Pondering the dollar drain.

Sticks not carrots

Thomas Vonier

Round two of the creation of DOE's Building Energy Performance Standards is underway. What are they? How will they affect the practice of architecture? Will they work? A top researcher with intimate understanding of their formulation has some answers.

Thomas Vonier is an architect and president of Thomas Vonier Associates, Inc., Washington, DC. Prior to establishing his own practice in 1978, he served for three years as director of energy conservation programs with the AIA Research Corporation. His firm integrates research with architectural design activity and has consulted for the past two years on the development of DOE's energy performance standards. Vonier also serves as a program director for the Association of Collegiate Schools of Architecture and recently organized a national student design competition on energy-conserving design. He also directs ACSA's Summer Institute on Design and Energy, held annually at MIT with support from DOE.

With release of the Notice of Proposed Rulemaking, DOE signaled that—after months of delay and heated internal debate—it was at last ready to unveil proposed standards that it saw as technically sound, legally sufficient and correct in policy terms. Departing significantly in certain areas from what had been laid out in DOE's advance notice (issued in November 1978), the recent NOPR provides the complete framework for the standards themselves and discusses ways in which they may be implemented.

The proposed standards, comprising only a few pages out of the hundreds contained in the NOPR, establish "energy budget levels" that building designs would have to meet before construction could commence. All new commercial and residential buildings would be subject to the standards and, if made "mandatory" through imposition of Federal sanctions against noncomplying states and localities, the standards or their equivalent will become a major part of the codes that every practitioner must follow.

The law passed by the 94th Congress calls for the standards to become final by 1980 and effective at the state and local level one year thereafter. DOE has used half—and will probably use all—of a six-month extension left in the law to the discretion of the secretary of energy. If the question of sanctions fulfills its promise for controversy and is argued during the election, it's likely that a delay in this schedule may result. Maxine Savitz, DOE Assistant Secretary for Conservation and Solar Energy, has been quoted as saying that a delay in the final standards until January of 1981 "may be acceptable."

By DOE's account, the standards are the most significant mid- to long-term energy conservation effort to emerge from the Federal regulatory process. Unquestionably there are major, unresolved issues associated with the standards DOE has proposed. The technical and policy dilemmas usually faced by a Federal agency assigned a responsibility of this magnitude were magnified initially for these standards by the almost total absence of any data upon which to base decisions. Four years and millions of research dollars later, the data problem now seems mostly to have been solved. The AIA Research Corporation led a massive effort to obtain useful information on the energy performance characteristics of recent buildings and went on to tackle the questions of how much better buildings might do in the future and what impact existing standards might have.

The proposed standards

The standards are directed at designs of new buildings and involve three interrelated concepts:

DEB: *Design energy budgets,* setting the maximum allowable energy consumption, in MBtu/sq ft/yr, without regard to the methods, materials or processes to be employed.

DEC: *Design energy consumption,* which is the calculated annual energy use, in MBtu/sq ft/yr, determined by applying the standard evaluation technique or approved alternate.

The standard evaluation technique specifies weather data, operating conditions, and other variables for the location and building type in question, and sets forth detailed instructions and procedures to be used in calculating design energy consumption based on building design characteristics.

The standards require, simply, that a building's designed energy consumption not exceed its design energy budget. The standard evaluation technique is the measurement tool used in making that determination. How much will the design use? The standard evaluation technique consists of a set of public-domain computer programs, each especially suited to a particular area of building energy analysis. DOE-2, a complex program developed for DOE at Lawrence Berkeley Laboratory, is at the core of the standard evaluation technique. Other programs, including DEROB and TRNSYS, augment for passive and active solar analyses. DOE expects to improve the standard evaluation technique and will establish procedures for having other, presumably simpler, techniques—approved as alternates.

It is not contemplated that many people would actually use the standard evaluation technique to demonstrate compliance with the standards. In addition to the simpler evaluation techniques that would be approved as alternates, DOE has said that the manuals of accepted practice will be developed, embodying design prescriptions suited to specific locales and buildings types. If the provisions contained in these manuals are followed, a design would automatically comply with the standards.

This approach is seen as a way of helping designers, builders and others to know that their projects are "on budget" from the outset, obviating the need for a complex analysis (and possible bad news) once the project design is complete.

The design energy budgets are set at present for 18 residential and commercial building types in 78 Standard Metropolitan Statistical Areas (SMSA). The SMSAs listed were chosen for the availability of weather data in a format suitable for use with the standard evaluation technique. The NOPR contains a procedure to be employed in extrapolating for climate areas outside the locations listed, making use of heating and cooling degree-day figures. DOE hopes to work with the National Oceanic and Atmospheric Administration to produce many more computer weather tapes—Alaska and Hawaii are not represented on the list in the NOPR, and many states have only one or two locations listed.

For commercial buildings, the energy end-uses covered by the standards are heating, cooling, lights, fans, domestic hot water, auxiliaries, escalators, and elevators. For single-family residences, a fixed domestic hot water budget is given, and lights are not included, on the theory that most residential lighting is owner-installed, not designed in. The standards do not specify what proportion of the total budget is to be used for what purpose, except in the case of residential hot water. If any portion of the building's energy requirements is provided by a renewable resource (active solar, for example) the energy involved is "credited" against the total design energy consumption.

Consider the source: The energy budget levels are "weighted" according to energy source. Separate budgets are given for single-family residences heated by, respectively, gas, oil, and electricity. The budgets for commercial buildings are based on average fuel-mix characteristics of designs in the research sample. The weighting factors (set at 1.0 for natural gas, at about 1.2 for oil, and at about 3.0 for electricity) were used in setting the budgets. Based on average national energy prices, the weighting factors are also used in arriving at the design energy consumption for a given building.

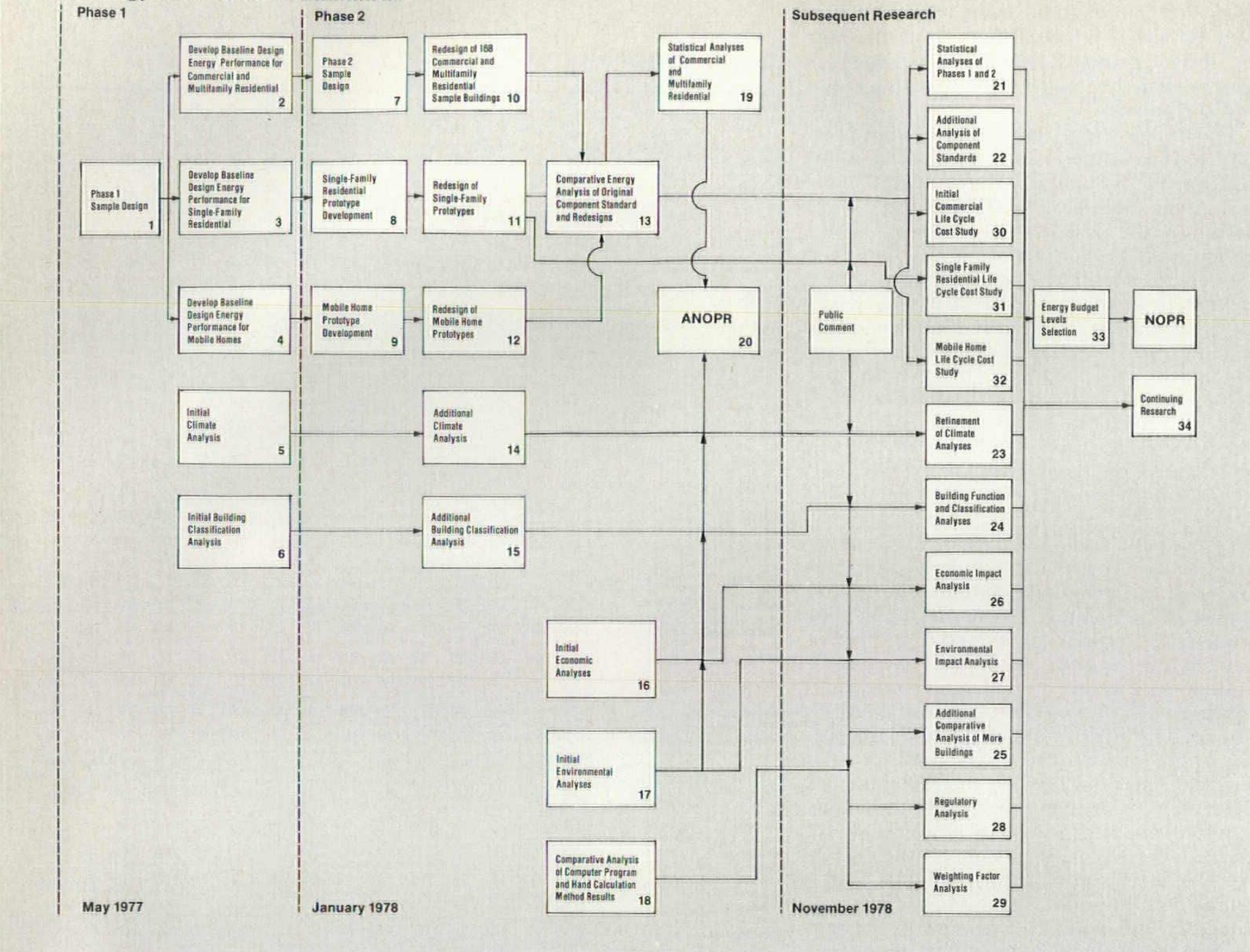
In a program plagued by delays and policy dilemmas, many of which seem now to have been overcome, the source energy issue has stood out as perhaps the most difficult aspect of the standards. DOE's advance notice drew heavy and most vehement public comment on this subject. While opinion was about evenly divided on the appropriateness of DOE's intent in suggesting the "resource impact" and "resource utilization" factors (or RIFs and RUFs, as they became known), nearly all comments questioned practical aspects of the concept.

Some DOE program officials have never

State	SMSA	Clinic	Community Center	Gymnasium	Hospital	Hotel/Motel	Multifamily High-Rise	Multifamily Low-Rise	Nursing Home	Office, Large	Office, Small	School, Elementary	School, Secondary	Shopping Center	Store	Theater/Auditorium	Warehouse
Alabama	Birmingham	123	107	127	353	166	114	110	161	113	101	89	117	181	142	139	53
	Mobile	142	129	147	406	192	127	132	187	131	116	96	133	207	166	162	47
Arizona	Phoenix	146	133	152	406	196	131	136	192	134	119	100	137	212	171	168	49
California	Los Angeles	112	101	115	364	157	103	103	151	106	91	74	106	171	132	126	42
	Sacramento	118	102	120	353	160	110	104	154	108	96	84	112	175	136	132	52
	San Francisco	108	92	109	353	150	103	94	143	101	87	76	103	165	125	119	51
Colorado	Denver	122	98	123	338	162	119	100	156	109	100	97	118	178	137	135	71
Connecticut	Hartford	125	101	127	338	165	122	102	159	112	103	100	121	181	140	139	74
D. C.	Washington	127	107	129	353	169	120	109	164	115	104	96	121	185	144	142	63
Florida	Jacksonville	143	130	149	406	193	128	134	189	132	117	97	134	209	167	164	47
	Miami	152	142	161	406	203	133	147	201	140	125	103	141	219	179	178	41
Georgia	Atlanta	122	106	125	353	165	114	108	160	112	100	88	116	180	141	138	53
Idaho	Boise City	124	100	125	338	163	120	101	158	111	101	98	120	179	139	137	71
Illinois	Chicago	127	102	129	338	167	124	103	161	113	104	103	123	183	142	141	75
Indiana	Indianapolis	128	103	130	338	168	124	105	162	114	105	102	123	184	143	142	73
Kansas	Dodge City	133	109	135	353	175	128	111	162	119	109	105	128	191	150	149	72
Kentucky	Louisville	128	107	131	353	170	122	109	165	116	105	98	123	186	145	143	66
Louisiana	New Orleans	144	129	149	406	194	130	133	189	132	118	100	135	210	168	164	52
Maine	Portland	130	100	131	335	169	129	101	162	114	107	109	127	186	143	143	86
Massachusetts	Boston	125	101	126	338	165	121	102	159	111	102	99	121	181	140	139	72
Michigan	Detroit	129	103	130	338	168	126	104	163	114	106	105	125	185	143	143	77
Minnesota	Minneapolis	142	109	144	335	180	140	110	175	123	117	122	138	198	155	157	93
Mississippi	Jackson	127	113	131	358	171	117	115	167	117	104	90	120	186	147	145	50
Missouri	Columbia	132	109	134	353	174	126	111	161	118	108	103	127	190	149	148	71
	Kansas City	133	110	136	353	175	127	112	162	119	109	104	128	191	150	149	70
	St. Louis	133	110	136	353	175	128	112	163	119	109	105	128	192	150	149	72
Montana	Great Falls	131	102	132	335	170	129	102	163	115	107	110	127	186	144	144	85
Nebraska	Omaha	130	105	132	338	170	126	106	164	115	107	105	126	186	145	145	76
Nevada	Las Vegas	130	115	135	358	174	118	118	170	119	106	92	122	188	150	148	49
New Jersey	Newark	129	107	131	353	171	123	108	165	116	105	99	124	187	146	144	68
New Mexico	Albuquerque	127	107	129	353	169	121	108	164	115	104	96	122	185	144	142	64
New York	Buffalo	129	101	130	338	168	127	102	162	114	106	106	125	185	143	142	80
	New York	126	105	128	353	168	120	107	162	114	103	96	121	184	143	141	66
No. Carolina	Raleigh	124	106	127	353	167	117	108	161	113	101	92	119	182	142	139	59
North Dakota	Bismarck	146	110	147	335	184	146	111	179	125	121	129	143	203	158	161	102
Ohio	Cleveland	129	103	131	338	169	126	104	163	114	106	105	125	185	144	143	78
	Columbus	128	103	130	338	168	125	104	162	114	105	103	124	184	143	142	75
Oklahoma	Oklahoma City	129	110	132	353	172	121	112	167	117	106	97	123	187	147	146	61
	Tulsa	127	109	130	353	170	119	111	165	116	104	95	121	185	146	144	59
Oregon	Portland	119	98	120	353	161	116	99	154	108	97	91	115	176	135	131	66
Pennsylvania	Philadelphia	131	107	133	353	173	126	109	160	117	107	102	126	189	147	146	71
	Pittsburgh	126	101	127	338	165	122	103	159	112	103	100	121	181	141	139	72
So. Carolina	Charleston	124	110	128	358	168	114	113	163	114	102	88	118	183	144	141	49
Tennessee	Memphis	126	109	129	353	169	117	111	164	115	103	92	120	184	145	142	56
	Nashville	125	107	128	353	168	117	109	162	114	102	92	119	183	143	141	58
Texas	Dallas	131	116	136	358	175	119	119	171	120	107	94	124	190	152	150	50
	Houston	145	130	150	406	195	130	134	190	133	118	100	136	211	169	166	51
	San Antonio	146	131	151	406	196	132	134	191	134	119	102	137	212	170	167	53
Utah	Salt Lake City	129	104	131	338	169	125	105	163	114	106	104	125	185	144	143	76
Vermont	Burlington	134	103	135	335	173	133	104	167	117	110	114	131	190	147	148	89
Virginia	Norfolk	123	105	125	353	165	115	108	160	112	100	90	117	180	141	138	56
	Richmond	129	107	131	353	171	122	109	165	116	105	98	123	186	146	144	66
Washington	Seattle	119	96	119	353	160	116	97	153	107	96	91	115	176	134	130	69
West Virginia	Charleston	128	106	130	353	170	123	108	164	115	105	99	123	186	145	143	68
Wisconsin	Madison	131	102	132	335	170	130	103	164	115	108	110	128	187	145	145	84
Wyoming	Cheyenne	128	100	129	338	167	127	101	161	113	105	106	125	184	142	141	82

Note: Figures include design energy requirements for heating, cooling, domestic hot water fans, exhaust fans, heating and cooling auxiliaries, elevators, escalators and lighting. Space is reserved in this table for restaurants and industrial buildings. This list is incomplete. It has been shortened to meet space requirements.

DOE's Energy Performance Standards



THE BUILDING ENERGY PERFORMANCE STANDARDS RESEARCH PROGRAM

The process of creating the Building Energy Performance Standards has been long and controversial. The flow chart above demonstrates the scale of endeavor which is currently underway.

been comfortable with linking the standards to source energy. "Architects and engineers shouldn't be asked to live with the consequences of decisions well beyond their control," said one, echoing the sentiments of many professionals familiar with the program. But others in DOE argued forcefully that building designers have an opportunity (if not an obligation) to base design decisions on the costs to the nation—in dollars and energy units—of using more or less of a particular energy form.

For the NOPR, the result of all this is the proposal for "weighting factors," based at present on national average prices for fuel oil, electricity, and natural gas. Conceding that price is at best an imperfect indicator of true costs, DOE determined that prices (for which at least some reliable data exist) promise to do a better job of accounting than RUFs and RIFs.

DOE's weighting factors are clearly inspired to continue the controversy. With such wide variations in price over small geographic areas and with experience showing radical changes in price over time, the concept is open to serious question.

Source energy will continue to be a problem for the standards. Basic questions, as might be posed by New Englanders who must pay dearly for fuel oil and have few reasonable alternatives, remain to be resolved.

Not yet included: The proposed rule leaves "space reserved" for restaurants, industrial buildings, and mobile homes. DOE's research into these building types is incomplete—in the case of industrial facilities, it has yet to begin. The Department's lawyers have constructed the law as calling for regulation of *all* buildings, so plans for additional work are underway.

Implementation: In comparison with determination of what the standards should be, in itself a complex and arduous undertaking, the question of how they should be implemented may prove to be even more taxing. Responsibility for implementation remained with the Department of Housing and Urban Development when DOE was formed in 1976 and received responsibility for development of the standards. The separation of the standards from implementation has been a major problem for the program. Just prior to release of the NOPR, after much haggling, the two agencies signed a memorandum of understanding that places

STANDARD METROPOLITAN STATISTICAL AREAS FOR THE NOTICE OF PROPOSED RULEMAKING

responsibility for developing implementation regulations with DOE. Legislative action may be required to make this arrangement official, and a bill transferring authority has languished on the Hill since late 1979.

One result of wrangling between the HUD and DOE staffs has been a delay in research and planning for implementation. The NOPR, at the insistence of HUD lawyers, contains only a "discussion" of implementation issues and strategies, watered down considerably from a draft section that had been circulating within DOE. Uncertainty over sanctions, too, has created difficulty, ostensibly because an implementation program for mandatory standards would probably differ markedly from a program designed for voluntary standards. Current plans call for DOE to issue proposed implementation regulations in conjunction with the final standards. At the same time, DOE would submit recommendations to Congress on the entire question of whether the standards should become mandatory and, if so, how and when.

The NOPR does contain the framework of an implementation strategy and probably signals basic elements of the more detailed rules that will follow. Three possible approaches are outlined and DOE suggests that all, in combination, will be necessary.

"*State certification,*" would involve a determination that Federal criteria had been met for a building code equivalent to or exceeding the requirements of the DOE standards, and for adequate implementation programs in local jurisdictions. DOE intends to develop model codes based on the standards, which could be adopted by states and local jurisdictions. It also plans to provide a method for evaluating local codes that are not based on the DOE standards.

The "*alternate approval process*" would permit building designs to be approved in jurisdictions where adequate codes or implementation programs did not exist. It would involve a determination—by a code official or a private design professional—that the design meets or exceeds the requirements of the standards. The local jurisdiction would then declare (presumably to DOE or HUD; it is not clear) that the requirements of the standards had been met.

"*Exemption*" is the third possible approach, reserved for areas where the "volume of construction is so low and building regulatory mechanisms so underdeveloped" that costs of implementation would exceed any expected benefits. DOE suggests that areas seeking exemption would need to provide data suitable for a detailed cost-benefit analysis. In any case, exemptions would be subject to review and granted only for limited periods of time.

Major issues of interest to architects

With this brief background on the proposed standards and the plans to date for implementation, let us consider some of the major issues likely to be of interest to architects, their clients, and colleagues.

Sanctions: Are the standards necessary? Should they be mandatory? Will the costs of implementation be outweighed by the benefits produced? DOE's findings, as contained in the economic and environmental impact analyses that accompany the NOPR, suggest that all of these questions can be answered affirmatively. By DOE's reckoning, residential buildings would be designed to

The cities shown on the map above will serve as the weather models for their respective states. Buildings in other cities and states will be required to use the data of an SMSA which is climatologically similar.

use between 22 and 51 percent less energy than in present practice, while commercial buildings would see reductions of between 17 and 52 percent, depending on location and building type. (These figures are based on comparison of the standards' proposed design energy budgets against data for 1975–76 practice; the budgets would call for design energy consumption below the base, within the ranges stated.) As a result of reduced fossil fuel consumption, major reductions in atmospheric pollutants could also be expected. And all of this, in DOE's view, can be accomplished at little or no increase in initial building costs, with major dollar savings to individuals and the nation over the longer term.

Congress will have the final say when it acts on DOE's recommendations for implementation. A senior DOE official, speaking freely in a late-night working session during preparation of the NOPR, may have summed up the Administration's present position: "My attitude is pragmatic. If it appears that there may be a need for regulation, if it appears that the benefits of the regulation far outweigh its costs, and if nobody is seriously injured in the process, then I think it's a 'good' regulation and we should have it—the sooner the better."

Even if no sanctions are imposed, DOE lawyers have interpreted the law as specifying that the standards will, when final, apply to all Federally subsidized and insured construction. In addition, the heads of all agencies and departments of the U.S. government must assure that their organizations are in compliance with the final standards. DOE has determined that, even without sanctions, the standards might apply to 65 percent of all construction.

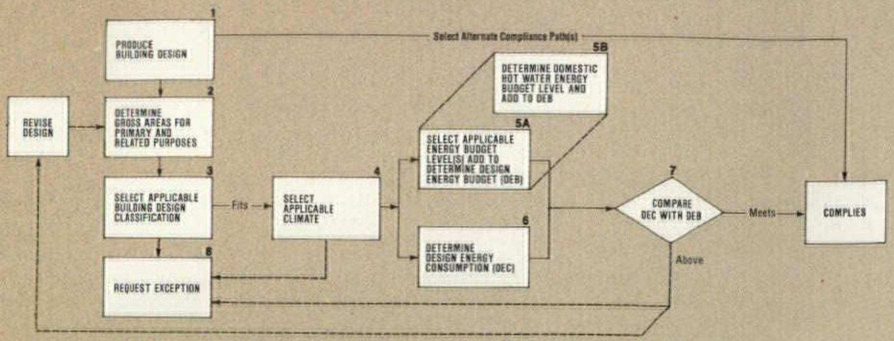
Effects on practice

It is probably too soon to say much on this subject, because the details of implementation are largely unresolved. In general, though, it is clear that—if it has not already made major inroads to the mainstream of professional practice—energy analysis of some kind will become an absolute requirement. The NOPR alone may prompt some clients to question how designs prepared for them compare with DOE's standards, thus "implementing" them in an unanticipated way.

DOE has said repeatedly that much of its future research and development spending will be in the area of simple, low-cost design and analysis tools. The Department already supports educational programs for faculty in architectural and engineering schools. These efforts, coupled with planned manuals of recommended practice, should help architects considerably in understanding and meeting the requirements of the standards.

Liability: Liability is also an issue. Suppose a design has been certified by an architect or engineer as being in compliance with the standards and, after using the building for some period of time, the owner discovers that actual energy use far exceeds that called for in the standards. As a result the owner sues the designer. A DOE lawyer responded to this question by saying that "the standards will look only as far as the building design." As to whether or not a client might look further, the attorney acknowledged that it was a "fascinating" issue. "I put the question back to you," he told the questioner. "If I were the client, would it be reasonable to expect the building to perform in accordance with representations made about its design?"

The matter is complicated. It is unlikely that all of the assumptions about climate, occupancy patterns, and building design features used in making the compliance evaluation would ever be duplicated exactly in practice. Thus, one might argue, it is not reasonable to expect that the building would achieve the exact performance suggested by the standard evaluation technique. DOE has been careful to assert that the evaluation technique is designed to serve as a common basis for comparison, not necessarily as an ac-



Application of proposed standards to typical building design process

An office building in Denver, Colorado under DOE's Proposed Standards

What would happen to an office building in Denver under the standards? Assuming that the building is greater than 50,000 gross square feet, the energy budget is 109 MBtu/sq ft/yr, in "weighted" terms. Here's an example of how this energy budget works out for various heating fuels, expressed in terms of site energy:

All Electric $\dfrac{\text{109 MBtu/sq ft/yr}}{\text{3.08 (Electric weighting factor)}}$ = 35.38 MBtu/sq ft/yr at the site

For an office building heated with oil or natural gas, assume that 40% of the total energy budget will be in electricity (for lighting, fans, air-conditioning and elevators). Thus, 109 MBtu/sq ft/yr X .40 = 43.6 MBtu/sq ft/yr ÷ 3.08 = 14.15 MBtu/sq ft/yr at the site for electricity. Subtracting this amount for electricity from the total (109 - 43.6 = 65.4 MBtu/sq ft/yr), the remainder is available for space heating and domestic hot water. Added to the total site electricity and divided by the appropriate weighting factors:

Natural Gas $\dfrac{\text{65.4 MBtu/sq ft/yr}}{\text{1.00 (Gas weighting factor)}}$ = 65.4 MBtu/sq ft/yr

65.4 MBtu/sq ft/yr + 14.15 MBtu/sq ft/yr = 79.55 MBtu/sq ft/yr at the site

Oil $\dfrac{\text{65.4 MBtu/sq ft/yr}}{\text{1.20 (Oil weighting factor)}}$ = 54.5 MBtu/sq ft/yr

54.5 MBtu/sq ft/yr + 14.15 MBtu/sq ft/yr = 68.65 MBtu/sq ft/yr at the site

These figures compare with 68 MBtu/sq ft/yr established as the mean of "existing practice" in 1975-76, and with 64 MBtu/sq ft/yr from the Phase 2 research into the impacts of ASHRAE Standard 90-75R. The mean of the Phase 2 "redesigns" was 40 MBtu/sq ft/yr for large office buildings. Some observers have argued that the weighting factors are unduly hard on all-electric buildings. This example shows that all-electric buildings would have much more stringent energy budgets.

The Notice of Proposed Rulemaking and ten technical support documents can be obtained from: Energy Performance Standards, Office of Buildings and Community Systems, U.S. Department of Energy, Mail Station 2114C, 20 Massachusetts Ave., NW, Washington, DC 20585 800-424-9040 toll free.

State	SMSA	Single-Family Detached			Single-Family Attached		
		Gas	Oil	Electric	Gas	Oil	Electric
Illinois	Chicago	39.1	46.5	46.6	29.2	34.8	36.0

What the Standards Would Mean in Chicago, Illinois

Taking the hypothetical case of a single-family detached gas-heated residence in Chicago, which will heat domestic hot water with gas, the design energy budget is taken from tables in DOE's proposed standards. For space heating and cooling in Chicago, the energy budget level is 39.1 MBtu/sq ft/yr To this figure must be added the energy budget level for domestic hot water, obtained by dividing the budget for gas water heating by the total gross area of the dwelling design (we've assumed a 1500 square foot residence):

Energy budget level for heating and cooling = 39.1 MBtu/sq ft/yr
(Single-family detached, gas space heat, Chicago)

Energy budget level for domestic hot water = 19.6 MBtu/sq ft/yr
(Gas; divide 29,500,000 by gross area, 1500 sq ft)

39.1 MBtu/sq ft/yr + 19.6 MBtu/sq ft/yr = 58.7 MBtu/sq ft/yr

Total design energy budget = 58.7 MBtu/sq ft/yr

It is important to note that the budgets are "weighted" by fuel type and the figures are not measures of energy used at the building site.

Now assume that a building design has been developed and has been evaluated by DOE's standard evaluation technique, which provides a computation of annual energy use measured at the building boundary. These hypothetical "site" energy figures must now be multiplied by the appropriate weighting factors. We'll assume that the design provides for some space cooling. As shown in the computation below, the designer and client are fortunate, because the design meets the requirements of the standards—its design energy consumption does not exceed its design energy budget.

Design energy consumption for space heating
20.0 MBtu/sq ft/yr at the site X 1.0, the gas weighting factor = 20.0 MBtu/sq ft/yr

Design energy consumption for space cooling
6.5 MBtu/sq ft/yr at the site X 2.79, the electricity weighting factor = 18.1 MBtu/sq ft/yr

\+ **Design energy consumption for domestic hot water**
14.0 MBtu/sq ft/yr at the site X 1.0, the gas weighting factor = 14.0 MBtu/sq ft/yr

= **Total design energy consumption**
52.1 MBtu/sq ft/yr

The deadline for written comments on the proposed standards is 30 April 1980. Comments should be submitted to the address below, and DOE asks that 15 copies be provided: Energy Performance Standards, Docket Number CAS-RM-79-112, Office of Conservation and Solar Energy, 20 Massachusetts Ave. NW, Washington, DC 20585.

curate prediction of actual performance. Whatever the case, it seems likely that the matter will eventually be litigated and this prospect has many practitioners worried.

Higher costs? DOE's data show that initial building costs would rise only moderately, if at all, as a result of the standards: about $1 per square foot in residences and between three and five percent in commercial structures. (The estimates are based on cost analyses of the redesigns produced in Phase 2 of the research effort and on more rigorous examination of costs for conservation measures in single-family residential buildings.) Little attention has been paid to the cost of design services, however, and it seems clear that additional analyses will lead to requirements for higher fees.

Stringency: The design energy budgets are very stringent. Writing in the *Progressive Architecture* energy conscious design issue a year ago, John Eberhard and Senator Charles Percy suggested that, to be useful, the standards would need to be very rigorous indeed, posing a genuine challenge. Designers, they stated, have demonstrated that it is technically possible to meet such a challenge.

Their statement might better have read "*some* designers." The proposed budgets are set at levels that were not reached by a large majority of the architects and engineers who redesigned buildings for "maximum technically feasible" energy conservation as part of DOE's research effort. This kind of stringency may lead to serious difficulty for many designers who are not familiar with energy-conserving strategies (not necessarily a bad result).

Monitoring and updating: The law calls for the administrating agency to review, evaluate, and update the standards periodically. With changes coming so quickly and dramatically in the energy situation, and with the promise of emerging energy conservation technologies, this is an especially key element of the program. Some DOE policy staff members have considered the possibility of "racheted" standards, rules that would—like the EPA mileage objectives—call for progressively stricter standards over time.

The use of price weighting factors would seem to indicate that some method is needed for periodic revision of the energy budget levels, based on new information about energy supplies and costs. Other parts of DOE regularly collect and analyze such information, but not for this express purpose.

Next steps: DOE is now in the midst of nationwide public hearings on the proposed rules. Volumes of written and oral testimony are expected from virtually all interested groups in the country. The commentary will be strongly worded and, if true to that received on the advance notice in 1978, will be about evenly divided on nearly every issue. DOE has a strong record of heeding and responding to public views, but as the program moves toward its final stages it will become more difficult to satisfy all diverse interests.

Meanwhile, research continues for the final standards. In fulfillment of legislative directives, DOE has consulted with the National Institute of Building Sciences, and NIBS now has a major management role in the program. It will serve as prime contractor to DOE on many aspects of implementation and will also manage work remaining on the final standards. The first major recommendation to come from NIBS after release of the NOPR was for full use of the six-month discretionary time extension.

There is no substitute for the direct scrutiny and participation of concerned individuals in the design community, each of whom will in some way be influenced by the program's outcome. Without the considered and interested comment of those who may ultimately be expected to abide by their provisions, these standards have a chance of becoming costly, burdensome, ineffective, and unpopular regulations, pressed into service by a country anxious to reverse its grim energy situation. And, in not contributing carefully and on a wide scale to development of the standards, architects and their colleagues may get just what they deserve. □

Architect-machine relationship in ECD

Architectural energy analysis

Dr. Vladimir Bazjanac

The dynamic action of buildings in the heat exchange process is difficult to predict. Designing to optimize heat exchange needs approximation, but if we ask the right questions, a computer can help us find good answers.

Dr. Vladimir Bazjanac is teaching in the Department of Architecture and is project director in the Center for Planning and Development Research at the University of California in Berkeley, and is also Guest Scientist at the Lawrence Berkeley Lab. Bazjanac is involved in design of energy-efficient buildings as well as consulting in architectural energy analysis. One of his current research grants with DOE is for the computer analysis of architectural designs. His results will be published periodically in P/A.

Architectural design is the primary force which sets the energy performance of buildings. The demand for heating and cooling and the use of lighting fixtures are determined by the layout and the orientation of the building, by its "envelope," fenestration, shading, and other design parameters. Mechanical systems are designed and operated *in reponse* to this demand. Each design decision has an effect on the ultimate energy performance of the building. This is true especially of the earliest design decisions, which often determine the extent to which the consumption of energy in the building can be minimized. If the architect fails to consider this, any energy-conserving design decision made later (including even the design of the most energy-efficient mechanical system) will merely constitute "retrofitting" of the building.

The planned design of an energy-conserving building requires the architect's understanding of the effects of design decisions on energy performance. Some effects (for example, of the orientation) are more or less obvious; others are more subtle and require rather complex analysis of many factors which may be unfamiliar or completely unknown to the architect at the time. This analysis, which assesses the effects of architectural design decisions on the overall energy performance of buildings, I call "architectural energy analysis."

Quantitative models of energy performance
Architectural energy analyses rely on the use of models which describe the energy performance of buildings. They are representations of buildings as energy systems and include only those characteristics and relationships which determine their energy performance. Other characteristics, perhaps important to the design but not important for buildings' energy behavior, are left out.

Quantitative models used in energy analysis are mathematical representations of complex thermodynamic or luminous behavior of buildings. Everything is described numerically: the weather, the building and its operation, the consumed energy. The behavior of buildings is simplified in models and only approximates what is happening in reality. Some are descriptions of only an individual factor and are quite simple. Others attempt to describe a multitude of factors which determine energy performance and are much more complex. Correspondingly, some models require only limited computation, while others cannot be operated without the use of sophisticated computer systems.

Quantitative models offer convenient "parametric" analysis of energy performance: the effect of planned change in a single energy parameter of a building. Properties of buildings or the characteristics of their use are changed by modifying values which represent them. Long-term change (e.g., performance over a whole year) can be simulated and analyzed in a short time. Modeling of environmental conditions is virtually perfect: any weather or environmental condition can theoretically be described at will.

Architectural or mechanical: It is important to understand the distinction between the "architectural" analysis of thermal behavior of buildings and the simulation of performance of mechanical systems. Many well-known models were designed specifically to simulate the performance of mechanical systems. Such models can be used to calculate heating and cooling loads of buildings only to the extent needed for the simulation of mechanical systems and typically ignore sensitive architectural design parameters (such as shading and daylighting). Only models that deal with architectural design parameters of energy performance in detail are discussed here.

Static or dynamic: Models of thermodynamic behavior can be static or dynamic. Static analysis considers thermal performance independently of time. Typical of this group are simple models which consider only a single factor of energy performance. A good example is the model of conduction through external surfaces (heat loss or gain is a function of surface area, resistance, and the temperature difference between the outside and the inside). The analysis in single-factor models is free of influence from other factors.

Dynamic models by contrast consider change in thermal conditions as a function of time. All models which simulate performance on hourly, daily, monthly, or yearly bases are of this type. Models which consider multiple factors in relation to each other (such as direct and diffused solar gain, reflectance and roughness of surfaces, thermal mass, etc.) are by necessity of this type. Dynamic models of thermal performance have another important distinction: some consider thermal mass of the building and the "delay" effect it causes, some do not.

Zones: Each area of the building with unique thermal characteristics is considered a thermal zone. Buildings are usually zoned by floor. A floor may have more than one zone to account for the difference in thermal behavior between the floor perimeter and the interior. Thermal zoning is an important issue in the use of complex dynamic models—insensitive zoning results in inappropriate description of the building.

Shading: Models used in architectural energy analysis must be able to simulate the effect of external shading. Simple models take shading into account only as percentages of glass shaded. It is more appropriate to "track" the sun and determine the position of shadow caused by the shading system. Most complex models of thermal performance use the latter method. Shading surfaces are treated as external walls and overhangs. Some models allow for simple configurations only, while more sophisticated models can analyze complex shading systems with many surfaces and different tilts, and can include shading from trees and surrounding buildings. Some can even simulate the performance of movable shades and thermal shutters.

Infiltration: Simulation of infiltration is a troublesome proposition as is the simulation of natural ventilation, and few models consider natural ventilation in their calculation of heating and cooling loads. Three methods of infiltration calculations are found in models of energy performance: air-change method, crack method, and the Achenback-Coblentz method. None describes actual infiltration under different circumstances accurately. It is almost impossible to predict actual infiltration because it depends so much on details and quality of construction.

Function: Energy performance changes with the use of the building. Some dynamic models allow the simulation of different patterns of use. This is accomplished through the "scheduling" of occupancy, of the use of lighting fixtures and user-operated equipment, and of the operation of shades and shutters. Schedules determine when occupants are using various devices in the course of simulation. Such use options as thermostat settings and night setbacks can also be scheduled in some models.

Weather: Energy performance of buildings is weather dependent and can be simulated in a number of ways, depending on the type of model and the purpose of simulation. For this purpose, National Oceanographic and Atmospheric Administration (NOAA) has compiled weather data on magnetic tapes. These tapes provide weather information for a full year for most major cities in the United States. They are used by complex dynamic models to simulate a full year of buildings' energy performance. When simulation of a full year is not needed, "design day" approach can be used. "Design day" represents a "typical" day of the year (typical for the intent of analysis) and contains weather data representative of the local climate which is condensed into one day.

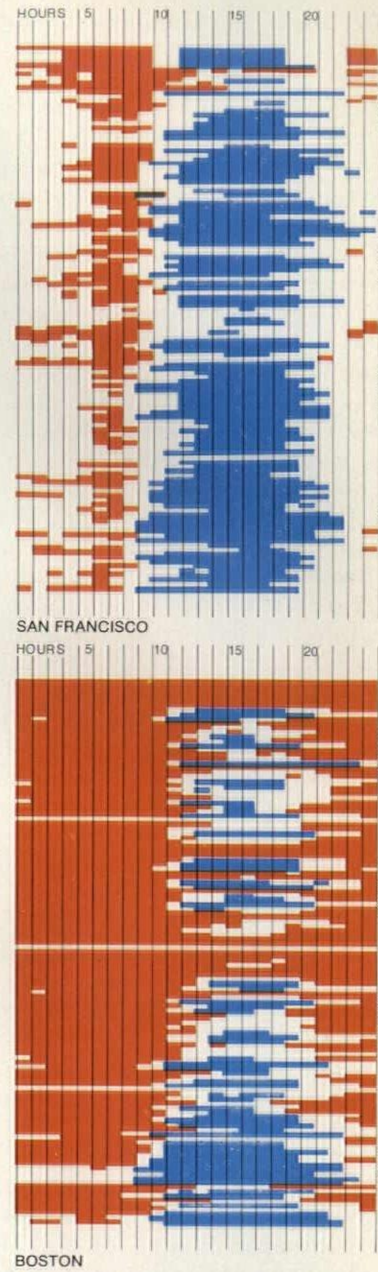
Some models need very elaborate data for their calculations, ranging from dry-bulb and wet-bulb temperatures, to wind velocity and direction, to cloud type and coverage. Most of them calculate both total and peak heating and cooling loads. In contrast, simple models may need only very limited weather data. For example, the previously mentioned model of conduction through external surfaces requires only outside dry-bulb temperature.

Combining thermal and daylighting analysis: Models for daylighting analysis require sky illumination data. Consequently the best analysis is obtained from the use of scale models which can be placed and studied in the actual location of the building. Difficulties arise when repetitive or comparative measurements are needed over extended periods of time—weather and natural illumination sometimes change too rapidly.

Most quantitative models of daylighting are complex. Only extreme sky conditions are considered: clear or overcast. Illumination from natural light is analyzed in a single room for a specific moment in time. Architectural design parameters, important in daylighting analysis and typically required by these models, are room size and shape, finishes of interior surfaces, design of windows, and shading devices.

Models which effectively link thermal and daylighting analyses are not yet available for public use although work on such models is now in progress. Currently, an architect can link thermal and daylighting analyses only indirectly by reducing artificial lighting loads in thermal simulation as a function of use of natural light.

Enter the computer: Models which require



MAPS SHOWING THE HOURLY WINDOW CONTRIBUTION TO TOTAL BUILDING LOAD IN BTU's PER SQ FT OF WINDOW

Key

Heating load does not exceed -10.00 Btu/sq ft and cooling load does not exceed 10.00 Btu/sq ft

Heating Load exceeds -10.00 Btu/sq ft

Cooling load exceeds 10.00 Btu/sq ft

Above are two computer-generated maps comparing the hourly performance of the same window design in two different locations throughout the year. The study is from Managed Window Systems project at the Center for Planning and Development Research, University of California, Berkeley and Lawrence Berkeley Laboratory.

elaborate data typically demand the use of very powerful computers. The manipulation of large data bases in some of the complex models requires very fast computers with large memories. The use of weather tapes from NOAA requires tape drives. Such models generate so much information that fast printers are needed. A large computer usually has many users and "turn around time" (time between the submission of input and the getting of results) can be substantial. The use of large, fast computers can be expensive.

Using complex models can be very time consuming. Information must be prepared in a form acceptable to the model and the computer and takes time to understand in detail—and that information is often vast. The user must be familiar with the documentation which describes the model, its logic and assumptions, and the operation on a particular computer system.

Simpler models which require only the use of programmable pocket calculators offer distinct advantages to an architect. They are much less expensive to use. They can be used at the drafting board; they require much simpler input; and they permit much faster analysis. There are, however, penalties for their use. Models are smaller and information from NOAA weather tapes cannot be used directly. There are severe restrictions on the size and complexity of buildings in analysis. As a result, complete analysis of buildings using programmable calculators often requires the use of several different models.

Limitations of analysis

Limitations of architectural energy analysis are inherent in the methods of analysis used. Quantitative models of buildings are representations of reality as seen by the models' designers. If a building or the objective of analysis does not fit this view, useful results can be obtained only when the model is modified. The performance of a passive solar house, for example, cannot be properly simulated with a model designed specifically for the analysis of high-rise office buildings.

As in any design, each model has explicit and implicit assumptions. Assumptions are the only means of dealing with aspects of reality which are not understood, cannot be controlled, or cannot be modeled. They are always made about the simulated weather, the zoning of the building, the use of the building, and the performance of lighting control systems. Explicit assumptions are usually stated in very general terms. It is sometimes difficult to interpret how they specifically affect the simulation of a particular building. Implicit assumptions are even worse. It is often necessary to understand physics or computer science to become aware of them. Difficulties in dealing with assumptions increase with the complexity of the model.

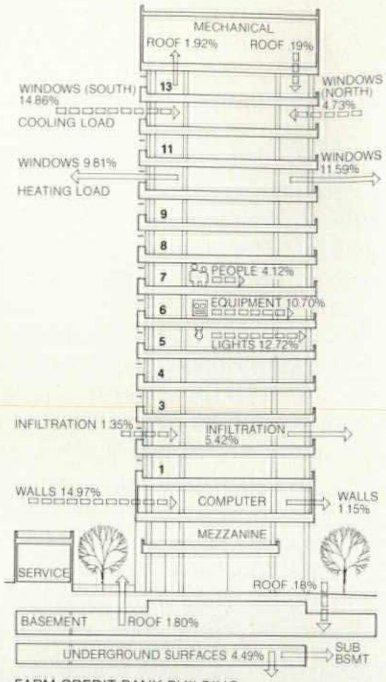
The accuracy of results is of course affected by our ignorance. Our understanding of processes and relationships which determine energy performance of buildings is limited. Their descriptions are incomplete, imperfect, and sometimes inaccurate. For example, sensitivity analysis with the DOE-2 program indicates that the simulation of infiltration may cause a 30 percent error in the computation of heating and cooling loads. Even when the theoretical understanding of a phenomenon is appropriate, its mathematical complexity may be of such magnitude that it can be modeled in usable form only if it is simplified.

Some limitations of analysis are due to the design process itself. A building is much better defined at the end of its design than at its beginning. Detailed information about the building, required by some complex models of energy performance, must be estimated early in the design process. As the architect designs the building in more detail, some of his guesses prove to be wrong. What is finally built quite often differs substantially in its energy performance characteristics from the building described for architectural energy analysis.

Architectural energy analysis is a tool for use in the design process. Its primary goal is to gain the understanding of the impact of design decisions on energy performance of the building. Expectations of predicting the exact energy consumption of the completed building result only in disappointment.

Architects and architectural energy analysis

What can an architect expect from architectural energy analysis? A better understanding of the what, the where, the when, and the how much of energy conservation, as well as advice about design. Specifically, energy analysis can assist in the following: **1** Determining the energy performance characteristics of individual design elements. This, for example, may mean to discover whether a certain element has the desired energy-conserving effect. It may also indicate the best position and orientation of the element, its optimal size, and the conditions under which it is most effective. **2** Establishing energy performance of the whole building. The overall performance is the sum of performances of individual components of the building. The components interact with each other and affect each other's performance. Each contributes differently to the sum, and the effect of a single component of energy performance is sometimes lost in the overall performance of the building. Energy analysis can provide the comprehensive understanding of how much is contributed by which component. **3** Making trade-offs. Architects, for various reasons, often cannot select the most energy-conserving materials or solutions. One material may be chosen at the expense of another. The most obvious example is the case when the high first cost of one energy-conserving solution forces the exclusion of another. Comparative estimates of the extent to which each choice affects the building's energy performance are important in the making of



FARM CREDIT BANK BUILDING, SPOKANE WASHINGTON

The section above shows components of heating and cooling loads for a building as percentage of combined loads. Below is a checklist of features characteristic of computer programs. Of the 6 samples, the first 3 are for programmable calculators; the last 3 are large computer systems.

LBL PASSIVE SOLAR	SCOTCH PROGRAMS	TEANET	BLAST 2	NBSLD	DOE-2	
			●		●	ENGLISH-LIKE INPUT
	●					STATIC MODEL
●		●	●	●	●	DYNAMIC MODEL
			●	●	●	WEATHER TAPES
●		●	●	●	●	DELAYED RESPONSE
	●		●		●	EXTERIOR SHADING
●	●	●	●	●	●	INFILTRATION
●	●		●	●	●	OCCUPANT-OPERATED EQUIP
●	●		●	●	●	LIGHTING
●		●	●	●	●	HOURLY ANALYSIS
●		●	●	●	●	DESIGN DAY ANALYSIS
	●				●	DESIGN TEMPERATURE
		●	●	●	●	THERMOSTAT
	●	●	●	●	●	CALCULATES HEATING LOAD
	●	●	●	●	●	CALCULATES COOLING LOAD
●						CALCULATES TEMPERATURE
●	●	●	●	●	●	DETAILED REPORTS
●		●	●	●		SUITED FOR PASSIVE SOLAR
●	●	●	●	●	●	SUITED FOR RESIDENTIAL
●	●		●	●	●	SUITED FOR COMMERCIAL
●			●	●	●	PUBLIC DOMAIN PROGRAM
●			●	●	●	USER MODIFICATION
●	●	●	●	●	●	UP-TO-DATE DOCUMENTATION
●	●	●	●		●	CONTINUOUSLY UPDATED

CHECKLIST OF COMPUTER FEATURES

trade-offs. **4** Deciding how to proceed with design. If there is a question which design alternative is the most promising to pursue, information obtained from energy analysis may help in the selection of the best one. Early consideration of energy conservation issues may avoid problems and embarrassment later in the design process. Architectural energy analysis brings the consideration of these issues to the beginning of the design. **5** Confirming intuitive design decisions. Architects often make design decisions without the explicit consideration of energy performance. They may deal with energy performance intuitively (perhaps relying on "conventional wisdom"), without the explicit understanding of energy aspects of their decisions. Architects may believe they are energy conscious—energy analysis will show if their design decisions are indeed energy conserving. **6** Understanding how different conditions of use affect the building's energy performance. Energy consumption in a building is a function of its use and the changing weather. Architectural energy analysis allows the architect to understand how to deal most effectively with the peculiarities of weather. It can also demonstrate which patterns of use of the building consume more energy. This may lead the architect to deliberately design control systems which will prevent such occupant behavior.

What is the necessary background for architectural energy analysis? There is a myth that, with so many calculator and computer programs available for energy analysis, the architect does not need to know much about energy analysis; it is enough to use a program and obtain information about the energy performance of the building. Such "analysis" can lead only to distorted, incomplete understanding of the building's performance. Output from quantitative models must be interpreted in view of the models' limitations. Without interpretation, numbers are often misleading.

To engage in architectural energy analysis the architect must have a basic understanding of thermal behavior of buildings and daylighting. He or she must also have at least some understanding of the particular models used in analysis, their logic, and the basic assumptions and conditions of use. Without that, the preparation of the building for analysis and the meaningful interpretation of results are not possible.

Besides access to appropriate equipment for computation, the architect should have access to full support documentation and prompt consultation. Good advice can save a lot of time when unusual issues or problems arise in analysis. Finally, the architect has to allocate enough time—architectural energy analysis, like design, tends always to take more time than planned. □

Ground rules: Architectural Energy Analysis

This project is directed by Dr. Vladimir Bazjanac, Center for Planning and Development Research, College of Environmental Design, University of California, Berkeley. Project staff includes Harvey Bryan (daylighting) and research assistants Peter Brock, Robert Engelsen, and Patrick Mervin. This undertaking would not be possible without the cooperation of the owners, designers, and engineers in the preparation of analyses of their buildings, the assistance of the Building Energy Analysis Group at the Lawrence Berkeley Laboratory in modifying DOE-2, and the help provided by special consultants on difficult aspects of analyses.

The work at the University of California is supported by a research grant from the U.S. Department of Energy, office of John Cable, Director, Buildings Division, Office of Buildings and Community Systems.

Progressive Architecture *wishes to invite its readers to comment freely on the value of this program. Suggestions and feedback are important to its future direction. Letters should be addressed to: Progressive Architecture, Architectural Energy Analysis, Richard Rush, Senior Editor, 600 Summer St., Stamford, Ct 06904.*

This issue marks the beginning of architectural energy analysis of selected buildings published in *Progressive Architecture.* Our main objective is to introduce energy conservation into the earliest stages of architectural design. By making energy conservation part of the continuous learning process of architects, we hope to: provide an understanding of how early design decisions affect energy performance of buildings; establish the methodology for evaluation of energy performance of buildings from architects' points of view; disseminate knowledge contained in the DOE-2 computer simulation model to the design community; and encourage a tradition of energy evaluation as an integral part of architectural evaluation of buildings. The title of this project is "Architectural Energy Analysis of Trend Setting Buildings." Its scope of work includes detailed analysis of energy performance of selected buildings, the publication of results simultaneously with the publication of the design, and the recommendation of possible areas of improvement in energy performance.

Architectural energy analysis is the analysis of heating and cooling loads and of the demand for energy from lighting fixtures and occupant-operated equipment (at the building location). It does not include the performance and demand for energy from any mechanical systems. It includes the understanding of energy conservation in buildings, and the quantitative simulation with DOE-2 and daylighting simulation models. Daylighting and thermal analyses are linked whenever possible, although other models are used when appropriate. When available, special studies, reports, and measurements are used to make the analysis as realistic as possible.

A summary of results of analyses will be published in conjunction with the publication of buildings in *Progressive Architecture.* Summaries will follow a standard format (see page 105) as much as possible, highlighting a) energy performance data on the entire building at the stage of design development as published; b) architectural features identified as characteristic for the building, with energy performance data for each feature; c) analysis of compliance with BEPS (after public hearings on BEPS are over and Technical Support Documents are finalized). Quantitative information from analyses will be published without any value judgments. Detailed reports and recommendations for improving energy performance of analyzed buildings will be available with the consent of buildings' designers.

Limitations of analyses and reliability of results are those of the methodology and tools used (see page 100). Summary reports will provide information about the magnitude of energy consumption as a function of architectural design. The first four reports are experimental in contents and format, and are intended to begin a dialogue with readers.

Hooker Office Building, Niagara Falls, NY

Rainbow's end

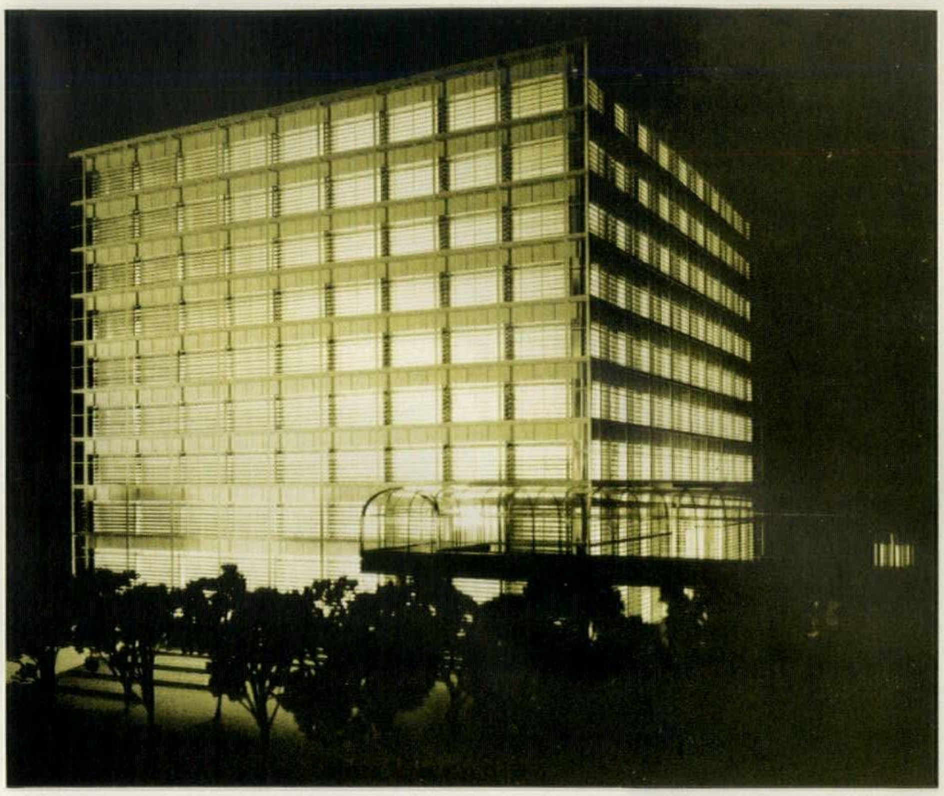
At the south end of the famed Rainbow Bridge on the Niagara River, a new focal point is to greet travelers from Canada.

On a very prominent site in a prominent city now fighting to rebuild an almost hopelessly eroded urban core, a new office building will join the effort. The corporate office structure for Hooker Chemicals & Plastics Corporation, designed by Cannon Design Incorporated, is far more than first glance might indicate. The unpretentious square plan, diagonally right on axis with the Rainbow Bridge, expresses its flexible office space function in a largely conventional way—albeit column-free between outer structure and core.

That first glance might not even indicate that an observer is confronted with anything much more ambitious than an admittedly handsome orthogonal, subdivided cube. But the second looks which should be triggered by the building's élan will reveal a whole other layer—literally—of content. The building has two skins, and sophisticated controlling features.

Along with the client's desire to consolidate disparate company facilities, and the intended expression of commitment to Downtown Niagara Falls, both client and architect wanted to do everything possible to promote energy efficiency. Mark Mendell, Cannon's principal-in-charge, describes the initial intent as one of incorporating simple solutions representing current abilities to conserve energy. If possible, off-the-shelf hardware, as opposed to highly technical devices, was sought—with the exception of the control and monitoring equipment, discussed later.

It bothered Mendell and his team that the pat answer to conservation was often to cut glazing areas out, or at least down. In order to both supplement artificial light with natural (reducing power demand) and allow maximum vision areas for the occupants, an extraordinary exterior membrane was needed. Since standard glazing, even double glazing, did not meet the design needs, the architects came up with an inner skin and an outer one, four feet apart. This arrangement, which admittedly will come at something of a cost premium, virtually eliminates air infiltration through the inner layer.



Of HVAC lineage

Between the membranes is possibly the biggest-scale set of venetian blinds ever, and off-the-shelf, no less. Casting about for an efficient yet inexpensive method of installing operable louvers, the designers discovered the system chosen, an assembly of airfoil-shaped louvers long used for HVAC applications. These assemblies will cover all glazed areas of the building envelope except the recessed lobby entry. Motorized screw-shaft rods will provide the power drive for each segment, activated by sensors for each building face.

All façades thus will be controlled separately, and sensors on the louver blades will, when shaded, stop movement. The system will allow horizontal fin alignment for elevations in shade, down to 45 degrees in full sun, or in between. At night when the building is unoccupied, the louvers will close up completely, retaining conditioned air from daytime operation. Even when the louvers are in the full sun position, daylighting properties will be retained, because the light will be refracted into the space by white or near-white fin surfaces.

As is obvious, the 4-ft space between building skins is the source of heat build-up in sunny orientations. That's fine, if heat is needed. When it's not, another set of sensors, this time temperature-activated, will operate venting dampers at the top and bottom of the "cavity," releasing the convective warm air at the top. Some convection will also occur *around* the building, with warm air flowing from sunny sides to cooler, shaded exposures. The precise flow of this air is more difficult to predict, but the effect should be beneficial.

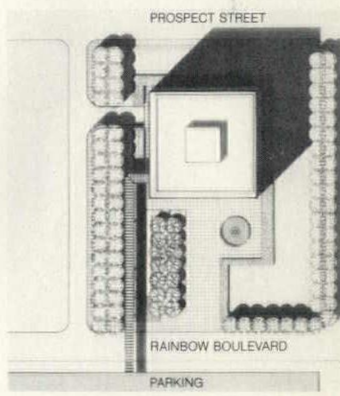
More than skin deep

Immediately inside the skin is a 15-ft perimeter lighting zone with two-stage lighting controls to allow for maximum daylighting benefits to reduce power use. The controls will allow for dimming artificial lights in accordance with light levels from outside. Elsewhere on each floor, localized task/ambient lighting will be employed. The designers expect to keep lighting energy use down under 1W/sq ft, taking daylighting into account.

In addition, a comprehensive central computer control center will oversee most building functions. Some of its duties will be to monitor security points, fire safety information, and HVAC dampers, fans, and the variable air volume system. It will also provide for data reduction, allowing precise pinpointing of operating conditions.

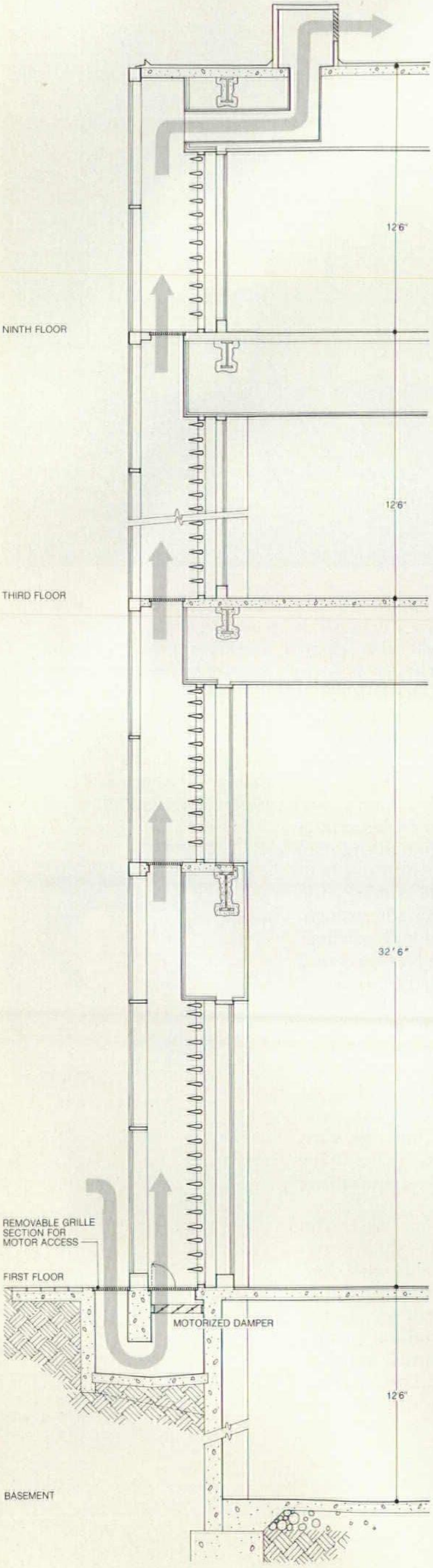
Scheduled for completion in 1981, the Hooker building should be interesting to observe "in action." Mendell points out that, from Rainbow Bridge for instance, the building will change from transparent on the left half to largely opaque on the right at certain times. The sides will vary constantly, depending on weather, time of year, and time of day. It may not be a pot of gold, but the Rainbow should end well, anyway. [Jim Murphy]

Although the louvers would normally close off façades at night to retain air that is conditioned by day, night model photo (above) gives a vivid indication of double-glazed skin. The northwest corner of the plan (below) points directly to Rainbow Bridge; view south and west frames Niagara Falls.

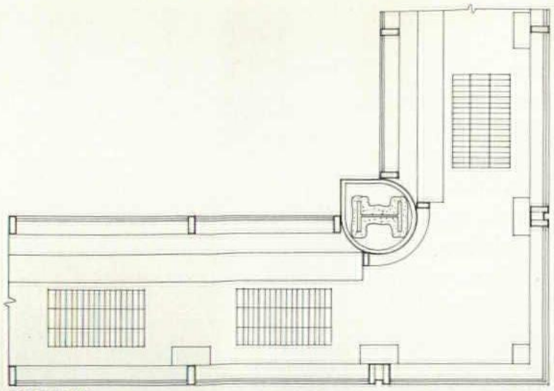


SITE PLAN N→ 60'

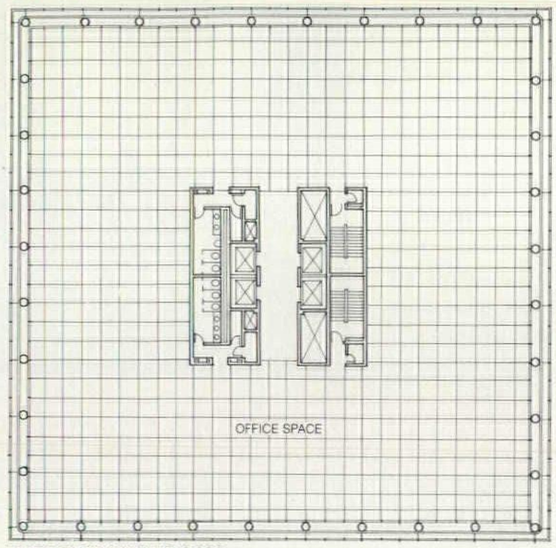
Hooker Office Building



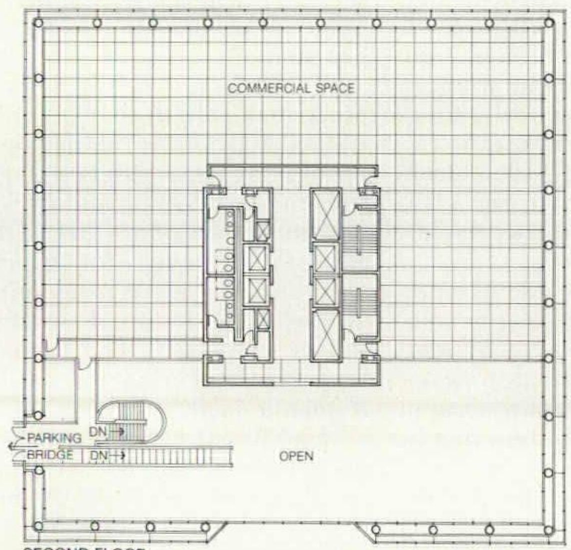
WALL SECTION 10'/3m



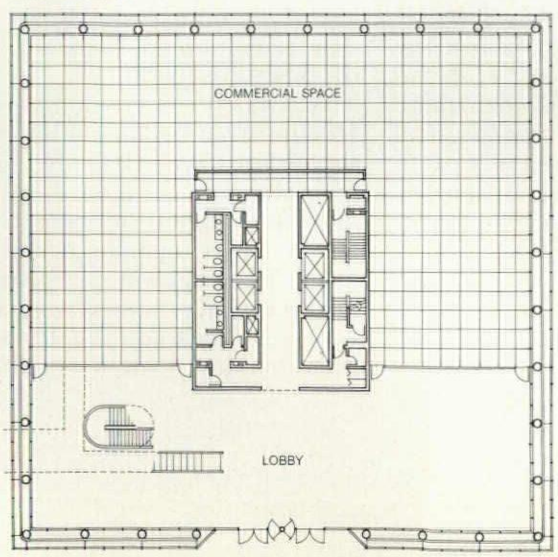
PART PLAN



THIRD THRU NINTH FLOORS



SECOND FLOOR



FIRST FLOOR N→ 20'/ 6m

Data

Project: *Hooker Office Building, Niagara Falls, NY.*

Architect: *Cannon Design Inc.; principle-in-charge, Mark R. Mendell; design team, Mark R. Mendell, Gautam Shah, Charles Arraiz, Alan Sloan, Jack Foster, Gerald Maslona, Dale Gaff.*

Client: *Hooker Chemicals & Plastics Corporation.*

Site: *2.3 acres of open urban renewal land, on axis with Rainbow Bridge linking U.S. and Canada, overlooking Niagara River gorge.*

Program: *corporate office space of 180,000 sq ft and 20,000 sq ft of commercial and office rental space.*

Structural system: *steel frame, metal deck.*

Mechanical system: *electrically driven centrifugal chillers (from which heat is recovered all year), gas-fired boiler, low-pressure variable air volume distribution; all building systems (solar shielding, HVAC, fire alarm, security, etc.) are integrated through a computerized automation system.*

Consultants: *structural, Gillum Colaco; energy, Professor John Yellott, Professor Richard Levine, Burt, Hill, Kosar, Rittelman Associates; acoustics, Bolt, Beranek & Newman; early planning, Hellmuth, Obata & Kassabaum.*

Building Energy Performance/Design Energy Budget: *114,000 Btu/sq ft/yr.*

Photography: *Barbara Martin.*

Going solar in the city

Harnessing solar energy for heating and natural lighting need not be reserved for new developments, nor for sunbelt areas, nor for residential units, contend researchers studying existing cities.

Courtesy NY Historical Soc.

Courtesy Barton Myers and *Design Quarterly* Magazine 108

Northern cities at the turn of the century: 1) New York, Broadway at 42nd St., 1885; 2) Hamilton, Ont., c. 1910; 3) Calgary, Ont., c. 1910; 4) Norfolk, Va, c. 1910.

Few of us need to be reminded of the steadfast connection between dispersed growth, characteristic of 20th-Century urban settlements, and high energy consumption. Cars, single-family dwellings, highway commercial strips, downtown office buildings, and suburban industrial parks all are manifestations of an expansion pattern based on a confident presumptuousness about fuel resources. Now with the fuel shortages and high prices upon us, we look for dramatic planning solutions.

The 20th-Century trend toward dispersed development directly reflects the character of the economic institutions that govern our society, a connection that has generated different urban forms in past centuries. The mercantile-based cities of the 17th and 18th Centuries, the industrial ones of the 18th and 19th Centuries, and finally the present-day corporate versions spawned distinct urban typologies. Older manufacturing cities show a concentration of workers' housing near factories, which in turn often lie at the edge of older, mercantile-based downtowns. Both urban types gradually gave way to the current version typifying our corporate society: new office towers are erected in downtown areas, far from the executive "bedroom" suburbs, and far from the places of manufacture. These in turn lie at some distance from workers' residences, which also are dispersed in relation to services.

The best new towns

As urban studies professor Jon van Til argues in his article "Spatial Form and Structure in a Possible Future" (*APA Journal*, July 1979), older cities represent models of energy efficiency. The mercantile/industrial form corresponds closely to the ideal urban settlement for an energy-conscious society. This concept, called by van Til a "diversified-integrated model," embodies the proposal that people settle in small nodes of concentration where they would live close to work, shopping, and other services. The nodes, 2000 to 3000 in all, scattered throughout the U.S., would mean new urban centers would not have to be built. Existing towns and cities could provide the shells.

The megacity or concentrated supercity that captured the imagination of many architects and planners in the 1960s doesn't meet the demands as well as the smaller nodal urban form. While the concentrated supercity poses the most dramatic alternative to dispersed growth, it would now be too expensive to build in terms of the energy it consumes—a "cruel paradox," van Til adds.

Not just climate

The advantage for the older Northeastern cities with an inherited infrastructure of support services and transit needs little explanation. Climate notwithstanding, a city like Boston has an irrefutable edge over a city like Houston.

Because of its climate, Boston clearly bears the brunt of higher space-heating bills. On the other hand, mass transit is plentiful and corporations are now building inner-city industrial parks in South Boston and Roxbury. The high cost of heating homes can be offset somewhat by the strong "retrofit" activity, and because of its planning advantages, Boston maintains an edge over Houston in energy efficiency.

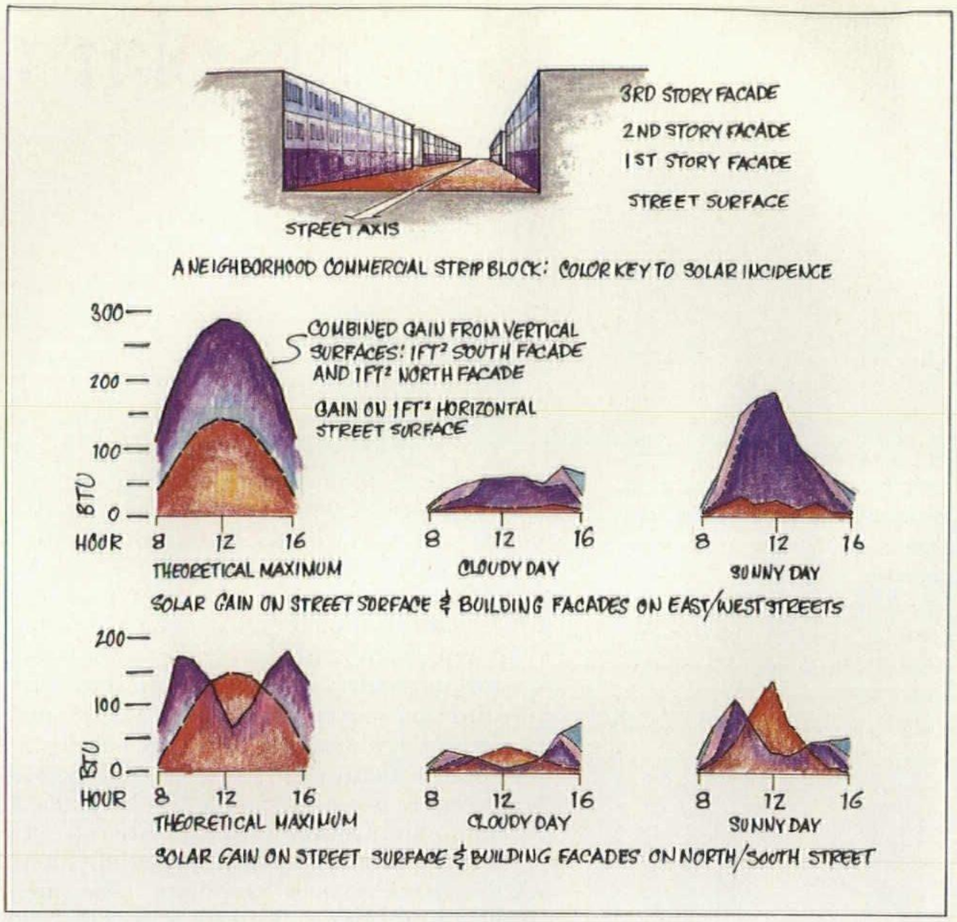
Back to downtown with DOE

Compact planning of medium-density building configurations does not solve the whole problem. Energy-conscious planners presently are trying to figure out how existing cities can harness alternate sources of renewable energy with old and new construction. Using the major source of renewable energy, the sun, increases the challenge.

Government agencies like the Department of Energy are trying to rise to the occasion. DOE has initiated the Solar Cities program, which, along with all sorts of other government-aid projects, it hopes will reduce consumption of nonrenewable energy sources by 20 percent in the next 20 years. Individual and multiple buildings or complexes qualify for the solar cities program, which is researching means of providing energy through the sun, as well as wind conversion, photovoltaic cells, and so forth. All sorts of design and planning efforts come under the purview of the program including building, designing and siting, land uses and street patterns, solar access protection, and historic preservation.

Frank de Serio, program manager for DOE's Passive/Hybrid System Branch, reports that the program applies to the 150 cities with the highest population centers. But, de Serio estimates, four buildings must be converted to solar energy to displace the equivalent of one building's consumption of nonrenewable energy. To meet the U.S. Government's goal by the year 2000, 80 percent of the *existing* building stock will have to rely on alternate energy sources.

Demonstration projects and conferences form a basic component of the DOE program. In addition, the Department offers free advice, technical assistance, and financial aid. The program has been broadened to include such endeavors as funding the drafting of zoning ordinances related to solar accessibility or harnessing other renewable energy sources. The design and construction of prototypical energy-saving projects, generated by private as well as public initiative, would also come under the purview of the program. Furthermore, a partnership between DOE and the National Bureau of Standards is now developing methods by which building owners, architects, planners, and government officials can analyze buildings and urban design complexes for site orientation, configuration, materials, and energy-load characteristics. The financial aspect of spurring energy-conserving measures for retrofit, through tax incentives, grants, etc., is being given due attention.



Solar in the city

Two energy researchers from the National Bureau of Standards' Center for Building Technology, Robert Hastings and Kalev Ruberg, have been studying developed urban areas to uncover potentials for solar energy applications. Too often, Hastings and Ruberg point out, current research is being carried out for single buildings, particularly single-family houses. Since much rehabilitation and recycling is now being conducted in cities, these pockets of development provide new opportunities for solar technology.

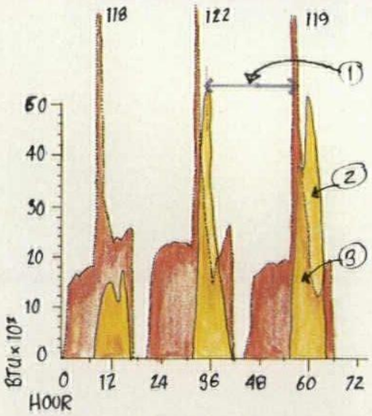
The main thrust of Hastings and Ruberg's research is directed at commercial or mixed-use buildings. Generally, they explain, it is assumed that energy demands for commercial buildings are higher for lighting than for heating, and therefore solar heating would not be practical. Actually, however, they find more energy is used for space heating in commercial buildings than for any other kind of use: space-heating needs are proportionately higher in smaller, older buildings than in newer office buildings that require cooling and heating. Hastings and Ruberg hypothesize that a greater dependence on natural lighting would mean that these new office buildings would also need to use less energy for cooling and proportionately more for space heating. Solar energy, with the added advantage of including natural light in its "energy package," could be very persuasive.

The time schedule of energy use is critical. Fortunately business hours coincide nicely with the use of the sun for heating and lighting. But commercial buildings need to warm up quickly early in the morning, particularly after a cold night. Thus nighttime thermal storage capabilities and orientation of the building to the southeast would most effectively harness solar heating and make use of natural light.

Access to sun

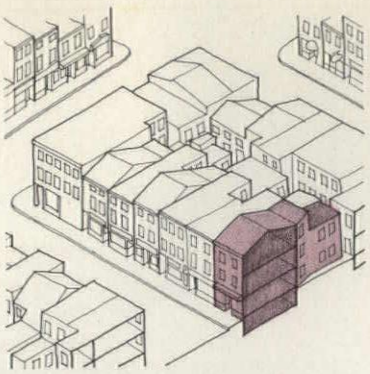
Access to the sun, plus its intensity, vary of course, depending on the development. In the urban context obviously not every building can face south-southeast. Access to the sun becomes even more of an issue when it is jeopardized with the increasing density of urban development. Thus it is not surprising to see right-to-light laws being proposed or explored in Japan and California (see p. 82 and P/A, April 1979, p. 76).

For their part, Hastings and Ruberg, again looking at a low-density block in a settled Northeastern city, note the portion of solar gain is surprisingly high. A south-facing surface in Columbus, Oh, for example, will receive on a January day 80 percent of its daily solar gain between 10:30 a.m and 1:30 p.m. Furthermore, they have found if the surfaces receive shade both before and after these times, the building will still get 60 percent of the sun's radiation. Not only does most of the radiation occur in these hours, but solar gain can result from both diffuse radiation and direct sunlight. In urban environments such indirect radiation comes from the pavement or even from particulate pollution in the atmosphere. In fact one study Hastings and Ruberg uncovered showed that at noon about 22 percent of the solar radiation available in

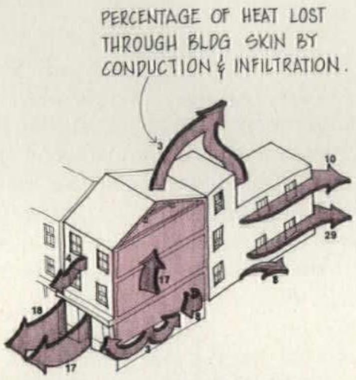


1 PEAK OF SOLAR AVAILABILITY RELATIVE TO PEAK HEATING LOAD.
2 EXCESS SOLAR AVAILABILITY THAT COULD BE STORED FOR NIGHT TIME HEATING LOAD.
3 SOLAR GAIN THAT IS DIRECTLY APPLICABLE TO HEATING LOAD.

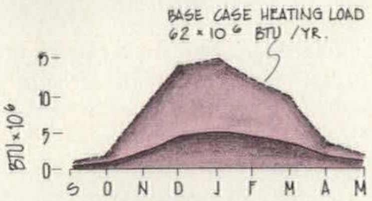
The above drawings have been executed by S. Robert Hastings and Kalev Ruberg. The drawings form part of a National Bureau of Standards study on urban solar applications, passive solar heating methods, and preliminary thermal performance data for a prototypical neighborhood commercial strip.



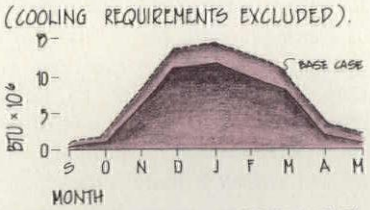
A NEIGBORHOOD COMMERCIAL STRIP SETTING (BASE CASE BUILDING SHOWN IN COLOR)



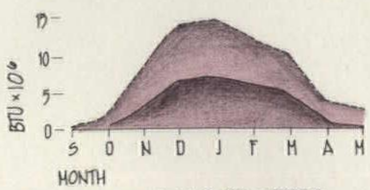
HEAT LOSS PATHWAYS THROUGH THE BUILDING SKIN OF A NEIGHBORHOOD COMMERCIAL STRIP BUILDING.



ANNUAL HEATING LOAD FOR THE WEATHERIZED CASE 19×10^6 BTU/YR. (COOLING REQUIREMENTS EXCLUDED).



ANNUAL HEATING LOAD WALL COLLECTOR CASE 47×10^6 BTU/YR.



ANNUAL HEATING LOAD ENCLOSED STREET STRATEGY 35×10^6 BTU/YR.

The above drawings, by S. Robert Hastings and Kalev Ruberg of NBS, show results of study in older neighborhood commercial strip in Baltimore.

an Eastern seaboard city is *diffuse* radiation, compared with 8 percent in a California desert site. (Desert sites still receive 20 percent more solar radiation.)

Interestingly, Hastings and Ruberg add, while not every grouping of buildings can have the ideal conditions of south façades in blocks oriented east-west, other areas of solar absorption exist. The street, for example, can act as a prime solar collector, and the two argue strongly that this advantage should be considered for its implications.

Commercial uses and solar energy

In working on a small computer program to calculate solar availability for various types of urban geometries, Hastings and Ruberg decided to pursue retrofitting existing neighborhoods rather than emphasize hypothetical urban forms. They chose a neighborhood in the Northeastern city of Baltimore, Md, to amass data that would be applicable elsewhere. They also decided that an older *commercial* strip, much like the main streets of many older downtowns, would offer a representative study area of a less than ideal solar situation. This kind of urban agglomeration is generally composed of brick row-house buildings, two to three stories high, with commercial space on the ground floor and residential or storage space above. Generally the buildings range in width from 10 to 40 ft and vary in floor area from 500 to 5000 sq ft. Everyone is familiar with the architectural styles—usually watered-down Federal overlaid with "contemporary" retail store fronts.

Testing alternatives

The two researchers found Baltimore's Cross Street revitalization area near the city's Downtown business district the proper prototypical situation. In this quarter, 42 percent of the retail businesses are small stores. Isolating one building out of the grouping, they decided to try three different solar design approaches, then compare the performance of each. The first approach called for just insulating the exterior walls and roofs of the building and adding double glazing. Another alternative to be explored involved the installation of active solar air collectors on the upper two stories of the south-facing wall. A third alternative they investigated projected the construction of a solar canopy over the street to absorb and store solar energy falling on and between the buildings.

The team found a typical building on which to base their calculations, an 800-sq-ft, three-story building with double brick walls. The ground floor was devoted to commercial space, with the two floors above unoccupied. Of the various kinds of energy needed, the building, like others in the neighborhood, uses about 58 percent for space heating. For purposes of analysis, Hastings and Ruberg established a 70 F temperature setting for business hours, with the temperature reduced to 56 F at night.

As part of the background for their calculations they had to figure out peak loads of energy use, detect pathways through which heat would be lost, and estimate the amount of internal heat gain.

To weigh the effectiveness of these three approaches against each other, a heating-demand profile was calculated for three days in January. Such profiles must take into account early morning heating demands and their peaks, plus the drop in heating requirements in the afternoon resulting from internal heat build-up, and the limited nighttime requirements. Since more heat is needed by these commercial spaces in the early morning, heating needs peak during the time when the stores just open.

An hour-by-hour examination of solar availability showed that the south-facing wall reaches a peak of solar intensity later than the peak heat needed for a commercial building. Since the amount of solar gain at noon on clear days exceeds the heating loads, excess solar energy could be stored in thermal-mass areas to be used as low, direct irradiated heat the next morning. With the case study building, Hastings and Ruberg also found that the upper floors received 72 percent of the total insolation in January on the south face.

Insulation on one alternative

In analyzing the data compiled on the three approaches investigated, Hastings and Ruberg hesitate to rank one method over the others, be it insulation, use of solar collectors, or the installation of a street canopy. Present rehabilitation plans for this kind of construction call for 3½ in. of insulation on a stud wall and the interior surfaces of masonry walls, plus 6 in. of loose fill between ceiling and floors. Double glazing and perimeter insulation at the edge of the floor slab help too. Given these conditions for the month of January, thermal data show that heating requirements would drop from 62 million Btu per year to 19 million Btu. However cooling and venting requirements in the warm months would mount considerably since the added insulation would also keep the heat within the building from escaping. Since internal build-up would cause overheating much of the year, these disadvantages have to be met: the auxiliary heating demand would in winter heating requirements.

Solar collectors on city blocks

The second strategy the team investigated was the installation of solar collectors on the upper walls of the building. Even though this method showed some advantages—such as a reduced heat loss—the disadvantages of collectors for heating this kind of building outnumber the benefits. Only a small part of the building envelope can be used for solar collectors, and thus only a limited percentage of the energy requirements for the building can be met: the auxiliary heating demand would be cut to 47 million Btu annually.

Cloudy conditions during the January test days didn't help: the collectors' yearly solar fraction (determined by the solar load ratio method) was calculated at 25 percent. The disadvantages spread out over the whole block of long, narrow buildings pointed to the main problem of adapting this method to this building configuration: "If the near walls of the north-facing buildings are shadowed, the cost of the south wall collector applications must then be amortized over the entire block," points out Ruberg, "and the energy savings become even smaller."

Street canopies as a third method
The third energy-saving approach investigated suggests enclosing the neighborhood commercial street with a canopy. After exploring this passive heating system with a semiconditioned environment, Hastings and Ruberg concluded that a closed canopy spanning a north-south oriented street with a serrated profile, south-facing glazing, and overhanging sloped roofs would provide the most efficient kind of heat gain in the winter and shade in the summer.

High internal heat gains in commercial buildings during business hours with the absence of nighttime gain plus the thermal mass of the brick would keep temperature swings down to a reasonable range in the winter.

The large thermal mass of the street and sidewalk pavement enclosed by the canopy effectively stores heat, and the area of building surface that loses heat is also considerably reduced. (Fifty percent of the total heat generally is lost from the front face of the case study building, largely due to shoppers going in and out.)

With this canopy design, the yearly solar fraction would amount to 57 percent for the case study building. Annual heating needs of this building would be lowered to 43 percent of the standard, a reduction to 27 million Btu annually. In addition, the closed canopy would offer 370 sq ft of semiconditioned retail space for each of the 48 commercial businesses in this study area, the two researchers estimate. In warm weather, natural ventilation through operable slits in the canopies could solve heat build-up problems. The major disadvantage of this method, Hastings and Ruberg make clear, however, is that the canopy would cut down on available natural light, particularly that which could be used for indoor illumination.

The street-canopy idea, they feel, has ancillary benefits: glassed-in pedestrian links between shops like Philadelphia's Galleria or Minneapolis' walkways would further spur revitalization efforts in these older downtowns, particularly where the climate is harsh. With the development of these pedestrian-oriented commercial streets, the upstairs spaces might then attract residential tenants. That, too, would reduce heating requirements on a per sq ft basis. In addition, direct-gain passive solar collection devices could be used for heating the apartments, suggest Hastings and Ruberg. This team is continuing its investigations in this area, particularly how public and private financing mechanisms can be employed.

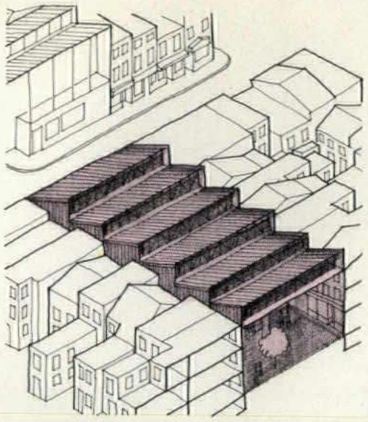
Hastings and Ruberg's canopy idea bears some relation to Buckminster Fuller's domed city projects. Interestingly enough, the town of Winooski, Vt, is seeking federal money to do just that—to install one or two domes over the town of 7000 and thus cut the cost of heating by 90 percent.

Other efforts
Other organizations and institutions have begun to undertake the investigation of urban buildings for solar applications. For example, Charles Burnette, director of the University City Science Center at the University of Pennsylvania, has a combined grant from NEA and DOE to investigate the large-scale application of solar heating in Philadelphia. While so far Burnette and his team on the Philadelphia Solar Planning Project have been studying residential urban settlements, they next plan to move into commercial sections in Philadelphia. In their work with residential buildings, the group has undertaken an inventory of the two-story brick row houses so common in Philadelphia (183,000 exist) and has begun to analyze this type of form for its thermal characteristics and performance, vis à vis solar heating.

And elsewhere
In P/A's special issue on energy last April, the need for planning and development for energy conservation was urged by Peter Calthorpe and Susan Benson. They argued, in fact, that the "form and density of housing, the land use patterns and resulting transportation systems have a greater potential for energy savings than any solar applications."

If patterns of growth and development are not addressed along with specific architectural measures, then the use of alternative energy sources will mean little. As many observers contend, the current experiments in solar technology have been implicitly reinforcing suburbanization patterns by concentrating on the single-family house. While to some degree this small-scale effort is understandable, solar experimentation will have to move to an urban scale to begin to solve the nation's energy needs.

Ralph Knowles, whose efforts were also discussed in last year's issue (p. 74), is addressing the forms that *new* urban development should take with regard to solar energy sources. This kind of effort, along with that concentrating on existing commercial and residential low- and medium-rise buildings in urban areas, is where the attention is needed. The implications are irrefutable: the two- to four-story row house must be retained, not torn down for redevelopment. This kind of construction offers dramatic savings: with the modifications that Hastings, Ruberg, and colleagues are pointing to on the commercial and residential settings, an energy-conserving future might be easier to attain. This possibility is rooted in the past—in the way cities developed and urban form took shape in previous eras. [Suzanne Stephens]



CANOPY ENCLOSING NCS STREET. NOTE SOUTH MONITOR ORIENTATION AND OVERHANG.

Notes on persons mentioned: S. Robert Hastings is a research architect at the Center for Building Technology, National Bureau of Standards, who has written on windows and energy conservation and on passive solar energy as an architectural design issue. Mr. Hastings practices in Reston, Va, specializing in residential passive solar design.

Kalev Ruberg, an associate of Mr. Hastings, is a visiting research architect at NBS from MIT's Department of Architecture, who also has written frequently on energy use in buildings.

Frank de Serio, an architect, is program manager of the Demonstration Programs Branch in the Office of Conservation and Solar Applications at DOE.

Charles Burnette, an architect, is Project Director for the Philadelphia Solar Planning Project at the University City Science Center of the University of Pennsylvania. Involving a group of private organizations with DOE and NEA funds, this project, they report, is the most comprehensive solar planning project within a major city.

More than just energy

Peter Calthorpe

Two large government clients are trying to develop buildings which express not only energy consciousness but a sensitivity to the people who work in them, the environment in which they stand, and the limitations on the resources they use.

Peter Calthorpe is a principal of Van der Ryn Calthorpe & Partners, Inverness, Ca. He has worked both for and with government on designing energy-conserving public buildings.

Two giant public institutions, the State of California and the Tennessee Valley Authority, are aggressively blending architecture and energy. The unique aspects of these programs are expansions of two classic government responsibilities. The first is its role as coordinator, integrating the various social and technical goals of society into cohesive programs which few private clients can duplicate. The second role is that of social and technical experimenter, taking risks the private sector generally avoids.

Having been a project designer for the California State Office Building, Site One A, and a design team member on the TVA complex, I would suggest there is much more than economics and energy motivating these projects. The programs came to represent a social philosophy and a political will. The new designs therefore take on a symbolic role, marking an emerging attitude toward diminishing resources, and satisfying government's need for a meaningful identity. In some cases, ironically, it became more important that the building look "solar" than actually reduce energy consumption.

The State of California, under Jerry Brown's era-of-limits philosophy, devised a major building program to provide the state with one-and-a-half million square feet of energy-efficient office space. Started in 1976 when Sim Van der Ryn became State Architect, the project involved resource policy and land use planning as well as architectural programming. The results have been: a master plan for downtown Sacramento (The Capital Area Plan or CAP), a major architectural competition (Site Three), one office building designed by the Office of the State Architect (Site One), and six projects designed by private firms.

TVA, with the recently appointed chairman David Freeman in charge, has also taken an active stance on energy issues in building design. Its first project, directed by Withers Atkins of TVA's architectural branch, is a 1 million-sq-ft office complex in Chattanooga. As in the California projects, its wide range of goals—satisfying user needs, employing infrastructure efficiently, and keeping cost as well as energy use down—has produced a bold political and architectural statement.

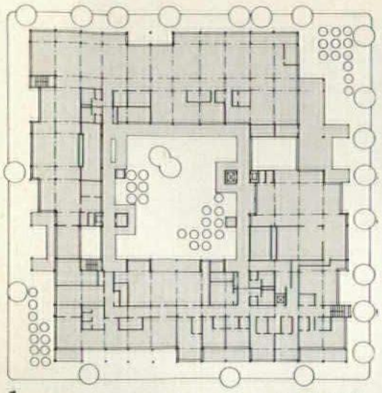
The State of California, in a publication called "Building Values: Energy Guidelines for State Buildings," set forth four performance measures for its new buildings. The first, a real estate investment measurement, incorporated the standard life cycle cost analysis and showed that the State's current leasing policy was costing 20 percent more than an owner-operator policy. The second criterion, energy investment, admitted the unpredictable nature of energy futures and took account of its ambiguous but central political realities. The third, cost of operation, was found to be far more tied to worker performance than construction or energy considerations. A standard building's cost breakdown is two percent for acquisition, six percent for maintenance, and 92 percent for personnel. The State publication emphasizes this point: "A better work environment that improved worker effectiveness by only six and one-half percent would be cost effective even if it quadrupled building costs."

This set in motion a new programming department in the State of California, headed by Bobbie Sue Hood, to solicit user participation and articulate user needs in the new building program. Its recommendations included crystal clear circulation; maximum views for work stations; individual control of lights, heating, and cooling; stairs (to reduce elevator requirements); office clusters; active and—when possible—sheltered streets; outdoor spaces with sunlight and shade; gathering places for work and social activity; scale indications for various distances; and flexible office space.

The final criterion, infrastructure costs, was more qualitative and became policy statement. For example, the response to transit needs was a policy of infill housing in the Downtown area to "permit one-third of State employees to live within walking or bicycling distance from work." Infill housing became a major scale determinant for the office buildings. Other concerns were land use, climate control, materials selection, and energy supply.

TVA's flagship

TVA constructed a similar set of criteria for their new office building program. Focusing on energy conservation, TVA assembled a blue-chip design team for their flagship project in Chattanooga. It included The Archi-



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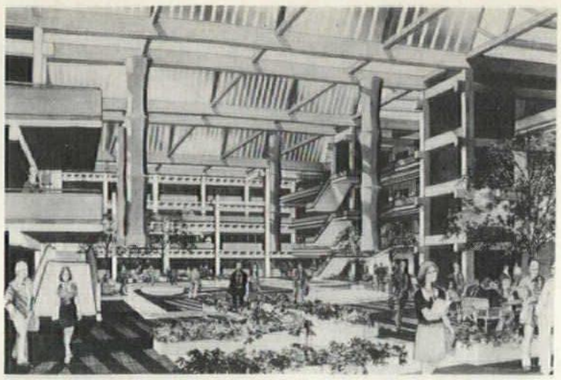

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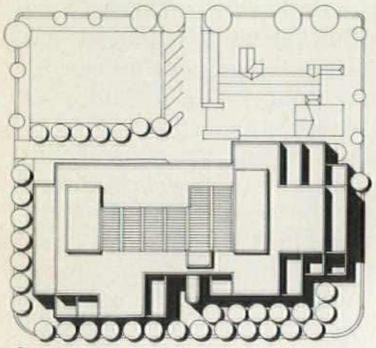

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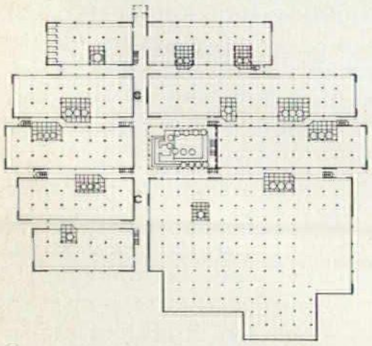
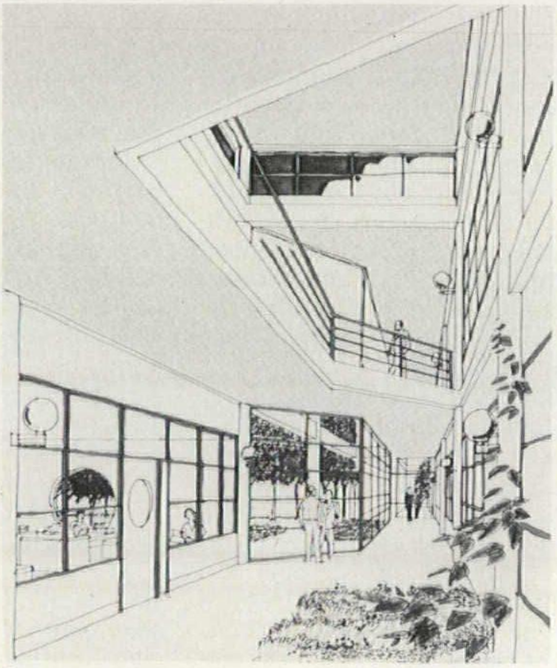


5 100' / 30m



6

1, 2 *plan and interior court for Site One A, designed by the Office of the State Architect of California; Peter Calthorpe, project architect.*
3, 4 *site plan and interior court for Site One B, Nacht & Lewis Architects of Sacramento.*
5, 6 *plan and interior perspective of Department of Justice building by Marquis Associates of San Francisco.*

tects Collaborative, Caudill Rowlett Scott, and my own firm (Van der Ryn Calthorpe & Partners) as architects; William Lam for lighting; William Le Messurier for structure; Bolt, Beranek & Newman for acoustics; Travis Price as solar ombudsman, and Syska & Hennessy for mechanical systems.

Like the California program, TVA's considered broad environmental issues. At one point housing within the project site was recommended in order to seed the Downtown area. TVA already provided commuter buses for a percentage of its employees, a factor that generated a more centralized circulation scheme than a drive-and-park approach would have. Ralph Knowles's concept of "the solar envelope" became a major criterion, eliminating high-rises and defining lot size in order to protect neighbors' rights. Much debate centered on which building skin material to use based on the amount of energy required to produce it. Surprisingly, thin aluminum turned out to use nearly the same amount of energy per square foot in production as did bricks.

The most interesting and perhaps far-reaching program TVA employed was the peak power credit. As a power company, TVA is all too aware of the growing costs and problems of installing new generating capacity. Therefore, any reduction in peak demand meant dollars saved in new equipment. This calculation, amounting to about $700 per peak kilowatt, was figured above and beyond a life cycle cost analysis based only on fuel consumption savings.

User needs vs energy

Given these innovative programs, the central question became: do energy strategies necessitate a thermodynamic straitjacket which compromises or preempts human needs, or are they potentially compatible? Does regional, climate-responsive design philosophy, for instance, even help create amenities?

Several design strategies succeeded in balancing these goals. Increasing perimeter area for as much daylight as possible, a design principle employed throughout these buildings, reduced energy consumption and enhanced the human environment.

California's Justice Building, San Jose Building, and Site Three have multiple courtyards to increase daylight penetration. Site One A, Site One B, and the Long Beach Office Building increase daylight zones by street side offsets, jogs, and terracing. The TVA design aggressively employs its solar courts for daylighting, using mirrors to reflect the light as needed.

Designing for daylight also affected the interior zones. All the buildings have greater proximity of work space to windows than is usual, generally by elimination of private perimeter offices. In several buildings, daylight penetration was increased with high ceilings and window heads. The Long Beach Building has a 14-ft floor-to-ceiling height; Site One A has 11-ft; and Site One B has 12-ft.

These architectural expressions also coincide closely with other program guidelines. Daylight elements such as the south side light shelves in the TVA building add texture and scale to the façade. The articulated massing answers the need for identifiable office clusters while the courts offer social gathering points. Task lighting is generally employed, allowing individual control and choice. In all the plans, massing for daylight generates a more intimately scaled building, offering coveted views and a generous and varied interior.

Another energy design strategy employed in these buildings is the use of buffer zones, semienclosed or completely enclosed spaces using natural climatic forces to temper their environment. The TVA solar courts and Site One atrium have operable louvers and glazed roofs, allowing passive solar heating in winter and shade in summer. The courts of the San Jose Building and Site One B have operable shades with no glazing, providing a less expensive tempered space, shaded and vented in the summer but sunny in the winter. The Justice Building is woven together with a grid of streets and courts, none of which employs mechanical air conditioning but which remain comfortable for circulation and work breaks. Organizing the building circulation in this way saves interior space and lowers perimeter heating and cooling loads. Some of the buildings use exterior balconies and landscaped areas to temper the microclimate surrounding them.

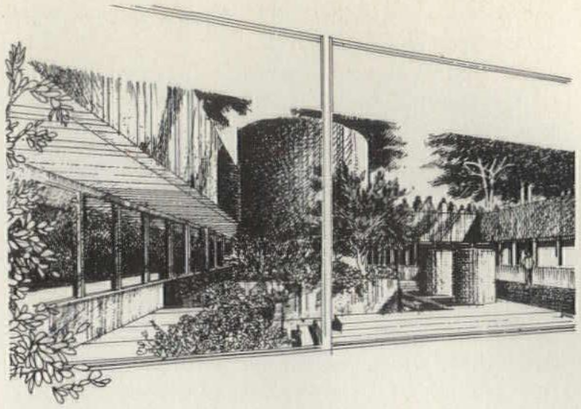
In contrast to buildings with homogeneous thermal environments, these buildings are organized by their transitional spaces, providing for that important program element of clear circulation. Reviving a grand architectural tradition, the courts replace the modern elevator core with a psychologically important social gathering place. As workers become more alienated and government becomes more labyrinthian, the function of these generous spaces could produce a stronger identity for the institutions, a monumentality which empowers rather than intimidates its users.

Diversity is a strategy for energy conservation which also coincides with user needs. By establishing a hierarchy of lighting needs and qualities, these buildings provide visual variety as well as energy conservation. In Site One and TVA, the lighting loads are reduced by separating the artificial light demands into ambient and task categories. This creates a less monotonous office environment. The circulation zones have different light levels from the courts. The layering of buffer zones, balconies, and covered walks generates a spatial richness which has long been lost from curtain-skin high-rise architecture. Façades are also more diverse; each orientation induces a different character. For Site One B and Long Beach, an element was developed in which shading devices can vary for each orientation. Site One has more disparate façades: operable shades on east and west, a fixed trellis on the south, and a varying structural grid.

The TVA building avoids the difficult east/west problem by organizing its core zones on these façades. Its south side uses a light shelf as shade and the north face is stepped, creating skylights on each level. This differentiation is reinforced by the skin materials. The south façade and atrium ends are clad in a bright brushed aluminum, augmenting the sunlit reflections, and the north side in brick, relating to the indigenous materials of the town. This may have the positive byproduct of reinforcing psychological certainty. "East," "West," "North," "South," like "front," "back," and "side," are architectural qualities which aid people's sense of direction and help define an urban fabric.

Conflicts

Not all energy-conscious design features have benevolent side effects. For instance, a conflict arose over operable windows. Workers wanted them and in certain respects they are considered an energy-saver. But restricting their use to appropriate days, estimating their effect on the mechanical system and the increased dirt and maintenance involved, were issues that were never resolved. If a building were under positive pressure, individuals could open windows in the winter without suffering consequences. In Site One A, key-operated windows were installed to make this option possible, with its balconies



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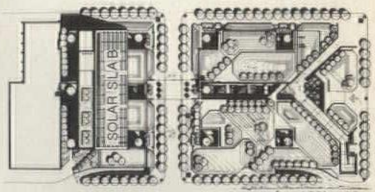

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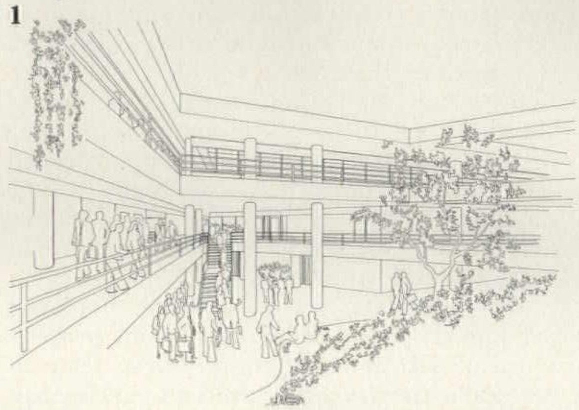

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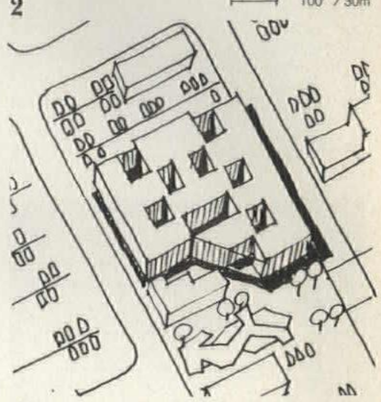

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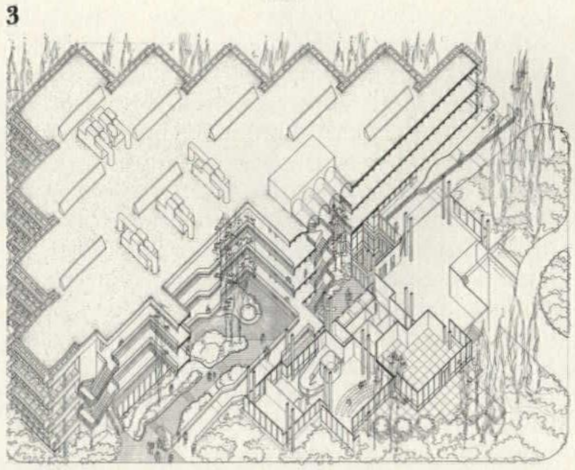

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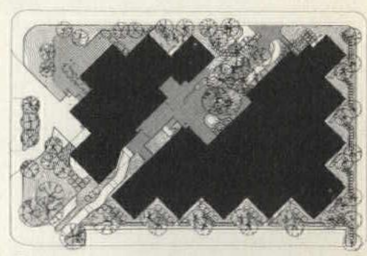

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1, 2 *light court and site plan of California State Office competition winner by Benham-Blair & Affiliates of California, Los Angeles.*

3, 4 *court and site plan of San José state office building by ELS Design Group of Berkeley; Sol-Arc, energy design consultants.*

5, 6 *axonometric and site plan of Long Beach state office building by a joint venture of Hugh Gibbs & Donald Gibbs and Kenneth S. Wing & Associates, both of Long Beach.*

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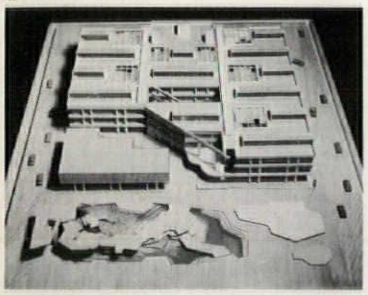

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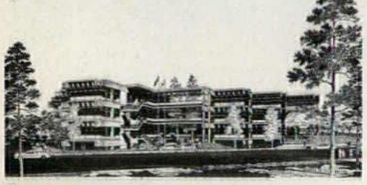

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Massing for daylight was an element common to most of the various California state office schemes: **1** *Site One A (Office of the State Architect);* **2** *Site One B (Nacht & Lewis);* **3** *San José (ELS Design Group with Sol-Arc, energy design consultants);* **4** *Department of Justice (Marquis Associates);* **5** *Long Beach (joint venture of Hugh Gibbs & Donald Gibbs and Kenneth S. Wing & Associates).*

intended as a trade off, giving people free access to the outside.

A related issue is open plan versus private office space. Private offices were considered less energy efficient because they inhibited daylighting and the free flow of heating and cooling. On the other hand, "task" heating and cooling systems, as in hotels, may ultimately save energy by allowing individual control. And a thin building with glass interior partitions could resolve the daylight problems. As for economic efficiency and flexibility, there are those who now question the gospel of open-space planning. Bobbie Sue Hood's recommendations stated that "in fact, large, open, loft-type offices are often less flexible than offices with fixed partitions." On the other hand, her survey showed: "All those questioned preferred a private space for themselves but considered open plan appropriate generally." The danger of open plan is its tendency toward overcrowding, which is extremely common in government institutions.

The automatic features of the buildings present a potential conflict with people's sense of self-determination. These features operate with various rhythms and cycles. San Jose's courtyard covers operate seasonally. Site One A's east and west canvas shades operate on an hourly basis. The Long Beach shading system allows change to accommodate new internal functions. In both Site One A and Site One B, the atriums have operable shading mechanisms to allow passive solar heating in the winter and provide protection in the summer. The TVA complex has four modes of operation for its mirrored louvers over the court.

But these dynamic elements produce some architectural compromises as well as premiums. On one hand, Site One A's fabric east/west shades enhance the façades, developing a changing character morning to afternoon, adding interest and color as the shades track the sun. On the other hand, the dynamic features are run by computers and may seem oppressive. Some experiences in Canada attest to people's dissatisfaction with automated shades which preempt the workers' participation. The potential for user-operated shades is perhaps the best option, as long as occupants are sensitive to the results of their participation.

Buildings as symbols

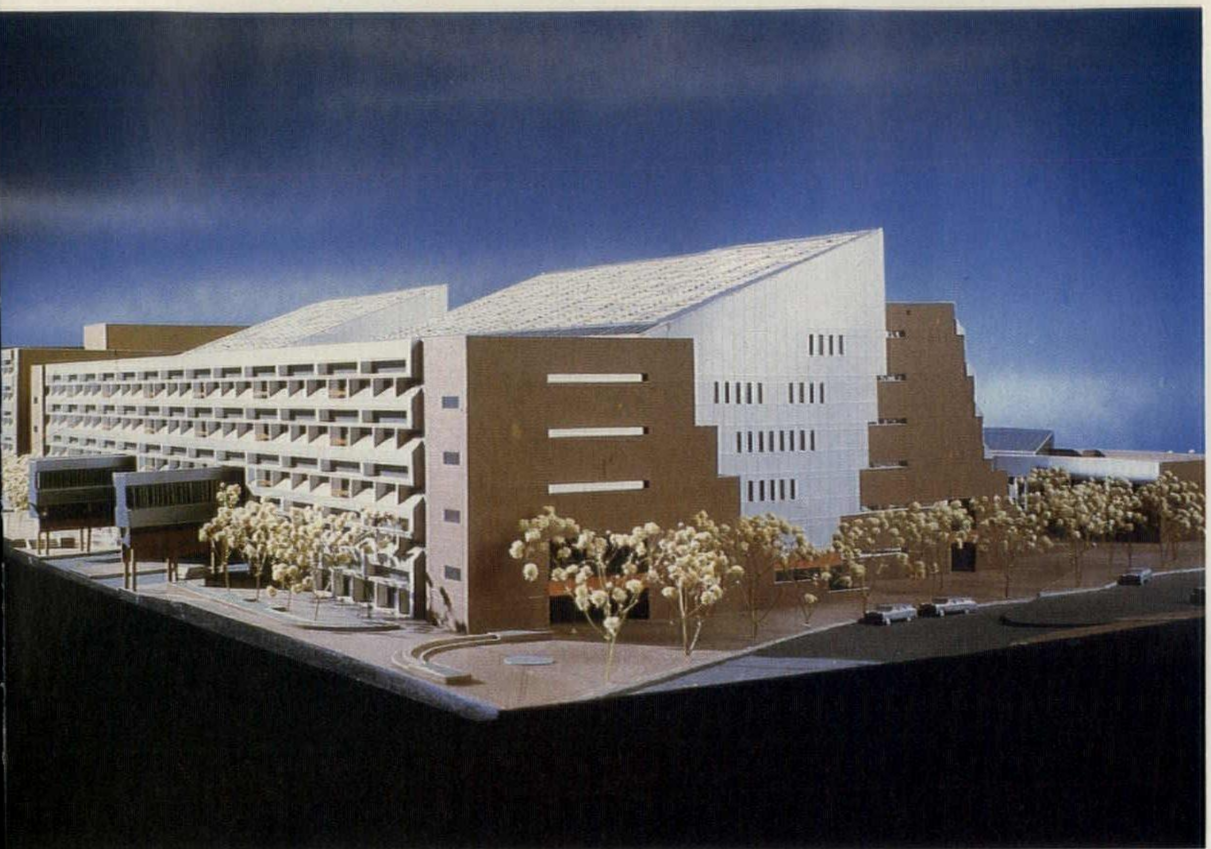
On the whole, the climate-responsive features in these projects seem to enhance the human environment while saving energy. But ultimately our public buildings are more than energy machines or efficient workplaces. They communicate the intentions of our culture—toward technology, nature, and toward one another. Public clients may therefore be evolving a new form of civic architecture. However, sensitivity to people and spatial generosity are not necessarily inherent in energy-conscious design. As much is derived from the sympathies of the designers. The California State program was heavily populated with individuals, such as Van der Ryn, Hood, and many others, who shared a background in social issues developed at the University of California at Berkeley in the 1960s.

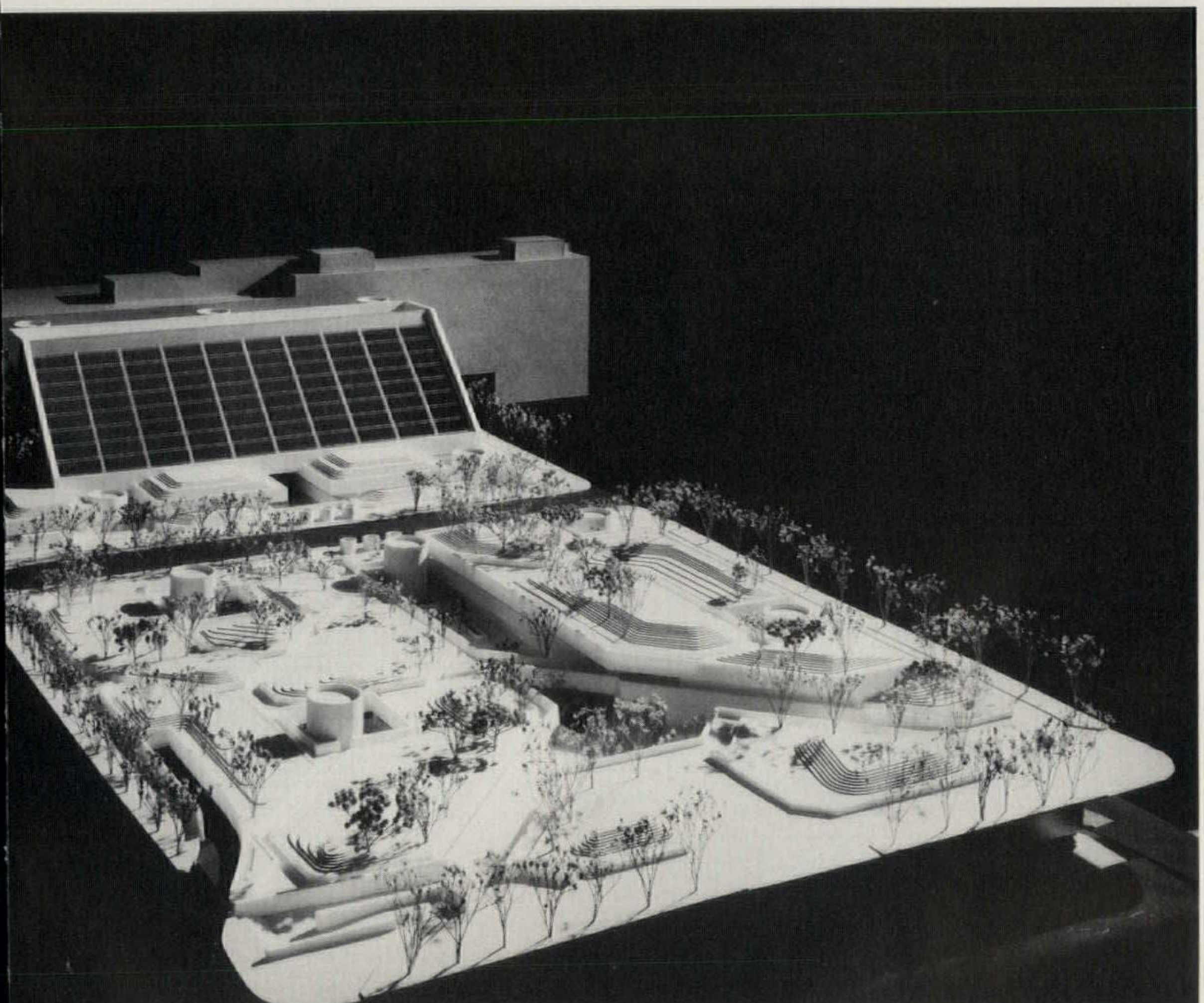
The California State Competition demonstrates another result (P/A, Feb. 1978, p. 70). Its program emphasized user-based concerns—light and views, scale and integration, community and informality. Five of the six finalists developed buildings along these lines, buildings that were highly textured, unimposing, the energy features so well integrated as to be invisible.

In contrast, the winner employed an active solar collector, the "solar slab," as its primary feature. The focusing-type collectors covered the south façade of the upper building completely, shutting out all views and light. The remaining office space was below grade, insulated with earth and penetrated by light courts. However, the solar collectors—though considered an extremely expensive cooling technique—were felt to have a visual presence. The building's form was seen as a powerful sign. Its monumental character ran counter to the program's stated intention but was consonant with longstanding yearnings for strong political and institutional statements. While the project provided a simple, clear circulation spine and much needed parklike open space, its form and scale are like a huge energy diagram announcing political intentions as simply as a billboard.

The TVA design shares some of these billboard qualities. Its lack of scale on the street creates an imposing form; diagrammatic in elevation and plan, monumental in section. The great shieldlike atrium ends may overpower the street. Certainly the mirror-covered atrium skylight, sparkling from a distance, is a powerful sign, even if mistaken for a solar collector. The atriums may be overwhelming—giant in scale, linear, and systematic—or benevolent—clearly organized, alive with light, a common ground for a large, rambling institution, a proud symbol of what it demonstrates.

So there it rests. Energy-conscious design for public institutions is on the one hand an opportunity for a new kind of regionalism tied to climate and human comfort. On the other hand, it is a microphone for political aspirations. Energy use, though it affects all aspects of design, is not so deterministic as to pre-define a building's character. Ultimately energy-conscious design is an expression of social, economic, and political viewpoints. As such, its architectural expression is inevitably caught up in the identity crisis of government in our time: the tensions between embarrassed bureaucracies and proud civil services; diagrammatic panaceas and subtle integrations; simplistic symbols and complex dialogs. It is caught, finally, between the individual and the institution. □





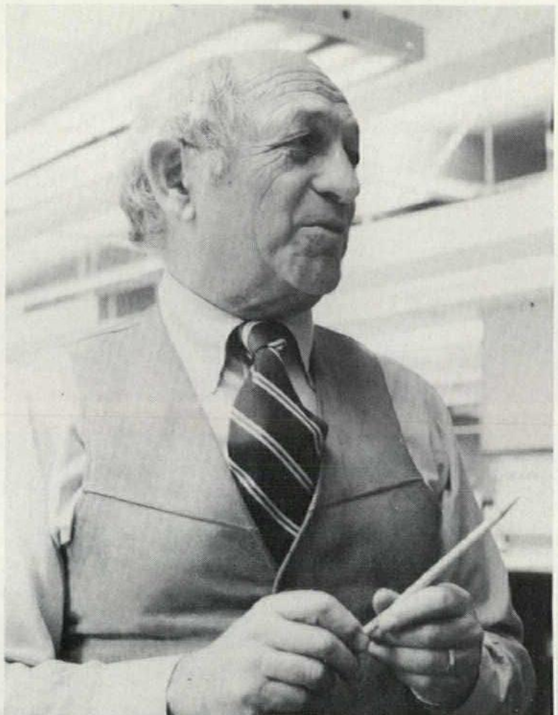
The Tennessee Valley Authority put together three architectural firms (Caudill Rowlett Scott, The Architects Collaborative, and Van der Ryn/Calthorpe & Partners), engineers, consultants, and its own architectural design branch for a new headquarters in Chattanooga (above and above left). Benham-Blair & Affiliates of California won the California State Office Building Competition with the design at left. Author Calthorpe feels the projects have as much to say about political symbolism as energy conservation.

From Salk to SERI

An energy-conserving building is only as effective as the team that designs it. The important interaction between architect and engineer is discussed by Fred Dubin and P/A's Richard Rush.

Fred Dubin is president of Dubin-Bloome Associates, PC, founded in 1946, and a partner in Fred S. Dubin International, Rome, Italy. Dubin has served on or consulted to many national energy-related committees including the AIA. He has lectured and taught at many colleges and universities around the world and is the author of several books including *Energy Conservation Standards for Building Construction and Operation* with Chalmers G. Long. Fred Dubin's major projects include the Salk Institute for Biological Studies in La Jolla, Ca; the Energy Conservation Demostration Building for GSA in Manchester, NH; solar energy heating and cooling system for the George A. Towns Elementary School, Atlanta, Ga; the United Nations Environmental Headquarters, Nairobi, Kenya; the mechanical, electrical, solar, wind, and energy management services for the National Headquarters of the Solar Energy Research Institute in Golden, Co. Photography: Dorothy Alexander.

In years past your mechanical engineering expertise has brought you into contact with such architectural luminaries as Corbu and Louis Kahn. Their ideas have certainly influenced and broadened your interest in architectural design. Your experience in combination with your recent Master of Architecture degree certainly qualifies you as one of the leading professionals who can discuss the changing interface between the mechanical engineering and architectural professions. Your involvement with Kahn's Salk Institute in La Jolla offers a good contrast with your present role in the planning of the new SERI Headquarters in Golden, Colorado. How receptive was Louis Kahn to an idea that would affect the form of his building that basically came from a mechanical or energy consideration?



Louis Kahn had a very strong design philosophy, very strongly history oriented, very much oriented toward structure as an expression of place and the use of natural light to enhance form. When I could tune in with him and show that what I wanted to do was completely compatible with what he basically wanted, which most often was the case, and I had a good rationale for it, he would design and adopt mechanical, electrical, or energy constraints as basic needs.

In the Salk laboratory, for example, he had originally planned to use the interstitial space on only one floor. I was able to indicate that it was essential for each laboratory floor to enhance the mechanical and electrical installations, to preserve adaptability, to reduce materials, and conserve energy. He readily adopted the entire concept.

Mechanical engineering or energy constraints also affected the overall shape of the Salk buildings. La Jolla, Ca, the site of the Salk Institute, has a benign climate. Kahn's early predesign concept included no air conditioning but had curved walls and columns in juxtaposition to create venturi effects and natural ventilation throughout the structure. He had based his ideas on published climatic data at the San Diego airport 10–12 miles away. I told him we had better know a lot more about the microclimate on the actual building site. He agreed and promptly rented a house adjacent to the site which we occupied for three months. He learned that the microclimate at the site was completely different from the airport data. La Jolla had early morning fog, turbulent air currents, and updrafts from the sea and nearby cliffs. There were other problems including dust in the area from other construction and noise from aircraft. After the three months, I insisted upon air conditioning because laboratory processes cannot exist without clean air, quiet, and a controlled work environment.

So Kahn said, "Well, why do I want this curvilinear form?" And I said, "Well, you answer that one." He changed his mind. The new design expressed his philosophy in another way. When he was shown that energy and conservation were fundamental, he was quick to respond in his design.

In Salk, we were concerned first with the laboratory environment, but we were very early concerned with energy. There were many energy-conserving features: exterior corridors to protect the inner spaces from excessive solar heat gain, heavy thermal mass floors and walls, efficient services and distribution systems in the interstitial space, modular lighting capabilities with really selective lighting to suit varying tasks, high temperature hot water instead of steam—and many others.

Louis Kahn was not particularly keyed to energy, but he was passionately linked to fundamentals. I think if he had lived a few more years, he would have seen more clearly that natural energy is poetry too.

Ten years ago you ran a basic mechanical engineering office. How has your office structure changed in recent years?

We now have four graduate architects on our staff. They are not necessarily designing whole buildings but are very much attuned to architectural design. All of them have had major energy and environmental training. None is registered incidentally, so we are not producing new buildings, but we are doing a lot of architectural design and analysis.

What precise role do the architects in your office play?

They are all heavily involved with passive solar design, wind, and energy-conscious buildings. We are doing early studies and quantification of passive design approaches. We are bringing such quantitative knowledge to our outside architectural colleagues on the design team, including the best utilization of space to reduce the energy loads. The design architects are most involved with functional space relationships for most effective heat storage or distribution. Wall partitions, for example, can enhance or obstruct the circulation of heat and the performance of a passive system. The materials themselves also can enhance energy conservation so we aid in clarifying the options.

In addition to our architects, we also have a computer specialist. We are bringing him up to speed on HVAC design while he brings others up to speed on computers. Another member of our staff, Amos Halfon, heads our computer section and is a very skilled HVAC engineer as well. Six people are especially trained in computer analysis and design.

We also have a number of new employees who have had solar and energy conservation in college but have very little practical experience. They are continually introducing the principles to some of our people who have been with us longer but who are strictly design engineers. We have interdisciplinary seminars within our office so that what one group knows can be shared with the others.

There is considerable difference in the way we practice now from 10 years ago. We used to have design teams, project captains, mechanical engineer, or electrical engineer. Before, our involvement with architecture was primarily my own domain. Now we have many more people who are concerned and involved with the total planning process. That is a big change.

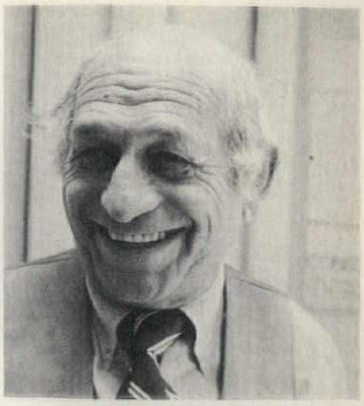
What is your present role in the design for the proposed new national headquarters for the Solar Energy Research Institute in Golden, Colorado?

Of course the project is a joint venture. The design team, the Table Mountain Architects & Engineers, consists of Caudill Rowlett Scott, John Anderson, Rogers-Nagel-Langhart, and Dubin-Bloome Associates. Our influence was felt very early in the programming stage.

SERI polled all of their in-house scientists and administrative personnel at the start. Each one stated his needs. The poll specified 700,000 sq ft of building space. A preliminary cost estimate revealed that the budget could not support that much area. To stay within the budget we said: "You really have to pare your space. What are you going to do in this space?" We challenged assumptions and met with the personnel who would be using the laboratories to try to refine the program. We had limited success because we had insufficient fees in the early stages to thoroughly determine the specifics. We asked: "Do you need a hood? Do you need a sink? Do you need a high ceiling for experiments?" We finally made our own assumptions of the number of hoods needed, the space requirements, and services needed. We were able to convince SERI to scale down their space requirements to 468,000 sq ft of building including 147,000 sq ft of laboratories. The architects from the other three joint-venture firms determined the nonlaboratory space requirements. Now that the conceptual phase is over we have hired Earl Walz as the laboratory consultant of the team for the design development stage.

After determining the conceptual needs for the laboratory, we asked: "How should these spaces be arranged?" I was holding out for interstitial space. I firmly believe that, for that type of building, interstitial space is very energy-efficient and cost-effective. Everyone finally agreed. As we proceed with the design, we are now studying the cost benefits. We were asked: "Isn't interstitial space simply adding more costly volume to the building?" Well, it isn't just that much extra volume. We don't have to light it to the same extent nor plumb it, except for the plumbing in the laboratories. It doesn't need plumbing for its own use. We also don't have to heat it or condition it. The space also serves as an exhaust-fan gallery and accommodates equipment which would need more expensive space in a more conventional building. We worked closely with the cost estimator during this stage.

Then CRS sent us a conceptual plan of the laboratories. I said, "We'll send you a plan of what we think the laboratory ought to be and let us get a response back from you." We laid out the laboratories on a structural module—12 ft wide and 30 ft deep. We defined what was going to happen in each module and were able to do piping and drops to



obtain unit cost for materials, fan coils, etc., and sent it back to CRS. We suggested the spatial arrangement, which will of course be refined.

What will be the additional influence of the architect on the laboratory plans?

He will study where the offices are in juxtaposition to the laboratories. We want to transfer energy and heat from one space to another or pick up waste heat in the labs and use it in the offices. The physical relationship is very important between those spaces. I also want to be able to introduce fresh air into the offices and bleed it through the laboratories so I can use it twice.

The architect alone cannot plan without the engineer who knows the principles that will lead to conservation and reduction in capital cost. So, what discipline is involved? Well, everybody is involved.

It always seems as if no matter what team we have, there has to be a team captain. Who is the captain of the Table Mountain A/E team?

We have a project director originally drawn from CRS but now from RNL for administrative matters. Paul Kennon and I are the design leaders, and our team comes to a consensus on energy, budget, aesthetics, and functional requirements.

The definition of the leader is not necessarily the one who makes the decisions but the one who translates them. Is he usually the most general?

It doesn't always follow that way. He must know enough to appreciate what he is being told. Someone must make evaluations. If there are conflicts, someone must decide. So far we have been able to reach a consensus in design sessions. It may not always be that way I am sure. We have an executive board with representatives from all of the four firms if a vote is finally needed to resolve disputes. I am responsible for meeting the energy budget since our contract with SERI calls for a strict energy budget. Architectural decisions which materially have an adverse effect on energy usage are vigorously challenged.

Sometimes these decisions are made at a very large scale, in the conceptual master plan for example. We asked questions: What are the building block locations? Where does the building fit into the slope and the contours of the site? Where can we build first and where can we add on? Where do the utilities come from and where do they go? I put many conditions on the master plan. I don't want one building to shade another on the south side. I want it to provide shade on the east and west to reduce summer air-conditioning load. An architect might ask, "Can't we handle it by fins or something?" Of course, but the site can do the task for you. For example, at SERI I would not accept the site on the top of the mesa, a condition first given to us. Energy and construction costs, as well as other nonquantifiable considerations, were studied. We discussed it at length and came to a consensus.

What changes in the production phase of the design were necessitated by the energy emphasis of the SERI design?

The conceptual design went beyond schematics in many cases. Some early solutions were worked out in some detail in order to control energy usage and construction costs. We did mechanical/electrical conceptual drawings, one liners, with typical lighting schemes, central energy plant, boilers, generators, rock beds, piping, services, and so on.

That is a rarity isn't it?

We usually insist on it being done early. You cannot estimate the job or have any cost control without it.

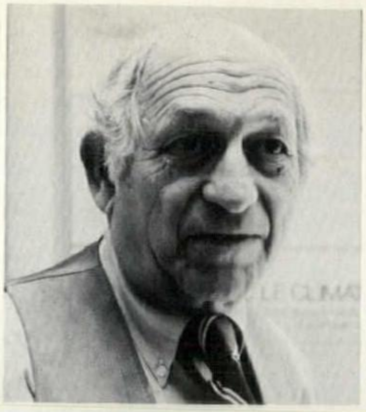
Do you do it on every job?

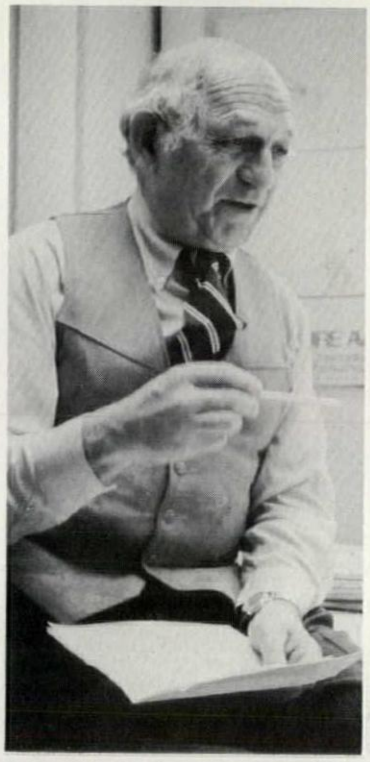
I would say so. Here is what we do. We select the major pieces of equipment and distribution systems, piping, and ducts. We prepare a description and schematic diagram of the control system for plumbing, major drain lines, services, and utilities. We size the water storage tank and locate it. We size the distribution systems; the same for the power.

The professional cost estimator on the SERI job, Richard Greene, was able to take off hundreds of feet of pipe of various sizes from our conceptual plans. We did not include every elbow of course, but we really went beyond the conceptual design. The client insisted on knowing costs at the conceptual stage in great detail.

You mentioned that the SERI building is currently about 486,000 sq ft. Let us say you have a 3000-sq-ft branch bank building. A ten-man architectural office has no mechanical engineer in house but wants to do an energy-conserving design. In the preliminary conceptual phase, would you have them call in a consultant to rough out a detailed mechanical and electrical scheme?

Yes indeed. If an engineer spends one or two days at that stage, he can set the direction and save the architect money over time. For a 300-sq-ft building, the conceptual drawing is really one-line simple. "We will feed it from here," maybe "box in this beam." The





architect can ask "Well, what happens if I don't want to have a drop here—I want a clean ceiling?" The engineer then supplies the alternative. If you find an engineer who knows mechanical, electrical, and plumbing, only one person is necessary for the early conference, and a lot can be accomplished in one day.

What about specifications? The architectural spec writer may not be familiar with new energy procedures or different types of machinery. When you give him your specifications does he just plug them in bodily?

Yes. We generally write our own specs. Mechanical, electrical, then these interfaces. Let's look at rock bed storage systems—they are mechanical, architectural, structural; it's all of them. Now we have the lead, in designing them. We select the size, the shape, the space, the plenums, the kinds of rocks that we want for the storage bin. We'll sketch it. We will then give the design to the structural engineer to make sure it is structurally compatible with the rest of the building. If there is a building above the bin, can it be part of the foundation? So there is close coordination required with the structural engineer, site engineer, landscape architect, and building architect—all with the mechanical engineer. All disciplines are involved.

Another case is the solar ponds that we're doing for SERI. We know the size of the pond, the depth, the kinds of liners we want, drainage, how we want the services managed. But then the landscape designer may come along and say, "Okay, I'll give you a berm here and a plant here." And I say, "Don't plant any deciduous trees where the leaves can fall on the pond." So we've got this need for a chain of expertise. And that drawing will probably be on the site plan, and I don't know yet who's going to produce it. Probably we'll make sketches and give them to the person who's drawing the site plan.

The coordination of all of the activities which take place during the drawing stages of a building has classically been the job of the architect. Is there a difference in an energy building?

No. But in an energy-conscious design, the engineer plays a larger role than before. Very often in retrofits it is the engineer who must lead. In the new breed of energy buildings designed in the past three years, the engineer and architect have worked closer together than ever before.

It sounds to me as if in the total design process—how you design and produce a building—there has not been any revolution, but some change has taken place. If a man designed a building from scratch, from beginning to end by himself, before, chances are, if it's an energy-conserving building, he now needs help. If, however, an office did buildings that were big enough to merit a mechanical engineer, structural engineer, electrical engineer before, some of the choices of who does what and when they do it have shifted to one side or another. There is a body of information that is in the building process that never received the emphasis before. How that body of information sifts into the design depends on who's doing it. It has to be there.

What has changed a great deal is our attitude towards the environmental conditions. In the past, we looked at outdoor climatic conditions as affecting the building load. They still do. In addition, we now look at climate as an energy source. How do we use the climate rather than just combat it? If the air is dry, evaporative cooling is viable. If there is a large diurnal swing in the summer nocturnal cooling is viable. We determine where the sun will strike the building of course for solar heat in the winter and shade in the summer. Climate has become a design tool to be used as part of the energy system—not just affecting the energy system, but being part of the energy system. That is a change, going back to what people recognized long before. We are on the bridge between the fossil-fuel age and the age of alternative energy sources.

What other role model changes would you like to see in the future?

Traditionally architecture was not a social force leader but followed social force and implemented it. That really has to change. Why shouldn't architecture and engineering be the leader—a social force? Who do you leave it to? Who are the leaders? There is no "they." It's "we." If we perceive that energy is a national need, an international need, then who is better qualified to state these principles and try to implement wise utilization of resources in our buildings than the design professionals who are just as broadly educated as, perhaps more so than, the bulk of our lawmakers. We also have the additional insight of what can be done. The architecture and engineering professions must really be leaders for a change. They are very, very timid about doing it. This is what I would qualify as a professional vs. a mechanic or a good technician. Professionalism to me seems to be service and leadership. It implies awareness. To make ourselves aware and to try to implement our work to further the greater good. In all cases we help ourselves by doing it. □

SERI Headquarters, Golden, Co

Solar nexus

Leaving virtually no energy stone unturned, a proposed new research facility to be constructed in Colorado is to be a showcase and study of solar energy applications.

Possibly no building in this issue—or this decade—obviates the need for energy planning as does this project. Indeed, the name of the client is enough to indicate the intended result. The Solar Energy Research Institute (SERI) permanent facilities complex, Golden, Co, was designed by the Table Mountain Architects & Engineers, a consortium comprising Caudill Rowlett Scott, Dubin-Bloome Associates, Rogers-Nagel-Langhart, and John Anderson & Associates. As indicated in the preceding article, Paul Kennon and Fred Dubin acted as design leaders for the group, and the resulting proposal represents a fine tuning of architecture and engineering dictates.

Siting considerations, always crucial, received very thoughtful scrutiny at the proposed SERI location. Originally it had been thought that the complex would sit atop the mesa on the north end of the site; but a challenge to that assumption came right at the start. Kennon and Dubin agreed that by moving the facility south, it could be nestled into a three-sided bowl where it would benefit from natural shelter from north winds and maximum sun on the south exposure. The top of the mesa will be the site of wind generators and field test areas. Uppermost in the progression down the "sun bowl" will be the initial Main Institute building complex; additional laboratories and offices are to be added downhill to the south. Below that are, respectively, the initial phase visitor and energy centers, initial parking areas and warehouse, and initial solar ponds to be surrounded by future parking.

Beginnings

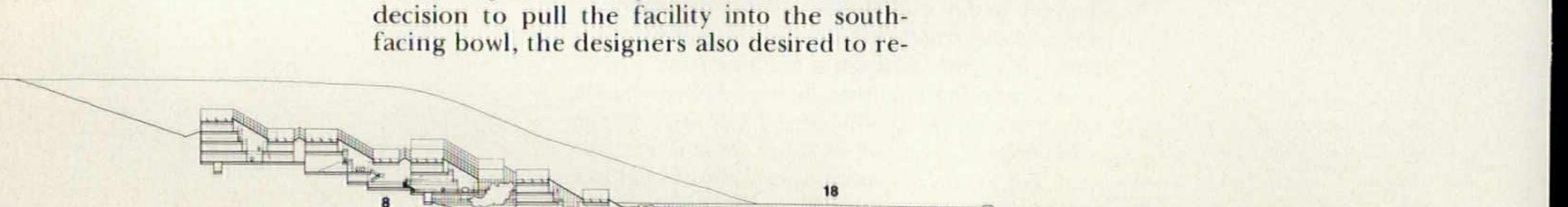
Among the many input parameters for the project, several affected the overall plan organization and the massing in a major way. The client stressed the imperative interaction between the scientific and the engineering disciplines in the SERI operation, resulting in certain adjacencies in plan. In addition to the decision to pull the facility into the south-facing bowl, the designers also desired to reduce its apparent scale, to lessen its impact on nearby residential and military areas.

The architects proposed a grid concept to form a matrix into which modular units of space could be plugged for maximum planning and future expansion flexibility. One result of combining these elements is a fairly extensive horizontal circulation system, as readily seen in the plans. These areas, however, do double duty. In both the east-west and the north-south directions, these spines offer the opportunity for the building to respond to the three-way slope of the site. At each north-south corridor/support function core, the overall mass pitches down toward the center.

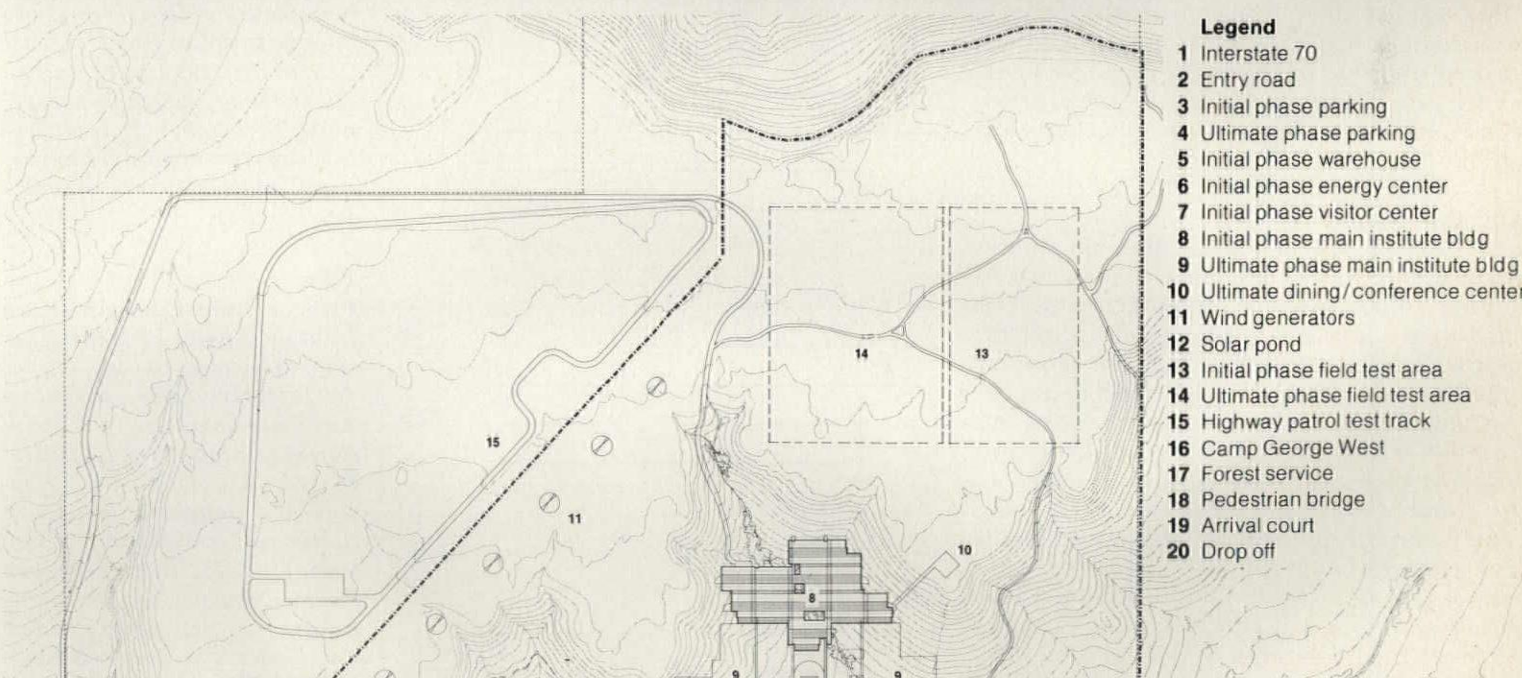
Broader east-west circulation spaces add still another facet to the parti, while still allowing the building to step downhill to the south. They are also defined as "solar courts" and, as such, are centerpiece elements in the design concept. Insolation entering the courts will be stored by various passive collection systems for reradiation. A large amount of the solar court roof area will comprise movable panels which will permit the exclusion of sunlight when desired, as well as allowing either retention or dissipation of inside heat as required. The precise nature of these panels is still undergoing study and refinement. Additional solar energy may be harnessed by water tanks mounted behind south-facing skylights, and by active collectors. Both features are located on some of the flat roof sections of the complex, in addition to the large solar array planned for the area between the visitor center and the main institute building.

There's more

Having provided for nestling the SERI complex into the contours on north, east, and west sides, for including the solar courts, and the active and passive collection methods, the design projects some added measures. The



SECTION



SITE PLAN

Legend
1 Interstate 70
2 Entry road
3 Initial phase parking
4 Ultimate phase parking
5 Initial phase warehouse
6 Initial phase energy center
7 Initial phase visitor center
8 Initial phase main institute bldg
9 Ultimate phase main institute bldg
10 Ultimate dining/conference center
11 Wind generators
12 Solar pond
13 Initial phase field test area
14 Ultimate phase field test area
15 Highway patrol test track
16 Camp George West
17 Forest service
18 Pedestrian bridge
19 Arrival court
20 Drop off

active systems (some initial phase, others later) take several forms. Photovoltaic collectors, for instance, are projected to contribute 240 kW to the building electrical supply, with an additional 240 kW developed by wind power. The focusing solar collectors—40,000 sq ft of them—will be used in conjunction with four Rankine engines, producing a total of 400 kW. Also proposed are two bio-mass boilers which, using wood chips—available from the forest service—for fuel to turn turbine generators, promise 2 mV.

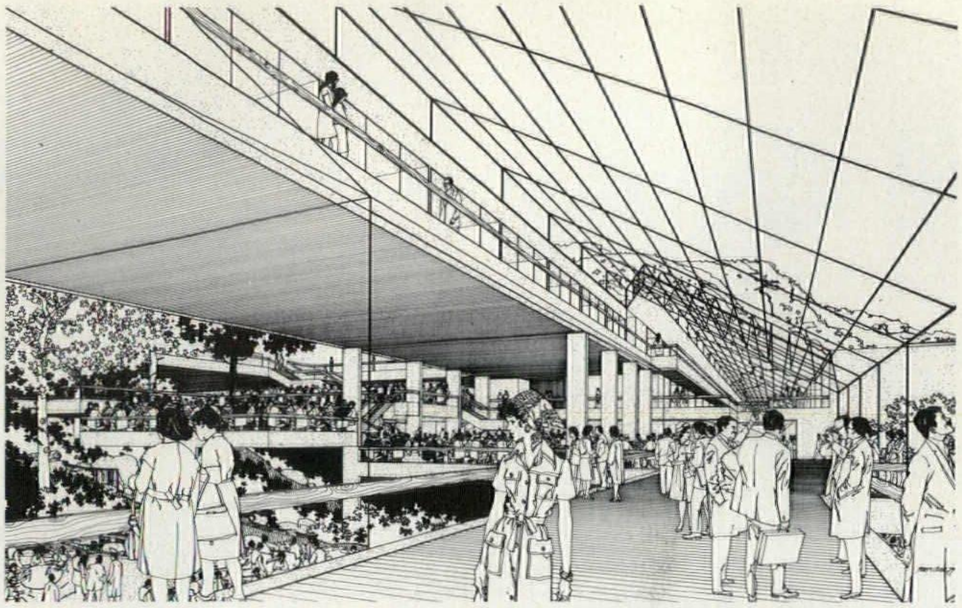
Among other measures incorporated in the scheme are the use of natural ventilation when and where possible, and of combination duct/light reflector fixtures to project natural light into interior spaces. Heat will also be reclaimed from building processes and equipment.

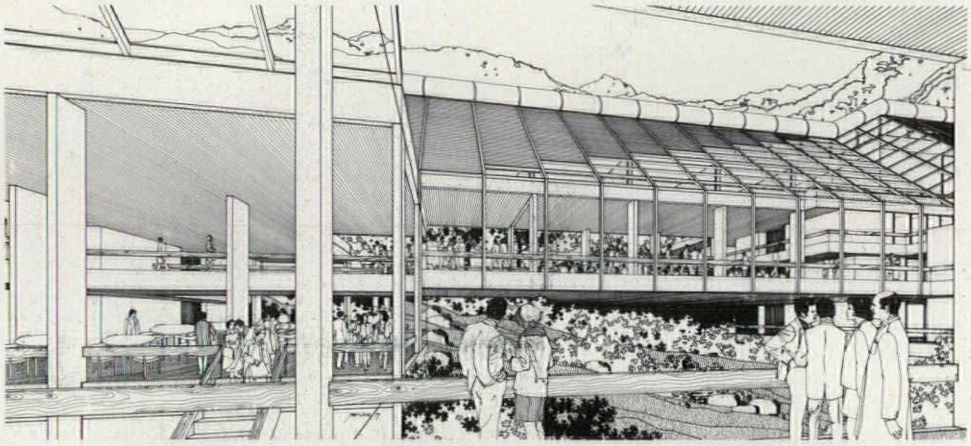
Solar ponds along the south end of the site will hold a saline solution to thwart convection currents which would normally occur, carrying heat to the surface to escape. A layer of fresh water, because it is lighter, rides atop the brine, acting as insulation. A black pool liner, an absorber, seals the bottom. The hot solution passes through a heat exchanger, actuating an absorption chiller to improve a heat pump's winter performance.

Not all of the measures at SERI have been covered here. Such elements as rock-bed storage, ice storage, evaporative cooling, gray water systems, and central computerized energy management are, like many of the features briefly touched on, subjects worthy of a complete discourse individually. What is important is that the SERI design team has pushed the state of the energy art to its current limits for the initial phase, with provisions for foreseeable and even speculative future applications.

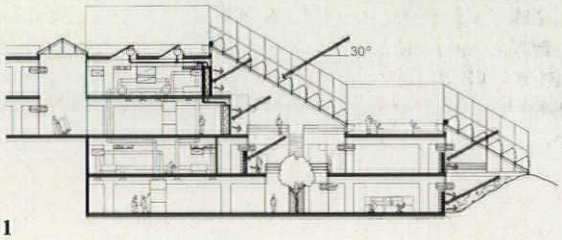
The expression

Given the proposed matrix, the plan should adapt well to future demands. Short of abandoning this orthogonal arrangement, it is hard to see how any other system could respond better to the site, since the modular units and the vertical stepping seem to handle the challenge well. If there are any uncomfortable confrontations between grid and contour, they can, with care, be resolved in the final refinement process. While the canted ends of some of the building elements may seem to hang out there in a somewhat fashionable flourish, it should be noted that future additions will attach to most of them. All in all, the experience of the building in its site, the drama of vertical and horizontal spaces, and the natural draw that bisects the complex diagonally should make the facility exciting, dramatic, and memorable. We'll be anxious to see for ourselves, somewhere around 1984. [Jim Murphy]





Drawings: Uri Hung



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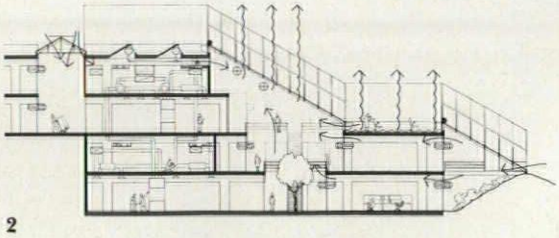

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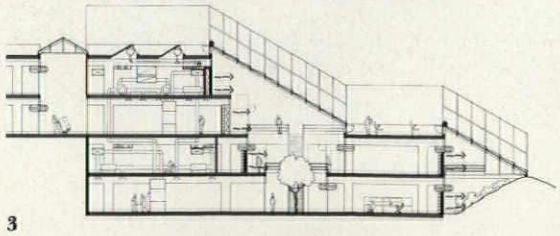

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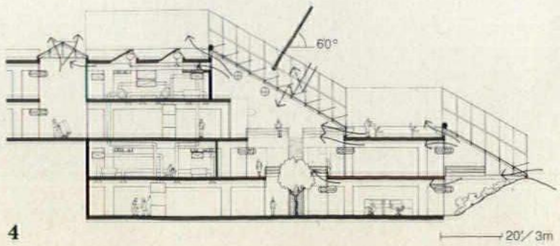


4

Natural draw (above) brings site through complex. The solar court sections (left) indicate 1) passive solar heating, winter; 2) passive night sky radiation/diurnal cooling, summer; 3) passive heating, night; and 4) day natural ventilation cycles.

Data

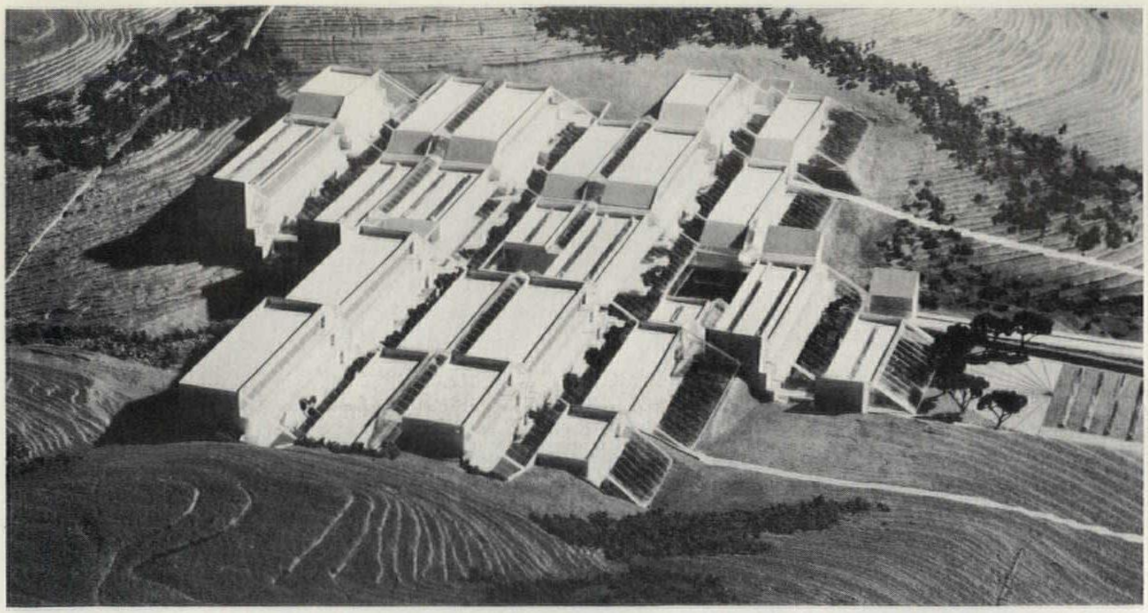
Project: *Solar Energy Research Institute (SERI) Permanent Facilities Complex, Golden, Co.*

Architects: *Table Mountain Architects/Engineers (Caudill Rowlett Scott, Inc., Dubin-Bloome Associates, PE, Rogers-Nagel-Langhart, Inc., John Anderson Associates). Design team: for CRS, design principal, Paul Kennon; designer, Jay Bauer; project director, Bob Carington. For Dubin-Bloome, Fred Dubin; for RNL, John Rogers, Richard von Luhrte; for John Anderson Associates, John Anderson.*

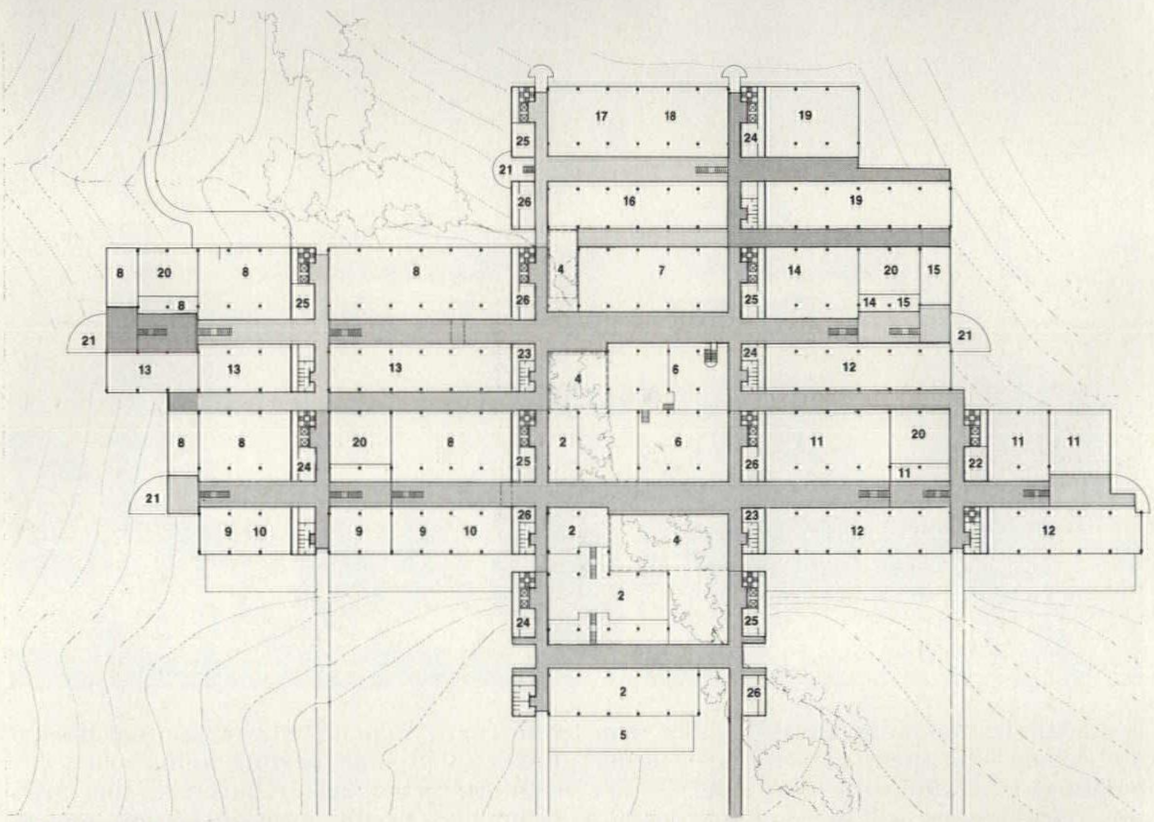
Client: *Solar Energy Research Institute.*

Site: *300 acres on South Table Mountain; a natural bowl off*

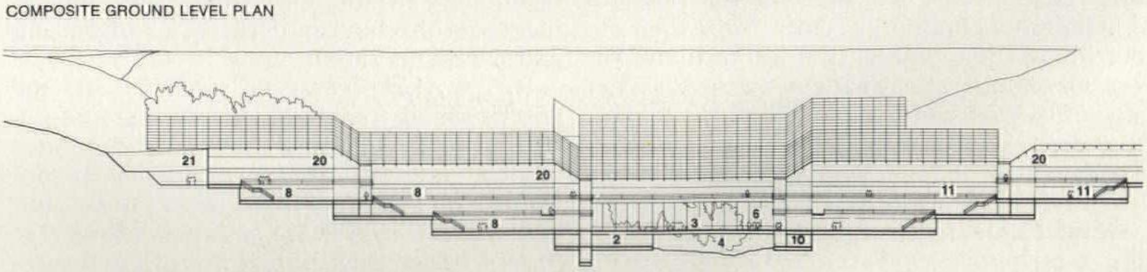
[Data continued]



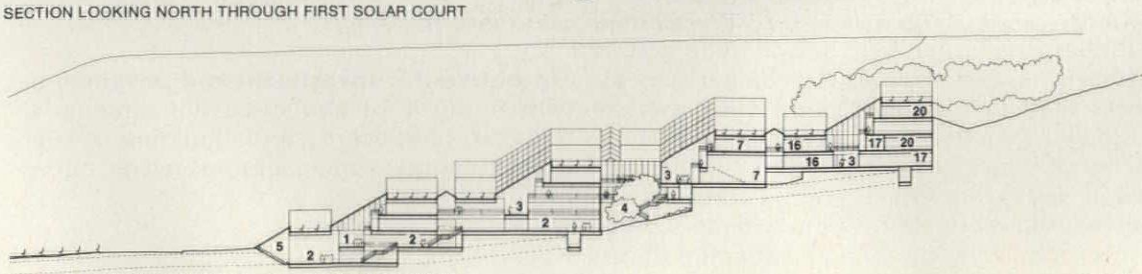
Data continued
the south edge of mesa will be the actual building site.
Program: *office and laboratory space and support functions, including conference center, cafeteria, administrative offices, etc., for a total of 915 persons. Total area (net) is 242,575 sq ft.*
Structural system: *concrete systems being investigated.*
Mechanical system: *a combination of elements including bio-mass boilers, purchased power (20 percent of normal building requirements), wind generators, solar-powered Rankine engine generators, waste-heat recovery, solar ponds, and future photovoltaic solar cell arrays. No natural gas or oil will be needed.*
Consultants: *mechanical, Dubin-Bloome Associates; civil/structures, Richard Weingardt Consultants; landscape, Harman, O'Donnell & Henninger Associates, Inc., and SWA Group, Inc.; acoustics, Coffeen, Anderson & Associates, Inc.; laboratory, Earl L. Walls Associates; fire protection code, Rolf Jensen & Associates.*
Costs: *budget, $65 million.*
Photography: *Andrew Kramer.*



COMPOSITE GROUND LEVEL PLAN



SECTION LOOKING NORTH THROUGH FIRST SOLAR COURT



SECTION LOOKING WEST THROUGH THE CENTRAL SPINE

Legend
1 Main lobby
2 Information center
3 Solar court
4 Exterior garden
5 Interior garden
6 Cafeteria
7 Conference center
8 Bio/chemical conversion
9 Support shops
10 Research division offices
11 Photovoltaics
12 Administrative / technical services
13 Analysis and assessment
14 Technology commercialization
15 Photovoltaics program
16 Academic / international program
17 Energy resource assessment
18 Testing and measurement
19 Thermal conversion
20 Interstitial space
21 Exterior terrace
22 Vendor room
23 Remote job entry
24 Storage
25 Service room
26 Conference room

Tomorrow's energy from yesterday

Don Klabin

Through a number of case studies, the author shows that the conservation benefits of reuse and continued use of existing buildings may be much greater than expected.

Thomas

The Ryerss Mansion ("Burholme"), c. 1850, Philadelphia, Pa, recently restored by Francis G. Vitetta Associates, Philadelphia. Restored as museum/public library, the house features attic insulation, polycarbonate storm windows, heat pump/ HVAC system, reinstallation of original shutters inside and out, blinds and shades, more localized light switching, fluorescent fixtures, relocation of attic work areas to basement.

Don Klabin, an architect and energy consultant with XENERGY Inc., Lexington, Ma, is involved primarily at present in research for the Department of Energy and the National Institute of Building Sciences to help develop energy performance standards for new buildings. Formerly a Senior Consultant in acoustics with Bolt Beranek & Newman, Inc., he is an instructor and the coordinator of the Building Technology curriculum at the Boston Architectural Center, and a lecturer at Catholic University. He is presently preparing a book entitled *10-d Design.*

Consider the following: in 1979 more than $40 billion was spent to renovate existing buildings and within the next several years this reuse activity will account for close to one-half of all building activity. More than 80 percent of the buildings that will be in use 30 years from now are already in use today. The importance of reusing old buildings is that they are repositories of energy. According to a 1977 study of New York City high-rise office buildings done by Syska & Hennessy with Tishman Research Corporation, those buildings built before 1900 averaged 95,000 Btu of energy per sq ft per year for all operating utilities over a five-year period. The best of them averaged 83,000. By comparison, offices built between 1941 and 1962 average 126,000 Btu per sq ft per year, and those from 1962–1970 averaged 115,000 Btu per sq ft per year. Other energy studies have shown that early 19th-Century buildings are even more efficient. Significantly, the sharpest declines in energy efficiency came with the development of central heating and air conditioning. The "architecture of the well-tempered environment" as Reyner Banham refers to it, depends entirely on mechanical forces to provide heating and cooling for comfort. It is an architecture that uses technology in the most inefficient way to overcome the energy deficiencies of glazing and overillumination.

For a comprehensive analysis of the energy-saving potential of reusing existing structures vs. building anew, the computer models contained in the Federal Advisory Council on Historic Preservation's study entitled *Assessing the Energy Conservation Benefits of Historic Preservation* should be reviewed carefully (see p. 25).

Incentives for investment and imagination

Often much of the discussion among architects, engineers, and building owners about energy *conservation* remains energy

Typical ASHRAE Energy Audit

The major sections and items within each section of a typical ASHRAE-based code are:

Design conditions
Outdoor design temperature.
Indoor design temperature.
Humidity.
Ventilation.

Exterior envelope
Maximum U-values of components (walls, roof/ceilings, floors, doors, windows).
Maximum overall U_0-values of walls, roof/ceiling assemblies, floors.
Maximum overall thermal transmittance value (OTTV) for exterior walls and the roof/ceiling assembly.
Insulation.
Vapor barriers.
Air infiltration at windows and doors.

Mechanical systems—HVAC
Sizing techniques.
Ventilation shut-off or volume reduction.
Minimum combustion efficiency.
Minimum coefficient of performance (for heating and cooling).
Air transport factor.
Controls (temperature, humidity, zoning).
Duct construction and insulation.
Use of economizer cycle.
Balancing.
Piping insulation.
Vapor barriers.

Electrical power
Power factor.
Voltage drop.
Lighting switching.
Metering.
Power consumption (motors).

Lighting
Illumination levels.
Lighting power budget.

Service water heating
Temperatures.
Flow rates.
Standby losses.

con*vers*ation because of perceived unsatisfactory payback figures. In today's highly inflationary economy, however, last year's "unfeasible" retrofit with a calculated payback of five years, for example, may be this year's "attractive" retrofit with a payback of three years. Consider, for example, that in the past year the price of heating oil in Massachusetts has doubled, inflation has exceeded 13 percent, the cost of insulation has increased 40 percent, etc. (this provides more than a 2:1 leverage in favor of insulation, by the way). These increases are far different from the inflation and discounting factors used by energy consultants in their 1979 calculations. It is clear, however, that in order to reverse the present trend to limited capital investment in retrofits to battle steeply rising energy costs in commercial buildings, we need some additional incentives.

Buildings
On the side of the designer, the government offered in 1979, and again this year, Appropriate Technology (AT) grants to promote the development of building technologies that meet local needs using available skills and resources. In New England alone, in 1979, 74 projects were funded with grants totaling $796,000; the average grant award was $11,000. It would be nice to think that architectural and engineering societies might consider increasing this seed money by returning to selected members a portion of the dues collected.

On the side of the building owner, financial consultants in the public and private sectors disagree as to whether the incentive for the building owner should be "solar bank" subsidies in the form of low-cost loans, for example, or energy investment tax credits, or exemptions from property and sales taxes. The issue remains, however, that we need something to prime the pump of energy conservation in the commercial building sector. The government and even some local banks have been fostering conservation in residences using these incentives, while at the same time virtually neglecting conservation in commercial buildings by a conspicuous absence of offerings. Yet, technically speaking, many of the actual construction improvements for energy conservation in the commercial sector are often similar in nature, if not scope, to those in the residential sector, e.g., weatherization, ventilation reduction, etc.

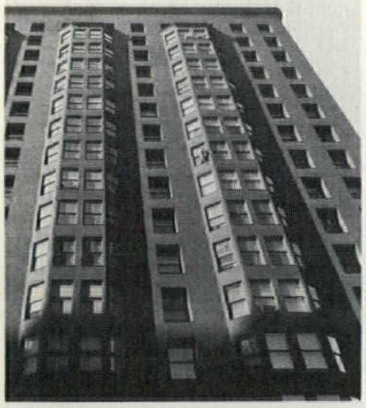
The Finnish government's recent strategy in the area of housing design may be an appropriate model for our government's strategy for national energy conservation. The Finnish solution was to create a tax benefit for the investor in housing below a stated size (100 sq m) and a tax penalty if above the upper bound of desired sizes (120 sq m). This scheme has particular relevance vis-à-vis the upcoming Energy Performance Standards. Regardless of the difficulty designers of federally financed housing may encounter at first in attempting to meet the BEPS Btu budget for the building, the provision of a financial carrot at the end of the sticky design process, if the budget is not only met but undershot by a certain percentage, would certainly entice the investment and development communities alike and is worthy of further consideration. What may prove to be the decisive factor, of course, will be the ease, or lack thereof, of achieving the stated budget in the first place, and only experience in simulating a number of designs will determine the practicality of Btu budget values.

The key to success in this endeavor, as with so many others, will be to entice the entrepreneurial spirit and Yankee ingenuity in all of us. This may mean using a diversified economic tool, one whose incentives might vary as a function of size of investment. Business owners, however small or large, need to know that their efforts at energy conservation are more significant than their electric meters and payback calculations may indicate, since they are all part of a larger plan.

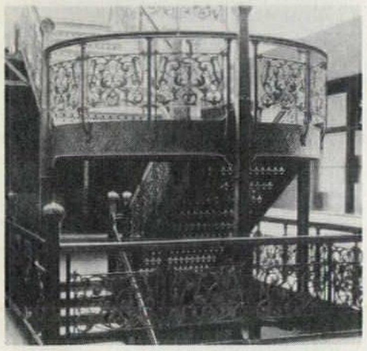
Cities
It has been the experience of many DOE or other government administrators to observe less-than-complete success with energy conservation programs when they have not been keyed to a well-defined, political/economic/geographical unit, such as a municipality or town. The lack of cohesion results from inherent duplication of effort within groups, or gaps between groups, unconsciously working in parallel. The newest attempt to unified conservation efforts beyond the scale of individual buildings is the selection of 17 cities in the United States as sites for a Comprehensive City Energy Management Program (CCEMP). This program, through its board of citizen advisors, will attempt to achieve a *cohesive,* multifaceted plan for each city tailored to the local set of conditions.

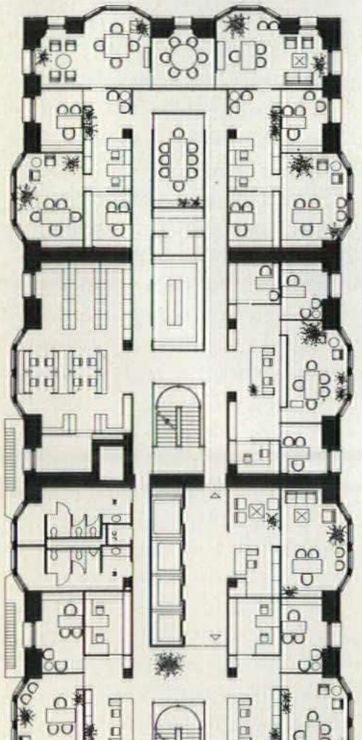
The success of the communities of Davis, Ca, and Portland, Or, in significantly reducing energy use on a community-wide scale was the stimulus for this program. Needless to say, the service of architects on these (and other) citizen advisory boards would be a valuable way to maintain a high professional profile and to assure that the newly developed energy conservation practices are consonant with other design standards and regulations.

Since the onset of the energy crisis in 1973, architects, engineers, and building owners have been working diligently to achieve lower costs and reduced energy consumption. The following case studies illustrate this point.



Richard Nickel





For the landmark Monadnock Building, Chicago, Il, it was found double glazing would be cost-efficient.

Energy conservation in existing buildings

Case Study No. 1: Monadnock Building, Chicago. The consideration for reducing energy use in the restoration and rehabilitation of existing—and especially landmark—structures is parallel to that for new structures and, in commercial structures, equally critical. In certain cases the fact that a given landmark structure may be less efficient in terms of contemporary standards of space utilization or other aspects makes energy conservation even more critical.

SOM's 1979 studies for the complete restoration and commercial redevelopment of the famous Monadnock Building (designed by Burnham & Root and constructed, during 1889–1893) was undertaken for Broadacre Management. This owner's representative was concerned with both architectural preservation and viable commercial redevelopment. The following components and alternatives were analyzed: double vs. single glazing, new vs. existing sash, insulation vs. uninsulated existing, masonry walls and roof, operable vs. fixed sash, centralized vs. decentralized mechanical system, reduction in lighting levels, and electrical vs. natural gas service as the fuel source for environmental control.

The principal finding of the SOM study was that the specific proportions, construction, fenestration, site, and climate of an existing building render results that are difficult to generalize. Second, especially in commercial structures, the detailed economics of development, of construction type and details of existing building, and the fuel escalation projections substantially affect the period over which cost benefits will be realized on energy-conserving first costs. Nonetheless, for the Monadnock Building, with 411,000 gross sq ft, 6:1 aspect ratio (400 ft north-south, 65 ft east-west), 16–17 stories in height with 35 percent glazing and 65 percent heavy masonry, it was found that double glazing could be financed with energy savings. It was also found that wall insulation could be justified if the interior finish of the exterior wall were to be replaced for other reasons, such as deterioration. A decentralized mechanical system might not only ease installation of new systems in an old building, but could permit savings in conversion time, and therefore energy use, if the owner and tenants could avail themselves of them. New sash or sealing of the existing sash to reduce crack section is essential to reduce infiltration, and could also show significant benefits. The existing character of the Monadnock Building also provided some benefits: the heavy masonry is clearly an asset in the Chicago climate because of the time-lag of its heat transfer, and the design of the bay windows shaped the interior space so that the layout of lighting fixtures could be arranged to provide adequate light levels on work surfaces but reduce general levels elsewhere.

A constraint provided by the existing building was the limited freedom in selecting the new windows. Reflective glass was considered and eliminated since it would not be required to attain ASHRAE 90-75 standards and would be damaging to the architectural character of the existing windows, which are recessed in the masonry.

The rehabilitation/restoration work in the building, which is currently occupied, is to be phased as the new tenant lease agreements are formulated. The elements slated for complete restoration are the exterior walls, cast-iron storefronts, first-floor lobby, and the famous cast-iron stairs. Tenant standards proposed for the refitting of the building were generated using contemporary rendition of the original building scale, including original door heights and proportions.

It is worthwhile to note that the SOM office proceeds through a predesign energy study on all renovations, whether a small library or a large office building. Their energy studies include in-house computer simulations using the TRACE and ASHRAE (APEC) programs.

Case Study No. 2: Baltimore City Hall, Md. The Baltimore City Hall (P/A, Nov. 1977, p. 76) underwent a program of restoration and renovation during 1974–76 by Architectural Heritage-Baltimore (Thomas Amsler, Charles Hagenah, and Kenneth MacLean) in joint venture with Meyers & D'Aleo Architects. Their initial feasibility study was resoundingly supported by public referendum for a bond issue to upgrade the 1875 structure. With its 2–4-ft-thick, marble-clad, exterior masonry walls, interior brick bearing walls, and vaulted brick coffers, the Baltimore City Hall is a premier example of a high-mass building and, thus, the time lag of its thermal response is of great significance.

Data compiled from similar heavy masonry structures at Harvard University indicate that the technique of night setback of thermostats is successful and appropriate for low-mass structures but *not* for high-mass structures where their storage of solar energy gained during daylight hours is reradiated at high levels during the evening hours. Lightweight buildings with their near-instantaneous heat gain and heat loss can be set back to 55 F, for example, and actually reduce consumption whereas in the high-mass building the structure will be heating itself above this level and therefore the automatic thermostat controls cannot be justified.

This lesson in thermal logic underscores the fact that *different design strategies are needed for different buildings* and that rules of thumb or other shortcuts in thinking should be applied judiciously.

Existing wood shutters located on the interior at the edge of the deep window recesses were stripped and refinished during the building renovation. After having been rendered inoperable by being painted shut over the years, the operable shutters are now of valuable assistance in controlling indoor temperatures due to direct solar gain.

Other significant energy conservation measures were gained from the addition of insulation to the deep, uninsulated attic at the top of the Mansard roof, and through the use of heat recovery between fan-coil units at the perimeter piped separately from units in the interior zone, connected to a cascading chiller system (designed by R.G. Vanderweil Engineers of Boston).

Case Study No. 3: Mechanics Hall, Worcester, Ma.

A historic concert hall (P/A, Nov. 1979, p. 84) constructed in 1857 was restored and expanded in 1978 by Anderson Notter Finegold in response to strong community support to upgrade the building by meeting current safety and comfort standards while preserving the excellent acoustics of the hall. In order to provide adequate life safety for the audience of 1500 seated on the third floor of a wooden structure, a new lobby was constructed at the rear of the existing building.

This "solar greenhouse" is now a major entrance of equal importance to the historic front entrance, because of the location of the present parking areas and changes to the downtown pedestrian and vehicular traffic patterns over time. The angular addition, which follows the property line, serves three primary functions: as entrance, additional egress (stairs and elevator access for the handicapped), and lobby for overflow crowds. In addition, because of the architect's use of glass full height for the exterior wall of the lobby, the space is used for meetings and exhibitions. The glass allows the lobby to advertise its functions at night, and during the day to conserve space-heating energy for the restored building by acting as a direct gain, passive solar collector. While there is a mechanical system to serve the lobby, it is not used at all on sunny days, and studies are now being made to consider recirculating the passively heated lobby air to other areas of the building requiring heat.

Anderson Notter Finegold's joint interest in energy conservation and historic preservation has led them to work currently with a community group on a federally funded demonstration project to explore the passive solar and energy conservation potential in rehabilitating existing urban multifamily row housing. Still in design, a portion of the exterior masonry walls will be covered with translucent insulated sandwich panels and will also incorporate active solar rooftop collectors for domestic hot water, reflective mirror-finish aluminum blinds, operable insulated shades for additional nighttime conservation, and new double- or triple-glazed sash. Although this project involves strictly residential uses, there are direct and important ramifications also for multiuse or strictly commercial functions in existing masonry buildings which are common to many other downtown "Main Street America" streets.

Otto Baitz

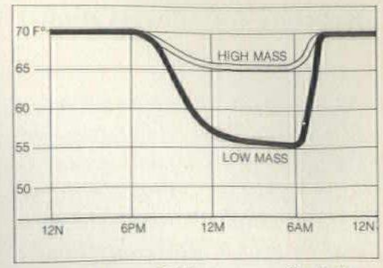
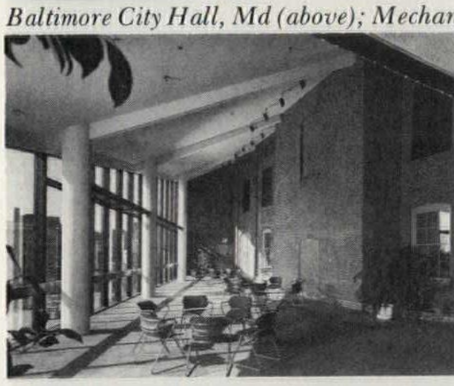


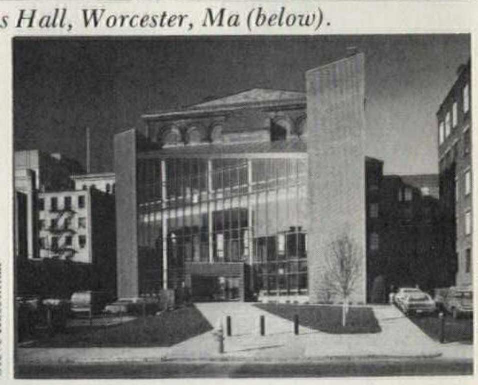
Chart shows differences of nighttime setback for high- and low-mass buildings.

Otto Baitz

Baltimore City Hall, Md (above); Mechanics Hall, Worcester, Ma (below).



Steve Rosenthal



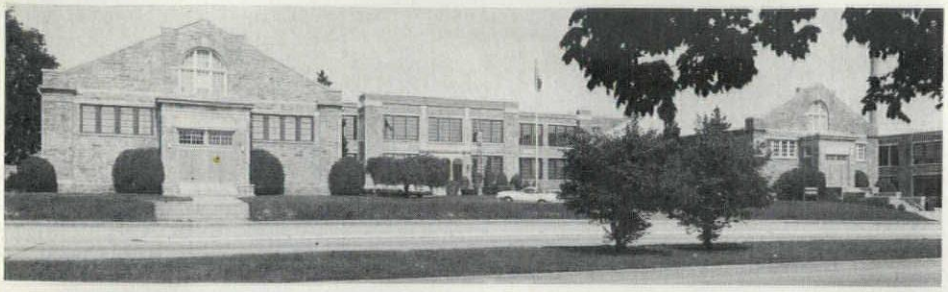
Steve Rosenthal

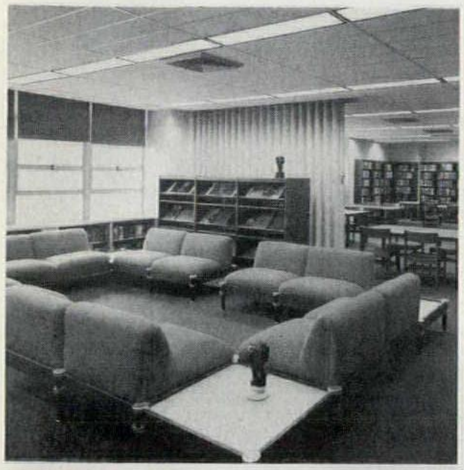
Steve Rosenthal

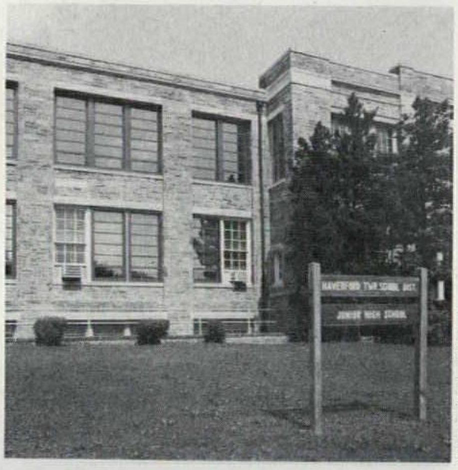
Refitting for conservation

At Haverford Jr. High School, Haverford, Pa (below), fuel consumption is 30 percent lower after replacing 600 deteriorating windows and upgrading heating and environmental control systems.

Case Study No. 4: One firm's experience.
Despite successes in promoting energy conservation design services, Vitetta Associates, an AE firm with offices in New Jersey, Pennsylvania, and Massachusetts, has discovered that most clients, whether public or private, develop attitudinal obstacles in evaluating capital expenditures for energy conservation purposes alone, even when the calculated paybacks are within a feasible range. These obstacles, however, are overcome when other architectural factors come into play, such as considerations of improved space utilization or expansion, change of use or irreparable construction (the most notable example of the latter being windows begging for replacement because of old age, poor maintenance, or faulty installation).





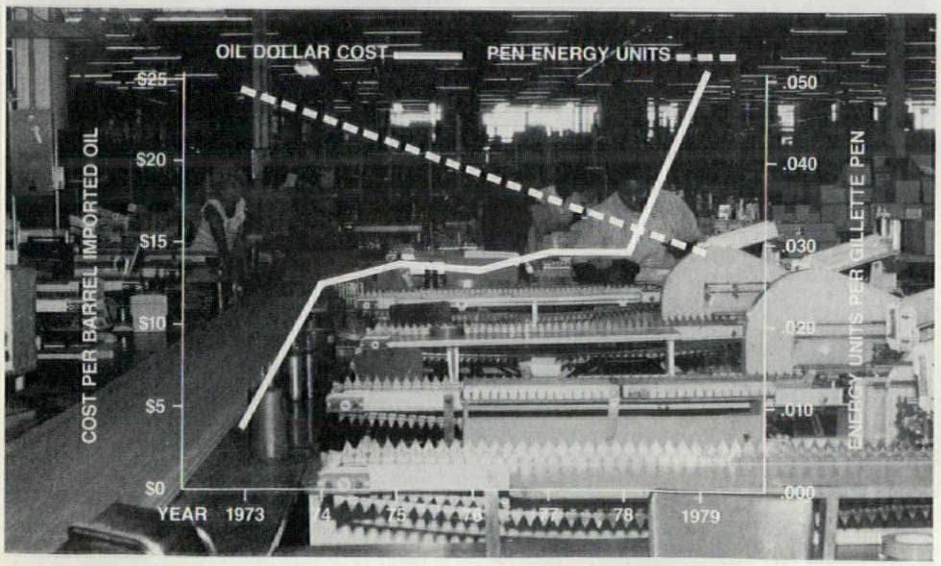


Photos: Robert Harris

At Haverford Jr. High School, Haverford, Pa, after upgrading the school's aging heating and environmental control systems and replacing more than 600 deteriorating wood windows, fuel consumption is said to be at least 30 percent below that of prerenovation levels. In refurbishing the 50-year-old building from roof to boiler room, the architects revamped the entire heating plant, replaced duct work and piping, improved ventilation in shop areas, and installed sophisticated zone heat controls and thermostats throughout the 116-room facility. Renovations to the heating plant included the installation of three new oil burners and replacement of the fire box in each of the three boilers. The initial phase of the renovation was completed at a cost well below the $3 million budgeted for the work and included the purchase and installation of double-glazed replacement windows. Besides increasing energy efficiency, the architects also updated the school's lighting system, relocated and expanded the library and industrial arts facilities, and designed an elevator to provide access for handicapped at five levels.

In upgrading the lighting system the architects called for more than 1200 new recessed fluorescent light units for classrooms and corridors and an additional 20 exterior floodlights. To avoid major disruptions in the educational program, more than 100 workmen were assigned to the fast-tracked job during the summer recess. As a result, at least 95 percent of the work was completed in time for the school reopening in September.

Replacing a 50-year-old roof on a 6-story light manufacturing facility for RCA in Camden, NJ, meant a costly investment. Since the company would have to remove and reset 34 air-cooled compressor/condensing units that were scattered across the roof, it sought a less expensive alternate means of providing comfortable cooling for the 560,000-sq-ft plant. In the redesign study, the architects learned that installing a new central-station direct-expansion screw-compressor system would cost about the same as resetting the existing condensing units. On the basis of this study, the company removed the rooftop units and purchased and installed a 300-ton direct-expansion screw-compressor evaporative-condenser system. The equipment has reduced power, operating, and maintenance costs by approximately $45,000 per year. Installed in the tower section of the building, the package uses all existing air handlers, ductwork controls, and refrigerant piping up to the fifth floor. The system supplies the 25 existing air handlers which in turn distribute a total connected cooling load of 208 tons. Suction and liquid piping, mounted on the ceiling of the fifth floor, can be tied into additional air handlers in the building by running branch piping from valves designed for that purpose. Most of the mechanical problems experienced with the old units have been eliminated. Preliminary data indicate that



The Gillette Company pays $20 million to generate $2 billion in sales—without an energy-conservation program, an additional $10 million would be spent.

power use has dropped 44 percent, resulting in an annual saving of approximately $15,000 in electricity. The equipment has also reduced demand charges. Maintenance has been reduced accordingly and lower maintenance material costs are expected to cover the labor costs.

Vitetta Associates has developed a computerized program for the purpose of evaluating existing building facilities for recycling purposes as well as for long-term maintenance schedules. The need to optimize the utilization of existing investments in terms of brick and mortar has required that architects become increasingly involved in the evaluative process to determine the optimum use of existing facilities as well as long-term need. In response to the specific needs of the New Jersey Department of Education, Vitetta Associates has evolved a computerized facility survey program based on a dictionary of items found in the mechanical, electrical, and structural aspects of facilities. The computerized program is based on a work item code and unit cost (dollar) take off, which are documented on inspection reports done by relatively untrained instructors. This utilizes basic appraisal techniques rather than high-level technical skills. A critical portion of the computer program includes an evaluation of insulating values of all components, life-cycle costing for improvements to these components or their replacement, and the impact of these long-term improvements on the operating cost. The system involves a detailed, item by item cost appraisal for all remedial work, as well as a methodology for determination of replacement, modification, or recycling decisions.

The same program surveys and evaluation techniques are being applied in a crash program being undertaken for the Philadelphia Naval Shipyard in which 248 existing facilities are being evaluated and recommendations are being made for remedial measures. A large portion of these remedial efforts is being directed at energy conservation including window replacement, additional insulation, and other methods of weather protection. The life-cycle costs of these improvements is being analyzed. A proposed budget and maintenance program will be evolved from it.

Case Study No. 5: The Gillette Company, worldwide.

Energy conservation measures of the Paper Mate Pen Company involved some of its 50 plants in 26 countries. A corporate energy strategy was initiated in 1973, and the fruits of the company's labors have become notable: a 38 percent saving worldwide, with savings at one facility (500,000 sq ft) as high as 44 percent.

Despite the use of different manufacturing equipment and different building envelopes, and given the widely differing climates from Spain to Minnesota, the energy-conservation strategies employed, which have been tailored to each particular set of circumstances, have been extremely successful. The quality of corridor and office lighting fixtures in the 300,000-sq-ft headquarters has been reduced with no loss in work area lighting intensity; high pressure sodium lamps have replaced fluorescent fixtures in manufacturing plants; heat recovery from compressors has provided space heating for warehouses; water consumption has been carefully tracked with recirculation savings equal to 417 million gallons per year (the annual water usage of 10,000 homes). All this, and the Paper Mate Pen and Safety Razor of 1980 work as well as the 1973 vintages.

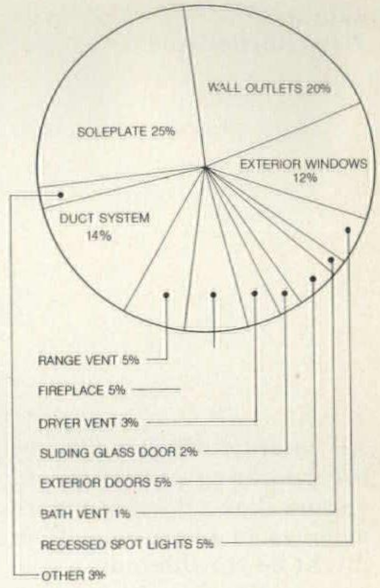
To put the energy conservation in even truer focus, Gillette's annual expenditure for energy is now only approximately one percent—$20 million to generate $2 billion in sales. Without their energy conservation program, an additional $10 million per year (!) would be spent, with a calamitous effect on earnings per share.

Conclusion

As stated by Dr. Edward Teller, Nobel Prize-winning physicist, in his newest book *Energy from Heaven and Earth:* "No single prescription exists for a solution to the energy problem. Energy conservation is not enough. Petroleum is not enough. Coal is not enough. Nuclear energy is not enough. Solar energy and geothermal energy are not enough. New ideas and developments will not be enough by themselves. Only the proper combination of all of these will suffice."

His clarion call for a pluralistic approach, one that will take advantage of indigenous resources as well as foster new synergistic technological developments, should be music to the ears of creative building designers. We are standing now at the brink of a new era which, undoubtedly, will shape new roles and opportunities for professionals. As in previous eras, architects should not hesitate to pick up the reins of leadership.

For the benefit of those architects who in the past, at the request of their clients, have laid energy pigs at the altar of first cost, hark: a new world is evolving wherein the heretofore sacred first costs are giving way to life-cycle costs. A significant moving (or inertial) force is clearly the banking community. However, that community cannot intuit what needs to be done. It is up to architects to persuade. We can no longer afford to bemoan our fate like some chorus in a Greek tragedy. The long range choice is to sharpen our skills on the cutting edge of technology or to become fossilized by the Fossil Fuel Age of Design—a mere 200-year flicker of the eye of history. □



This chart shows the relative contribution of infiltration sources in a typical residence. (From Electrical World, *Nov. 1, 1978.)*

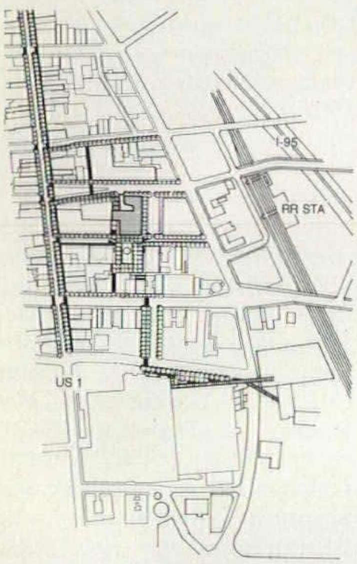
Acknowledgments

The author wishes to thank the following for their valuable assistance in providing information for this article: Stephanie Gibson, Northeast Solar Energy Center (NESEC), Cambridge, Ma; Robert A. Hutchins, Skidmore, Owings & Merrill, Chicago, Il; Tyrone Pike and Stephen Weinstein, The Ehrencrantz Group, P.C., New York, NY; John Whitehead, Francis G. Vitetta Associates, Westfield, NJ; Gary Vanderweil, R.G. Vanderweil Engineers, Inc., Boston, Ma; Cameron Beers, Gillette Company, Boston, Ma; Amsler Hagenah McLean Architects Inc., Boston; Architectural Heritage-Baltimore Inc.; Meyers & D'Aleo Architects Inc., Baltimore, Md; John Ingwersen and James Alexander, Anderson Notter Finegold, Inc., Boston, Ma.; Bruce Keller and Douglas Gardner, Kalwall Corp., Manchester, NH; Richard Taylor, *Interiors.*

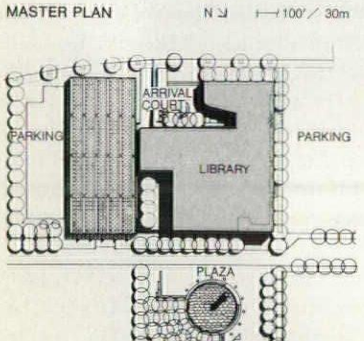
Library,
New Rochelle, NY.

Levels of conserving

An energy-efficient library incorporating part of an old garage shows there are more avenues to conserving than might be considered.



MASTER PLAN N ↘ 100'/30m



SITE PLAN N ↘ 100/30m

The new library was seen from its beginning as a focus for revitalization of the downtown. It is having that effect, but because various firms are involved in implementation of building refurbishing and new planting, the work is not proceeding precisely as shown in the master plan.

When considering the many avenues open for energy conservation through building design, it is now increasingly recognized that the way is no longer limited simply to the prospect of reducing fuel consumption. At a broader scale, we now realize that conservation can also mean reusing, or making better use of, resources that already exist. In this respect, an existing building or even an entire city can, regardless of their age, be seen as valuable resources that already have considerable amounts of energy invested in them in terms of such things as materials, original cost of labor for construction, and even years of past maintenance. We now realize that all of this need not necessarily be thrown away, and it is the acceptance of just such an idea that has a great deal to do with the new 67,000-sq-ft library in New Rochelle, NY.

From its inception, the library scheme was seen not only as an opportunity for reusing something that already existed, but also as the focus for revitalization of the town's decaying urban center, which was itself considered a valuable resource that could be lost if something were not done about it fairly quickly.

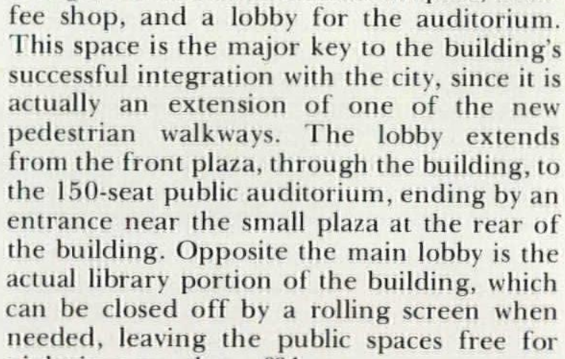
The story goes back to the 1970s when, over a period of seven years, New Rochelle lost three of its major department stores. Other nearby communities had outstripped the town in terms of new retail development and had attracted the more moneyed buyers, leaving New Rochelle with a population unable to support the retailers in the manner to which they had become accustomed. In 1975, however, an AIA R/UDAT visited the city, and a year after its recommendations were made, the community started a new \$20-million capital improvement plan and revitalization effort. With funds coming from federal, state, and local sources, this comprehensive scheme was able to encompass a façade improvement program (40 storefronts have been refurbished to date), and an extensive pedestrian walkway system incorporating two new urban plazas. At the center of the plan, destined to become the focal point for a city that had previously had none, was to be the new library/cultural center complex facing one of the new plazas.

Pomeroy, Lebduska Associates, who were architects for the library with associated architect Fred W. Lyon, were also responsible for the town's new master plan. As a consequence, they were able from the beginning to integrate the building and the town into a more successful union than is perhaps usually the case. In fact, as Lee Harris Pomeroy explains it, the plan of the library was actually generated from the plan of the town, and this alone accounts to a considerable extent for the building's formal success.

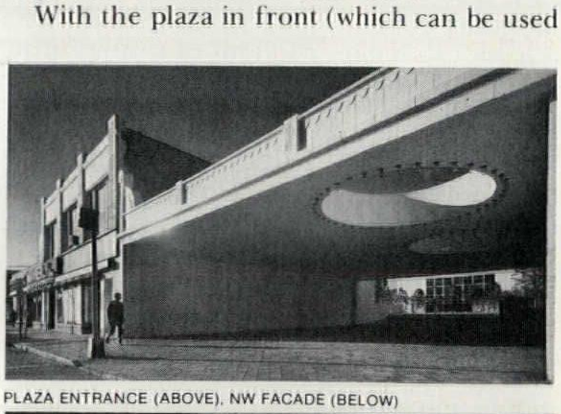
The library

The library is divided into two sectors, which are basically the public and private zones of the building. The 4000-sq-ft public zone of the main lobby could be seen as oversized in relation to the rest of the building were it not for the fact that this area serves not only as a lounge, but also as an exhibition space, a coffee shop, and a lobby for the auditorium. This space is the major key to the building's successful integration with the city, since it is actually an extension of one of the new pedestrian walkways. The lobby extends from the front plaza, through the building, to the 150-seat public auditorium, ending by an entrance near the small plaza at the rear of the building. Opposite the main lobby is the actual library portion of the building, which can be closed off by a rolling screen when needed, leaving the public spaces free for nighttime or other off-hour uses.

With the plaza in front (which can be used

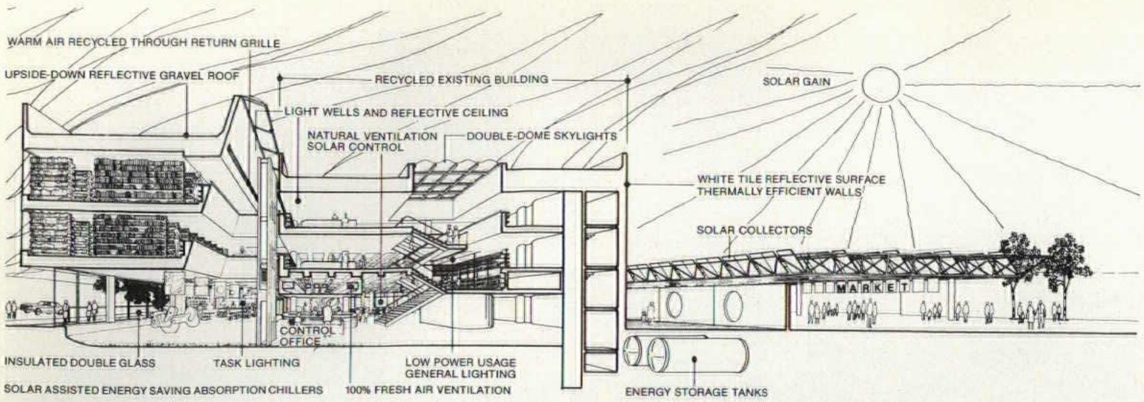


PLAZA ENTRANCE (ABOVE), NW FACADE (BELOW)




Public Library


Library



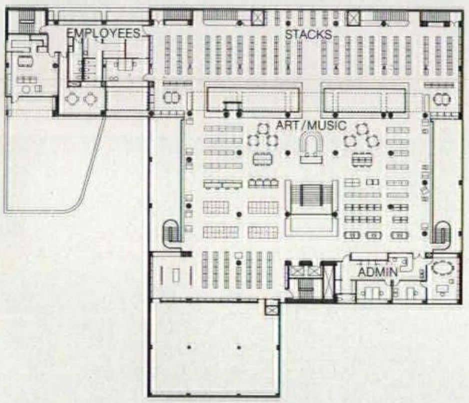
SECTION

for summer activities), with the interior pedestrian walkway, the auditorium, and its increased library capabilities, the facility has unquestionably taken on the role as a focal point of the city as was hoped. But in addition to this, and because of it, the library and its main plaza are also beginning to have a direct and positive effect on the buildings nearby. A number of exteriors have already been refurbished, and some store owners who were opposed to the plaza and walkway system in the beginning have now opened new entrances facing those amenities.

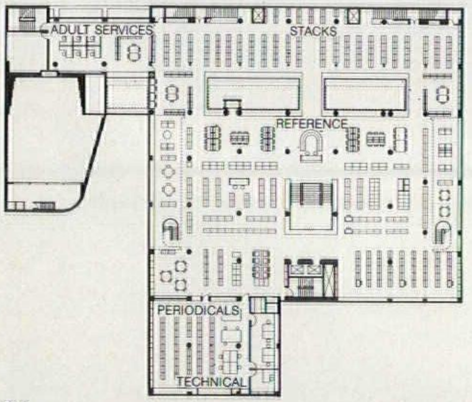
Not only has the library encouraged reappraisal of that which is around it, however, but it also has become its own best advertisement for encouraging the reuse of what already exists. The main library section of the building is housed in a recycled automobile garage, which makes up about 60 percent of the entire complex. From this older structure, the stacks are "hung" over the lobby (to free it of columns) in an arrangement that defines a three-story skylit gallery. The reading rooms, browsing areas, circulation desks, and offices are in the recycled building, where the low ceiling heights have been offset by introducing a series of new double-height spaces, by exposing the coffered ceiling, and by creating a wide, skylit central stairway.

The building, however, is not only an admirable example of intelligent conservation policy through its encouragement of revitalization around it and through its own use of recycled materials. In the most conventional understanding of the meaning of energy conservation through building design, the library is a model of good sense. Inextricably woven into its design is a major energy-conservation program. This includes a life-cycle program incorporating low-level task lighting, automatic switching, natural ventilation through operable windows, 100 percent fresh air ventilation through the air-handling system, double-glazed insulated windows, and the use of the plaza fountain as a heat sink. In addition, the exterior walls are highly thermally efficient; their panelized masonry skin is composed of white glazed porcelain tiles preset into a 6-in.-deep factory-cast concrete system that also includes two inches of insulation, plus gypsum board.

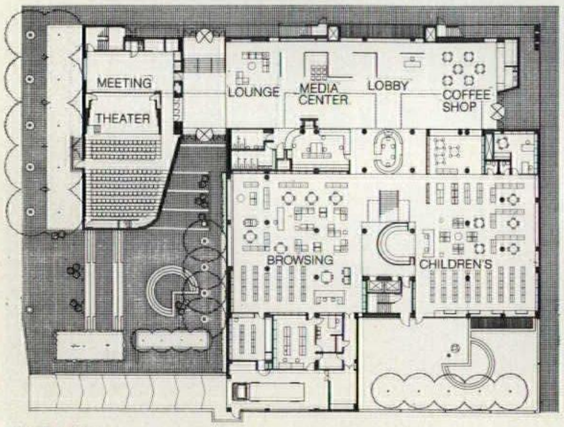
A new space frame will soon begin construction at the south side of the building. This will support a 6500-sq-ft system of flat-plate solar collectors, for which the underground storage tanks are already in place, that will heat and provide hot water for the building. In addition, this new extension of the library will also enclose a new neighborhood market to be installed under the space frame. When all is completed, the New Rochelle facility will function at all levels of conservation: as a progenitor of the revitalization of the urban fabric, as an example of the intelligent reuse of existing materials, and as an energy conserver in the conventional sense. [David Morton]



THIRD FLOOR



SECOND FLOOR



FIRST FLOOR N 20'/3m

Data

Project: *New Rochelle Public Library and Plaza, New Rochelle, NY.*

Architects: *Pomeroy, Lebduska Associates, New York, NY; Fred W. Lyon Associated Architects, New Rochelle, NY. Design team: Lee Harris Pomeroy, John Lebduska, Jane Siris, Oscar Jobmann, Richard Foley. Downtown master plan: Pomeroy, Lebduska Associates.*

Site: *urban lot in central business district; building mall developed as extension of new east/west pedestrian walkway system.*

Program: *new library, developed closely with new master plan to become central focus and cultural center intended to encourage revitalization of decaying downtown.*

Structural system: *reuse of existing garage structure of steel frame and reinforced concrete; new steel framing system hung from old structure to free new lobby of columns.*

Major materials: *exterior wall skin of precast concrete panels with glazed ceramic tile cast into each unit, double glazing.*

Mechanical system: *conventional system to be supplanted by system of flat-plate solar collectors with solar-assisted absorption chillers.*

Consultants: *Vreeland and Guerriero, landscape; Pomeroy, Lebduska Associates, interiors; Zorab Vosganian Associates, structural; Jack Green Associates, mechanical; Euclides Photios Theoharidies, graphic designer; Howard Brandston Lighting Design, Inc., lighting; Intechnology Inc., solar systems; Richard Chaix, fountain consultant.*

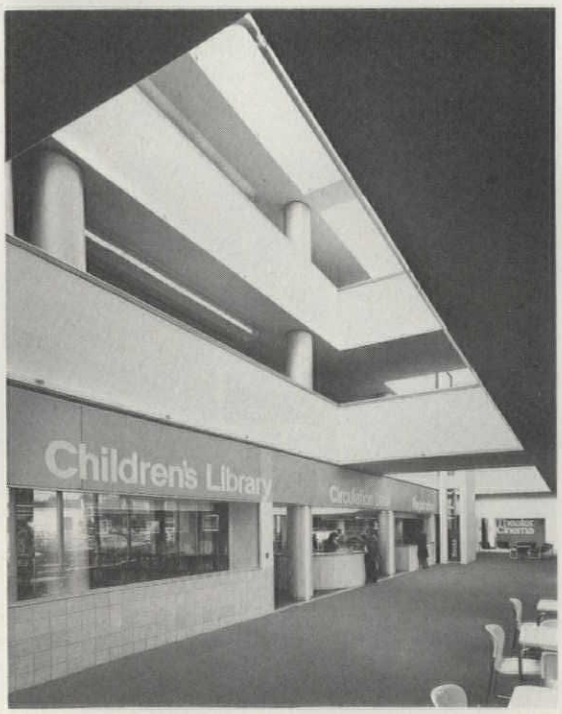
Client: *New Rochelle Development Council and City of New Rochelle, NY.*

General contractor: *Polera Construction Co., Construction managers.*

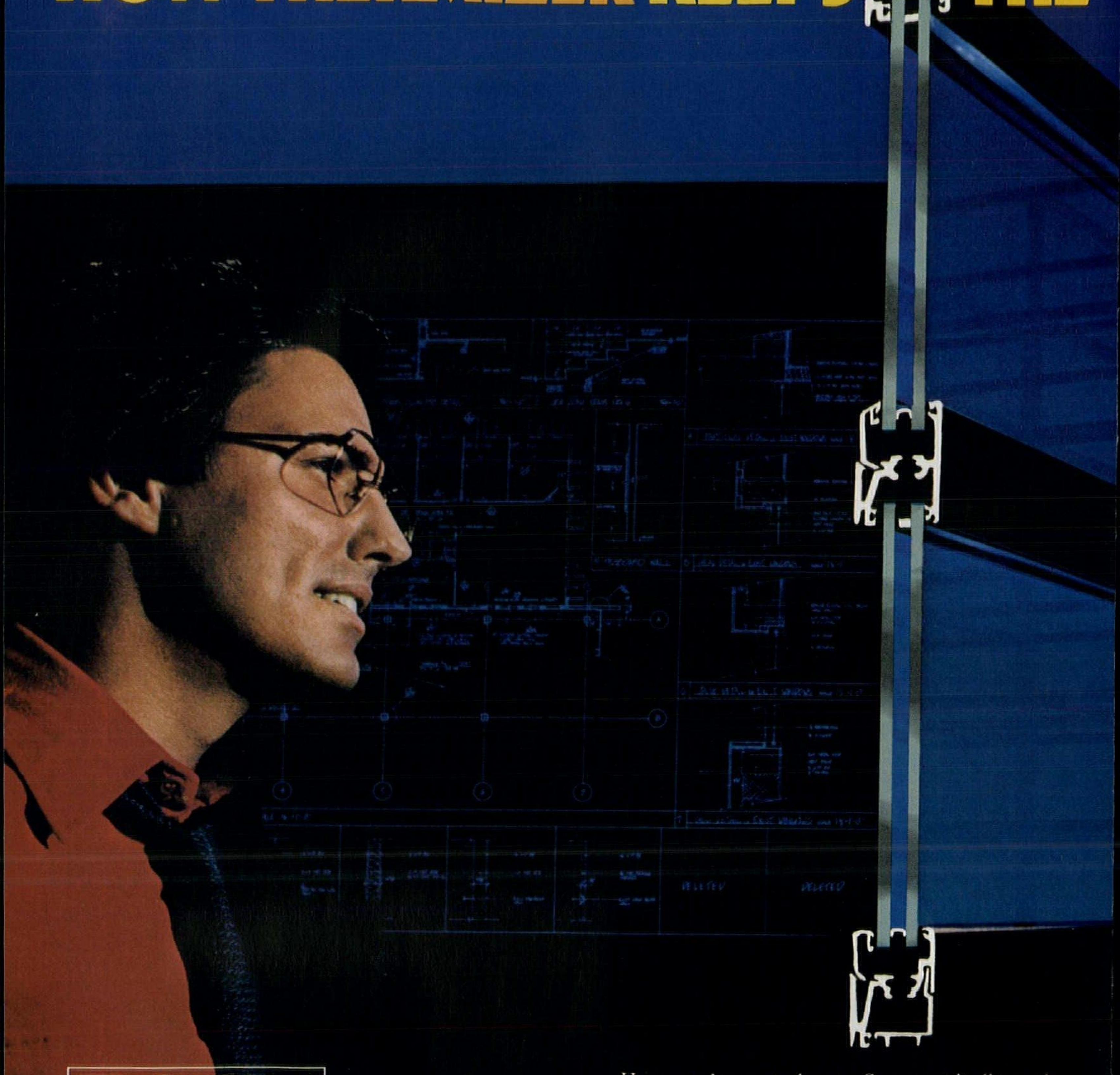
Cost: *$6,000,000 includes furnishings and interior finishes of 67,000-sq-ft building, new outdoor plaza, site work, landscaping.*

Photographs: *Ezra Stoller © ESTO.*

New stairwell in reused garage (above right); main library mall (right); reading area with task lighting (far right).


Children's Library

HOW THERMIZER KEEPS THE



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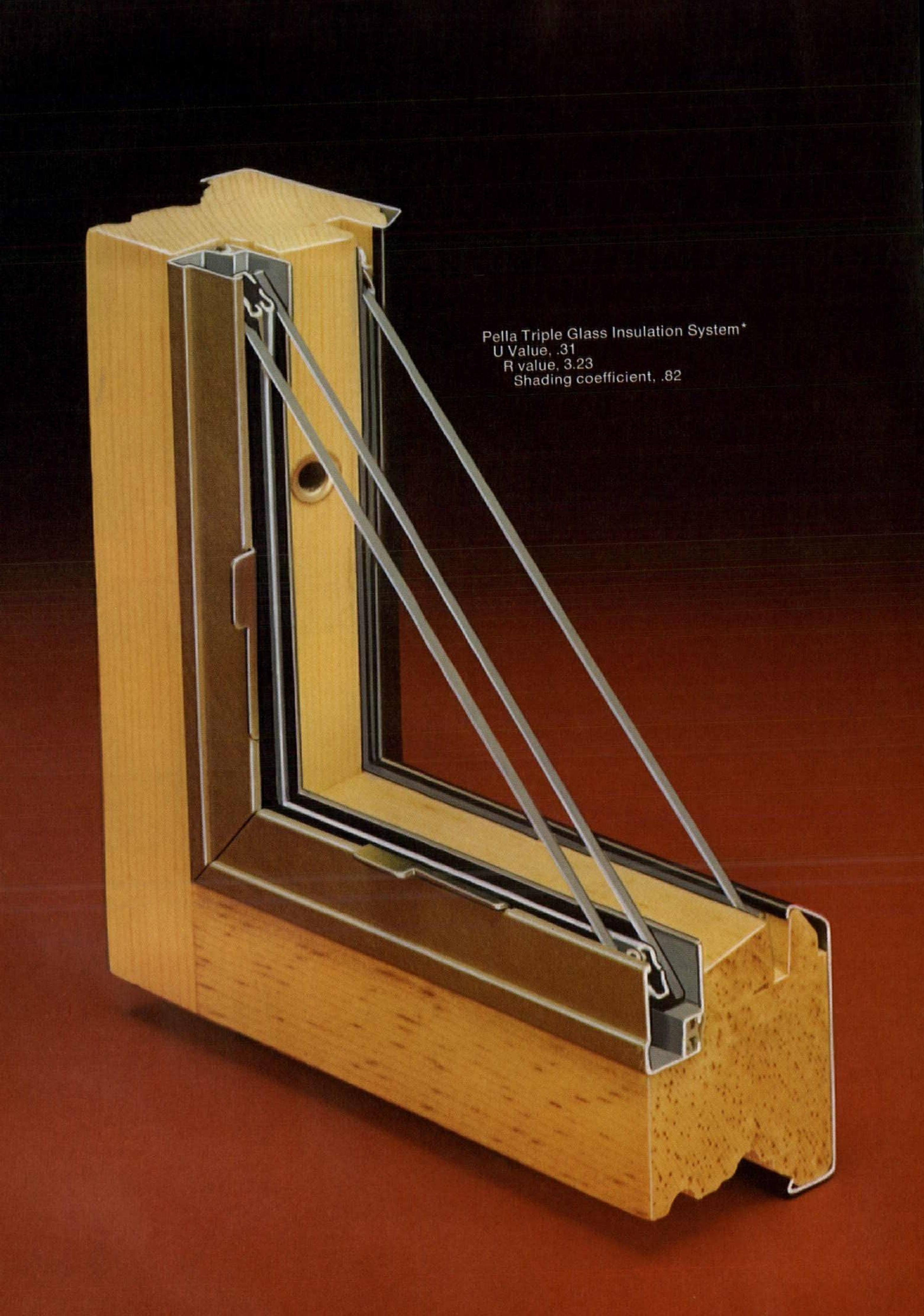
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R value, 3.23
Shading coefficient, .82

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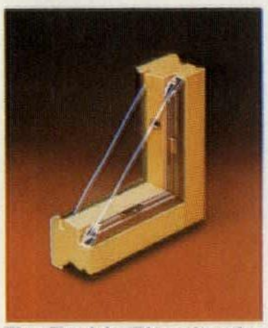
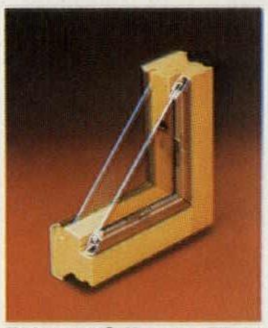


The Double Glass Insulation System outperforms welded insulating glass, yet costs less per window. (U value, .41; R value, 2.43; shading coefficient, .88)*



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*Pella Clad Casement 2048 was used for testing. U and R values are given for the total unit. Slimshade data is for white slats tilted 30-45°. Information based on one or more of the following: ASHRAE Handbook of Fundamentals 1977; testing by Yellott Solar Energy Laboratory; testing by Rolscreen Company; testing by Dallas Laboratories; information supplied by P.P.G. U Value data based on: Outside temperature — 0°F; inside temperature — 70°F; outside wind velocity — 15 MPH.

**Data based on Pella Large Fixed Clad Casement 6068

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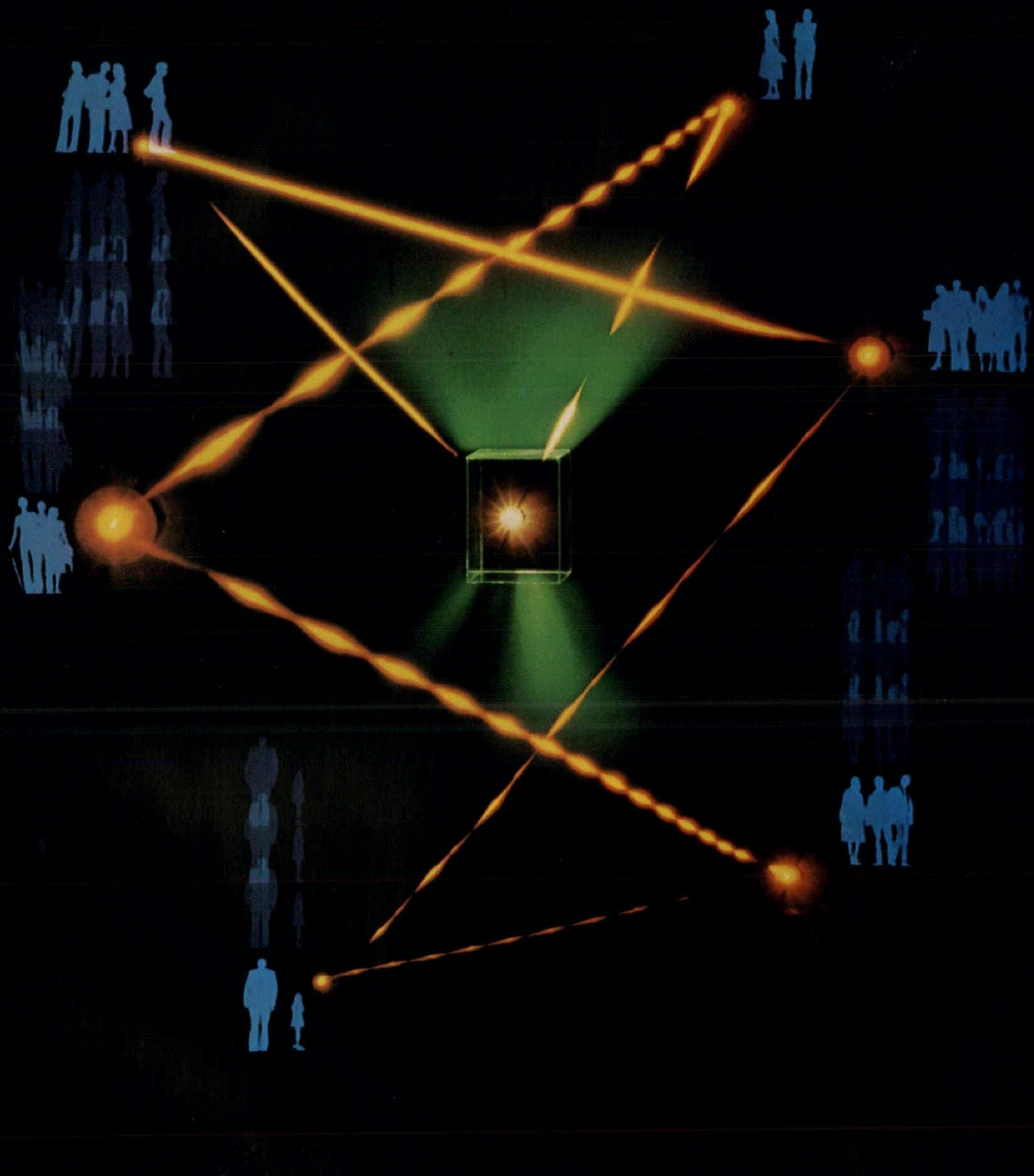

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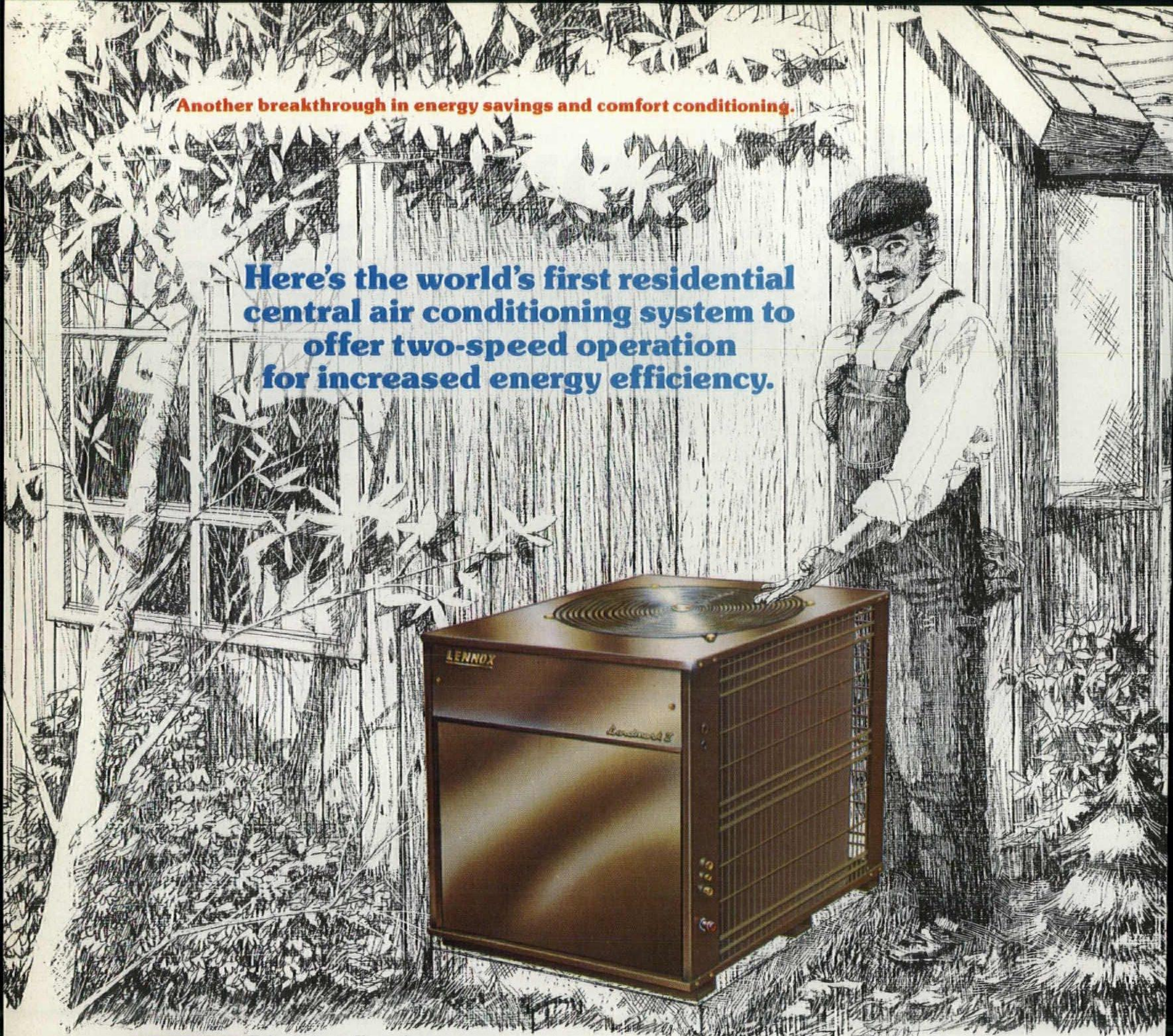

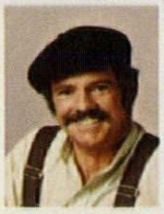

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The HS11 offers unique selling benefits for quality home builders and light commercial customers.

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The two-legged thermostat

Jay L. McGrew

The human mind and body have a tremendous potential to compensate for the errors in our buildings. Carefully instrumented research throughout the country has produced a striking conclusion.

Jay L. McGrew, Ph.D., is president of Applied Science and Engineering and of the Vertical Tube Reactor Corporation, both in Englewood, Co. He is involved in many energy-related projects such as the study and improvement of the thermal performance of commercial and residential buildings. The efforts of his firms in many states often entail testimony to legislative groups on energy matters. Prior to establishing his own firms in 1971, McGrew was the Chief of the Heat Transfer R & D Laboratory at Martin Marietta in Denver, where he directed several aerospace programs.

Each animal is specialized to function efficiently under its own set of "thermal" environments. In general, temperature is controlled by altering the rate of heat loss to match heat production, but a limited ability to alter heat production based upon temperature is exhibited in some animals. Shivering, for example, in humans, dogs, and certain other animals is an attempt to increase heat production in cases of subnormal body temperatures. Heat loss, which can be varied over broad limits in warm-blooded animals, depends upon the combined mechanisms of radiation, convection, conduction, and evaporation.

Physiological studies have shown that over long time periods the human species has a great ability to adapt to very diverse climates. Consider, for example, the extremes of the Eskimo and the Negro. The Eskimo is physically adapted to succeed in the Arctic climate. He is short and rather stocky, with short fingers and extremities. He has a great ability to develop subcutaneous fatty tissue for insulation and the gastronomical ability to digest large quantities of energy-producing fat. The Eskimo has been described by various authors as being quite comfortable while mostly bare in an igloo at 32 F.

The Negro is physically adapted to the hot, humid climate of the Equatorial regions. As contrasted to the Eskimo, the Negro is characterized by much greater height, with extended extremities which increase heat loss, and little if any fatty tissue on those extremities. The Negro has a highly developed and efficient perspiration system, permitting him to effectively cool and maintain physical activity under extremely hot conditions. Persons from other geographical origins generally fall between these two extremes in their ability to tolerate heat or cold.

Within a given human group of common geographical origin, both systematic and random variations exist in the ability of the individual to adapt to the environment. In general, the younger individual tends to have a higher metabolism rate per pound of mass and a smaller surface area. Thus the younger person, producing more heat and losing less, is comfortable in cooler environments. As the person ages, the metabolism rate decreases as the surface area increases and the individual tends to require somewhat warmer temperatures. As a general rule, females have somewhat lower metabolism rates and also higher ratios of surface area-to-heat production than men. Thus females generally tend to prefer somewhat warmer temperatures than men of the same age and origin. The metabolism rate of females decreases more rapidly with increasing age than does that of the male.

In addition to the problem of maintaining constant temperature in the hypothalamus of the brain by losing heat at a rate almost equal to the rate of production, the feet, hands, and exposed portion of the head pose special problems in maintaining physical comfort. The body uses these three areas as special variable heat exchangers in maintaining hypothalamus temperature. If the brain senses a temperature rise due to increased physical activity or other factors, the peripheral artery system in these areas is dilated somewhat and warm blood is circulated closer to the surface, thus increasing cooling. Similarly, if the hypothalamus senses temperatures below normal, constriction of the peripheral arteries occurs.

Human comfort

Since the flow of blood to these three heat exchange areas might be greatly reduced or perhaps even stopped under conditions of extreme cooling, and such an event would, if continued, result in freezing and loss of the extremities, these areas are liberally covered with temperature sensors. Thus, the individual senses a feeling of cold and discomfort if the extremities are cold even though the body core temperature is proper. Comfort then is nature's way of informing the individual about the condition of various body areas and urging some corrective action to be taken. Feet, hands, and exposed portions of the head are the primary "comfort sensing" zones.

Stratification: During cold weather, a surprisingly large vertical temperature gradient will exist in a typical room. Our measurements in various buildings show that temperature differences of 10 F to 20 F are very common. Thus with a mid-room temperature of 70 F at the thermostat, the floor might be 60 F or even cooler. Many individuals will experience serious discomfort with their feet in 60 F air even though on the average the room is at 70 F. Older individuals will generally experience greater discomfort than younger people under such conditions.

Vertical temperature stratification in cold weather results primarily from the effect of windows, infiltration, and room heating. A boundary layer of cold air flows down past the window and forms a horizontal layer of cold air at the floor. Cold air from the opening of a door will cause the same effect. Heat introduced into the room causes an upward flow of warm air. Thus, stable vertical temperature stratification occurs in cold weather. Sustained vertical air mixing will transfer heat to the floor, thus reducing the temperature gradient and increasing comfort. Our experiments have shown that it is necessary to duct air from near the ceiling and exhaust it at the floor at a volumetric flow rate equivalent to 1/20 of the room volume per minute to adequately reduce the vertical temperature gradient in cold winter weather. This vertical mixing is particularly important in cases of vaulted ceilings, large glass expanses, or frequent door openings. Proper mixing permits the building to be operated somewhat cooler during winter while actually increasing comfort, since floor temperatures are raised and ceiling temperatures are decreased.

Radiation: Cool air flowing past the human body can cause excessive heat loss and discomfort. But radiation heat loss can also cause discomfort. Under normal circumstances a typical individual might radiate between 5 and 10 Btu per hour per square foot of surface exposed to the environment, and sufficient blood circulation can occur to maintain a comfortable temperature over the exposed surface. If, however, reduced circulation occurs, for example, because of constriction of the peripheral artery system resulting from general cooling of the body, or a cold radiation absorption surface is "seen" by the exposed body surface, low surface temperature and attendant discomfort will result. The figure next page indicates the relationship between comfort and the thermal energy which must be supplied to the radiating exposed body surface, the temperature of the cool absorbing surface.

It should be remembered that a comfortable surface temperature for one individual is not necessarily comfortable for another. If, as an example, a particular individual perceives 50 F skin temperature as "comfortable," which is reasonable, and has a blood circulation capability adequate to deliver approximately 8 Btu per hour to each square foot of exposed skin, then that individual will generally experience comfort radiating to an absorbing surface at or above 40 F. If, however, the absorbing surface drops below 40 F, the individual experiences discomfort due to cold exposed-skin temperature.

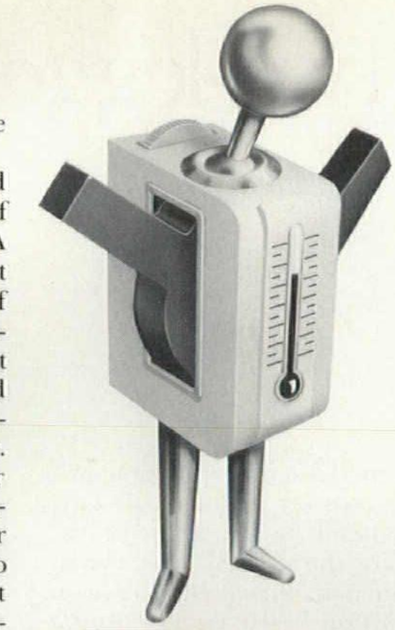
A very common example of discomfort due to radiative cooling is the individual sitting next to a window on a cold winter day. The temperature of a single pane of glass tends to be somewhere near the average of the indoor and outside temperatures under calm, sunless conditions. For example, at night with no wind, if the room air is 70 F and the outside temperature is 0 F, the glass temperature will be about 35 F. Most individuals will be quite uncomfortable while close to such a cool surface. If, on the other hand, the outside air temperature were 30 F, the glass temperature would be near 50 F, and most individuals would feel comfortable in spite of the radiative effect. The downward descending layer of cool air in such conditions leaves the bottom of the glass at about the average glass temperature and forms the cold boundary layer on the floor as described earlier. Thus, the individual might not experience discomfort because of direct radiative skin cooling, but might nonetheless experience discomfort due to cool feet. An optically opaque drape covering the window will of course greatly ameliorate the problem of discomfort due to radiative cooling. Higher metabolic rates caused by such factors as increased physical activity decrease the level of discomfort as well.

The individual and energy use

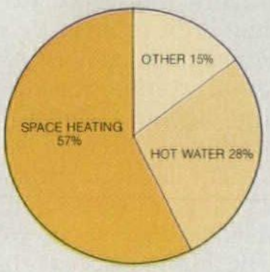
A large fraction of the energy used in buildings is consumed in order to maintain human comfort but, as we have seen, "comfort" is not based upon a fixed set of temperatures but is dependent strictly upon the heat-production and heat-loss relationship between the individual and the environment.

In a study of energy use in a sample of homes in Denver, we were surprised to find that the home having the poorest energy conservation design used less total energy over the year and during each winter month than almost every other home in the study. In the same study we also found that no significant correlation could be found between double-pane windows and increased insulation, and reduced energy consumption for the building as a whole. Subsequently our studies in Salt Lake City, Seattle and Portland, Phoenix and Las Vegas have produced similar results. Others such as Wybe Van Der Meer of the University of New Mexico and the Home Builders Association of Washington State have reached similar conclusions. On the other hand, during the past few years we have also conducted detailed studies of heat flow through windows, walls, ceilings, and floors in occupied buildings and have found, for example, that double-pane glass clearly reduces heat loss from windows during cold weather, and adding insulation to an uninsulated ceiling also significantly reduces heat loss. It might then appear that the results of the overall energy use studies and our detailed heat-flow studies are contradictory. More careful analysis shows that such is not the case.

The occupant of the poorly built home has simply become a resident expert on energy

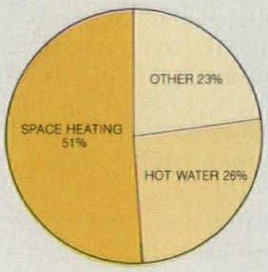


THERMOSTAT MAN



GAS & ELECTRIC HOMES

SPACE HEATING	94,627,000
WATER HEATING	47,048,000
OTHER USE	23,953,000
TOTAL	165,628,000

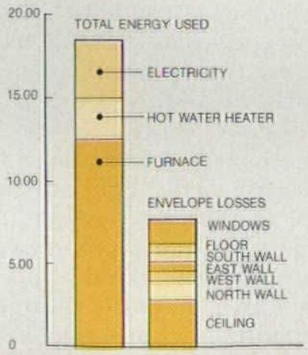


ALL ELECTRIC HOMES

SPACE HEATING	53,074,000
WATER HEATING	26,256,000
OTHER USE	23,952,000
TOTAL	103,282,000

HOME ENERGY USE, NORTHWEST U.S.

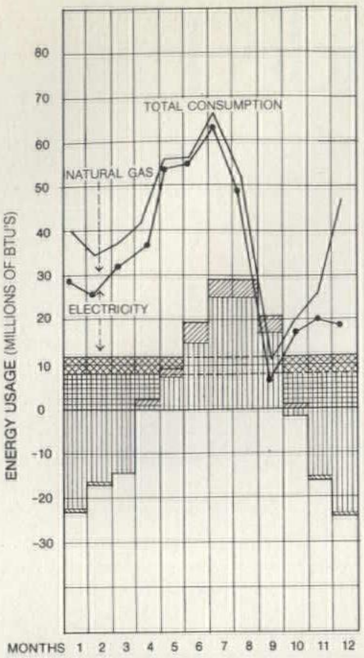
MILLIONS BTU'S



ENERGY USE IN A MINIMALLY INSULATED DENVER HOME DURING DECEMBER 1979.

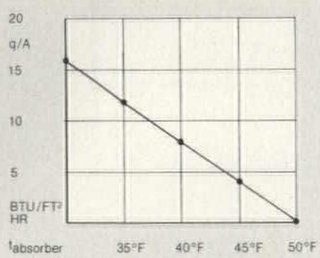
AVERAGE OUTSIDE TEMPERATURE DURING MONTH: 32.3°F

LONG TERM AVERAGE DENVER DECEMBER TEMPERATURE: 32.6°F

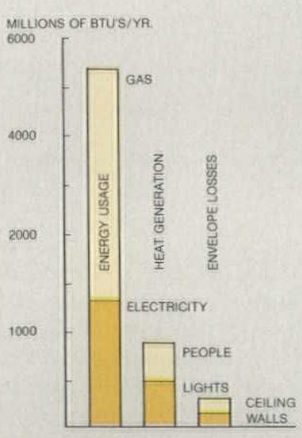


FIRST NATIONAL BANK OF ARIZONA
YEARLY ENERGY PROFILE

KEY
CEILING LOSS
WALL GAIN
WALL LOSS
CEILING GAIN
PEOPLE
LIGHTS



q/A = Heat which must be transferred to the exposed surface by blood circulation in order to maintain a "comfortable" 50°F skin temperature while radiating to a cool absorbing surface at temperature t



ENERGY USE PROFILE:
CHELALEM SCHOOL

The charts shown portray the energy use character of building types: high internal load versus high external load.

conservation. She has learned to do the innumerable small things which, taken collectively, reduce energy consumption and thus compensate for the poor building. She has learned to operate the building economically while maintaining what she considers adequate comfort.

Whereas internally generated heat from lights, people, and equipment is generally large compared to envelope losses in nonresidential buildings, it is usually not too significant in residences. Typical results are shown in our recent detailed instrumented study of a modest frame home in Denver. The 950-sq-ft home was instrumented in early November, 1979, and was continually monitored for several months. The four uninsulated walls were instrumented with heat-flow to measure total heat-flow through the wall. Thermocouples were used to measure inside and outside wall surface temperatures. The floor and ceiling were also instrumented for heat flow and temperature. The floor is completely uninsulated and the ceiling is minimally insulated with a simple reflective barrier. Thermocouples were used to measure mid-space temperatures in the ventilated crawl space, and mid-space and under-roof temperatures in the ventilated attic. Hot water heater and furnace gas consumption were monitored by individual meters. Energy use in the building was monitored for the time period from December 1 through December 31, 1979.

During December about 7.5 million Btu flowed through walls, ceilings, floors, and windows, and over the Denver winter heating period we project a total heat loss of approximately 34 million Btu from the house. Total energy use for the house for the past year has been 148 million Btu in natural gas and 18.2 million Btu in electricity for a total energy consumption of 166.2 million Btu. For the minimally insulated home in cool Denver, heat loss through the structural elements is about 20 percent of the total energy consumed. Thus it can be seen that variation in such items as hot water and electrical usage due to the various living habits of diverse families can easily mask the effect of the structure. Indeed, returning to the low energy consumption in my first example of a poorly constructed home we can reasonably conclude that the occupant is responding to the economic need to save money. In such a case one would have to be extremely cautious in recommending any energy conservation measure to the owner because many "conventional wisdom" items simply would not produce measurable and economic savings.

Energy use in various climates

In our studies in the diverse climates of Denver, Salt Lake City, Phoenix, and Seattle, we evaluated energy use in single-family homes. A comparison of these study results is instructive. Seattle homes tended to be maintained at about 68 F in the winter (many were cooler), while Phoenix homes were maintained considerably warmer. In general the Seattle resident stated a preference for the somewhat cooler temperature, while the Phoenix resident readily indicated discomfort at temperatures below 78 F or 75 F. At the same time we found that the levels of artificial illumination in the Seattle homes were much higher than those encountered in Phoenix. Similarly, hot water heaters in Seattle homes were maintained at considerably higher levels than were those in the Phoenix homes. It can be reasonable argued that low electricity rates in Seattle might play a part in the high illumination levels and higher hot water temperatures found, but certainly part of the reason also might be related to the cool, damp, relatively sunless winter encountered in that area. Higher illumination and warmer water might tend to compensate for the cooler environment. On the other hand, in Phoenix, heat and light are the foes; lower illumination and tepid water are preferable.

Thus we see that in Seattle the individual is physically more comfortable in a cooler building since he has tended to adapt to cooler environmental temperatures, but emotionally prefers brighter environments and hotter water. By contrast, the Phoenix resident has adapted to warmer temperatures but prefers more subdued light levels and cooler water.

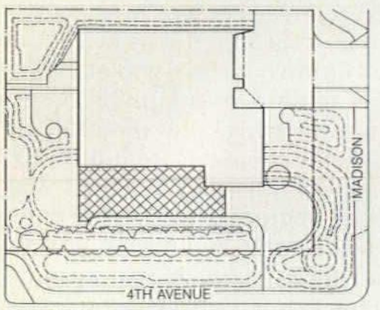
Engineers and technicians at the Applied Science and Engineering (ASE) laboratory in Denver have studied energy consumption in residential and nonresidential buildings in various areas of the United States. They have conducted experimental research in actual buildings to develop a wide base of "real-world" data. They have instrumented homes and nonresidential buildings in Denver, Salt Lake City, Phoenix, Las Vegas, Seattle, and Portland to measure heat flow through ceilings, walls, floors, etc., and electrical energy use, furnace gas consumption, door opening, and many other factors. The development of precise computer models based upon the "real-world" data can be used by the architect or engineer, for example, to evaluate more accurately and readily the actual thermal effect of various types of window arrangements and treatments in a particular application, or to evaluate the actual payback of insulation or the effect of color on heat flow.

Conclusion: These studies clearly show that the building operator is the most important single variable in establishing energy consumption levels. Our studies show that a second factor contributing to the lack of correlation between good thermal construction and reduced energy consumption is the fact that in most homes and nonresidential buildings the envelope is not the major physical factor in energy use. We have instrumented numerous banks, churches, schools, office buildings, and other types of nonresidential buildings and have found that internal heat production and the mechanical equipment are generally the most important physical factors involved in their energy use. □

Solar house and research facility, Denver

This building is loaded

Solar architect Richard Crowther orchestrates his own new house and working space for optimum energy efficiency. The result is a lesson in solar options and an eyeful of building.



SITE PLAN N↑ 20'/6m

The American solar house is both part of the problem and part of the energy solution. Solar prophets and wisemen alike extol the merits of earth berms and sun for use in their new single-family dwelling. Regardless of the type of energy consumed or the efficiency of consumption, the single-family home is the worst possible fashion in which to live if the objective is optimization of energy usage. As tragic as it is, as per capita income increases, per capita energy consumption also increases. The most energy-conserving people in America are also the poorest. Conservation of energy is therefore not the top priority in choice of dwelling. When we, as architects, build a house, we accept energy waste and "space piracy."

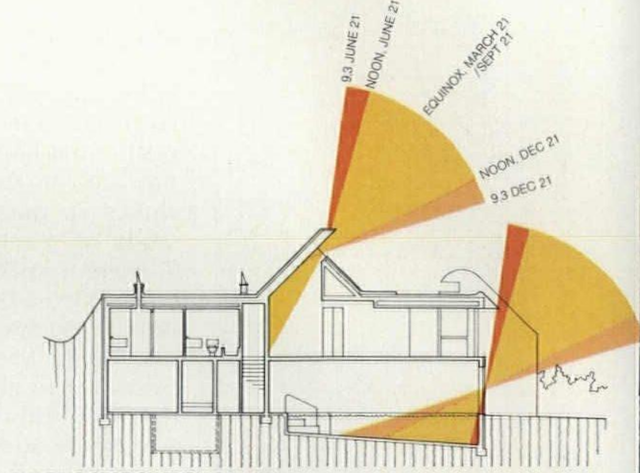
The research and design which typifies all of Crowther's buildings is in greatest abundance in the houses. In his own new research facility home in Denver, he accepts the role of "space pirate." His laboratory-house-retreat-office keeps the paradoxical incongruities of the outside world at bay. Inside is a world where life makes more sense.

Like Dr. McGrew, author of the previous article, Crowther recognizes the importance of the human being in compensating and regulating energy consumption. He readily accepts the sensitivity of his own body to guide him in fine tuning his own interior environment. In a very real sense, he wears his building like clothes.

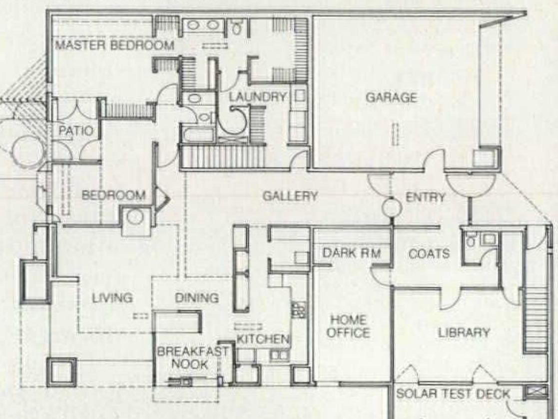
This is not the first home Crowther has built for himself. During 40 years of design and experimentation he has built five; his first one was built in 1943. All of his own houses have served as home offices, many have also been full-size test facilities, and some have been intended for multiple occupancy as this one is.

There were, however, two new programmatical explorations for this house that have had a rather large influence on the resulting form: first, the large solar-heated gallery space adjacent to the entry serves as a primary heat "accumulator" for the house; second, the cellular nature of the plan enables parts of the house to be thermally isolated. In keeping with the full-size laboratory function of the building, Crowther experimented with many different types of energy sources, as well as sizes and shapes of space. There are nine thermal zones in the building.

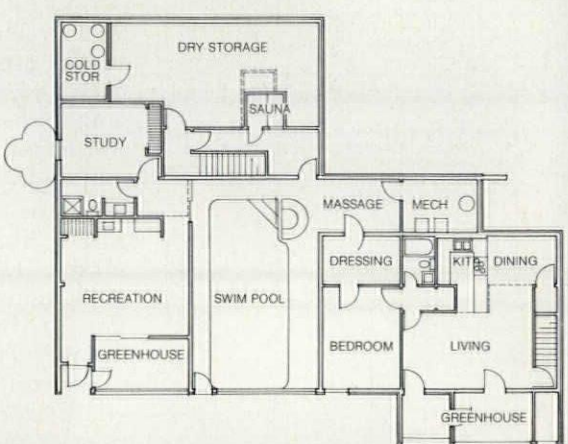
Central gallery: The key thermal zone in the house is the central gallery. Says Crowther: "Get the hottest air to one place—you can use it more effectively." Direct and reflected sunlight enters through a narrow band of double-glazed clerestory windows at the apex of the shed roof space. The dark colored concrete surfaces store the direct-gain solar heat and radiate heat. A ceiling plenum in the kitchen also channels heat into the gallery from the appliances. Of course heat given off from the occupants using the space also rises in the gallery. Excess heat is destratified by a fan-and-duct system that draws off the upper layer of heated air and delivers it to the concrete thermal mass of a storage room in the basement below. In the heating season, there-



BUILDING SECTION THRU GALLERY



MAIN LEVEL



LOWER LEVEL N↑ 20'/6m

(Top right) The eastern elevation of the building includes the entry. After passing the entry air lock, one enters the gallery (above) and walks through the dining area (middle right) to the living room. From there (at right) both the gallery and dining space are in view.

Solar house and research facility

fore, the upper-level floors are warmed from below. In the cooling season, this heated air is exhausted into a large duct adjacent to the entry which also can channel air from the swimming pool on the lower level to the roof.

Work space: The work space of the building can be entered and used in complete separation from the remaining building. The unheated entryway serves as a buffer from the building exterior to the office interior. To the south, the solar test deck acts as an additional climatic buffer. In the winter months the sunlight falls on the inside wall of the solar test deck, while in summer the direct solar heat falls only on the floor. As the space itself heats up, of course, the doors into the library can be opened. Also for daytime heating, a hooded venturi ventilator can draw the heated air through the cored slabs in the ceiling above the library by induction or wind movement. In the summer, the same ventilator can draw the cool night air through the test deck space and into the roof slab. The test space itself is, of course, vented in this manner. It can also be exhausted by the negative pressure created when wind passes over the wind-foil shape on the roof or through vents in the south elevation.

The heat source for Crowther's home office, adjacent to the library, is simply its wall and window. The thinly insulated 8-in. concrete wall is colored and textured to absorb solar heat. There is direct solar heat gain available through the double-glazed window. Blinds sandwiched between glazing sheets offer solar control.

Main living area: The living, dining, breakfast, and kitchen areas are designed to be a thermodynamically isolated ensemble within the house if necessary. The sitting area, breakfast nook, and kitchen all have direct sun, and when the greenhouse below the living room heats up, hot air is also available to the living space above it.

The deep-set concrete boxed windows in the living room store heat in the winter and provide shade in the summer. By pulling insulating panels across these windows, heat gains and losses can be regulated. Crowther prefers that the heating and ventilating function of windows be separated. The windows are not operable. Ventilation is available from an exterior-to-interior weather-sealed ducted vent. Eutectic salts will be installed eventually behind the seating to further capture solar heat. Their low-temperature phase change captures heat and then serves as a radiator. A wood stove is nestled into the inside wall of the living space and can be used for cooking.

The breakfast nook provides another strategy with its direct solar gain taken by the dark quarry tile on its concrete floor, movable side-sliding insulation, and exterior canopy for summer shading. Ventilation is available but again separate from the fixed single-glazed window.

Both living room and kitchen receive additional light from "sky shafts," the periscoping vertical tunnels which channel reflected light down into the space with minimal heat loss.

Sleeping quarters: The sleeping quarters rely on insulation and petty heat theft. Auxiliary spaces are protected from heat loss on the north side by a concrete-covered earth berm (the covered earth remains dry). Below the laundry and dressing space is the heated space storing drawn-off gallery heat, a solar heated water tank, and sauna. This heat permeates the concrete mass in this section of the house. The west-facing sunroom acts as a climatic buffer for the bedrooms. Direct solar gains to it are controlled by vertical shades.

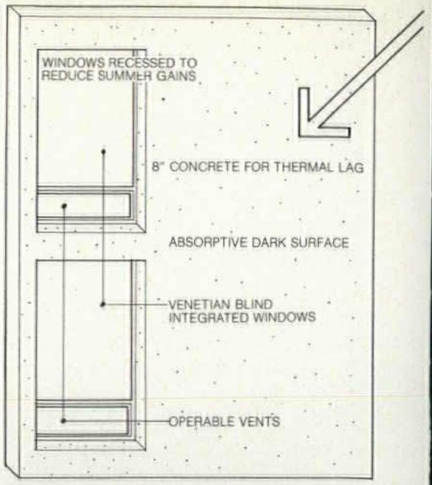
From above, a "solar chimney" services the master bedroom. A solar chimney acts like a west-facing solar air collector with its lid off. By heating up in summer, it induces air flow in the space. Circulation begins outside on the patio. Air is drawn through a ducted vent (cooled) below ground and enters the room just above the floor line. It then circulates across the space at a diagonal and up through the solar chimney. In winter, the solar chimney is shut, but the underground duct is used to temper the fresh air brought into the room.

Sky shafts help illuminate the bathroom, laundry, and guest bedroom. A sky shaft also illuminates the garage to the east of the sleeping and dressing areas. The garage itself acts as a climatic buffer.

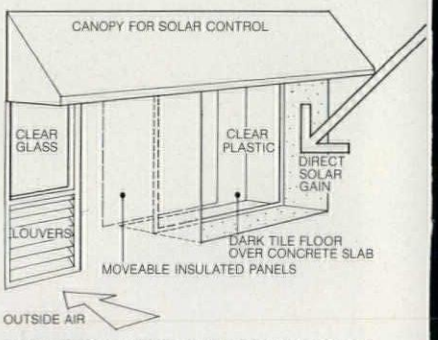
Lower level thermal zones: The lower level consists of four primary thermal zones. The thermal mass of the storage zone in combination with the sauna serves as a primary, well-insulated heat sink for the building. The caretaker's apartment can function completely independently from the rest of the house, and, although the functions of the swimming area and recreation spaces are related, they can be maintained as two separate zones.

The apartment space is below grade except to the south. The solar greenhouse serves therefore as the primary heat source with access through the greenhouse door. Venting from it is achieved when negative pressure over the roof's airfoil pulls the heated air up through a duct to the roof.

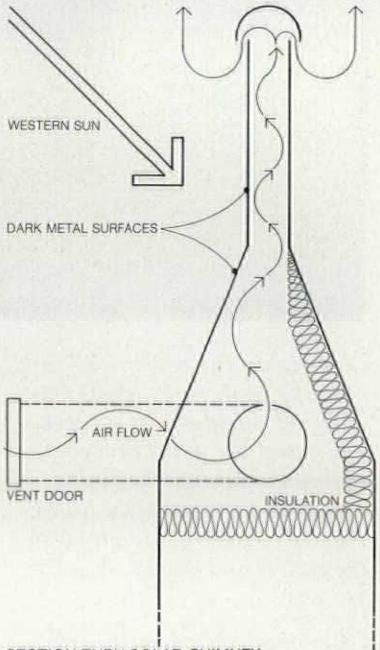
The pool space is, of course, heated primarily by the pool itself. When the sun enters the south-facing window wall, it falls into the deep end of the 11,000-gallon swimming pool. The sun shading is such that the lower winter sun penetrates well into the rear of the pool. Water, of course, is an excellent heat storage medium. A floating, translucent pool cover reduces evaporative heat loss. The pool is also heated by 400 sq ft of liquid solar collector on the roof of the building. (This is Crowther's first active collector for his own house.) Its heated hydrocarbon fluid circulates in a loop from roof to 1100-gallon concrete water tank in the underground storage space adjacent to the pool. The pool water is then piped over a heat exchanger from the storage tank. A water-to-air



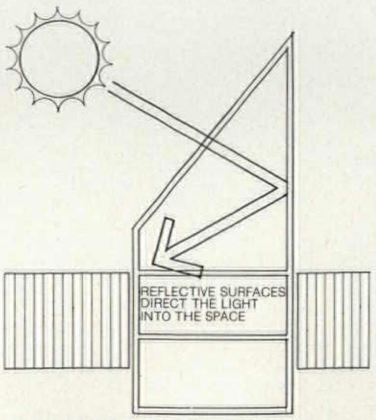
SUBSYSTEM 7: DIRECT GAIN & STORAGE WALL



SUBSYSTEM 8: UPPER LEVEL BREAKFAST NOOK

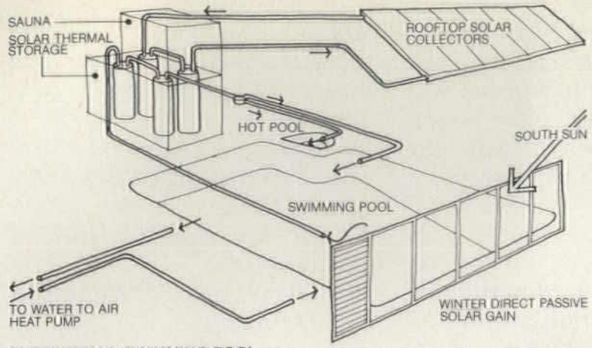


SECTION THRU SOLAR CHIMNEY NORTH SIDE MASTER BEDROOM

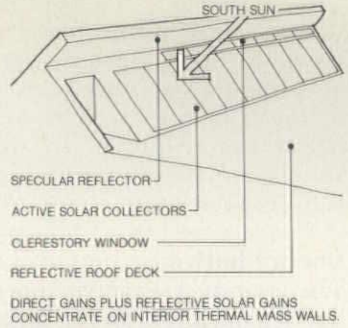


SKYSHAFT INSULATING AIR CHAMBERS

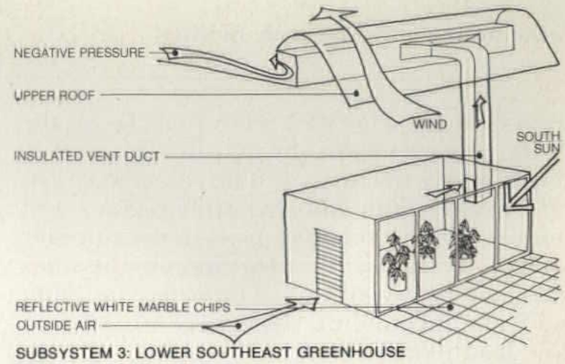
Opposite: (top) Southeast exterior; (bottom) west view.



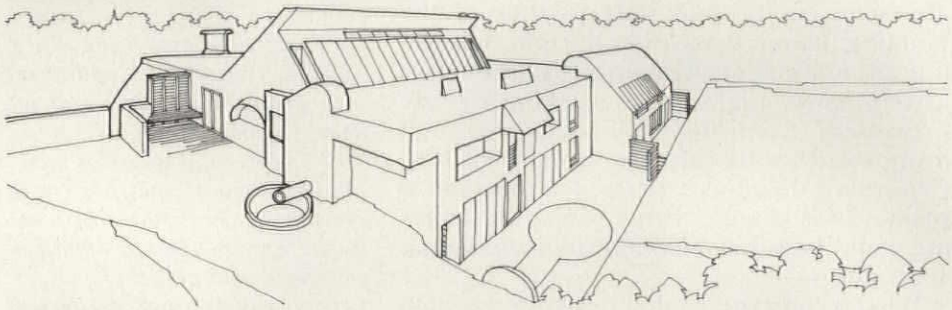
SUBSYSTEM 1: SWIMMING POOL

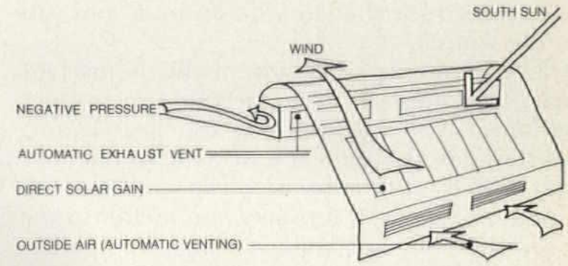


SUBSYSTEM 2: CLERESTORY

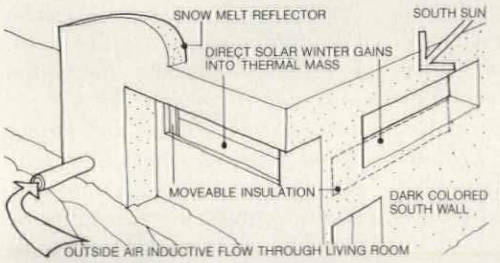


SUBSYSTEM 3: LOWER SOUTHEAST GREENHOUSE

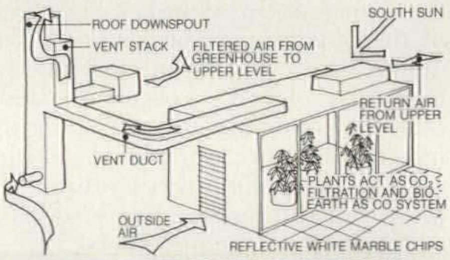




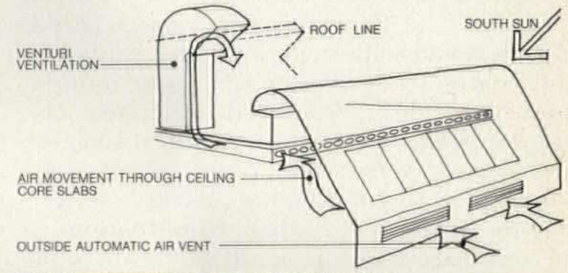
SUBSYSTEM 4A: SOLAR TEST SECTION FOR COOLING (MODE 1)



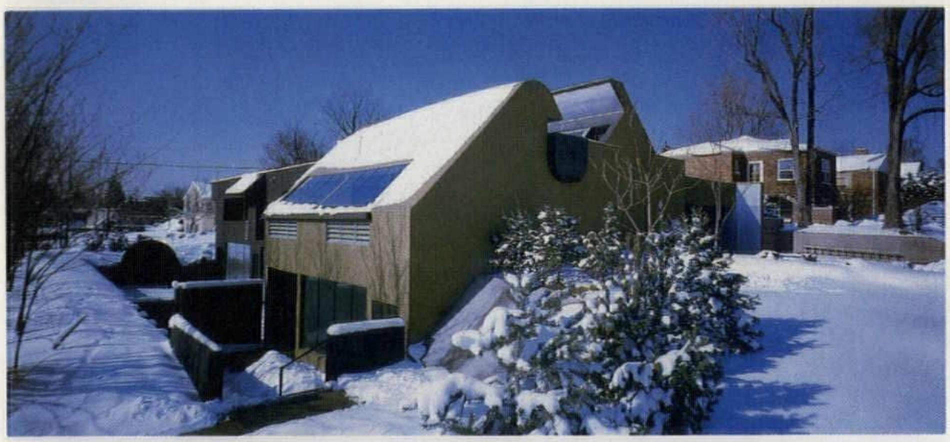
SUBSYSTEM 5: UPPER LEVEL LIVING ROOM



SUBSYSTEM 6: LOWER SOUTHWEST GREENHOUSE



SUBSYSTEM 4B: SOLAR TEST SECTION (MODE 2)



heat pump is installed to deliver tempered air to the spaces above, or it can be reversed to heat the pool in other seasons. The pool space is below the living room and its heat rises to the floor above.

Another south-facing greenhouse services the recreation spaces adjacent to the pool, the sun entering the greenhouse through clear, cellular sheet plastic. The white marble-chip patio outside acts as a solar reflector adding to the solar gain of the greenhouse. The space can provide air tempering, heat, humidification, and ventilation for the recreation space and is intended to function as a natural air filtration system. Return air from the spaces above is ducted down into the greenhouse. Fresh air is added when necessary through outside vents. Air is circulated with the help of an induced air flow which terminates in the large downspout from the roof. Filtered air then is directed back into the upstairs spaces.

The total design: All of Crowther's buildings are designed from the inside out. There were fewer drawings for the Crowther house than for a normal building although the plan emerged only after several different versions. Crowther served as his own contractor and made running changes in the building as it was being constructed.

The spaces which need light and view are clustered to the south and west of the building. Earth berms protect the north exposure from winds. The east elevation faces the street, provides access by car, and asks rather emphatically for privacy. The recessed courtyard to the south will also offer privacy and augment the recreation spaces in the summer while opening the lower elevation to the sun's direct and reflected rays. The walls extending out from the building will help control the air flow around it. Trees and foliage are strategically placed for shade in the summer and sun in the winter.

The elements of weather will themselves play an important role in the functioning building. Not only will the sun heat it and wind cool it, the snow will insulate its flat roof and reflect sun onto its walls and into its glazed openings. Rainwater and melted snow from the roof are collected in a 700-gallon cistern for watering the landscape.

The construction material is reinforced concrete. The floors are prestressed, cored, prefabricated slabs supported on steel beams and columns. The outer walls and foundations are solid prestressed concrete. The exterior walls are surfaced with a layer of polystyrene board with a waterproof, self-bonding synthetic coating called "Settef." The insulation is 4 in. thick from footings to the roof except on the south where the solar heat gain was desired, and only a 1-in. layer was used. The polystyrene roof insulation is also on the exterior, covered with an aluminized protective layer.

Through the use of insulated, heavy thermal mass, Crowther is able to "ride out" rapid 40 F fluctuations in climate with only minor variations of interior temperature. In addition, the walls, floors, and roofs are all integrated thermally causing the structure to "pull" heat from place to place within the material.

The choice of material greatly affected the color of the building. Although Settef comes in a great variety of colors, a multi-colored surface would be impractical. The material is not mixed like paint and must be troweled into place. Crowther chose, however, to moderate the heat gain by applying a lighter color to the east and half of the south façade. Amazing as it may sound, he was afraid that he would overheat his building combating the cold Denver winter with the hot Denver sun!

The texture of the Settef also adds to the thermal advantages of the material. A high-texture material maintains its protective "thin film" better than a smooth surface in moving air. There is a similar motivation for insetting the windows to protect the thin film.

Reflective surfaces are another important part of the design. In addition to the snow and marble chips, a reflective surface on the garage wall bounces sun to the dark-colored recessed garage door, warming the garage in winter and helping to melt the snow on the driveway. The reflective surface on the visor over the gallery clerestory helps attract heat to the gallery as well as to the solar panels below the windows. In summer, with the snow gone, the aluminized surface of the roof reflects solar heat.

Energy holism

The logic and sensitivity portrayed in the spatial organization, siting, and configuration of the building proceeds from place to place, choice to choice, and scale to scale in the building. Rooms behave like ducts in channeling air movement, wall surfaces and colors are chosen to augment the decisions already expressed. Even the mailbox is designed using swatches of carpet to avoid heat loss. Crowther's design is expressed in time and is planned for change. If necessary, the building could be subdivided into four individual apartments.

What is constant in other designs is variable for Crowther. In addition to the physical shell of the building, consideration is given to air quality. Both organic and inorganic air filtration have played a role in the design. The building eliminates air infiltration; therefore, its air must consciously be renewed. The air outside is polluted; therefore, Crowther promotes adding air volume to his house in order to dilute the pollutants.

He is also concerned about the negative bodily effects that electromagnetic fields might have and has added wire mesh to the inner west walls and portions of the ceilings to ground them. He is acutely conscious of the biophysical effects of fumes, outgassing of materials, and all materials that come in contact with the body. He is a vegetarian and won't allow smoking in the building, period.

He is monitoring the ionization content of the air in various spaces of the house. People are themselves "positive ion machines." Residential and commercial interiors, however, typically lack adequate negative ions for optimal health. For this reason the major spaces in the house contain devices attached to the ceiling which initiate negative ionization. He is experimenting with the combination of positive field resonance and negative ion generators.

Few buildings built today are totally self-sufficient. Richard Crowther uses tiny 1000-watt electric heaters spotted throughout the upper floor: in the guest bedroom, the breakfast nook, the sunroom, and one in the living room. The bathrooms (there are five) have auxiliary 500-watt heaters. Crowther had originally intended that the liquid-to-air heat pump serve as his main source of backup and provided ducts for that purpose into the main spaces. In use, however, the building responds so well to solar energy that he prefers the "toaster" size electric heaters.

The key to the Crowther energy-efficient design is his use of buffers. The landscaping is a buffer for the building, and cellular buffer spaces protect the interior spaces from the exterior. The series of soft shields do not say no to nature, they just order her stay. [Richard Rush]

Data

Project: *Solar Research and Energy Design Residence, Denver, Co.*

Architect: *Richard L. Crowther, Principal of Crowther Architects Group.*

Client: *Mr. and Mrs. Richard L. Crowther.*

Site: *corner site with 100-ft and 125-ft frontages.*

Program: *2400-sq-ft primary residence. 1000-sq-ft library, solar test deck and home office. 1000-sq-ft caretaker's apartment with greenhouse. 1000-sq-ft indoor swimming pool area. 1000-sq-ft educational, recreational, guest quarters with greenhouse and three-car enclosed garage. Outdoor sunken courtyard and gardens.*

Structural system: *prestressed concrete perimeter, interior foundation, and enclosure walls. Prestressed concrete floor and roof slabs. Lower level slab on grade. Steel columns and beams. Wood frame clerestory and south side enclosure.*

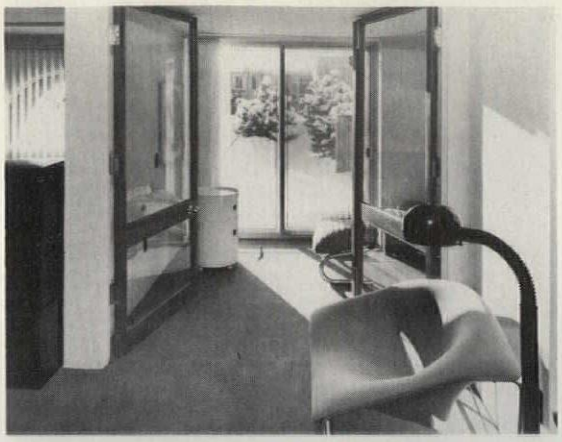
Major materials: *waterproof synthetic coating over polystyrene rigid insulation as an exterior envelope surface. Insulating glass and acrylic glazing. Single-ply roofing. Interior dry wall, quarry tile, wood flooring and carpet (see Building materials, p. 226).*

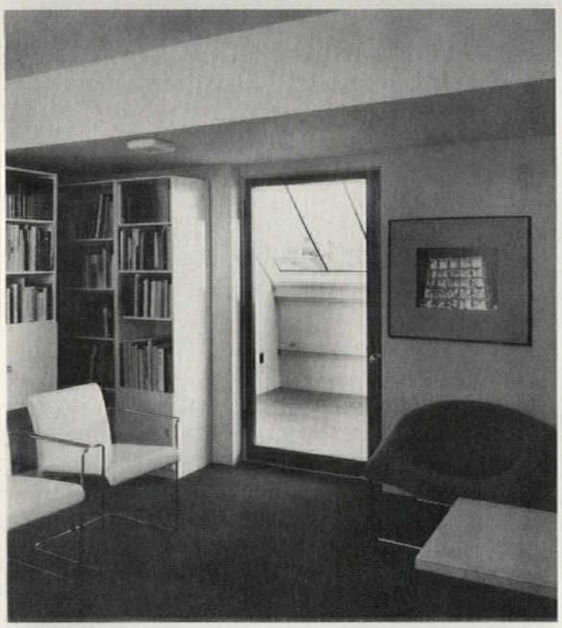
Mechanical system: *active solar collector for hot water, sauna, and swimming pool heating. Water-to-air heat pump incorporated in pool. Electric fans and assorted low-wattage electric heaters.*

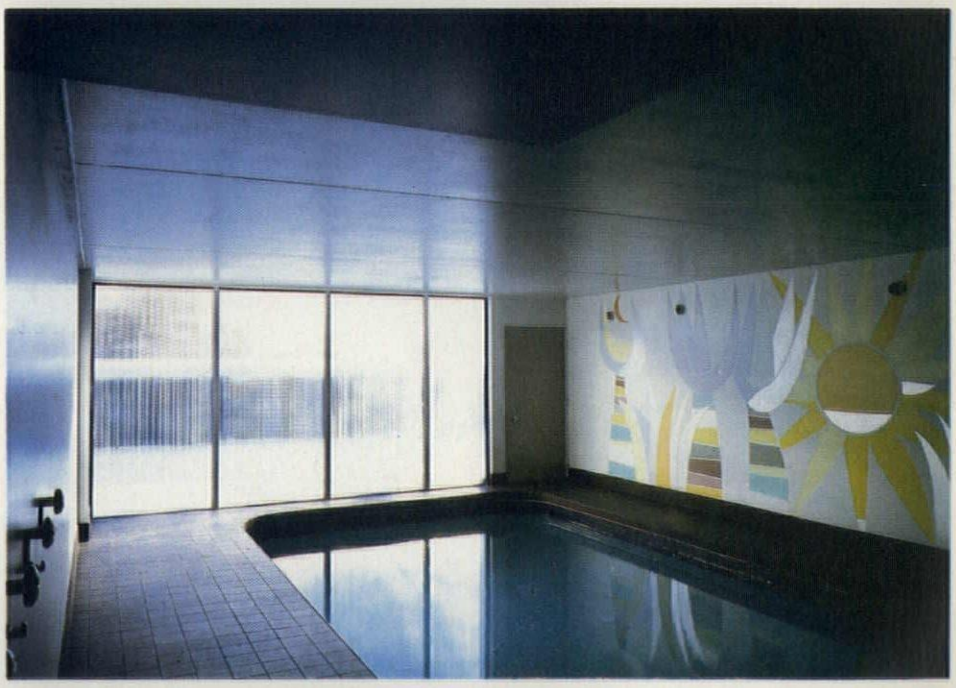
General contractor: *Richard L. Crowther.*

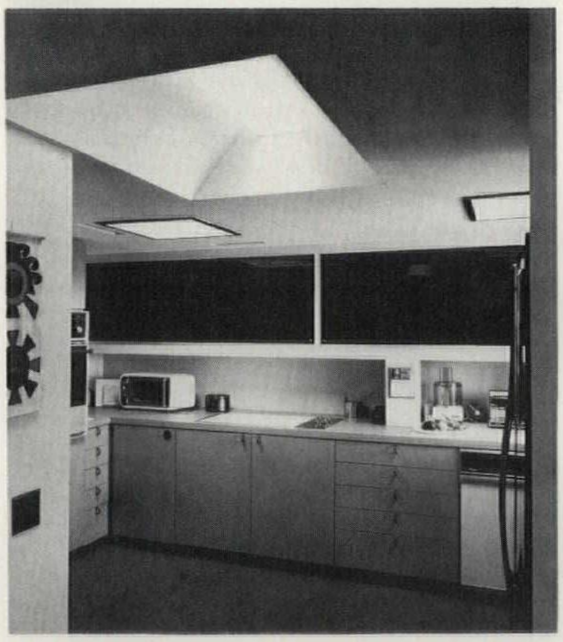
Costs: *$320,000.*

Photography: *Joel Strasser.*







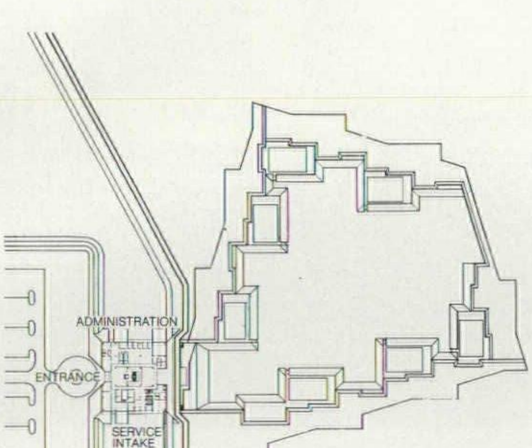


Photos left to right and top to bottom: sunroom between bedrooms, dining and living rooms, library next to office, swimming pool space, kitchen, work space in guest bedroom.

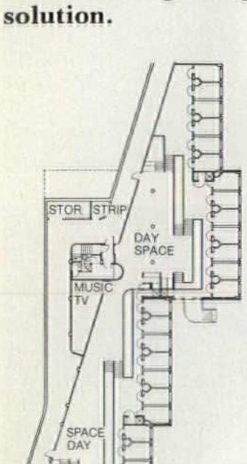
Minnesota High Security Correctional Facility, Oak Park Heights, Mn

City under sod

Covered on three sides by earth, this high-security correctional facility proposes an interesting energy-saving solution.



LEVEL 4



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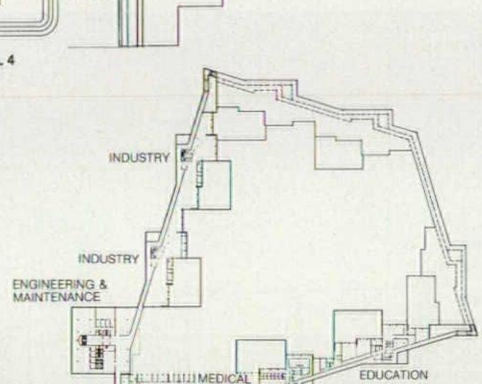

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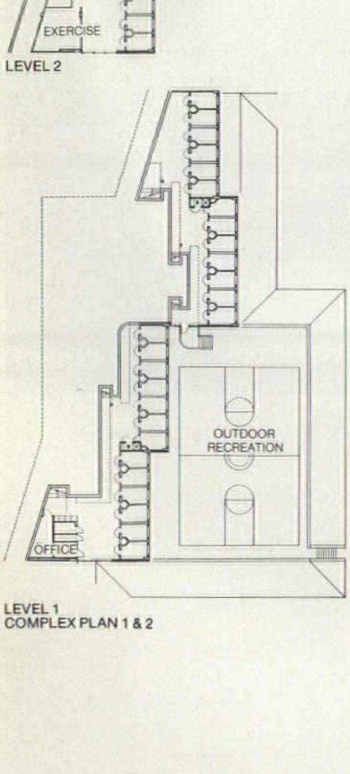
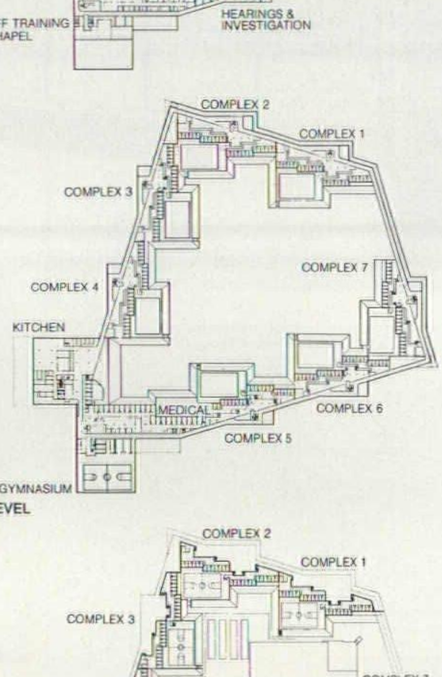
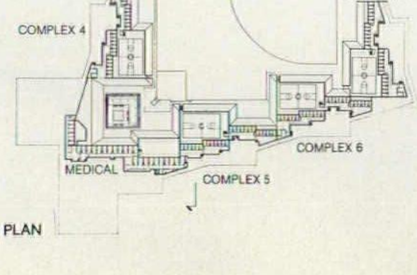


LEVEL 1
COMPLEX PLAN 1 & 2



SECOND LEVEL



FIRST FLOOR PLAN

It may seem perverse to suggest that when we turn to models for energy-efficient cities, we should study an underground prison. Yet this facility, planned for a hilltop site in a wooded area 40 miles from Minneapolis-St. Paul, should offer valuable data on both energy conservation and the kind of environment created with earth-sheltered architecture. Designed by Gruzen & Partners and Winsor/Faricy Architects, the 275,000-sq-ft complex for 400 inmates will be covered with earth on three sides to cut costs of heating and cooling.

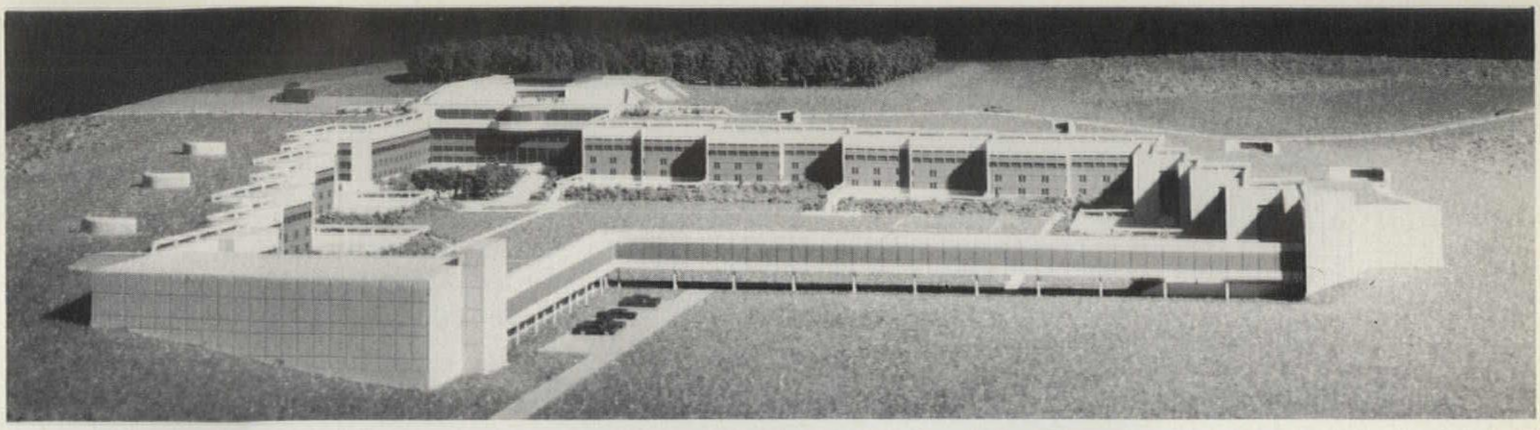
The rugged terrain, which varies up to 150 ft in elevation, including a large gully on the site, afforded the opportunity to create this underground community (even though one million yards of earth had to be moved). Yet in an area where the temperature averages 28 F in the winter months with 8159 degree days annually, the heat loss for a building this size would normally be about 2,763,000 Btu per hour. By burying the building partially into the earth and exposing only one elevation, the architects and engineers were able to cut the Btu consumption almost 20 percent.

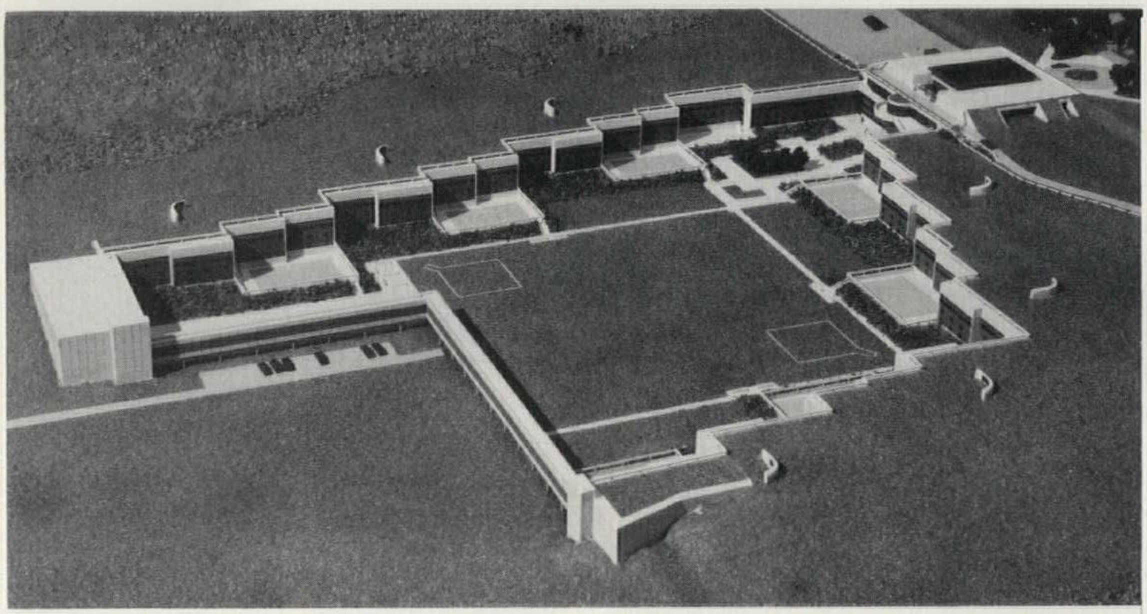
At the beginning, the underground concept was difficult for some corrections officials to accept. They were afraid that the scheme would promote a claustrophobic environment rather than one that would further the rehabilitative goals of correction institutions. The architects, working within a prevailing enlightened incarceration philosophy, designed the spaces to mitigate any sense of being buried underground.

Design concept

The scheme breaks up the housing into seven 52-person units, all of which open out onto outdoor recreation areas. Even these outdoor spaces are subdivided: each "house" adjoins its own informal yard overlooking the large central court where scheduled recreation takes place.

The single rooms or cells in each of the units are staggered along this exposed wall, so that narrow, vertical windows will permit light to penetrate the rooms, while still maintaining an appreciable degree of security. In-





Aerial view showing living units around open court, visitors' building (top right).

side, the rooms open onto semiprivate areas and connect to larger dayrooms, promoting that hierachy of private to public space generally deemed significant to the livability of all types of housing.

The residential units are placed on the first two levels of the three-story-high buildings, with educational and administrative functions on top. The circulation on the top level is continuous; in the residential units, segmented for security. The unit dayrooms adjoin the courts, providing both access views and natural light. From the central court, inmates will also have a more expansive view through a bridge to a nearby ravine and hills.

A core building at one corner of the complex, also built into the hill, is the only building that comes into sight as visitors approach the center. Located between residential units and parking, it will mark the entry to the complex.

Energy features

The entire structure, of poured-in-place concrete frame and flat slab with retaining walls 30 to 40 ft deep, will be evident at certain points. Facing brick over poured-concrete surfaces on the exposed walls will be insulated with 2-in. plastic foam for a U-value of .06. The roof, which has patrol areas, will have a U-value of .04.

While the building is run on electrical energy, with a heat pump, a pipe coil will be installed to reclaim heat from return air and kitchen exhaust. This device, plus wall insulation, is expected to cut energy consumption for heating by 25 to 30 percent. The heat pipe coil was chosen over the heat wheel simply because the coil is smaller and easier to clean.

A closed water-storage system also conserves energy: in the off-peak hours, water is electrically heated to 105 F and stored in two 25,000-gallon tanks for peak demand. Similarly in the summer, cold water is stored at night for daytime air-conditioning needs. As an additional measure, a computer controls this storage, as well as regulating heating and cooling.

The complex, to be completed in the summer of 1981, should be interesting to analyze in terms of energy consumption as well as livability. Aside from the various correctional debates about the nature of incarceration, it would be instructive to analyze this kind of complex for its applicability for other facilities such as hospitals, colleges, and hotels. [Suzanne Stephens]

Data

Project: *Minnesota high security correctional facility, Oak Park Heights, Mn.*

Architects: *Winsor/Faricy, St. Paul, Mn; Gruzen & Partners, New York. Design architects for Winsor/Faricy, Wayne Winsor, principal in charge; Thomas Lynch, project architect; Terrance Korman, associate project architect; for Gruzen & Partners, Paul Silver, director of criminal justice; Samuel Posner, project manager; Peter Samton, design director; Peter Krasnow, project designer; and William Bellsey, Jeffrey Gilbert, Edward Tanaka, Robert Zimmerman, design team; Paul Willen, Barbara Geddis, planning and program.*

Site: *208 acres of rugged terrain 40 miles from Minneapolis.*

Program: *housing for 400 inmates with rooms 70.5 sq ft (net), plus medical, industrial work and educational space, administration, support and maintenance, totaling 330,000 sq ft.*

Structural system: *reinforced concrete frame, flat slab, 30-ft-deep retaining wall.*

Major materials: *face brick, over 8-in. poured-concrete backup; aluminum projected windows over steel subframe. Interior finishes are poured concrete or concrete block.*

Mechanical system: *480-volt electric boilers (see text for details).*

Consultants: *C.A. Wood & Associates, landscape; Kirkham, Michael & Associates, structural, mechanical, and electrical.*

General contractor: *McGough Construction Co.*

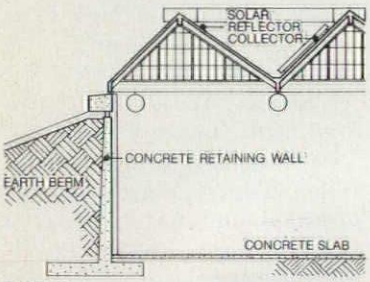
Client: *State of Minnesota Department of Corrections, James Zellmer, prison planning director.*

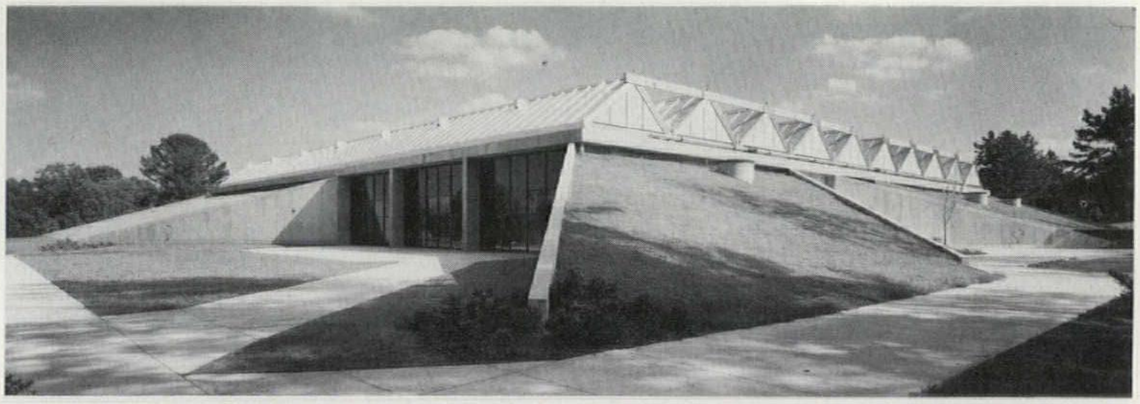
Costs: *$29,000,000; $87.88 per sq ft.*

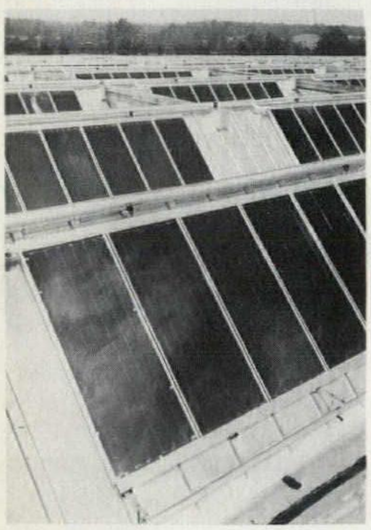
Shenandoah Solar Recreation Center, Shenandoah, Ga.

A Georgia peach

A recreation facility in Georgia uses sun not only for heating and cooling, but also for ice making.







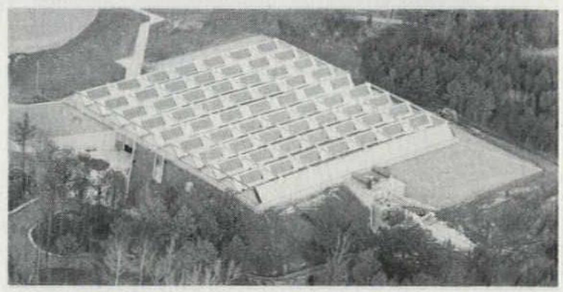
The sawtooth roof at the Shenandoah Recreation Center supports both solar collectors and reflectors at their respective optimal angles of 45 and 36 degrees (above); further advantages are gained through berming and burying the 58,000-sq-ft structure.

The Shenandoah Solar Recreation Center is probably the largest structure in the country to be both heated and cooled by solar energy. The building is thoroughly admirable in a great many respects, but even with this being the case, it has not been able to fulfill the precise role for which it was originally planned, which was to be a focus and inspiration for a new solar community.

The 58,000-sq-ft building was designed as the community center for a new solar energy suburb located 35 miles south of Downtown Atlanta. Shenandoah was to have had a solar technology park occupied by manufacturing and research/development industries involved in solar energy. Attractive tax incentives were available for both business and residential construction using solar devices, but few moved into the town, probably because those looking for the bucolic life in the sun could find it closer to Atlanta. The town foundered for a while, but then began to pick up when a new sales strategy was instigated, directed toward marketing houses in the wooded community as second homes. Shenandoah seems now to have found its level, and only the recreation center remains as a clue to its earlier prospects.

The center was designed by Richard L. Taylor and James B. Williams of Taylor & Williams (formerly Taylor & Collum), and its solar energy system was designed, under the direction of Dr. James R. Williams, by an engineering group at Georgia Institute of Technology.

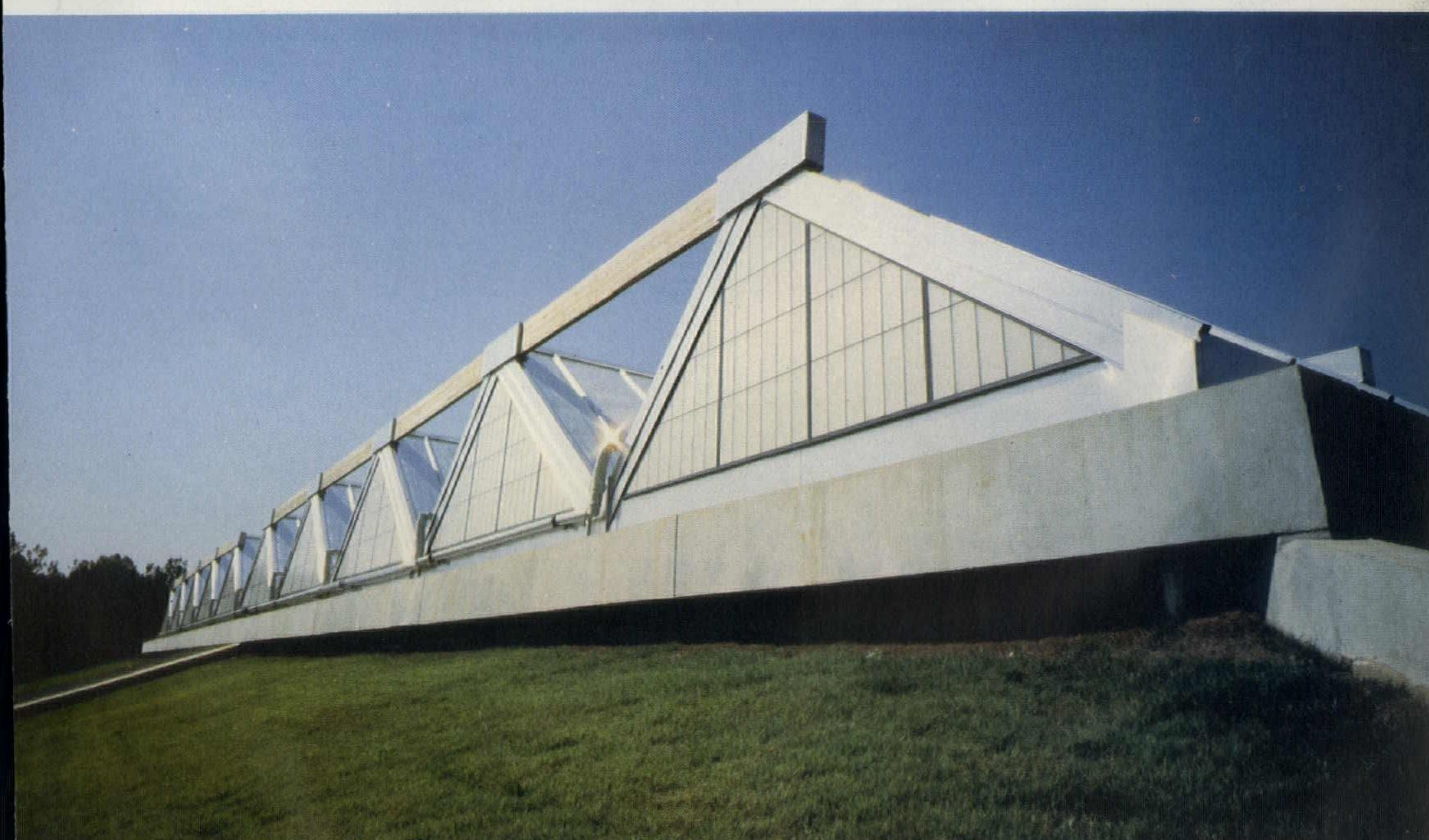
The actual size of the building was determined by the requirements of its program, with the regulation ice hockey rink dictating the length, and the basketball court determining the height. Those, in turn, suggested the square shape—the most efficient volume-to-exterior form available for these needs.



To reduce heat loss and gain, the building is set four feet below grade, with the soil removed for excavation forming a berm of insulation around all but the building's north side, where double bronzed glazing is used to give views to the lake and woods beyond.

In order to have clear spans for the recreational functions, wooden trusses were used. These, in combination with a system of folded plywood plate forms, support 63 8½' x 21' flat-plate copper solar collectors displayed on a 10,500-sq-ft roof area. On this polished aluminum roof, the diagonal chords of the trusses are designed for supporting both solar collectors and reflectors at their respective optimal angles of 45 and 36 degrees. The hot water collected is stored in a 15,000-gallon tank and a 5000-gallon buffer tank, and chilled water is stored in two 30,000-gallon tanks, all of which are embedded into the earth berm around the building.

The solar system, which can be augmented by natural gas, provides the space heating, cooling, and domestic hot water for the building. In addition, however, it can also provide heat for the outdoor pool when needed, and heated water can be used for the hourly re-



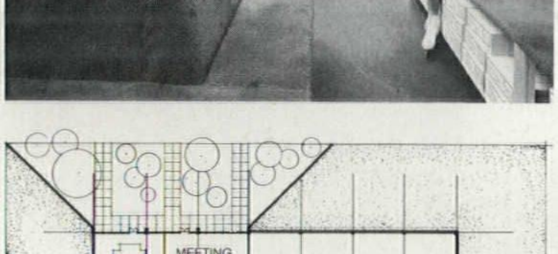
The building's mechanical systems (facing page, bottom) are displayed at the entrance (see plan, below) in an overt and welcome gesture for conservation. Exhibit (right) is next to entry; rink (left) and shop (below) use natural materials.

surfacing process required for the ice hockey rink. Waste heat from this process is not discharged, however, but used for controlling the temperature in the ice rink. In all, the solar system supplies 90 percent of the space heating requirements, and in its first summer of operation it provided 90 percent of the cooling needs for the center.

Wherever possible throughout the building, mercury vapor lights have been used with dimmers to minimize energy use. For natural daylight, insulated translucent fiberglass has been installed between the diagonal chords of the trusses at the east and west sides of the building.

The total additional cost for converting the Shenandoah center from a conventional design, as originally planned, to a solar-energy facility has been estimated at $726,000. This includes both the design and the installation of the energy system, for which the funding was made possible by a grant from the U.S. Department of Energy Research Development Administration.

When the building was designed four years ago, its fuel cost was estimated at $118,000 a year as opposed to $38,000 a year for the redesigned structure. Considering the fuel costs of that time, the payback period for the additional cost incurred by the solar system and its installation was estimated at 11 years. The absolute certainty about this building today is that that is one figure that will decrease much more rapidly than originally anticipated. [David Morton]



Data

Project: *Shenandoah Solar Recreation Center, Shenandoah, Ga.*

Architects: *Taylor & Williams (formerly Taylor & Collum), Atlanta, Ga; Richard L. Taylor, partner, James B. Williams, partner.*

Site: *9-acre site of second-generation scrub-pine thicket chosen to avoid encroaching on hardwood forests.*

Program: *community center for a new town, with primary focus to be on recreational activities, designed for solar heating and cooling.*

Structural system: *concrete retaining walls, steel interior columns, open web wood roof trusses.*

Major materials: *reflective coated aluminum roofing, wood framing and exposed rigid insulation ceiling, poured-in-place concrete exterior walls, unfinished wood interior partitions, insulated fiberglass skylights (see Building materials, p. 226).*

Mechanical system: *solar system is reflector-augmented with high-performance flat-plate collector array; solar heated water drives 50-ton absorption cycle air-conditioning system for cooling or direct conversion for heating. Conventional system is gas-fired boiler; distribution is via exposed conventional forced-air duct system.*

Consultants: *Taylor & Williams, landscape; Nancy Mitchell and Associates, interiors; Wright Engineering Associates, Newcomb & Boyd, mechanical.*

Client: *Shenandoah Development Co.*

General contractor: *Batson Cook Co.*

Cost: *$2,995,431 including site work, interior finishes.*

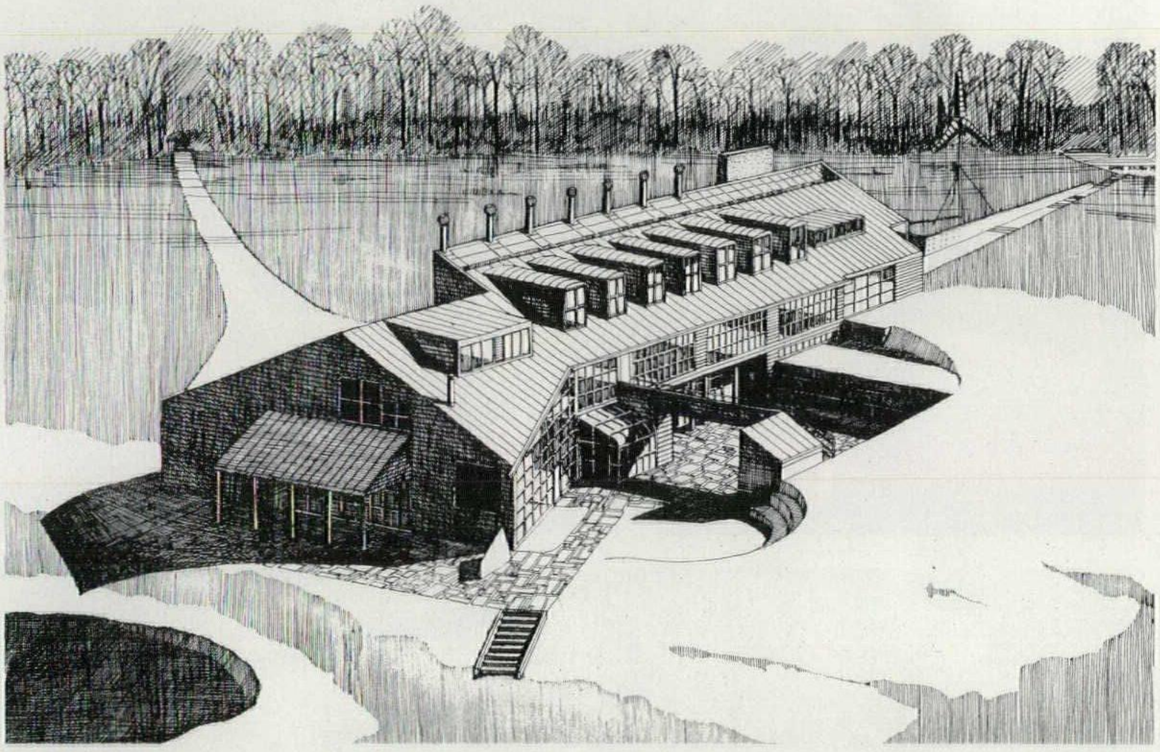
Building Energy Performance Standards/Design Energy Budget: *118,000 Btu per sq ft per year.*

Photography: *Gabrial Benzur.*

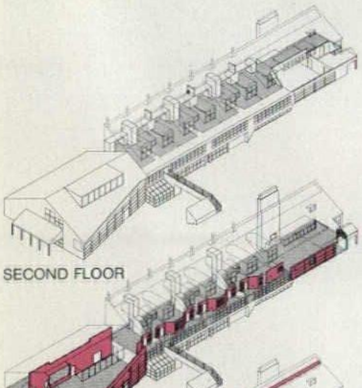
Milford Reservation Solar Conservation Center, Milford, Pa. and Prototype Passive Solar Townhouses

Design dilemma

Kelbaugh & Lee move on to larger solar buildings and expanded philosophies, with divergent results.



The Milford Center (this page and facing) is intended as a teaching machine about energy and the environment for groups of urban youth. The axonometrics are coded to indicate which walls and floors are directly heated by the sun (in red) and which help store heat (in gray). Facing page: Two energy diagrams, for winter solstice and summer solstice, show expected thermal circulation. The project is under construction, with completion scheduled for fall.



The subject of energy consciousness and design is a touchy one. Many of the energy activists would just as soon forget about aesthetics and at least as many aesthetes would just as soon forget about energy. The group in the middle—of which Douglas Kelbaugh is a talented example—are faced with the difficult task of being the most visible people trying to order the implications and priorities of post-oil crisis architecture.

Kelbaugh, for instance, has been doing passive solar houses for the past six years; three years ago, he formed the firm Kelbaugh & Lee of Princeton, NJ. Two new projects, the Milford Reservation Solar Conservation Center and a government-sponsored prototype for infill passive solar townhouses, mark a certain coming of age for the firm. Not only do both extend the firm's penchant for ingenuity in what Kelbaugh calls "dumb technology," but they represent a determined, and changed, design standpoint. Says Kelbaugh: "I went to Princeton under Eisenman, Gwathmey, and Graves, and did flat roofs until Milford." He describes Milford as "vernacular imagery and historical vocabulary." Alluding to influence from Charles Moore, he suggests that the building is "meant to evoke images of wooden farmhouses of the region, despite the fact that the internal structure, floors, walls, and partitions are concrete to store solar energy." The townhouses, with their dormer windows, shed roofs, and cross-bar windows, are comparable.

Milford Center

Both projects are intended as national models. The Milford Center, now under construction, is to be a teaching machine. Up to 114 students at a time will be brought for two-week stints to learn about the environment. Part of that will consist of operating the thermal shutters, shades, windows, and vents, cutting wood for stove, fireplace, and furnace, and monitoring the composting toilets. On a 1600-acre tract near the Poconos, the nonprofit, all-year-round camp provides dormitory sleeping, dining, lounges, a library, classrooms, and an outdoor amphitheater.

Because of the facility's unique purpose, the architects made an effort to fit as many energy-conserving techniques into the relatively small (17,000 sq ft) building as possible. For passive solar heating—which is expected to provide approximately 75 percent of space and water heating—there are Trombe walls, drum walls, direct-gain windows, an attached greenhouse, and hot water preheating. The hot water preheating tube, which extends the entire 160-ft length of the roof, is a Kelbaugh & Lee adaptation of conventional bread-box preheaters. In an insulated box, surrounded by aluminum foil and exposed to the sun through a double-glazed south-tilted edge, the 18-in.-diameter black pipe holds, and heats, water for about one full day on its way from the well to the water heater. At night a thermal blanket lessens heat loss.

Fourteen composting toilets—"easily the world's largest installation," laughs Kelbaugh—are expected to reduce water use by 40 percent. Along with the cheaper site-built concrete ones is one fiberglass prefab model so comparison statistics can be kept. There is a windmill to generate electricity. For cooling, part of the building is built into the earth. There are night vents and blowers to wash the masonry with night air.

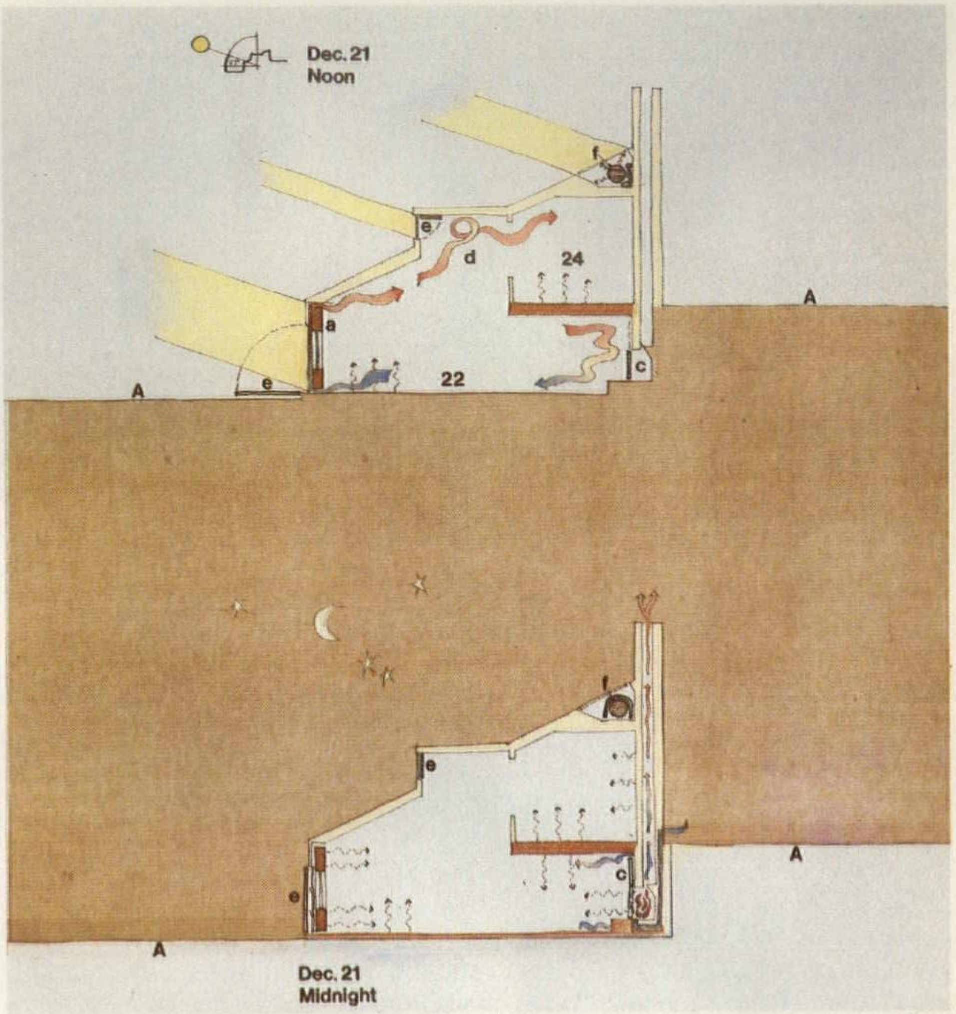
The exterior is covered with cedar siding and roofed with corrugated asphalt. Inside, concrete block and vinyl are the norm, with special walls of glass block and Southern yellow pine and special floors of rubber tile and bluestone pavers.

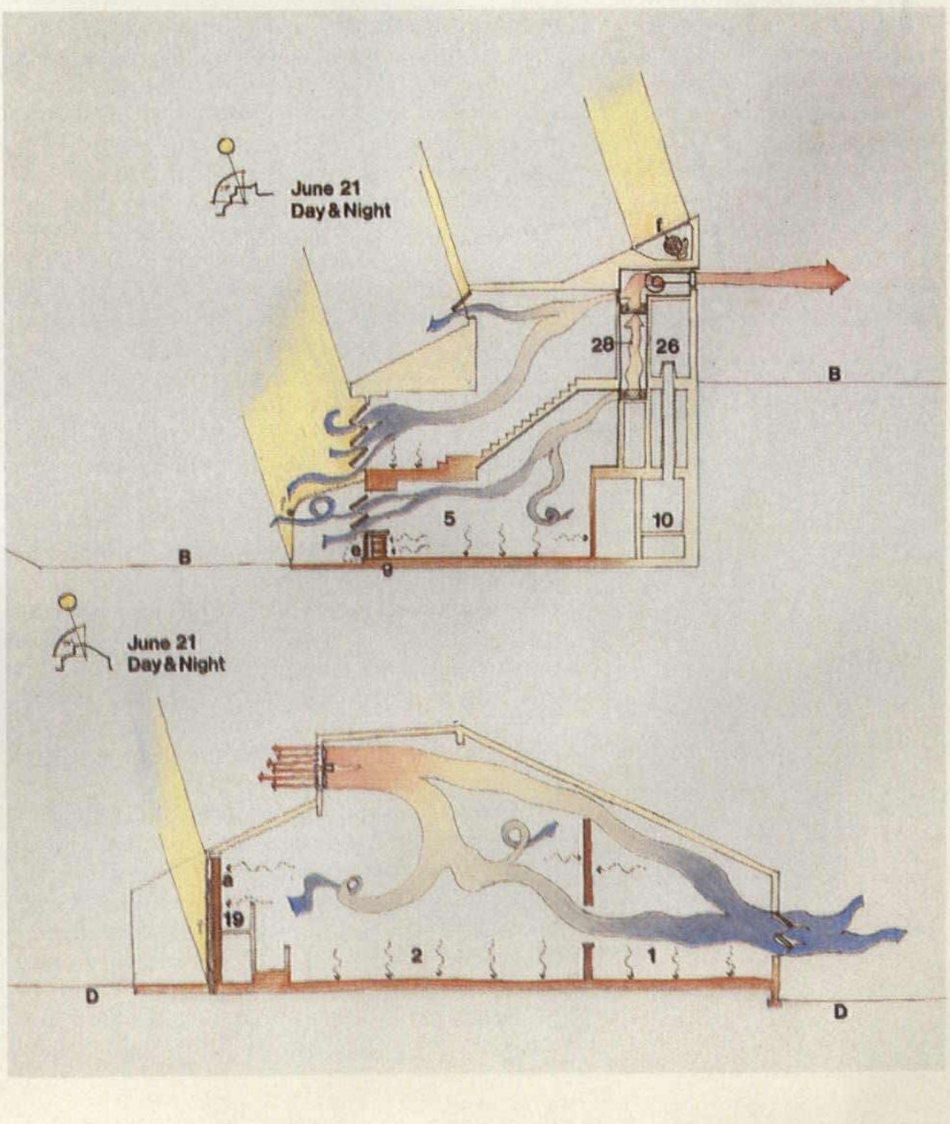
Infill townhouses

The townhouses were commissioned by the Northeast Solar Energy Center. After years of Department of Energy and Housing and Urban Development sponsorship of single solar houses, the government decided to invest in multifamily housing with its inherent thermal and transportational advantages. Among the firms chosen were Kelbaugh & Lee in association with Donald Prowler of South Street Design in Philadelphia. Adapted to the Mid-Atlantic region, the houses come in two versions, south-facing and north-facing. The south-facing houses have a yard in front with a 6-ft wall along the street for privacy. The north-facing houses have their yard and a greenhouse in back. Large rotary ventilators, lifted from farms and factories, function atop chimneys, and bread-box preheaters dot the roofs.

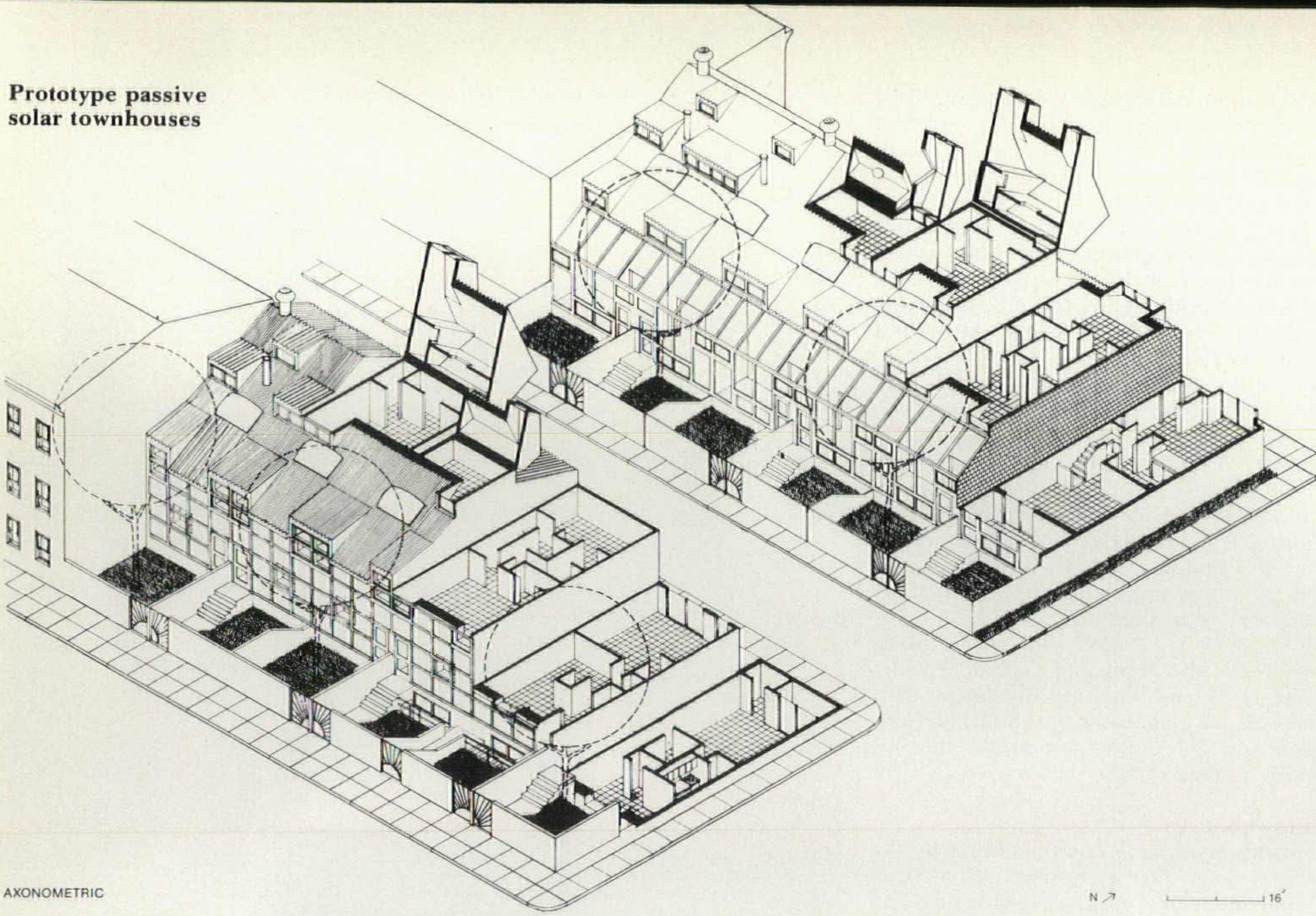
As for the possibility of the project's ever reaching fruition, the architects are investigating the possibility of developing the townhouses themselves, in either Philadelphia or Trenton. While intended for a "moderate- to middle-income" market, the sale price estimates are more like $100,000 for the two- and three-bedroom units, perhaps less if renewal land is available. Exterior walls might be either wood or brick veneer. Most interesting are the alternating elevation rhythms between chimneys and windows, obscuring the actual distinctions between units. Perverse as well as ambiguous, that demarcation actually occurs down the center of the cross-bar windows.

Solar contribution to space and water heat is expected to be 62 percent. "I do not design for a preconceived auxiliary fuel bill," Kelbaugh admits readily. "I incorporate as much passive technique as is architecturally conven-





Prototype passive solar townhouses



AXONOMETRIC

Planned as urban infill for a mid-Atlantic location, this prototype (above and facing page) includes both north-facing and south-facing passive solar townhouses. The south-facing houses have a glass wall façade and front yard. The north-facing houses have greenhouses and yards in back. A huge farm or factory-type rotary ventilator is included for each unit. The complex rhythm of the façades obscures the divisions between units, which occur—not without mannerist perversity—down the center of the cross-bar windows.

ient, as well as balancing what is technically possible with what is cost effective."

Keeping the faith

Part of the coming of age is coming to terms with a contradiction within himself, and many like him. On the one hand, Kelbaugh sees solar design as a practical responsibliity and a set of technical problems. Aesthetic considerations are unrelated. He designed his early houses in an abstract, 1920s-derived style; current projects in something more Colonial with occasional traces of his earlier de Stijl proclivities still apparent. He makes no claims of solar advantage for either.

On the other hand, Kelbaugh wishes to be identified with energy as a cause. And it is an identification which goes beyond lobbying. The firm's logo is a pseudo gum package with the brand name "Environmint" and the slogan "Here comes the sun." He and various of his energy-concerned colleagues have a loose association they half jokingly call "The Black Holes," but seriously think of as an alternative to the "New York Five." Their idea of how to inculcate the study of solar technology into university programs is to hold special "Energy Days" rather than simply fold the relatively straightforward technology into existing coursework.

Most to the point, Kelbaugh found himself, at this stage in his design life, needing to construct a position paper—self-commissioned. In it, he takes a view that can only be described as militant. He declares that "a new cosmology is here," that the shortage of fossil fuels is leading not only to design which incorporates solar technology but design which reflects a changed view of the world. It is a view in which man does not dominate nature but is merely another creature subject to its forces.

In manifestoes, it is always easy to read "should" where "is" appears and thus save the writer from the burden of proof. But this tract has more serious problems. The connecting links are missing. There is no discussion of what the technical relationship is between solar technology and any particular formal decision. There is no discussion of how the new cosmology might be convincingly expressed formally either, whether perhaps the use of natural materials or forms might be relevant or what the implications are for scale.

The point is that the manifesto, finally, is not really arguing for any given philosophy or any given formal expression of it. The argument is an attempt to give the implications of fuel shortages a level of theoretical significance it cannot possibly possess. Kelbaugh's motivation—if one reads it correctly—is understandable. A man who put two years into VISTA setting up a community design center and five years advocating community participation as a planner, he has long been looking for an incontrovertible sense of purpose.

The discrepancy is that Kelbaugh as a designer regards energy concerns as an important technical responsibility to be seen in perspective, and Kelbaugh as an advocate sees energy concerns as the basis of a philosophy. It is the former position that seems to hold the most promise. [Nory Miller]

Data

Project: *Milford Reservation Solar Conservation Center, Milford, Pa.*

Architects: *Kelbaugh & Lee, Princeton, NJ.*

Program: *a 17,000-sq-ft dormitory and classroom building for urban youth to study energy and environmental issues on a rotating basis. Sleeping capacity is 114.*

Site: *1646 acres of semi-wilderness near the Poconos.*

Structural system: *precast hollow-core concrete slabs on concrete retaining wall and column/beams with concrete spread footing foundation.*

Major materials: *cedar siding with double- or triple-glazed windows on the exterior; a corrugated asphalt roof and interior walls of concrete block, glass block, and wood (see p. 226).*

Mechanical system: *four types of passive solar heating, two types of passive cooling, wood/oil furnace.*

Consultants: *Raval Engineering, structural; Robert Bennett, mechanical.*

General contractor: *Dorsan.*

Client: *Milford Reservation.*

Cost: *$1.2 million; $65/sq ft.*

Building Energy Performance Design Energy Budget: *171 MBtu/sq ft/yr.*

Data

Project: *prototype passive solar townhouses.*

Architects: *Kelbaugh & Lee, Princeton, NJ.*

Program: *one- to three-bedroom townhouses for upper middle income with passive solar benefits, 660 to 1684 sq ft.*

Site: *hypothetical urban infill in mid-Atlantic region.*

Structural system: *concrete slab on grade, load-bearing party walls.*

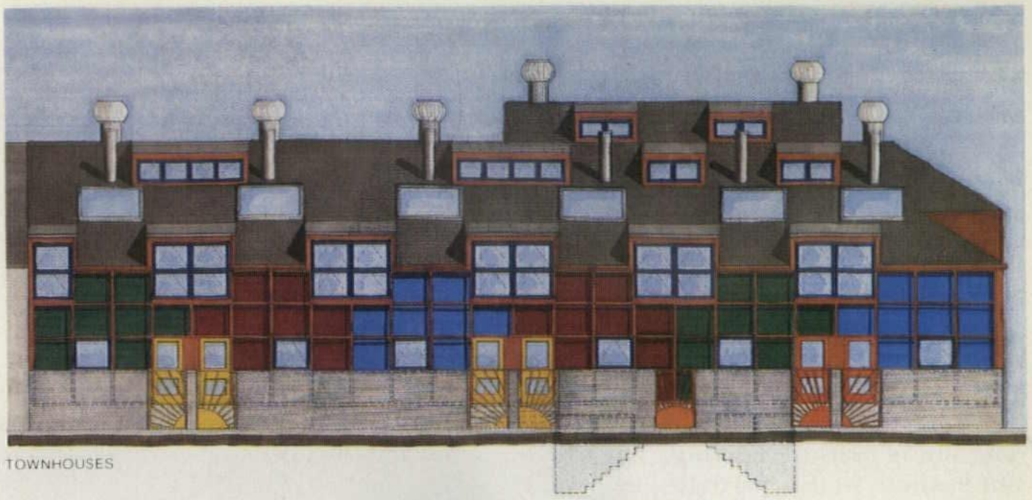
Major materials: *wood or brick exterior; painted concrete block and gypsum board interior; floors, quarry tile and hardwood or vinyl (see p. 226).*

Mechanical system: *forced hot air, gas-fired back-up furnace.*

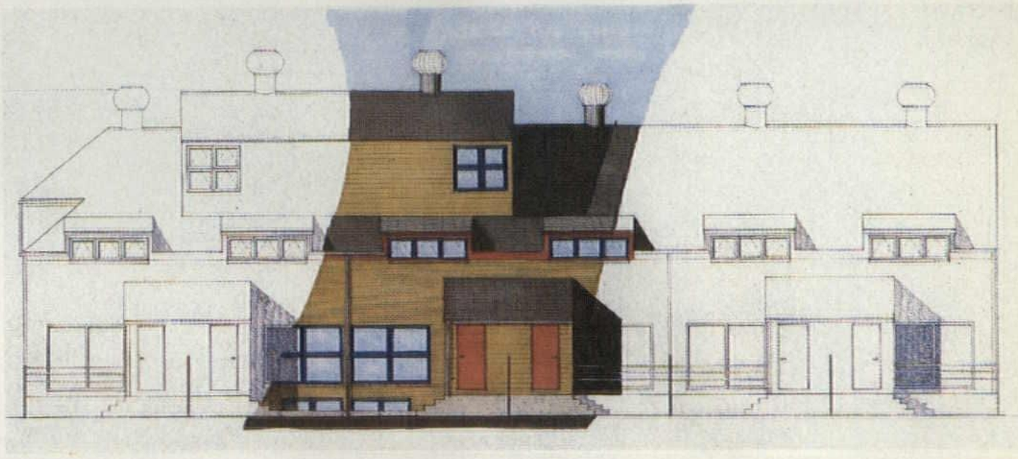
Client: *Northeast Solar Energy Center.*

Cost: *$24,000 1BR; $60,000 2BR; $69,000 3BR; $40 per sq ft including $3 per sq ft incremental cost for solar systems.*

Building Energy Performance Design Energy Budget: *45.7 MBtu/sq ft/yr (2 BR unit); 44.4 MBtu/sq ft/yr (3 BR unit).*

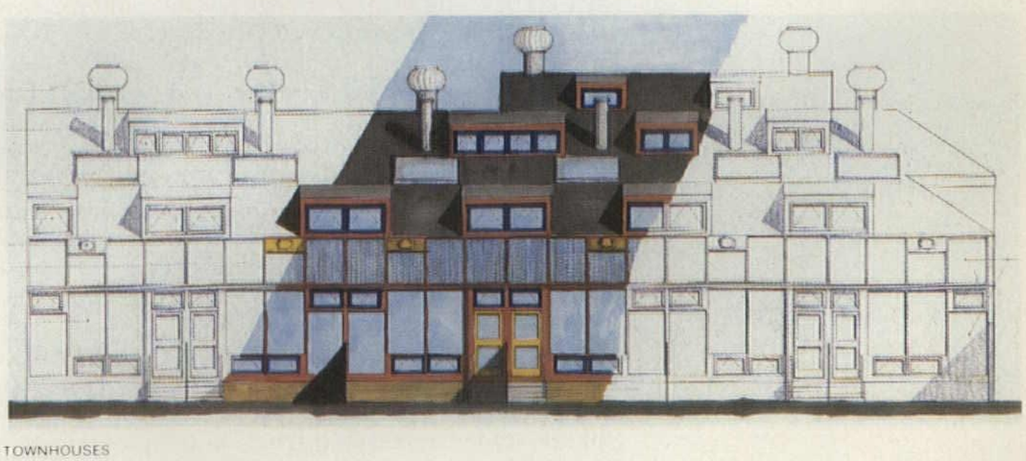


SOUTH FACING TOWNHOUSES



SOUTH FACING TOWNHOUSES

NORTH FACING TOWNHOUSES

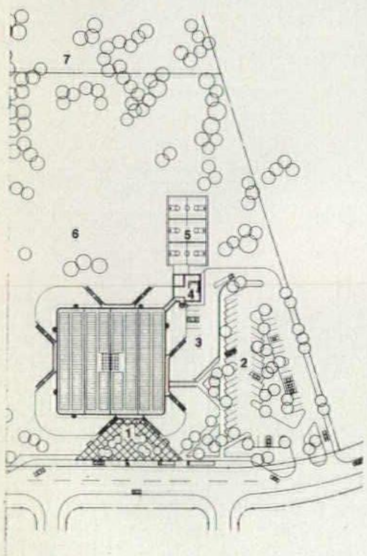


NORTH FACING TOWNHOUSES

Floyd Elementary School, Miami, Fl

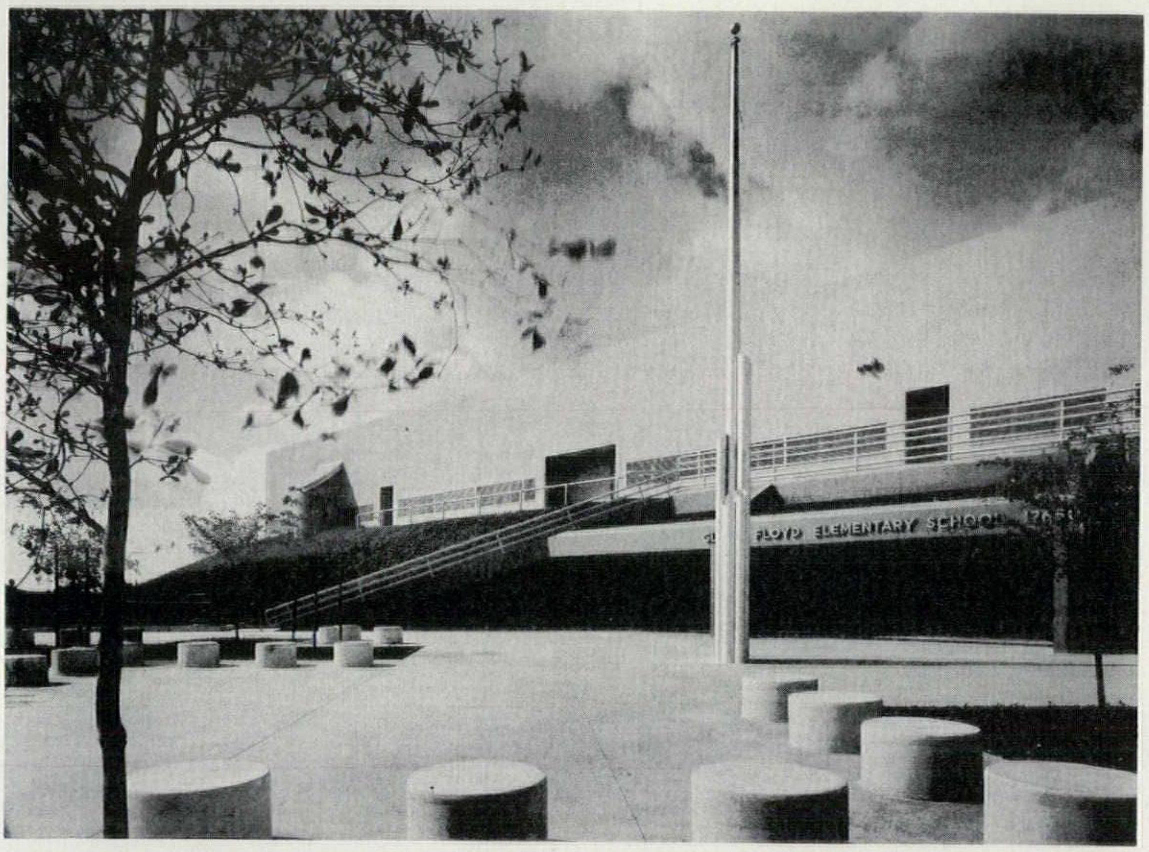
Cool school

The sun is used for cooling, not heating, in this partially bermed school in South Florida.



Legend
1 Entrance
2 Parking
3 Service entry
4 Mechanical
5 Play courts
6 Play field
7 Adjacent park

Entrance plaza (right), south elevation (opposite, top), detail of berm and light well (opposite).



In a climate with an average daytime temperature of 75.5 F, and a number of degree days totaling 200, the cost of air-conditioning loads could send chills down the spine of any economically minded school administrator. The design for Floyd Elementary School seeks to counteract that expense. The school plans to harness solar energy to provide at least 70 percent annual energy for its cooling needs and 90 percent for its hot water.

The Miami-based firm of Saez/Pacetti, founded nine years ago by two young Florida-trained architects Diego Saez and Richard Pacetti, obtained the commission to design the 70,000-sq-ft school. To do so they had to convince the school board that they could produce an energy-efficient building that would accommodate 930 students in the kindergarten through sixth grade.

The idea for the demonstration project had been initiated by the University of Miami, which desired to study the use of solar energy for air conditioning in a subtropical climate. Once interested, the Dade County School Board obtained a DOE grant to take care of the added cost of installing solar collectors. In turn, the school includes extensive energy-monitoring capabilities in an adjoining structure.

The rooftop solar collectors formed only one part of the energy-saving program. Not only were alternate means of energy supply sought, but ways to cut *demand* initially had to be explored. Thus a number of air-cooling features that could be described as "passive" or even just "low-key" were incorporated into the design.

Passive features

The 40′ x 40′-square building, of conventional poured-in-place and precast concrete, is carefully bermed so little exterior wall is exposed to the sun. Two carefully incised portions of the berm allow glass walls to be inserted for access and natural light to the first level.

The walls exposed above the berm on the second level have been insulated with expanded polystyrene for a U-value of .09 (R-

11). The roof itself is protected from heat gain by expanded polystyrene insulation 3 in. thick which, with the composite concrete roof deck, creates an overall R-value of 29 (U-value is .034). In addition, the shading caused by the solar collector assembly should reduce heat gain even further.

A band of fenestration wraps around the perimeter walls of the second story. Since glazing would cause some heat gain, the architects installed aluminum louvered blinds on the outside of the glass for sun protection and security. The screen, with blades 1½ in. wide, and 1½ in. apart, still allows light to enter the classrooms.

Low-key features

To diminish the internal heat build-up due to artificial lighting used in the classrooms, architects Saez/Pacetti collaborated with electrical and mechanical engineer Aaron Hertz to come up with a specially designed lighting installation. Freestanding fixtures about six feet high, rather like minimal sculptures in their appearance, are placed throughout the interior of the school. In each of these high-intensity fixtures, three lamps, one a 400-watt high-pressure sodium vapor, one super arc metal halide, and one small quartz incandescent, are mounted within the top of the stand and directed upward at a reflective metal dish. These lighting standards provide glare-free uniform illumination. Hertz reports that the levels exceed 70 footcandles of equivalent spherical illumination with a visual comfort probability of 100. In addition, only two watts of electricity are used per square foot.

To further reduce the demand for air conditioning, Hertz and Saez/Pacetti installed a heat wheel that dehumidifies incoming air. The electrically run air-to-air rotary heat exchanger reclaims energy from conditioned exhausted air as it is replaced with raw outside air. This feature alone should reduce energy consumption by an estimated 30 tons. In fact all of these features are expected to substantially cut the demand for air cooling: the berm reduces the air-conditioning load by an estimated five tons, as do the roof insulation, the collector array shading, and the lighting fixtures, respectively. Since the second-floor wall insulation cuts the a/c load 2.5 tons, in toto these features knock off nearly 60 tons from the a/c demand. Usually schools of this size would require about 190 tons, or 54,720,000 Btu per day for cooling. Some—in the fingerlike configuration common with many open-plan schools—even require 225 tons. With these features, Floyd Elementary uses 125 tons of refrigeration on the hottest, most humid days and about 90 to 110 tons normally.

The active part

Unfortunately, because of technical problems, the active part is not acting right now. With the solar collectors in place, it is estimated that the collectors and the four lithium-bromide chillers hooked up to the collector will be able to provide at least 100 tons of the demand. The architects and engineers favored multiple small-capacity absorption chillers for flexibility. At least four chillers were needed, explains Hertz, but each produces about 26–27 tons at its peak. The solar component and chillers of course would still use electrical power for pumps and cooling tower. But where they would save energy would be with the compressor.

Right now, the compressor, running on a fifth back-up centrifugal chiller, uses 90 to 93 kilowatts per hour to supply the 125-ton (peak) demand of the school. With solar collectors, that figure would be reduced by 60 kilowatts per hour.

The battery of solar collectors has been selected to conform to ASHRAE 93–77 performance specifications. Computer analysis determined that the angle of the flat-plate collectors could be as shallow as 15 degrees and still be effective, and thus diminish chances of damage during hurricanes.

In actually cooling the building, the chilled water is pumped to the heat wheel that creates the cool, dehumidified air. This air is then carried by fans through a medium-pressure duct system to variable-air-volume terminal boxes in separate zones of the building. Thus these units can be regulated independently of each other. A computer duct program and a special wash filter are additional features included in the mechanical system design that cut down on energy waste at the distribution points.

Since demands for *heating* the building are not high, it is warmed by radiant-panel electrical heating. Zone controls also regulate heat, which goes on when the temperature drops to 65 F.

Educational features

The design of the school reflects not only current thinking in energy conservation, but also newer, revised approaches to the design of educational facilities.

In recent years it has become quite commonplace for new schools to be built without windows. Generally this introverted measure is assumed to reduce threat of vandalism, ease maintenance, and prevent children from being easily distracted. Some energy conservation-minded people even think that no windows means no heat gain. But as architects and engineers know, artificial lighting makes its own demands: air conditioning often has to compensate for heat from added illumination required.

In addition, schools in Florida and elsewhere have found that, with or without windows, vandals will be vandals: some speculate that the constricted atmosphere created by windowless environments brings out the vandal in everyone.

With one floor actually underground (or under-berm), Saez/Pacetti had to find some means of giving physical and visual access to the out-of-doors to the children on the first level. Besides the cuts in the berm on each of the four sides to introduce additional natural light into the classrooms, Saez/Pacetti installed silolike lightwells along the perimeter of the school. Panels in the sides of the air shafts would permit firemen to use them as access chutes. The floors of the lightwells offer alcove space for plays, exhibits, and other activities in the conventionally shaped classrooms. Upstairs, the fenestration bordering the classrooms above the berm has been kept to a narrow depth of three feet, but placed at children's, not adults', eye level.

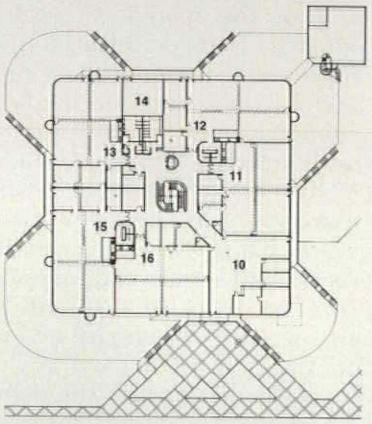
The public spaces of both floors receive natural light from portholelike skylights in the roof over the main central stair, itself a dramatic focus for internal circulation. While open classrooms have long been favored in Florida, that too is undergoing serious revision. Saez/Pacetti designed the quadrants with sliding panels, to subdivide the quadrants into additional quadrants and diminish the sense of being in a gymnasium-like space.

Form for all seasons

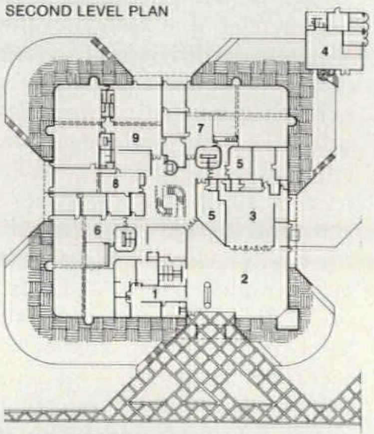
The energy-saving features of the building and the spaces determined by the program are integrated quite nicely by the handling of the various formal elements.

The incline of the berm is too steep for the structure to actually melt into the landscape, however. Yet as the planting grows more lush, the blending of the manmade topography with the actual landscape is starting to occur. The result is rather like a machine-age Mayan temple—aided by the good proportions and the uncluttered, crisp detailing of the gray concrete walls and the orange metal pipe railing. The top of the lightwells, however, trimmed in segmented instead of curvilinear flashing, introduces a jarring note to an imagery that otherwise evokes current Milanese design.

The interiors are reasonably pleasant, although it is quite apparent that furnishings and finishes must be ordered from a stand-



SECOND LEVEL PLAN



FIRST FLOOR PLAN N→ 20'/6m

Legend

1 Administration
2 Commons dining
3 Food service
4 Mechanical building
5 Mechanical room
6 Primary pod 1
7 Primary pod 2
8 Exceptional children
9 Kindergarten
10 Library media center
11 Intermediate pod 1
12 Primary pod 4
13 Intermediate pod 2
14 Mechanical room
15 Primary pod 3
16 Intermediate pod 3

ardized selection. Instead of installing hung ceilings, the architects decided to expose the ducts, electrical raceways, and water pipes to promote the impression of a clockworklike mechanism on display for the inquisitive minds of the young. This open ceiling does swallow up some of the light that would otherwise be bounced back into the space. Nevertheless the articulation of the elements and the added depth in the ceiling create visual interest and spatial differentiation often missing in open-plan spaces. The lighting, too, shapes and molds the spaces, including the fluorescent cove lighting that dramatically washes the walls.

Exposing the concrete coffers of the ceiling and hanging acoustical baffles like pennants from the ceiling soften the architecture, too, and greatly help cut down the sound level.

A disturbing element inside is the limited choice in colors, particularly the overly intense hues of orange and blue here and there. The gray paint the architects chose for the interior walls of the lightwells flattens the space. Unless sunlight is bouncing directly down, these large concrete silos appear as rather gloomy apses at the edges of the classrooms.

These comments must be measured against the broader accomplishments of the entire solution. As a conscientious effort to save energy and provide a workable environment that children and adults can actually enjoy being in all days, its value as a prototype is considerable. However, final word will have to wait until the solar collectors are installed and the monitoring of the system is completed. [Suzanne Stephens]

Data

Project: *Gloria Floyd Elementary School, Miami, Fl.*
Architects: *Saez/Pacetti Architects and planners, South Miami, Fl. Diego Saez, Richard Pacetti, Jeffrey Evans, William Liddy, project team members.*
Site: *ten acres in southern section of Miami, flat, lightly wooded.*
Program: *(see text).*
Structural system: *concrete and masonry. First-floor retaining walls precast twin tees; second-floor walls masonry. Second-floor slab and roof are precast joists, concrete deck.*
Major materials: *concrete, gypsum board, lath and plaster.*
Mechanical system: *(see text).*
Consultants: *Aaron Hertz & Associates, air conditioning, electrical, plumbing; J.W. Schubert & Associates, structural; Mueller Associates, solar engineer.*
Contractor: *B.E.C. Construction (phase 1), Marbilt, Inc. (phase 2).*
Costs: *$4,435,694 overall cost; $63.37 per sq ft. Solar collectors: $864,194.*
BEPS: *57,000 Btu/sq ft/yr.*
Photographs: *Dan Forer.*

Energy: An expanding force for change

Energy-conscious design is rich with potential. The source of the problem, however, is in the hands of people abroad. The immediate solution is in the hands of the people at home.

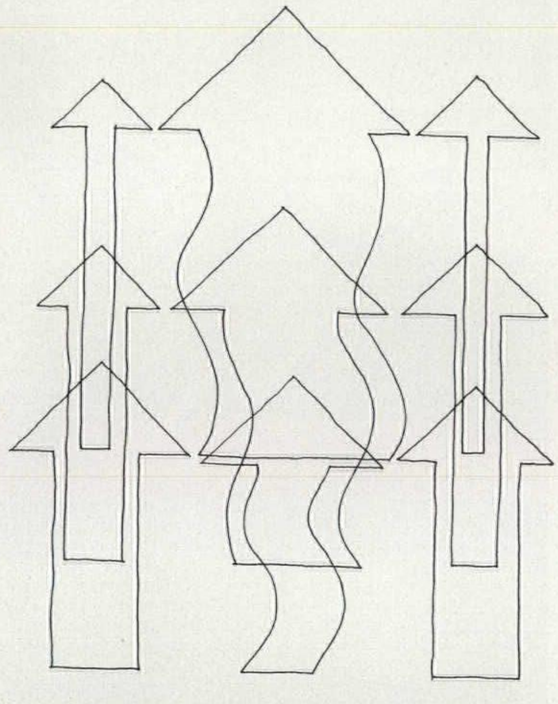
The slow, meticulous process of selection which passes for history is grinding up energy-conscious design as surely as it grinds up all forms of culture. Ten years from now there will be no "energy-conscious design." All design will be energy conscious. Until then it will act as a balancing force. And there will be some changes.

Our lives: The living habits of people have already changed. The foods we eat give us energy and use up other forms of energy. What we cook and how we cook it has come into focus. The clothes we wear are affected by energy either in their warmth, weight, permanence, or in the materials of which they are made. The cars we drive and the question of whether we drive at all has been asked again.

Our cars: The American public is apparently still content with paying $10–$15 thousand over time for a new automobile, an object which does nothing but diminish in value, cost more each year to run, and waste time and effort on repairs. This same public is reluctant to spend $1500 for a solar water heater because it is afraid that it will not work perfectly when installed. This will have to change.

In the heat of summer, traffic jams the city streets. Heat from the engines and the exhaust flows into the concrete streets and buildings. The air conditioners are on in the cars and the buildings. The hot air pours out onto the street. City air is polluted and the windows are closed. The answer is clear. Electric vehicles, low noise, no pollution, open windows. How long will it take?

Our homes: Any real estate agent can tell you why the single-family dwelling predominates. It is not because we enjoy mowing grass, shoveling snow, house repair, or because we enjoy that 40-minute drive to and from work. The house has proven to be a solid investment; even in the 1973 energy crunch, the combination of dwindling supply and increased demand kept prices up. The income tax structure in this country all but forces us to hock our lives for a house. Now the picture is changing. A single-family dwelling which is a generically poor user of energy can use oil



for heating and increases the demand, reduces the supply, and increases the cost of oil. Whether or not you or I live in a house, whether we live in a region where oil is the primary fuel or not, in terms of inflation we all pay. We pay higher gas prices, transportation, and food costs, and we must include the price of the Sixth Fleet to defend the Persian Gulf. We all pay the price of the single-family house whether we live in one or not. This will have to change.

Our country: As long as the control of the environment is a decision made by people, it will be people who determine the balance between energy supply and demand. Through use, as has been shown in this issue, a poorly constructed building that is an energy sieve can be more conserving overall than an energy-efficient building poorly used. Obviously, this is not an argument for poor construction. It is an argument for intelligent utilization of energy-efficient buildings.

The options for environmental control of a building, passive or active, are put there by the architect. The environmental controls that are designed into the building are not just switches. The siting and orientation for environmental benefits determine what the envelope or mechanical options are.

The variables, then, are only put into the building as they are perceived by the architect. The more education and understanding of the options and values which determine their selection, the more effective their resulting use will be.

The selection of options is based upon their effectiveness, their value in both abstract and monetary terms. The rest of the society and the governing bodies have a great deal to do with the value system which makes the selection of those options possible. When energy values are not present in the individual client, but are important for the general good, the government tries to create the values. Whether a piece of land is used as a forest, a single-family plot, an apartment house, or a jail is largely a decision of government. In its choice of building type and size, the government is affecting the energy situation to a much greater dimension than any architect can.

National lawmaking attempts to find the best possible route for the country as a whole. Therefore local, state, and regional needs are subservient to the national wellbeing.

The international situation is, however, the most primitive of all. Although a structure of law and government exists, it is clear that in and of itself the world is ungoverned and apparently ungovernable. Wealth: material or monetary; power: military or economic, and to some extent time and distance, still rule the world.

Our world: The world hovers closer to the brink of war than we like to think about. There is another threshold yet to cross with energy. It is not a threshold that we can be made to cross by law or that can be economically justified. It is not visible or tangible and not a switch or motor. The only near-term solution to the energy situation is our self-imposed will.

We keep waiting for the right law, the right sexy package, the right ad to make energy consciousness economically sound, culturally acceptable. It is not coming, *repeat, it is not coming.* We cannot legislate or sell culture. The society must voluntarily take a step. It must give energy consciousness value with a capital "V."

The stakes are no longer that vacation in the RV or the gas-pump price. We are putting wheat and corn into gas tanks and talking about thermonuclear war to protect oil. Not since medieval times have buildings been used as a weapon. Today, architecture is a weapon.

The last 20 years have fractured, exploded, and fragmented this country. The society came apart and is in the process of reassembling itself. We are a step from reassembly, a step from war, a step from a country bigger than the sum of its parts. This is not perfection or utopia. It is sanity. [Richard Rush]

There are several conclusions which can be drawn from this issue. Among them are:

1) International politics is the largest single force affecting our economy and therefore our buildings.

2) A bona fide energy technology has emerged which is recognized, used, and exchanged between countries. A concerted effort needs to be made by architects to exchange these ideas, experiences, technologies, and products. Most of the industrialized countries of the world, for example, have great expectations for solar water heating as well as photovoltaic and wind-powered electrical generation.

3) In its political activity, its lawmaking, and its buildings, the government can have a strong effect on the energy problem. The scales of energy responsibility and energy knowledge are not often related. Unfortunately many practitioners in the trenches of the energy war have lost the vital ability to generalize the problem.

4) The government and manufacturers of building products need to work with architects/engineers and economists to develop a set of incentives which can be offered to building owners to retrofit their buildings for energy conservation.

5) Energy-conscious planning is essential prior to energy-conscious architectural design. Decisions made at the broad scale can add to or subtract from the options at the building site.

6) The Building Energy Performance Standards are upon us. Every practicing architect and engineer in this country has the responsibility to obtain, study, evaluate, and comment to the government about the positive or negative feelings that he or she has about BEPS. Several of the buildings in this issue have their BEPS budget numbers listed in the data block.

7) Energy-conscious design requires a team effort. The procedure of creating a building has been positively affected in the conceptual stages of design by the early formation of the team. Architects and engineers need to encourage team skills in their practice and their education.

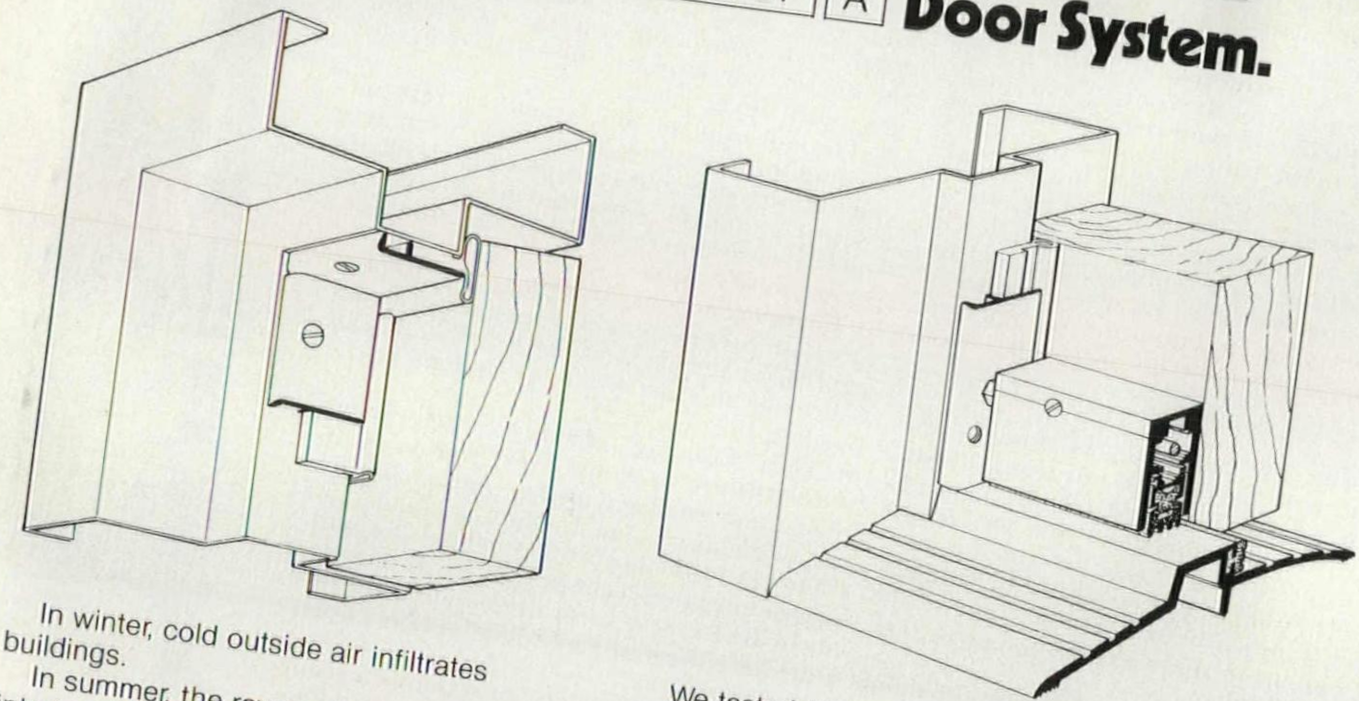
8) The total thermodynamic behavior of a building for energy conservation can be very complicated. The computer represents a tool of great capacity and someone on the design team must eventually learn to use it.

9) The restraints on energy use affect more than just the building. They strongly affect its use and the health of the user. Architectural research must thoroughly investigate the biophysical ramifications of energy design as well as the behavioral effects and the impact of energy legislation on other types of building regulations.

10) The top energy designers are leading by example. As energy-conscious design becomes the rule rather than the exception, those architects who have led the revolution are leading us back to an architecture rich with invention. Energy-conscious design has spread to nearly every building type. Energy-conscious design—is there any other kind?

Save your energy!

...with Zero's new AIR-STOP A Door System.



In winter, cold outside air infiltrates buildings.

In summer, the reverse is true: cooled interior air leaks out, or "exfiltrates".

In both cases, there is serious energy loss.

Zero now offers a way to eliminate such problems. We do it with one of our Air-Stop Door Systems.

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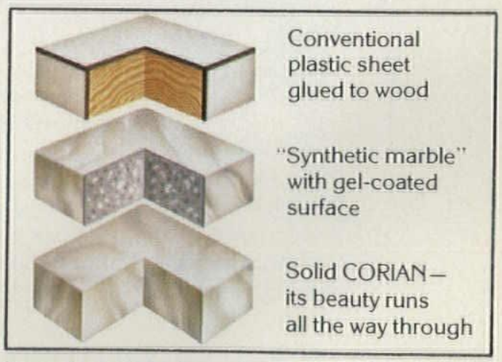

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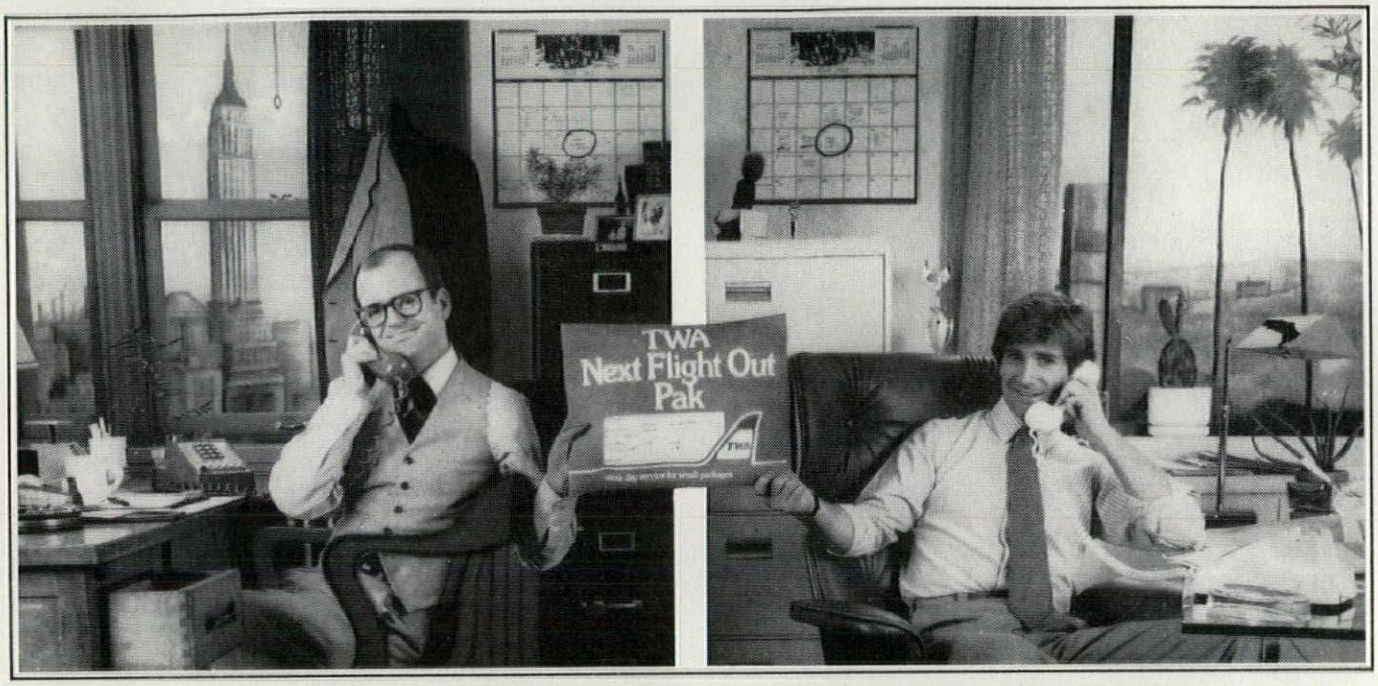

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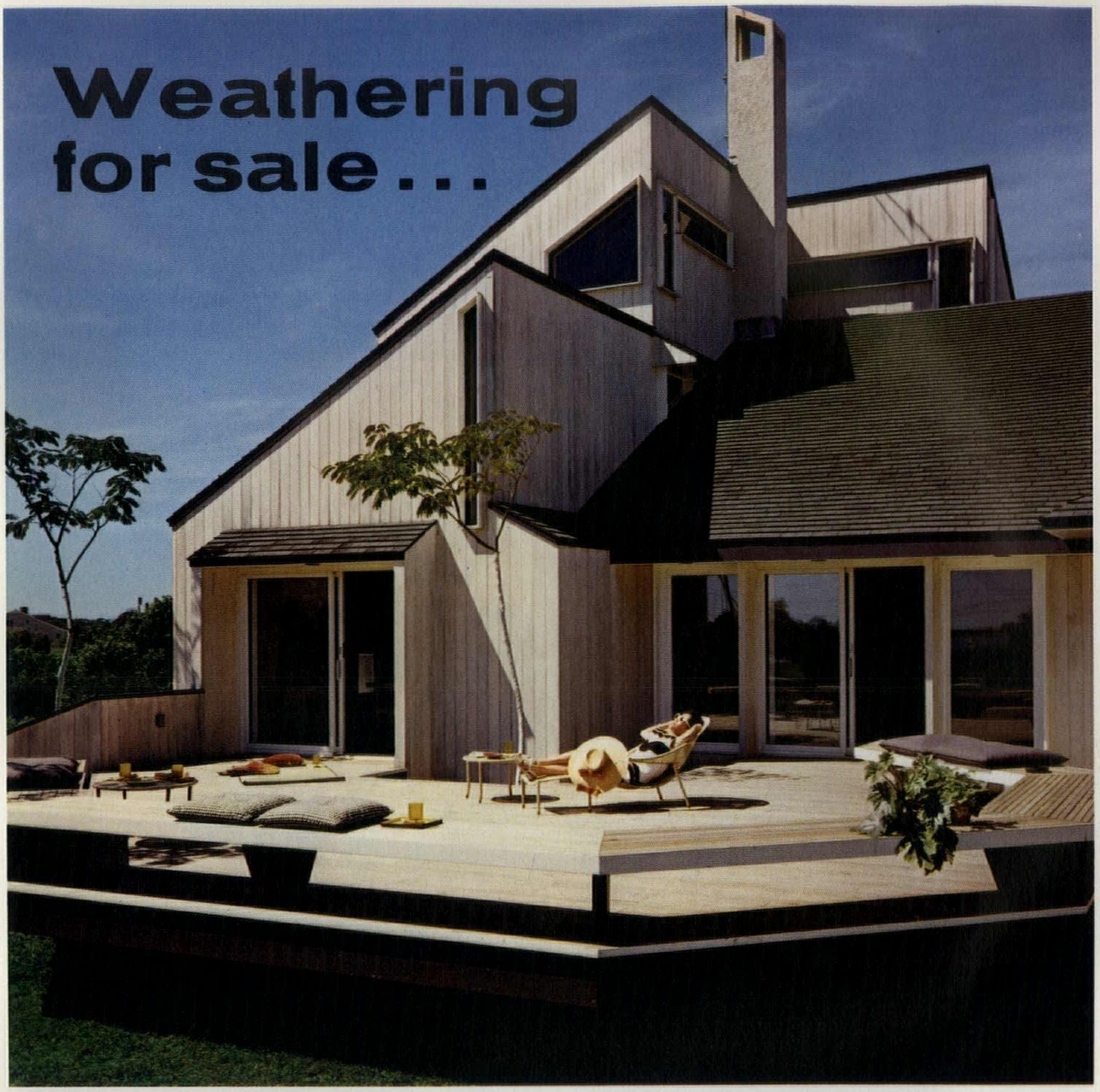

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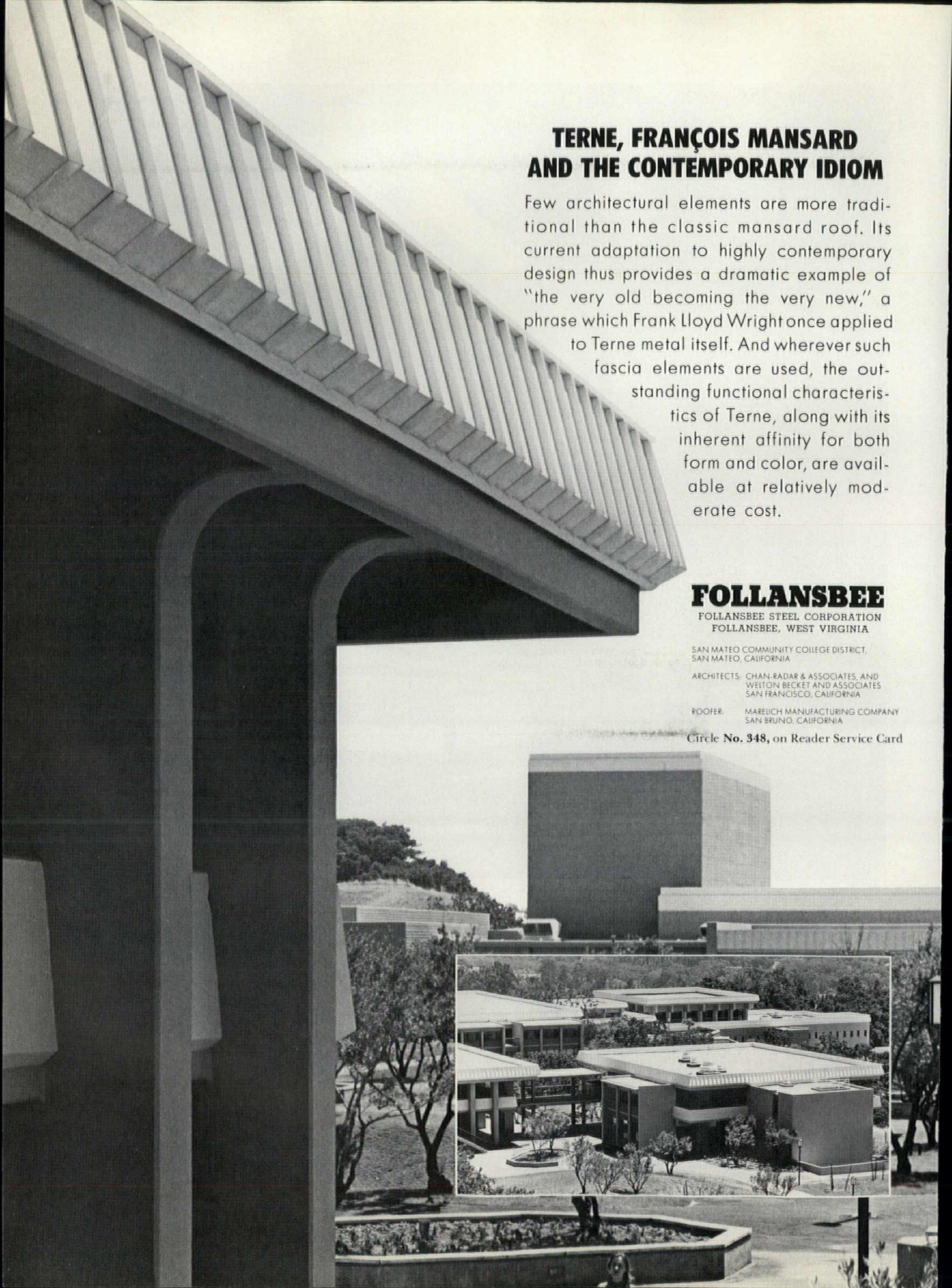
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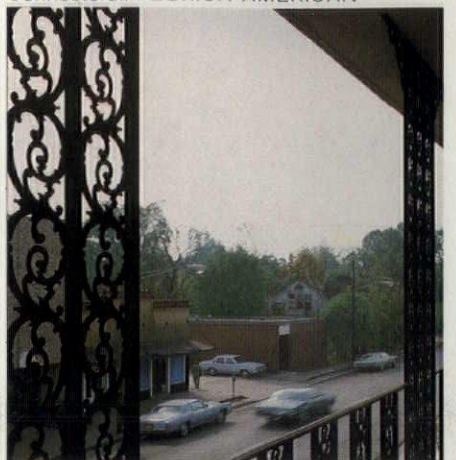
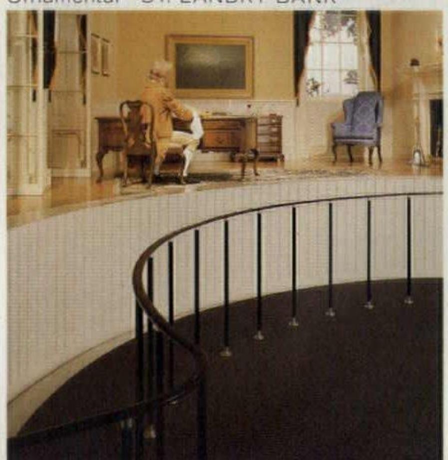
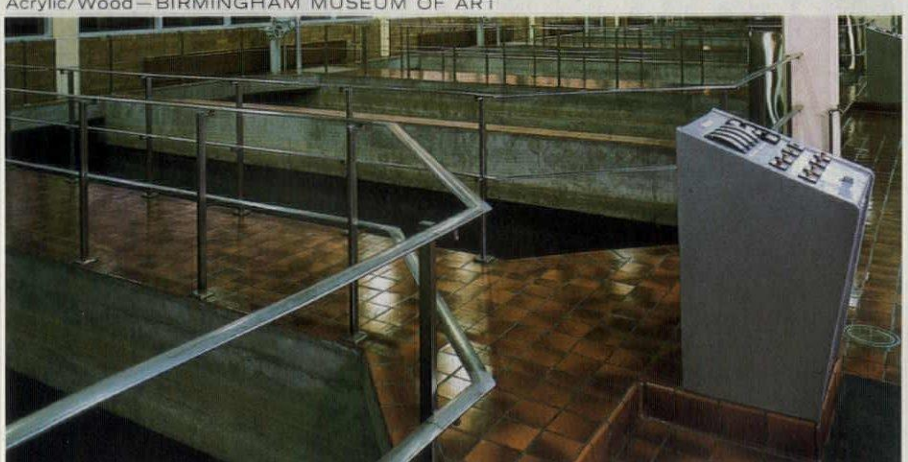

Ornamental—ST. LANDRY BANK


Acrylic/Wood—BIRMINGHAM MUSEUM OF ART


Colorail—SPOKANE STORY


Carlstadt—STONES RIVER TREATMENT PLANT

ZURICH AMERICAN INSURANCE CO.
Moorestown, New Jersey—
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Fabr: Albro Metal Products Corp.

ST. LANDRY BANK, Opelousas, Louisiana—
Arch: Bank Bldg. Equip. Corp. of America;
Fabr: United Steel Co.

SPOKANE STORY, Spokane, Washington—
Designer: Zentis Design.

BIRMINGHAM MUSEUM OF ART,
Birmingham, Alabama—
Arch: Warren Knight & Davis Inc.;
Fabr: Newman Brothers Inc.

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Nashville, Tennessee
Arch: The Chester Engineers;
Fabr: USONA Manufacturing Co.

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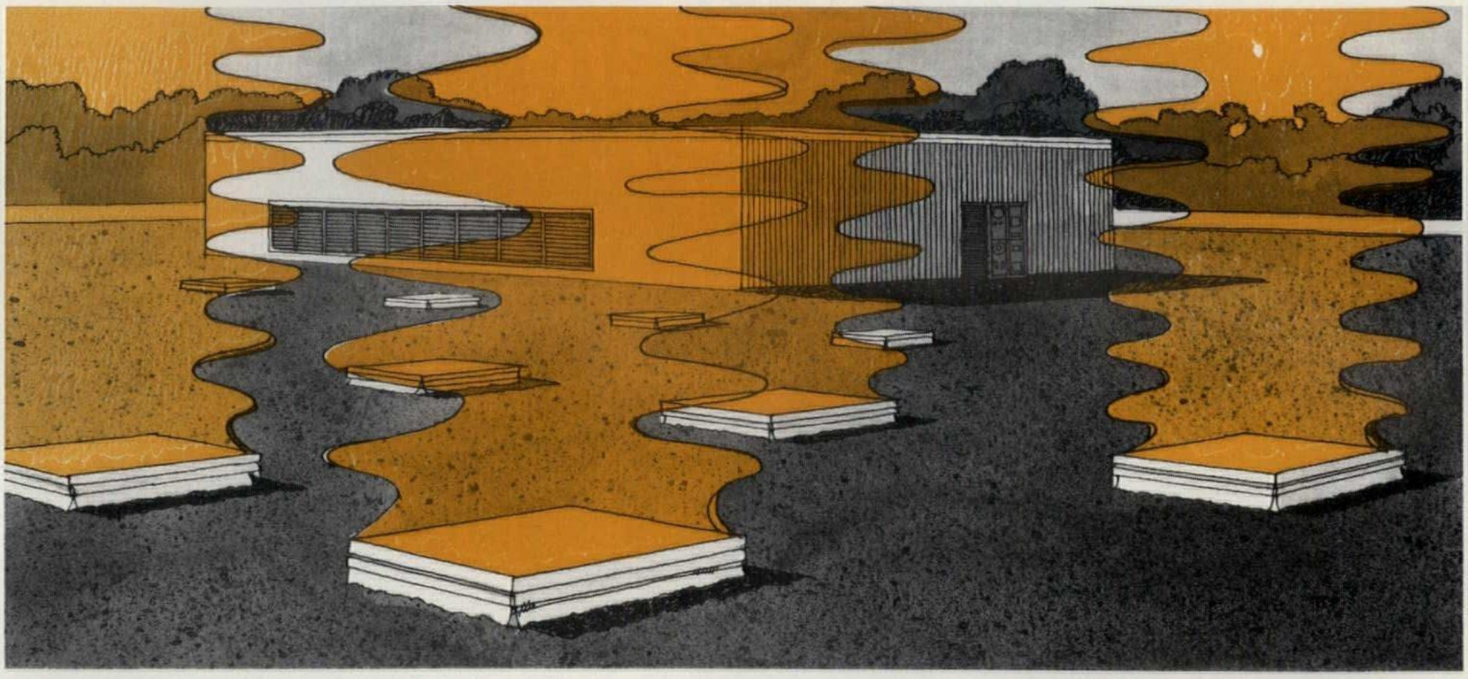

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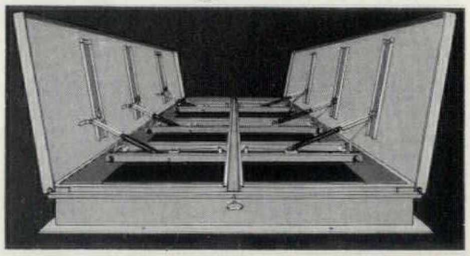

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AO-39-1

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Circle **No. 377,** on Reader Service Card

Energy-related specifications

William T. Lohmann

Energy considerations may be prominent on the building surface, but in the specs it is 'business as usual.' All of the innovative energy-saving techniques have their place in conventional specifications.

William T. Lohmann, AIA, FCSI, is Chief Specifier for C.F. Murphy Associates, Chicago, Il.

The apparent impact of a new energy conscience on construction specifications is slight. Specifications do not group "energy" factors (or "safety" or "security") under a common heading. They are dovetailed into appropriate trade or equipment sections. Even products, such as reflective glass and solar-collector piping, find their places under familiar titles. There is no need to throw out your copy of the CSI "Masterformat."

We are faced, however, with a greater need for effective coordination between the architectural and engineering specifications in our documents. Design criteria are becoming more stringent. Systems are more complex. Rapid changes in test methods and performance data quickly make manufacturers' catalogs obsolete. Architectural, mechanical, and electrical functions are more interdependent than in the past.

An early meeting with the project engineers can begin to resolve potential conflicts in format, style of writing, and terminology. Sample specifications and master sections will help. Out-of-house consultants particularly need such guidance. They must also be cautioned to review drafts of the "front-end" documents prior to preparing their specifications, avoiding duplication of such information in places other than the General Conditions and Division 1 sections.

The flow of design information between architects and engineers is critical. Building construction impinges directly on mechanical design, affecting such factors as solar gain through glass and heat absorption of floors and walls. Mechanical and electrical equipment items likewise affect, indeed become, architectural features. Solar panels replace walls or roof. The possibility of future retrofit for wind-driven generators or photovoltaic cells involves present design allowances for structural support and access. Remember that a roofing manufacturer's warranty usually does not cover damage caused by roof-mounted equipment. Early overlap decisions in these areas should be documented in outline specifications and confirmed at each stage of design.

During preparation of the specifications, precepts for good technical writing apply—clarity, brevity, consistency. Extensive editing is sometimes necessary to achieve a uniform level of detail and a sense of cohesiveness in the documents. But it is worth the effort. Finding "furnish and install" in one section and "provide" in another can lead to erroneous bids. The same is true for other problem phrases—"exposed," "by others," "allowance"—if they are not defined and used consistently.

Duplication and omission of information are hazardous. To specify all motor starters in a section under Division 16 Electrical and also in the heating and ventilation sections under Division 15 Mechanical is both expensive and confusing. To forget them is disastrous. Common practice puts starters for loose motors in the electrical work and those for motors mounted in preassembled equipment in the mechanical sections.

Such trade "assignments" are often necessary. Wiring for other electrical components usually follows the guidelines established for motor starters. Full-color coding of piping and conduit should be specified under the painting section, yet stenciled bands and letters and adhesived-backed labels normally appear in the mechanical and electrical sections. Pipe-covering requirements must be correlated for the plumbing, heating, refrigeration, and process piping trades. Unless indicated on the drawings, the specifications must define contract or trade limits for site utilities and building services.

When selecting mechanical and electrical equipment, investigate the impact of the new energy performance codes. The equipment must comply. Eventually, standardized testing, perhaps by rating agencies, will simplify its selection and specifications. Until then, specify required performance and means of determining compliance. The manufacturer should certify that his equipment meets or exceeds these specifications.

Perhaps the classic coordination problem has arisen with development of the "integrated" ceiling, involving up to six trades in one assembly. Because of its complexity, many firms now specify all components in a section under Division 13 Special Construction and cross-reference related work in the mechanical and electrical sections. This can result in a single-source responsibility for the entire system.

Before releasing the documents for printing, potential problem areas should be reviewed with care, preferably by someone other than the author. A final check of scope items, cross-references, and known problem areas will also reduce confusion during bidding and construction of the project. □

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Circle **No. 316,** on Reader Service Card

Solar collectors vs. local ordinances

Norman Coplan

Of the many strategies for improving the energy performance of buildings, the installation of solar collectors poses the most immediate challenge to local codes and zoning ordinances.

If solar energy is to be a realistic alternative to traditional sources of energy, it is necessary that a serious examination and analysis be made of our laws to determine how they must be modified to accommodate and facilitate this technological development. One of the greatest concerns in this context is how our laws should be modified to ensure solar access to homeowners utilizing this technology, more specifically to protect solar collectors from shadow. One suggestion has been for the states to adopt legislation which would classify certain conduct and/or conditions, which might impair the use of solar energy, as a "public nuisance" under the inherent police power of the state to protect the safety, health, and general welfare of the community. Although this approach involves constitutional questions, statutory restrictions whose purpose would be to encourage the use of solar energy would undoubtedly be sympathetically received by the courts.

A more immediate obstacle, however, to the wider use of solar technology are local zoning ordinances or building codes which have not been reviewed and/or modified to accommodate the utilization of solar energy. Illustrative of this problem was a litigation in New York last year involving the effort of a homeowner to obtain a building permit to install solar collectors for his home, which installation apparently violated the then prevailing zoning ordinance *(Katz v. Zoning Board of Appeals of the Town of Mamaroneck)*.

The petitioner in the *Katz* case had applied to the Municipal Building Department for a permit to construct a solar panel domestic hot water system, which panels were to be placed on the roof of his home. The permit was denied because of a provision of the local zoning ordinance which restricted the area of mechanical equipment to 10 percent of the roof area on which the collectors were to be located, whereas the installation of the collectors would cover 20 percent of the supporting roof. The petitioner appealed to the Town Board of Zoning Appeals requesting a variance. This was initially denied, but thereafter the petitioner revised his plans to reduce the area of mechanical coverage to 16 percent of the supporting roof area and reduced the angle of the panels so that their visibility from the front of the house was reduced by 70 percent. Upon his reapplication, the Board of Zoning Appeals again denied the variance, despite the fact that no neighboring residents objected to the variance and 26 neighbors actively supported the same. The petitioner then instituted a further appeal to the Supreme Court of New York.

The Court, in reversing the Board of Zoning Appeals, ruled that the Board had been incorrect in interpreting the zoning ordinance as limiting the mechanical coverage of the "supporting roof." The Court pointed out that the petitioner's roof was made up of eight separate sections and that the limitation was not to be measured by the section which supported the mechanical equipment, but rather in relation to the area of the entire roof.

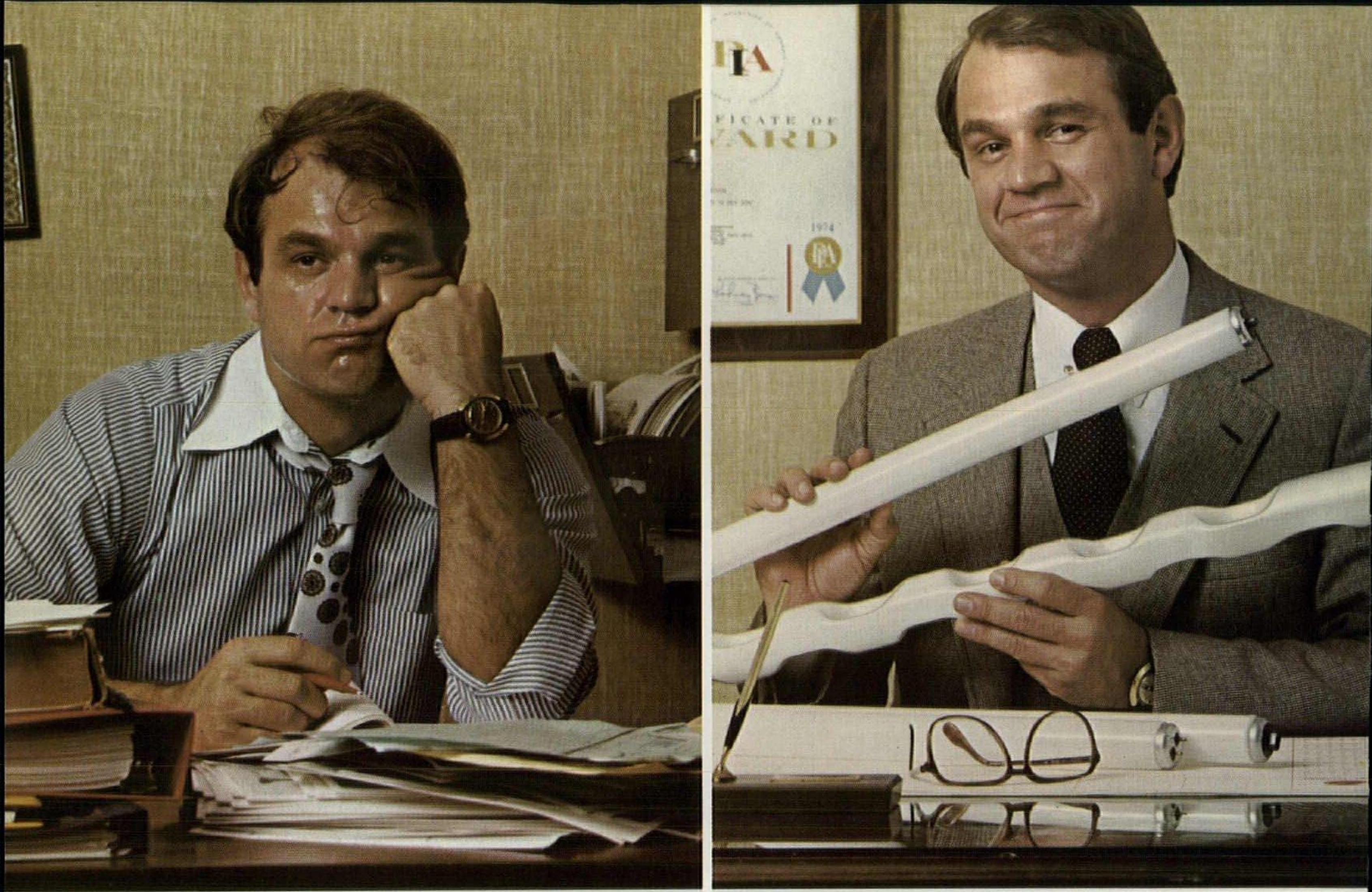
More significantly, however, the Court ruled that even if the Board's interpretation of the ordinance were correct, the denial of a variance to the petitioner was arbitrary and capricious. The Court said:

"It must be remembered 'that zoning ordinances, being in derogation of common-law property rights, are to be strictly construed against the municipality and in favor of the landowner.' Even if Section 89-45A were applicable to petitioner's proposed construction, this Court finds and so holds that petitioners have shown practical difficulty sufficient to justify an area variance.

"In this day of what for better expression may be termed the energy crunch, the purposes of restrictive zoning must, to some extent, give way to declared policy of governments to conserve energy in all ways possible yet consistent with environmental standards. . . . In the accomplishment of the above, it is incumbent upon the zoning agency to adopt an attitude other than an ostrich head-in-the-sand approach, especially when adoption to changing scientific advances follows and complies with national and state interests in energy conservation. It has been said that 'our increasing dependence on foreign energy supplies presents a serious threat to the national security of the United States and to the health, safety and welfare of its citizens' and that, further, 'the mass production and use of equipment utilizing solar energy will . . . promote the national defense.'"

The Court concluded by pointing out that in furtherance of the public policy of the United States, the Energy Tax Act of 1978 was adopted, providing a monetary incentive for domestic solar hot water systems for private dwellings and that such policy has been followed by similar State expression of public policy and monetary tax relief. In particular, the Court pointed out that the Energy Law of the State of New York imposes upon municipalities the duty to review their rules and regulations not only to make them consistent with the State declared policy for energy conservation, but where "inconsistent, to make necessary changes to comply with the Act's stated purposes."

Implicit in the Court's decision was a criticism of the Town for failing to review its ordinance to make it comply with prevailing public policy. It is apparent that proper planning to achieve the use of alternate sources of energy includes, as an essential ingredient thereof, the necessity for reviewing and revising local zoning ordinances for their compatibility with such objective. □



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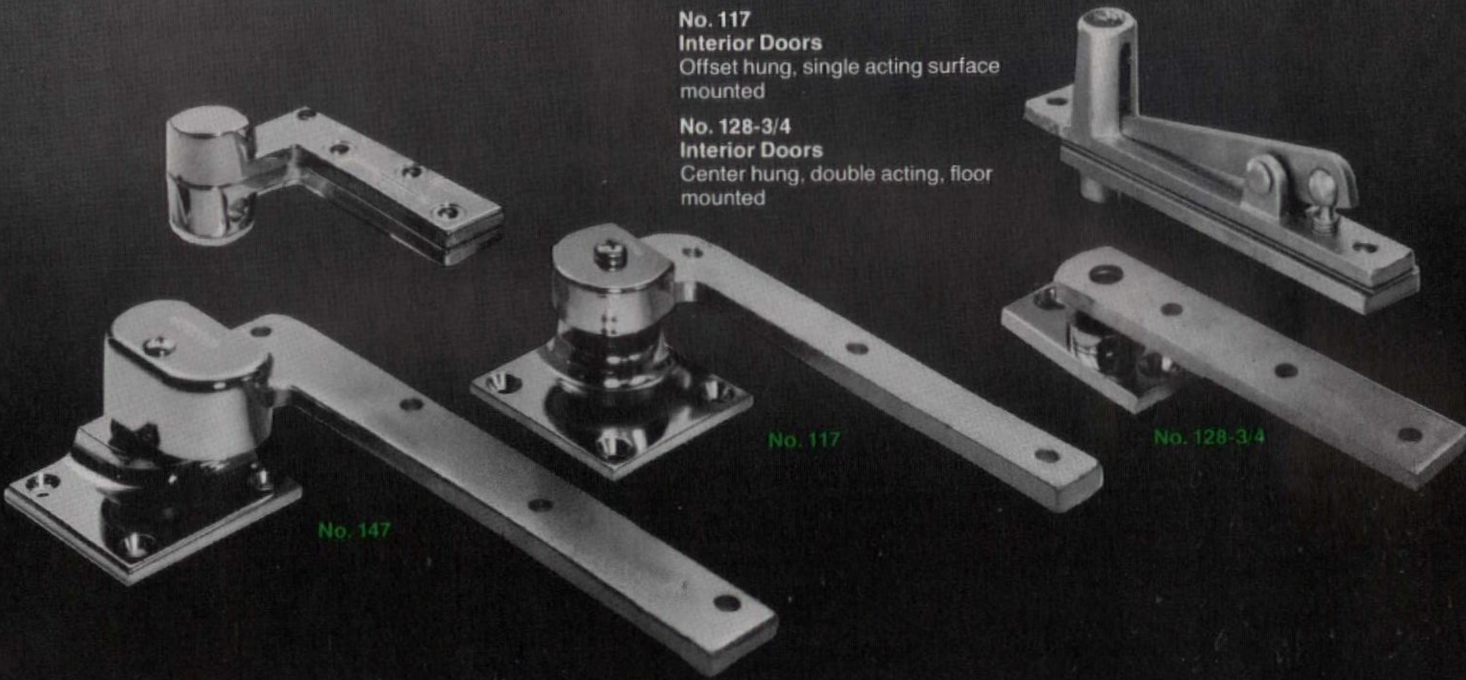

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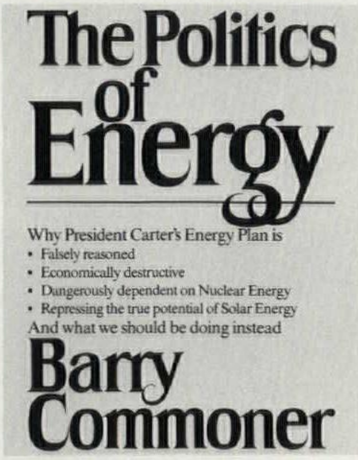
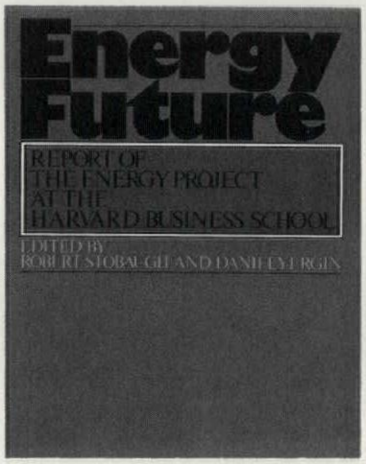
The future and politics of energy

Books





The Politics of Energy *by Barry Commoner. New York, Alfred A. Knopf, 1979. ix, 102 pp., hardbound, $10.*
Energy Future: Report of the Energy Project at the Harvard Business School, *edited by Robert Stobaugh and Daniel Yergin. New York, Random House, 1979, x, 353 pp., hardbound, $12.95.*

Reviewed by John P. Eberhard, Director, Architectural Research Association, Inc., Bethesda, Md.

These two books, one by a renowned environmental biologist (Commoner) and the other by a team of newly acclaimed Harvard Business School professors, arrive at very similar conclusions by taking considerably different approaches. Their conclusion, that conservation (or more clearly, improved energy efficiency) is the best energy policy alternative for the United States, should be welcome news within the architectural community. As I will suggest a little later in this review, it is the professional design community—and more specifically architects—that have the responsibility and the opportunity for making the largest contribution to reducing our nation's dependence on fossil fuels. It is worth noting, as well, that the long-awaited report of the National Academy of Sciences, "Energy Policy in Transition 1985-2010," has added still more reinforcement to this message of conservation. The Academy study insists that "slowing the growth of energy demand will be essential, regardless of the supply options developed during the coming decades. In fact, the demand element of the nation's energy strategy should be accorded the highest priority."

Both of these books are well written but are stylistically and conceptually different. Commoner is quite clearly an advocate and a critic. He is an advocate of a policy alternative he has coined "The Solar Transition," and is a severe critic of the past and present Federal policymakers. The Harvard Business School professors are policy analysts with good common sense and what would appear to be no beginning bias towards any of the alternatives they discuss. Each of us probably brings some preconceptions and personal bias to the reading of any book; and each of us naturally tends to accept with a positive nod of the head statements the author makes which support our point of view. We naturally find it difficult to believe the authors are very well informed if they happen to
[*Books continued on page 193*]

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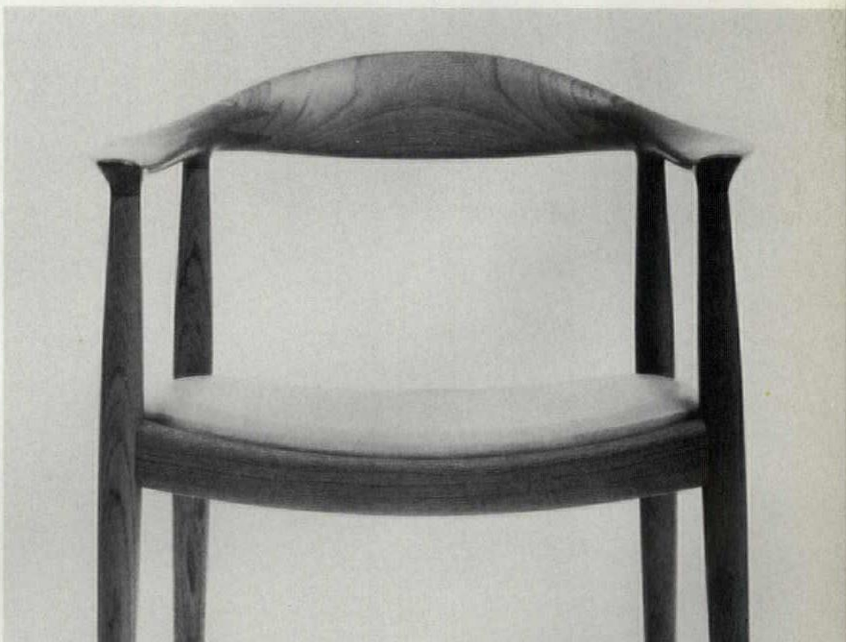
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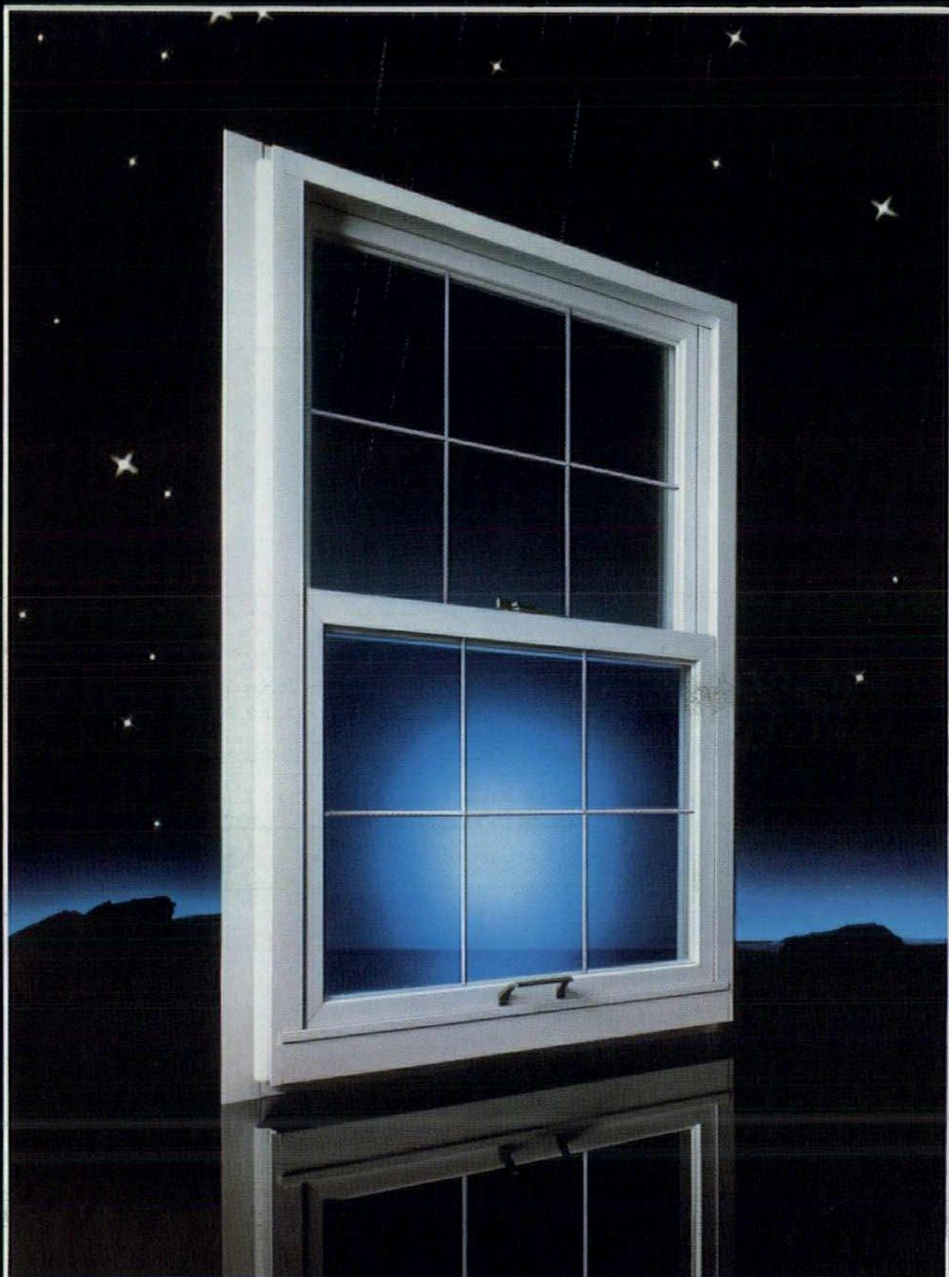

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Books continued from page 191

differ with us. I approached both of these books in much the same manner. I expected to agree with Commoner because I thought I knew what he would say, and I expected to disagree with the Harvard book because of all of the publicity the authors had received. (Besides, I am an alumnus of MIT.) Just the opposite happened. I found Barry Commoner's strident tones and fuzzy policy position to be difficult to accept, but I found the good common sense and clear prose of *Energy Future* to be easy to read and very convincing.

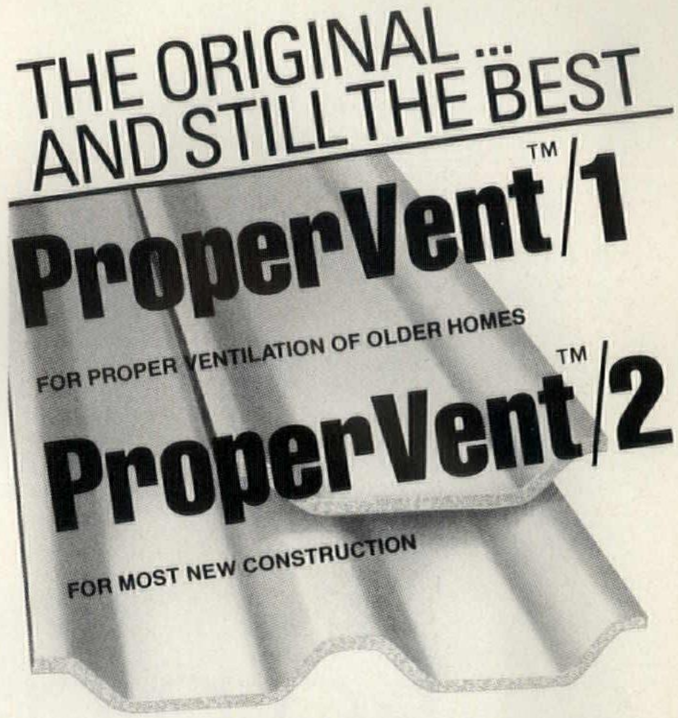
The only difficulty I found to be common to the two books was the academic penchant for extensive footnotes (although they are thankfully located at the end of the books and not scattered over every page of text), and the diarrhea of numbers. I'm going to assume, for the purposes of this review, that you have some general sense of the numbers involved with energy and that whether or not we expect to use 80 quads of energy or 135 quads by the year 2000 is not critical to your professional response. If buildings use 26 percent of the nation's energy budget or 31 percent is not going to impact your opportunity, and whether or not solar energy has a payback of 2.8 years or 8.4 years is less critical than that you resolve to inform yourself and your colleagues of how you can incorporate "energy-conscious design" into your practice. Both books take some pains to point out the weakness of numerical calculations that others have made—Commoner even calls the energy models of the Carter Administration "the politics of deceit"—but both books tend to draw specific conclusions of what would likely happen to energy prices that have turned out to be far lower than what has actually happened at the gas pumps only a few months after the books were published.

Barry Commoner makes the following argument. The Carter Administration's National Energy Plan as presented to Congress in April 1977 was "confused" at best and probably "deceitful" on purpose. He argues that although the plan called for conservation measures, including the development of energy alternatives such as solar and wind energy, that the plan was actually a not very subtle support program for the advocates of increasing our supplies of fossil fuels—including nuclear energy. He also points out that an analysis of the tables which accompanied *The National Energy Plan* shows that consumers would be expected to make a much large reduction in their use of energy than would industry. As a result of the disparity between facts in the tables, facts from a complex mathematical model (PIES) used by the then Federal Energy Administration, and the prose of the President's message, the legislation got hopelessly mired in Congressional committees resulting in what Commoner calls the "Politics of Defeat."

In Chapter 5 of his book, Commoner comes to the crux of his presentation. He points out that fossil fuels in the final analysis are finite—they can be and likely will be used up. As they become more and more scarce their price will continue to escalate. He suggests that the "Politics of Choices" leaves us only two alternatives for the future—solar energy (in its broadest sense this includes wind power, bio-mass, and photovoltaics) and nuclear energy (but only if it is based on the breeder reactor). He argues that nuclear energy, even though highly subsidized, is a *new* technology that seems already to have lapsed into "economic senility," while solar energy is an *old* technology ready to cross the threshold of economic viability.

Commoner's dénouement is "the Solar Transition." He argues that we should use our dwindling supply of fossil fuels in a manner that "bridges" from the present situation to a future time in which we will be well supplied from renewable sources. He sees natural gas, supplemented with gas from bio-mass, and co-generation as two of the major ingredients of this strategy. What he seems not to recognize is the possibility that new inventions and innovations might substantially change the nature of demands as well as sources of supply. He also makes a strong argument for more "social governance" in major policy decisions because electric utilities and oil corporations will oppose a solar future—what many readers will suggest is reworking our economy into more of a socialist state. For me the book's central strategy remains un-

[*Books continued on page 194*]



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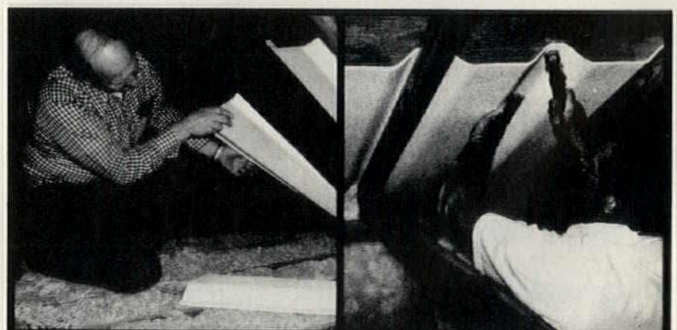

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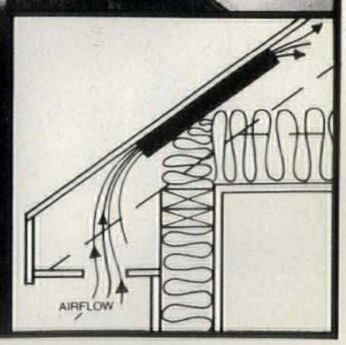

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Books continued from page 193

convincing, but then you should read it and decide for yourself.

Robert Stobaugh, Donald Yergin, and their Harvard colleagues are much more convincing and far easier to read. Their central theme is very clear. The United States needs a *balanced* energy program based on realistic assessments of our supply and demand alternatives. They point out quite convincingly in their first five chapters that each of the fossil fuel alternatives—oil, gas, coal, and nuclear—has an inherent limitation as a supply alternative. Even if each of them were to achieve the goals of their most ardent supporters, they would not provide sufficient supplies through the end of this century (much less beyond) to meet our projected demand on a "business as usual" basis. They arrive at the same position as the first energy report of the American Institute of Architects (dated 1974), namely that conservation is our "key energy source." They conclude that "in the near term, conservation could do more than any of the conventional sources to help the country deal with the energy problem it has."

While the architectural community should surely support the thesis of *Energy Future,* there is one serious flaw in the authors' discussion of conservation in buildings. They quote Dick Stein on the need to reverse our commitment to sealed buildings—that's fine. They quote Don Watson and Bruce Anderson when they discuss the opportunity for passive solar design—great! But, when they advocate a major program to save energy in existing buildings, they turn to the limited concept of "retrofit." To quote them, "*Retrofit* is a space-age term, describing the upgrading of a complex system through the insertion of improved components." In buildings, they say, this means changing equipment and structure to improve thermal and lighting efficiency. Somehow, with all of their common sense, they missed a key point: people and their activities place demands on energy sources not the inanimate buildings that provide shelter for these activities.

An empty building, a ghost town, or even an unused bedroom needs no retrofitting since no one will need to be kept comfortable there. We need to be sure that existing buildings have a good fit between their program requirements and their existing space configuration before we worry about palliatives such as more insulation, storm windows, or even cogeneration. We should be sure that our architectural evaluation of fitting program requirements to available space also includes any "energy conscious" redesign we can do to make a better fit with the climate. That's a good role and an important one for architects to play. If this kind of analysis is done thoroughly and with imagination, it can represent the largest reduction in building energy demand—and it comes right off the top of the demand side. We obviously have not done a very good job of selling our role in the energy picture thus far or two such thorough books would not find it so easy to largely ignore the role of architects in energy conservation.

Energy Future makes it clear that: "No easy remedy will solve the energy crisis. Solutions, however, will emerge from a recognition and comparison of benefits and risks, possibilities and obstacles, across a wide range. Political choices are therefore involved, which is why the energy crisis is a crisis of our political system." How will you vote?

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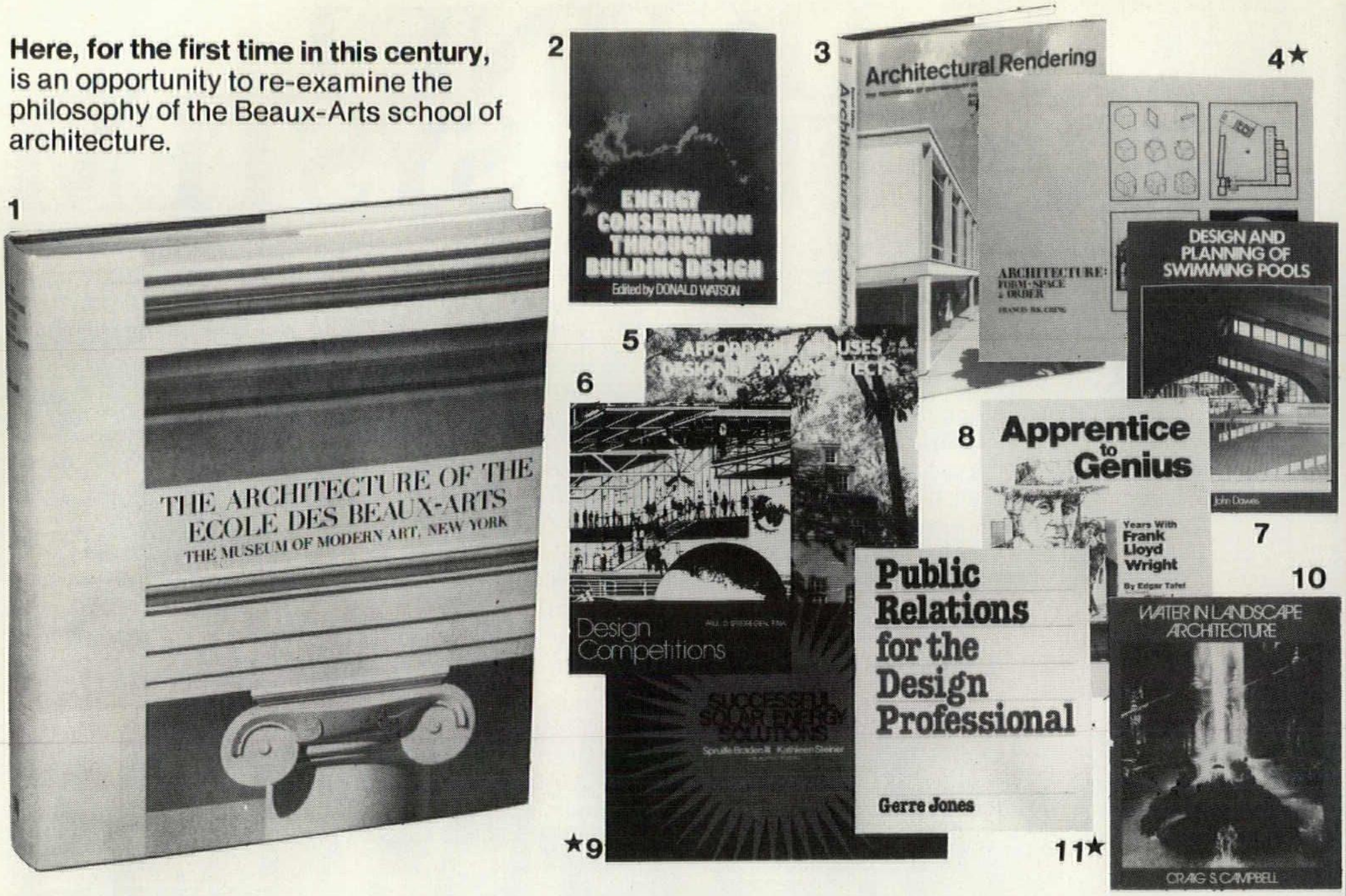

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This attractive book will aid communication between landscape architect, architect and layman with a comprehensive collection of photographic portraits of trees whose structure, habit and other characteristics make them especially useful in relation to buildings and outdoor spaces.
Circle B625 under Books.

NEW★

26 How to Recycle Buildings

By Laurence E. Reiner,
244 pp., illus. . . . $18.50

The concensus of opinion by many authorities in the building industry is that recycling is here to stay and to expand. Here is an excellent reference on how to find, evaluate, survey, finance and market recycling projects profitably.
Circle B626 under Books.

Products and literature

The following items are related to the theme of this issue, energy conservation. They are grouped here for the convenience of the reader.

Daylight control

Daylight control is a function of almost every aspect of design, from the direction the windows are facing to the size and shape of the room inside. In terms of products, there are basically four kinds: things to put outside the window; things to make the window of; things to put inside the window; and things to adjust the level of artificial light. Many devices have been around for years with the state of the art having as much to do with how to use these products as what is available. Architects are discovering, for instance, that the plastic-coated aluminum panels from industrial buildings can be very useful as shading devices.

Integral to the process is redefining the task from simply defending the interior against overheating. Daylight control now means harnessing the sun to reduce lighting load resulting in techniques like light shelves to bounce sunlight into buildings. Movable louvers with one side reflective and the other matte can be very effective in beaming light deep inside as can blinds with the same properties (available on custom order and in development as a stock item). Several companies are working on photochromic window glass, which, like "polarizing" eyeglasses, adjusts its tint according to brightness. Other researchers are taking a serious look at refractive glass, those ripple windows from the 1940s. The ripples were made of prisms grooved into the glass which bring light in and bounce it off the ceiling, allowing deeper penetration.

But bringing sunlight in is only half the task; the rest is to turn lights off to compensate. To the traditional on-off switch and more recent stepped controls, solid-state circuitry has introduced continuous dimming, either by user control mechanisms or photosensors.

In addition, attention is being paid to avoiding heat loss as well as heat gain. Among the newest items are heat mirrors—films applied to the inside of windows—which reflect infrared rays back into the room; and rolling screens and shutters of wood or plastic, that have been used in Europe which both modulate daylight during the day and form a thermal barrier at night.

Products

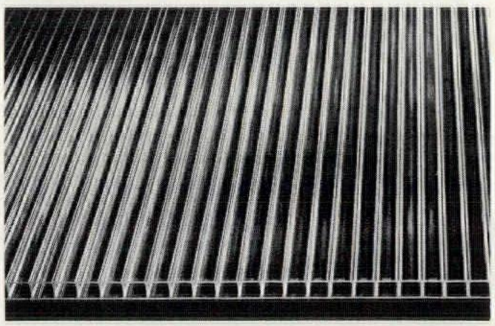
Solar screens of tiny fixed louvers tilted at 17 degrees protect against heat and glare. The screens, installed outside sun-exposed windows, keep building interiors up to 15 degrees cooler while admitting diffused daylight. Almost invisible from the inside, the screens permit as much as 84 percent clear outward visibility, according to the manufacturer. The screens are made from a bronze alloy coated with an organic finish for corrosion resistance and are enclosed in aluminum frames. They are available in widths up to 72 in. and can be hung from the top, in vertical rolling tracks, or in horizontal or vertical sliding tracks. KoolShade Corp.
Circle 100 on reader service card

Rolladen shades shield against heat loss or gain, reduce sound, and also serve as security guard, since they lock from the inside. When not in use, they roll up and store out of sight. Shades operate by manual crank, pulley strap, or electric motor. They are made of PVC with dead air space, PVC with polyurethane insulation, or aluminum with polyurethane insulation. American-German Industries, Inc.
Circle 101 on reader service card

Paesar fluorescent lighting controller has a sensor that automatically monitors the amount of daylight entering the room. The sensor sends a signal to the power control to gradually reduce power to lamps as daylight increases, maintaining a constant level of light. The manufacturer says that lighting energy savings of as much as 50 percent are possible and that cooling costs are also reduced. Lutron Electronics Co.
Circle 102 on reader service card

ECALO (Energy Conservation Automatic Light Output) is an available-light sensing system that adjusts fluorescent lighting to a predetermined level. The controllers, taking into account direct or reflected sunlight, are reported to save 43 to 58 percent in energy used. Payback period is six months to three years, depending upon the type of fixture used. Controlled Environment Systems, Inc.
Circle 103 on reader service card

NorCore™ high-strength, lightweight plastic honeycomb material is used in transparent ceilings, walls, partitions, skylights, and geodesic domes. It has light transmission or translucent properties and retains a high degree of thermal insulation. Because it is a thermoplastic, it can be molded into curved shapes through the thermal forming process. It is available in opaque colors, clear transparents, transparent tints, and translucent colors. Norfield Corp.
Circle 104 on reader service card



Exolite double-skinned acrylic sheet for glazing offers high light transmission, good U-value, and easy on-site fabrication. Integral ribs form a series of insulating air cells. The material has high rigidity and load strength, impact resistance, and excellent weatherability, according to the manufacturer. Panels are ⅝ in. thick, 47½ in. wide, and come in standard lengths up to 20 ft. Uses include glazing, skylights, and lighting fixture diffusers. CY/RO Industries.
Circle 105 on reader service card

Sol-R-Veil is PVC-covered fiberglass material offering shade with visibility. Intended for exterior window installation, it also can be adapted for use on window interiors. The material can be used on roll-up shades, spring rollers, or on motorized versions controlled by a solar cell. Panels that slide, vertical blinds, and other treatments are possible. The fabric requires little maintenance: it can be vacuum cleaned or washed with a mild detergent. Sol-R-Veil Inc.
Circle 106 on reader service card
[*Products continued on page 202*]

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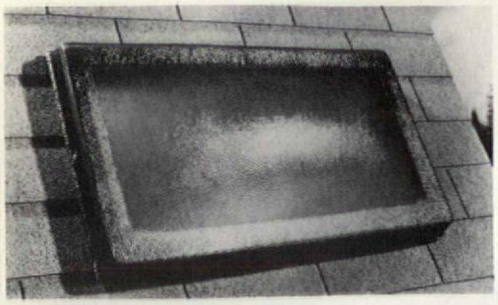
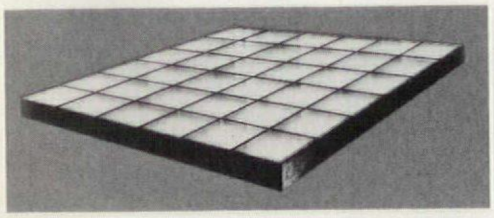
Circle **No. 308,** on Reader Service Card

Products continued from page 200



The Tri-Therm Skylight has an outer dome of GE's Protect-A-Glaze® sheet and an inner diffuser panel of GE's Lexan® structural sheet which combine to provide three layers for high impact strength and superior thermal properties. The outer dome has a pebble finish and comes either clear or tinted for solar control. The skylights provide daylighting and thermal gain to help reduce energy requirements. They are lightweight, economical, and easy to install. Faulkner Plastics.
Circle 107 on reader service card

Insulating skylights of translucent, impact-resistant sandwich panels are adaptable to many types of installation. Single panel size is up to 6′ x 25′, with larger areas covered by multipanel units. The fiberglass-reinforced skins provide diffused light without excessive loss of heat. The panels are offered in a choice of core patterns, skin colors, surface finishes, and light-transmission values. Cemcel Corp.
Circle 108 on reader service card



Single, joint-free all-plastic skylights provide natural light and insulate against thermal heat loss in winter and solar heat gain in summer. The 1½-in.-thick sandwich panels have a 1⅜-in. dead-air space which results in a U-value of 0.425. Outer and inner skins are translucent fiberglass-reinforced acrylic polyester laminated to a 6″ x 6″ interlocking grid core. The skylights transmit about 40 percent of the sun's rays in a diffused manner, without glare. Solartron Corp.
Circle 109 on reader service card

Cool-View reflective glass comes in four configurations, each with a choice of glass and coating. Weath-R-Proof insulating glass has two lights separated by dehydrated air space and offers the greatest environmental control. Monolithic is a single light for economical glazing in warm climates. Laminated is used in installations requiring safety, sound control, security, or for overhead glazing. Spandrel is heat-strengthened. Environmental Glass Products.
Circle 110 on reader service card

Sunglas Reflective, a reflective glass, blocks up to 65 percent of the sun's heat and has 30 percent visible light transmittance to reduce the need for artificial lighting. A thin metallic oxide permanent coating reflects solar energy, and the special composition of the glass absorbs and reradiates additional solar energy to the outside of the building. By eliminating hot spots near windows, the glass helps to maintain more uniform temperature in the building. Ford Glass Division, Environmental Products Dept.
Circle 111 on reader service card

Literature

Operable windows of several types are described and illustrated in a 20-page brochure. There are styles with narrow slat blinds between the outer and inner glazing to aid in heat and glare control. Others have insulated glass or double glazing. In-swinging and pivoting windows can be cleaned, or replaced in the event of damage, from the inside. Detail drawings and photos show window construction. Disco Aluminum Products.
Circle 200 on reader service card

Sun Control products shown and described in a four-page color brochure include Harosol® fold-up awnings, Haroscreen® sun protecting material for the outside of buildings, Harodark® 100 percent blackout blind, and Haro Sunbreaker® aluminum louvers. General information, construction details, fabrics, control methods, and applications are provided. Hamel, Inc.
Circle 201 on reader service card

'IES Recommended Practice of Daylighting' recognizes the potential for saving vast quantities of energy that might otherwise be used for artificial illuminating. Emphasis is placed on newly developed building and lighting technology and on aspects of energy conservation and life-cycle cost benefit analysis. Included are the architecture of the building, visual performance criteria, daylight design principles, examples, and charts to facilitate use. The 64-page publication, RP-5, is available at $8 to IES members, $12 to nonmembers, from: Illuminating Engineering Society of North America, 345 E. 47 St., New York, NY 10017.

'How to predict interior daylight illumination' is a revised 44-page booklet that discusses the type of light needed, available daylighting, the prediction formulation, how to figure in overhang, and other factors to consider. A summary of procedure and examples of calculating daylight under different circumstances are provided. The booklet is available at $1 per copy. Other daylight designing aids are the "Heat Gain Calculator" (35¢) and "Sun Angle Calculator" with separate cards for four different latitudes and a booklet of instructions ($5). The three items are available separately or in a kit ($6) from: Libbey-Owens-Ford Co., Merchandising Dept. P-1, 811 Madison Ave., Toledo, Oh 43695.

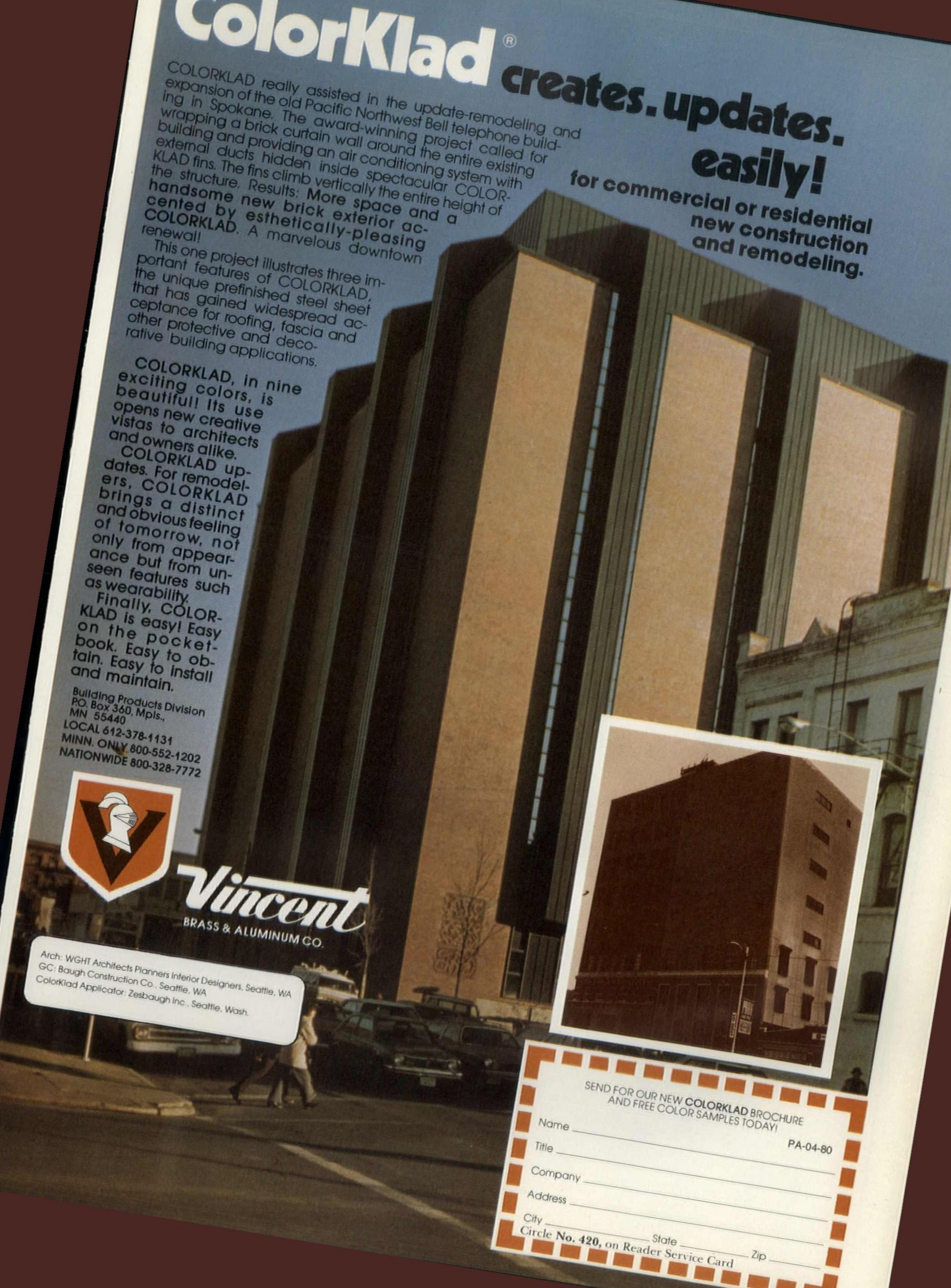
The Heatstopper™ shade, made up of five layers of plastic film, is installed on the inside of a window. It is raised and lowered manually by means of a bead chain. In the lowered position, the five layers separate to provide a series of dead-air spaces. For greatest effectiveness, the shades operate in a frame, with special seals to reduce air movement past the shade. A four-page brochure gives installation information, technical description of the system, energy savings and payback data, and results of tests. Insulating Shade Company, Inc.
Circle 202 on reader service card

Nunsun transparent reflective film for windows reduces glare, provides daytime privacy, and adds shatterproofing characteristics to glass. According to the manufacturer, use of the film on windows of a building where glass area is equal to 10 percent of floor area will reduce air-conditioning energy required by one-third and heating energy required by one-fifth. The film is also available in roll-up shades that have the advantage of being adjustable up or down. Thermo-Screen, Inc.
Circle 203 on reader service card

Vertical blinds can cut summer heat gain to lower air-conditioning loads. They also are adjustable to reduce glare. Several fabrics are available, some with perforations to allow the view to be seen even when the blinds are closed. There are some types that also provide acoustical control. Materials available, applications, and specifications for various types of blinds are provided in a 24-page brochure. LouverDrape, Inc.
Circle 204 on reader service card

Blinds for conserving energy are the subject of a six-page brochure. Diagrams show how they save energy, winter and summer. Graphs indicate dollar savings in heating and cooling costs. Included is a table of shading coefficients for Riviera blinds, along with data supporting the charts shown. Levelor Lorentzen, Inc.
Circle 205 on reader service card

Kool/Wall track-mounted solar screens reduce solar heat gain in the summer, yet can be retracted to let in the winter daytime sun and lowered to retain building heat at night. A four-page brochure discusses and illustrates details of the controls, track design, and installation. The system can be combined with photoelectric lighting zone controls to reduce artificial lighting needs. Kool-Shade Corp.
Circle 206 on reader service card
[*Products continued on page 204*]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Products continued from page 202

Lighting devices

While much of the world still depends on burning oils and wax for its light, the technological changes in lighting since the oil embargo in developed countries has been dramatic and promises to be even more so in the future.

We now speak of lamp efficacy in lumen output per watt consumed. Energy saving means both lowering wattage (lighting accounts for five percent of U.S. electrical use) and redirecting the heat lighting produces.

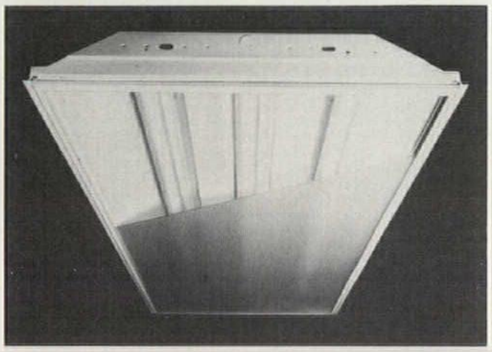
Office planning now frequently means task/ambient arrangements and a host of new products. In addition, the relationship between visual comfort and worker productivity has led to serious experimentation and new offerings in prismatic, polarized, batwing, refractive grid, and tinted lens fixtures.

Much of the research has been devoted to increasing lumens per watt from fluorescent bulbs—which have been brought from 37 to 100 in the past 40 years and are expected to go higher. Lower wattage bulbs (34, 35) for 40-watt ballasts are available and in situations where a bulb resulting in a 10 percent reduction in illumination is acceptable, even further savings can be effected. Fluorescents that work as conventional incandescent bulbs will be available soon. Incandescents can be expected to move from 17 lumens to 30 per watt.

Products already on the market offer savings in electricity upwards of 50 percent. The move toward high-intensity discharge lamps is placing increasing emphasis on improving their color rendition with, again, some improvements available.

Low wattage and very low heat ballasts are being marketed but the most exciting possibility is solid state circuitry. In large installations, return of air through lighting fixtures is increasingly common. Intended to reduce heat load, the technique also has favorable effects on lamp efficacy and equipment life.

Products



A three-lamp fluorescent troffer, designed with one less lamp for energy saving, can further cut energy costs because it is wired for one, two, or three lamp operation. The troffer is 3½ in. deep, has a door that can be hinged from either side, and has a 2″ x 3″ wiring access door. Keene Corp., Lighting Div.
Circle 112 on reader service card

Energy-efficient fluorescent lighting fixtures, Form 4, in 4-ft and 8-ft standard length use one or two fluorescent lamps. They may be mounted directly to the ceiling, hung from stems or cable hangers, attached to the wall by brackets, or mounted wall to wall. They are suitable for direct lighting, indirect lighting, or a combination of both. Lighting diffusers are parabolic-shaped louvers or acrylic lenses. Finishes offered include nine colors and three metallics. Columbia Lighting, Inc.
Circle 113 on reader service card

SPJ2 ambient lighting uses both metal halide lamps rated up to 100 lumens per watt and high-pressure sodium lamps rated up to 118 lumens per watt, and accommodates ballasts for up to 400-watt lamps. The luminaires provide improved lighting and cost savings in open-plan offices where partitions are 42–65 in. high, and lighting cannot project above the panel. The units can be mounted on shelves, on panel sides, or on freestanding files. Because one lamp provides as much light as 16 4-ft fluorescent lamps, fewer fixtures are required, reducing wiring and installation costs and cutting HVAC loads. SPI Lighting/Area Lighting Div., McGraw-Edison Co.
Circle 114 on reader service card
[*Products continued on page 206*]

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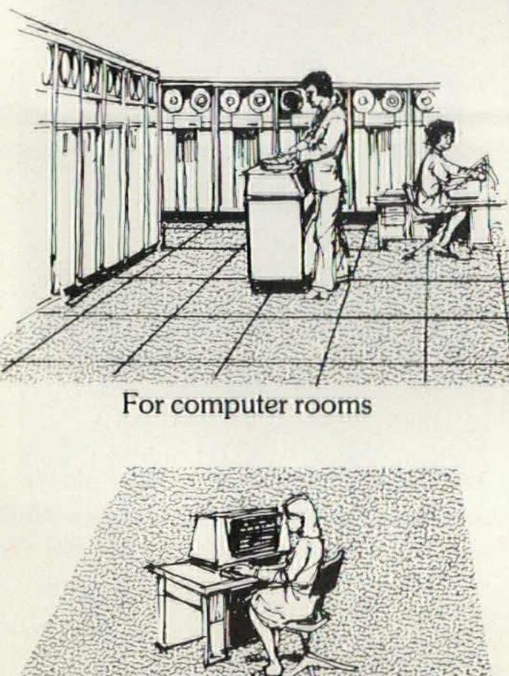
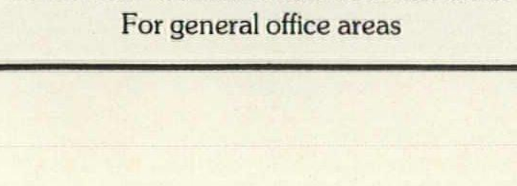


For computer rooms



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Compu-Carpet™

COMPU-CARPET anti-static carpeting is a unique, high performance floor covering developed specifically for use in modern offices, computer rooms, terminal areas and other static-sensitive environments. Attractive and durable, Compu-Carpet has anti-static properties superior even to those of hard surface flooring.

Compu-Carpet meets IBM resistance recommendations. Since its anti-static properties are inherent in its construction, protection is assured for the life of the carpet. Compu-Carpet carries a 5-year static and wear warranty.

See Sweet's Catalog 9.28/Un. Send for complete details.

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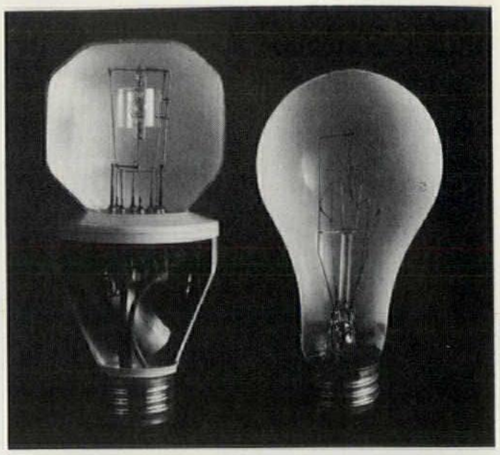
Circle No. 355

Products continued from page 204

ParPower spot track lights use all-purpose lamps, yet provide concentrated light because of the reflector design. Air flow around the bulb has a continually cooling effect which prolongs bulb life. Less heat is generated because low-wattage lamps are used. NuTone Div., Housing Products Group, Scoville.
Circle 115 on reader service card

Indalux® indirect ambient lighting using energy-efficient HID lamps, features computer-aided reflector design to provide maximum light distribution, in a pattern consisting of three basic components: direct lighting providing maximum reflectance without glare; reflected light offering maximum wide-angle light; and diffused lighting to reduce direct brightness and eliminate hot spots. There are three lighting systems: high-level symmetrical, high-level asymmetrical, and low-level for mounting below 72 in. J.H. Spaulding.
Circle 116 on reader service card

WAL wall-mounted luminaires provide energy-efficient illumination for walkways, courtyards, entrances, building security, and loading areas. An aluminum reflector directs light at the target, without glare. There are two types: a clear lens model for areas where light control is necessary; and a prismatic lens model where light distribution to the front and sides of the fixture is required. The luminaires can be used with high-pressure sodium, mercury vapor, or metal halide lamps. Crouse-Hinds Co.
Circle 117 on reader service card



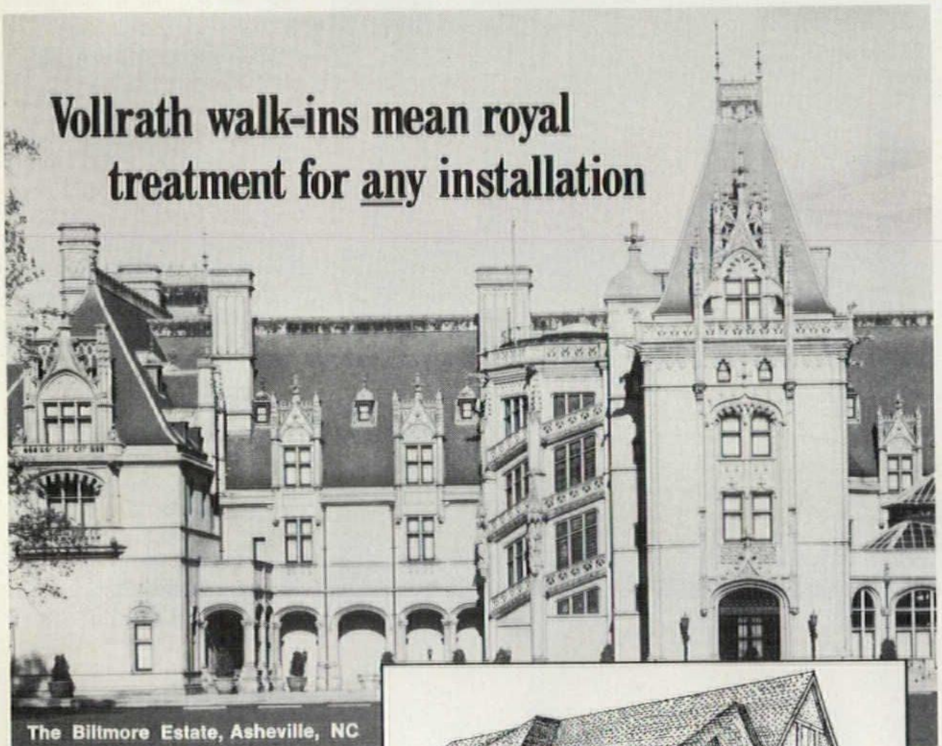
The 'Electronic Halarc' bulb is an energy-saving bulb that fits standard household fixtures. To become available in 1981, the bulb has electronic controls in the base and an arc tube in the top. It has high and low settings, with the high setting producing as much light as the 150-watt setting of the typical three-way bulb using about one-third the energy. General Electric, Lighting Business Group.
Circle 118 on reader service card

A fluorescent lighting remote control regulates lighting levels to reduce electrical usage. Lighting is triggered by electrical impulses from the control along existing electrical wiring into the controlled fixtures, where a small receiver turns on the lamps. Maximum range of the device is 300 ft. It can be installed on most new or existing 120- to 277-volt fluorescent systems without major rewiring or redesign. Sylvania Lighting Services, General Telephone & Electronics.
Circle 119 on reader service card

Wall-SavER-30 is an extended-life reflector light bulb that saves up to 55 percent in energy costs over the higher wattage bulbs it is intended to replace. Its beam focuses about 2 in. in front of the bulb, permitting the 67-watt ER-30 to replace a 150-watt R-40 flood lamp at a substantial saving in energy according to the manufacturer. The bulb has a life rating of 5000 user hours and comes with a one-year free replacement warranty. Duro-Test Corp.
Circle 120 on reader service card

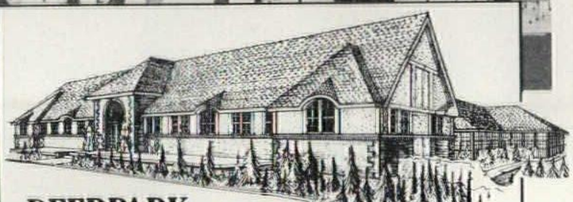
Energy-Lok™ energy-saving ballast for fluorescent lights is said to have double the life of standard ballasts. For use in commercial, industrial, and institutional buildings, the ballasts are expected to save from $90 to $360 per fixture over the life span. Designed for two-lamp, 40-watt fixtures, the ballasts can be used with either standard or energy-saving fluorescents. Jefferson Electric.
Circle 121 on reader service card

Emergency lighting energy planning table illustrates the economies of using [*Products continued on page 211*]

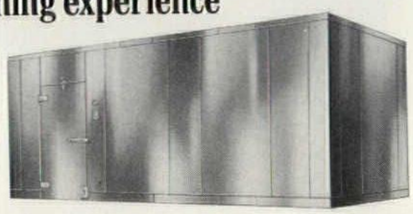


On the grounds of the lavish Biltmore Estate, America's finest castle and North Carolina's outstanding tourist attraction, is Deerpark—the Biltmore dining experience. Only the finest quality refrigeration equipment is good enough for this outstanding facility. That's why a Vollrath walk-in cooler-freezer was specified.

From spec to finished project, Vollrath specialists assist in mechanical/electrical requirements; size, storage and materials data. On time delivery with reliable post-sale service is also a part of Vollrath's royal treatment. And isn't that the way *you* and *your* clients should be treated?



DEERPARK... where Vollrath's dual temperature walk-in is part of the Biltmore dining experience



Vollrath serves markets world-wide with modular walk-in coolers, freezers, and refrigeration systems... when only the best is good enough.

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The capable hands of Vollrath build exactly what you want in a quality walk-in cooler/freezer.

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Circle No. 309, on

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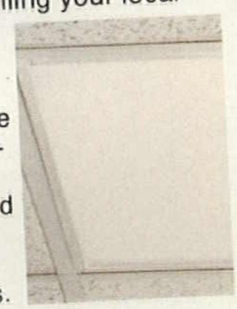
Efficient use of energy is another benefit of controlled lighting by Holophane.

And choices range from HID luminaires to prismatic lens fluorescent fixtures. They all deliver illumination which can reduce eyestrain and promote better worker productivity while giving products more customer appeal.



Learn more about our commercial lighting line by calling your local Holophane representative. He'll show you the latest in attractive high quality lighting. And provide the ESI, VCP and cost data you'll need to prevent glaring mistakes.

Or contact Neil Thompson, Johns-Manville Sales Corporation, Holophane Division, P.O. Box 5108-PA4, Denver, CO 80217. Phone 303/979-1000.

JM

Johns-Manville

Circle **No. 366,** on Reader Service Card

Products continued from page 206

battery-operated equipment. The table includes information on the company's newest products such as models that power remote heads, multidirectional units, exit signs, and an emergency lighting fluorescent power pack. Dual-Lite Inc.
Circle 122 on reader service card

Tracklighting designs added to the Lytespan line include: "Bell" Lytespot, with an internal reflector and a special lens to concentrate the light beam; "Flashlyte," a slender shape for accent lighting or a soft wash of medium intensity light; and "Scoop" Domelight, for installation on a track or suspension from a cord. Lightolier.
Circle 123 on reader service card

A 12-volt track-lighting accent light with a self-contained transformer has been added to the TRAK-1 lighting system. It is cylindrical, with a rotating bezel for easy orientation of the beam pattern. According to the manufacturer, it offers energy-efficient operation along with other features including concealed wiring and swivel with positioning lock. Progress Lighting. Subs. of Walter Kidde & Company, Inc.
Circle 124 on reader service card

Literature

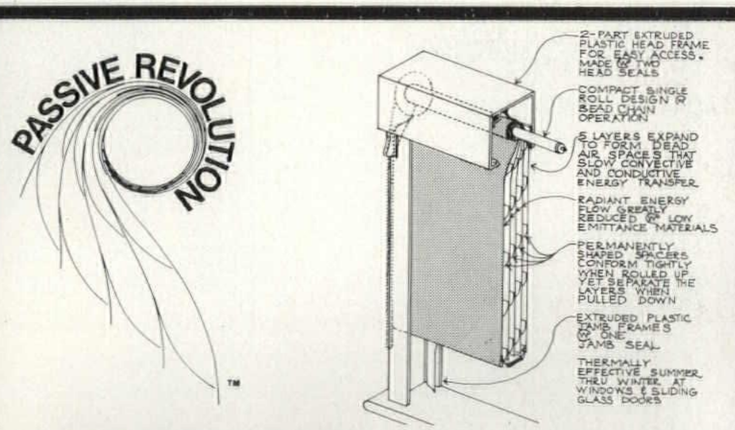
Campus lighting brochure provides engineers, architects, consultants, and designers with information about campus lighting. Also included is information about cost payback. For example, according to the manufacturer, converting a typical mercury vapor system to high-pressure sodium reduces energy consumed by 14 percent while providing 106 percent more light. A 12-question test helps in the evaluation of the effectiveness of present lighting. The 10 luminaires described have applications in parking lots, indoor athletic facilities, walkways, building entrances, roadways, and driveways. Lighting Systems Dept. General Electric Co.
Circle 207 on reader service card

X-Parabolic fluorescent luminaire. Basic design concept and energy-conservation, cost-saving, and light-output advantages are presented in a 48-page brochure. Photographs, drawings, graphs, and diagrams support the text. Typical applications include offices, schools, stores, and hospitals. Lighting Products, Inc.
Circle 208 on reader service card

'Design Criteria for Lighting Interior Living Spaces,' is intended as a guide to designing lighting for all interior spaces. It defines lighting problems in detail, presents the design objectives, and discusses quality and quantity criteria to be used in the design. Sections on lighting methods, equipment available, and energy considerations are included. Copies of the 56-page paperback are $7 to IES members, $12 to nonmembers. Order ISBN-0879950064, prepaid, from Illuminating Engineering Society of North America, 345 E. 47 St., New York, NY 10017.

Low-energy consuming light fixtures for showrooms, stores, display windows, galleries, museums, homes, and offices are described and illustrated in a six-page brochure. The lamps, which consume less energy and generate less heat than standard voltage lamps, are available with light beams ranging from very narrow spot to wide flood. There are several fixture styles and mounting devices. Lighting Services Inc.
Circle 209 on reader service card

HandiLiter-S, an energy-saving light fixture, is shown and described in a [*Literature continued on page 213*]



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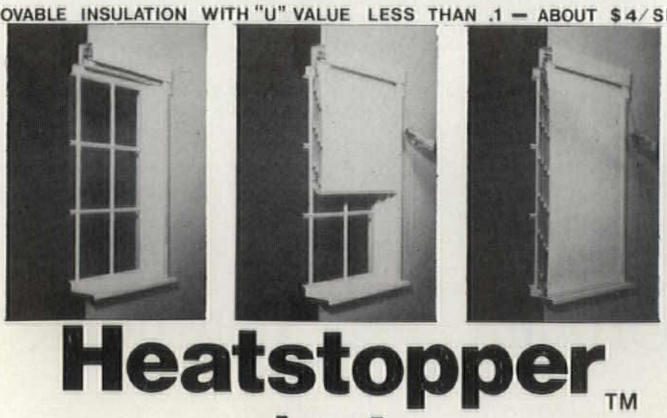
Heatstopper™ **shade**
If you would like a more complete description of the **Heatstopper**™ shade, please send $1.00 for our 12-page color brochure and order form (IS Publication 0101801) to: Insulating Shade Company, Inc., Box 282, Branford, CT. 06405

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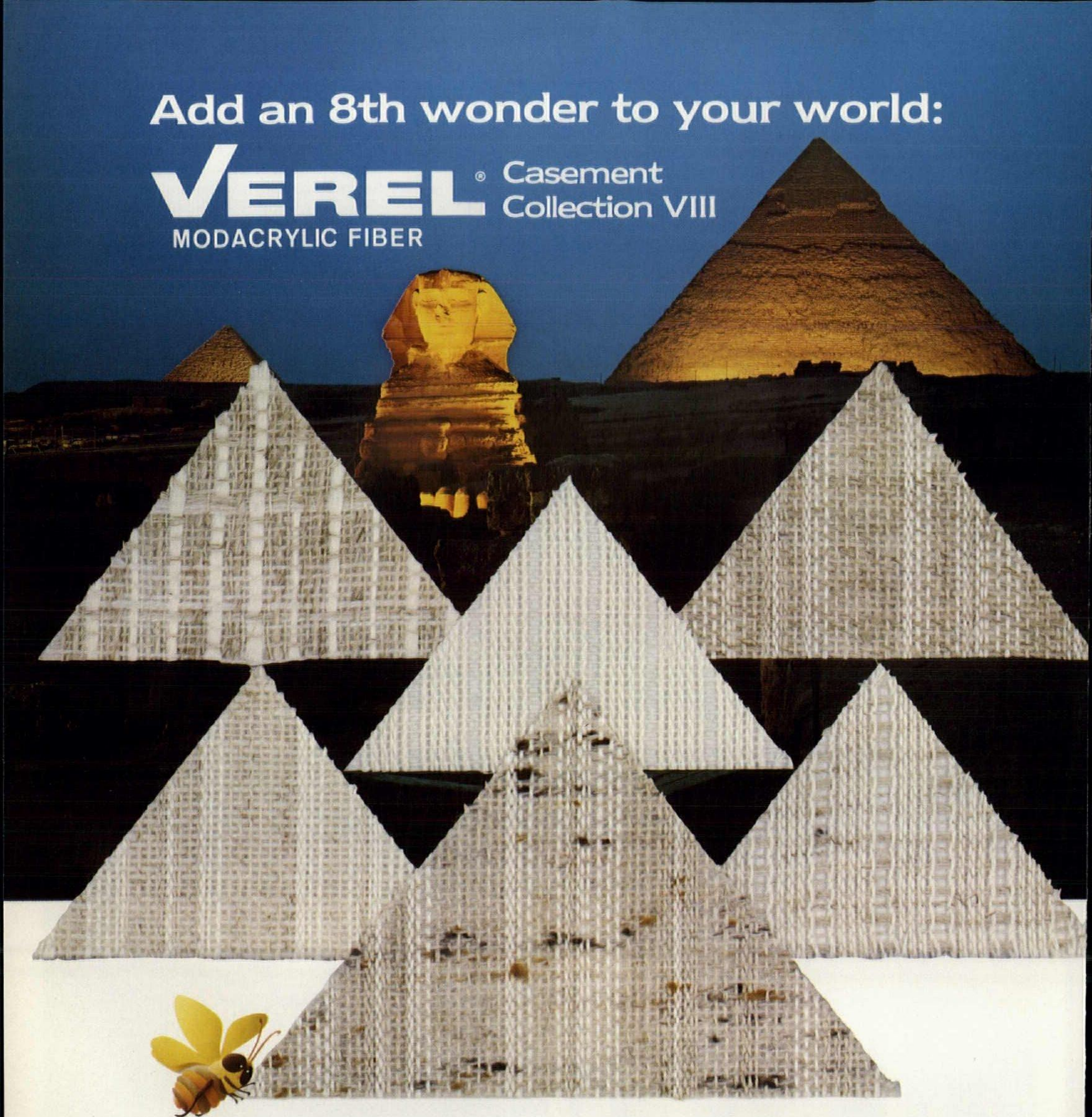

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Circle **No. 324,** on Reader Service Card

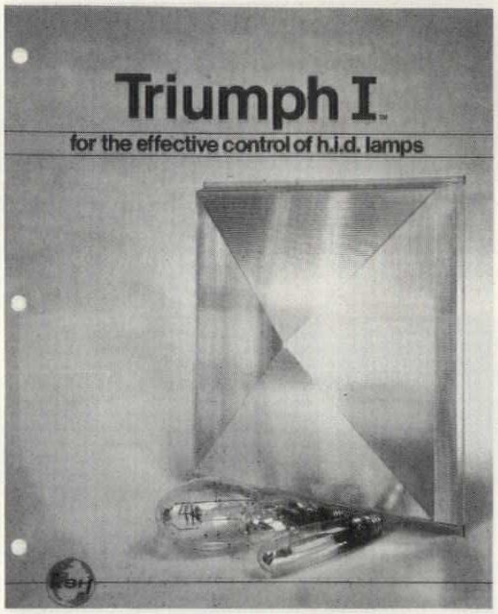
Literature continued from page 211

four-page catalog. Specifications, ballast information, and installation data are provided. Applications listed include shipping docks, bank canopies, assembly lines, security areas, parking garages, and covered walkways. Chart compares the number of fixtures required for equal light output, operating cost for each, and savings possible. Guth Lighting.
Circle 210 on reader service card

'Polarized Lighting' explains light polarization and its effect on visual performance and glare reduction. The six-page, full-color brochure explains how polarized light cuts energy costs and includes suggested product specifications. Polrized Corporation of America.
Circle 211 on reader service card

Monitrol LC-500 automatic control permits lighting cost reductions averaging 40 percent, according to the manufacturer. A six-page, full-color brochure explains the necessity for lighting control, describes the unit, and supplies technical data on both installation and operation. Data provided show that the system offers a 15-month return on investment. CSL Industries.
Circle 212 on reader service card

Maxi-Miser® systems are described in a four-page brochure that provides electrical data and specifications for fluorescent lamp/ballast systems. Compared with standard fluorescent lighting, Maxi-Miser is said to use fewer watts and to reduce energy costs by as much as 21 percent. Information is also provided about performance, energy savings, and payback period. General Electric, Lighting Business Group.
Circle 213 on reader service card



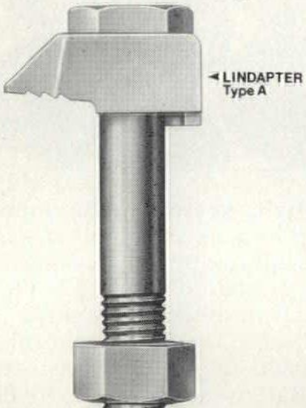
Triumph I prismatic control lens for 2' x 2' HID light fixtures is described in a 12-page, full-color catalog. The lens distributes lighting 40–45 degrees from vertical, thereby improving efficiency and requiring fewer lighting fixtures. The brochure compares Triumph I with conventional lighting systems, provides design data for different lamp sizes, and includes a variety of indoor and outdoor applications. K-S-H, Inc., K-Lite Div.
Circle 214 on reader service card

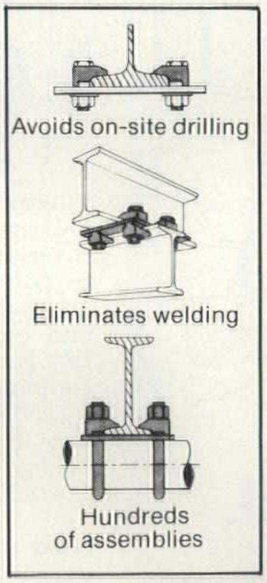
Perimiliter luminaires are highly efficient wall lights that use energy-saving HID lamps. The luminaires provide uniform lighting at a 6 to 1 ratio of spacing to mounting height, compared to 4 to 1 with other wall lighting. Four-page brochure describes internal and external features and provides installation data, mounting detail specifications, and photometric data. Hubbell Lighting Div., Harvey Hubbell, Inc.
Circle 215 on reader service card

Interior lighting catalog for 1980 offers 16 pages of integrated ceiling/lighting systems. Included are energy-efficient luminaires, modular suspension grids, air-distribution equipment, acoustical and decorative ceiling materials, and lighting for open-plan offices. Selection guide lists components for each system. Johns-Manville Service Center.
Circle 216 on reader service card

PAR and R reflector lamps as substitutes for standard incandescent lamps are described in an eight-page lamp engineering bulletin. With reflectors en-
[*Literature continued on page 214*]

Make clamps from standard bolts . . . in seconds. Save time, save money.





The Lindapter hook/bolt construction system provides unlimited applications in construction, plant and factory maintenance, in heating, lighting, ventilating, pipe, cable and steel work. In use for over 40 years. Send for literature today.

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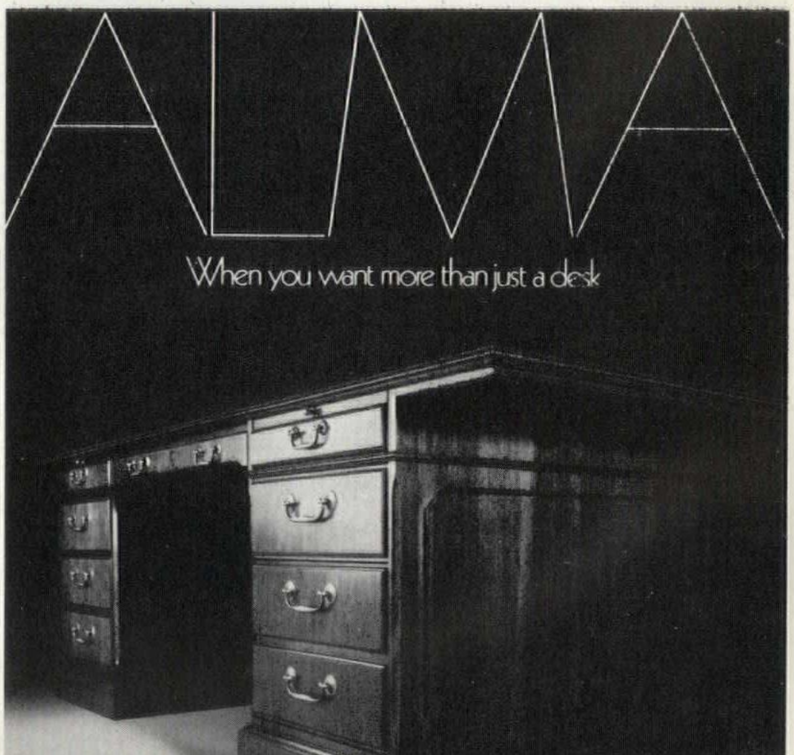

Literature continued from page 213

closed within the lamps, they are unaffected by dirt and operate at higher lighting efficiency. The bulletin has instructions for calculating power cost savings possible with PAR and R substitutions, an example of savings in a typical installation, and a complete list of available lamps with built-in reflectors. Lamp Commercial Div., Westinghouse Electric.
Circle 217 on reader service card

Photovoltaics

Photovoltaics are a Buck Rogers technology which is available today. Light-induced electromagnetic reactions in silicon crystals cause an electric current to flow. When a series of cells are wired together, on the roof, for example, enough electricity can be generated to run the air conditioning of a house in Las Vegas or to provide electricity for a whole housing complex in Quincy, Ma. Although the price is prohibitive, it is now possible to reliably furnish electricity to a building with an array of photovoltaic cells. As recently as last year, manufacturers were predicting the esoteric technology to come into economic range by 1986. Now the supply and demand curves are expected to cross as early as 1982. You can thank the Ayatollah for that. We can also thank the stimulus of government funding which has helped researchers with giant steps towards practicality. Bugs to be worked out are relatively simple ones: how to build an inexpensive direct-current submersible water pump; how to convert direct current to AC cheaply; or perhaps how to permit the consumer to credit his electric bill by wiring directly into the electrical grid for the community.

Literature

Unipanel® solar electric panels convert light to electricity through photovoltaic effect. The panels are suitable for low-power applications such as telemetry stations, environmental sensors, alarm systems, radio communications, and emergency lighting. The high-efficiency solar cells are encapsulated in silicone rubber on an aluminum frame. The panels can be used singly or in series/parallel arrays and come with brackets adjustable to a range of angles to suit their location. Solarex Corp.
Circle 218 on reader service card

Solar electric panels and a motor designed and built to be used with the panels are described in a product bulletin. Information includes characteristics, construction, and areas of application of the panels. They are made up of a series of 18 4-in. cells completely sealed between two sheets of glass and framed with aluminum. Wm. Lamb Co.
Circle 219 on reader service card

'Building Blocks for Solar Electricity' describes solar cells, panels, arrays and electrical generator systems. It provides a formula for estimating the size of a solar-electric system. Diagrams show how solar electricity is made. Specifications for standard panels are included. Solarex Corp.
Circle 220 on reader service card

Photovoltaic system components are described in a six-page folder. Cells are covered with tempered glass and backed by polymer-coated steel foil. The parts are fused by a special laminating process and enclosed in an aluminum frame that is sealed to prevent moisture penetration. Batteries that store the electricity are also described. An explanation of how the system works is included. Arco Solar, Inc.
Circle 221 on reader service card

Solar electric systems and cells are discussed in a four-page brochure that shows typical panel configurations and explains how electricity is produced from solar energy. Product bulletins for several types of solar power modules provide electrical performance data, application information, and a list of the features of each module. Photowatt International, Inc.
Circle 222 on reader service card
[*Products continued on page 216*]

Saving energy has never looked this good.

The Upland Model 207 is an elegant woodstove. Handsome design and the luxury of an open fireplace option create a look to enhance the decor of any home.

The Upland Model 207 is an efficient woodstove. An airtight design and "S" pattern baffle system evenly distribute the heat from a single load of wood for 10 to 14 hours.

The Upland Model 207 features... manual draft control for simple heat adjustment... top or rear vent for installation in a variety of applications... easy access to the interior for cleaning... ¼", high tensile strength cast iron construction... a full year guarantee against defects in materials or workmanship.

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For more information, write: UPLAND WOODSTOVE CO., Dept 6, P.O. Box 87, Greene, NY 13778.

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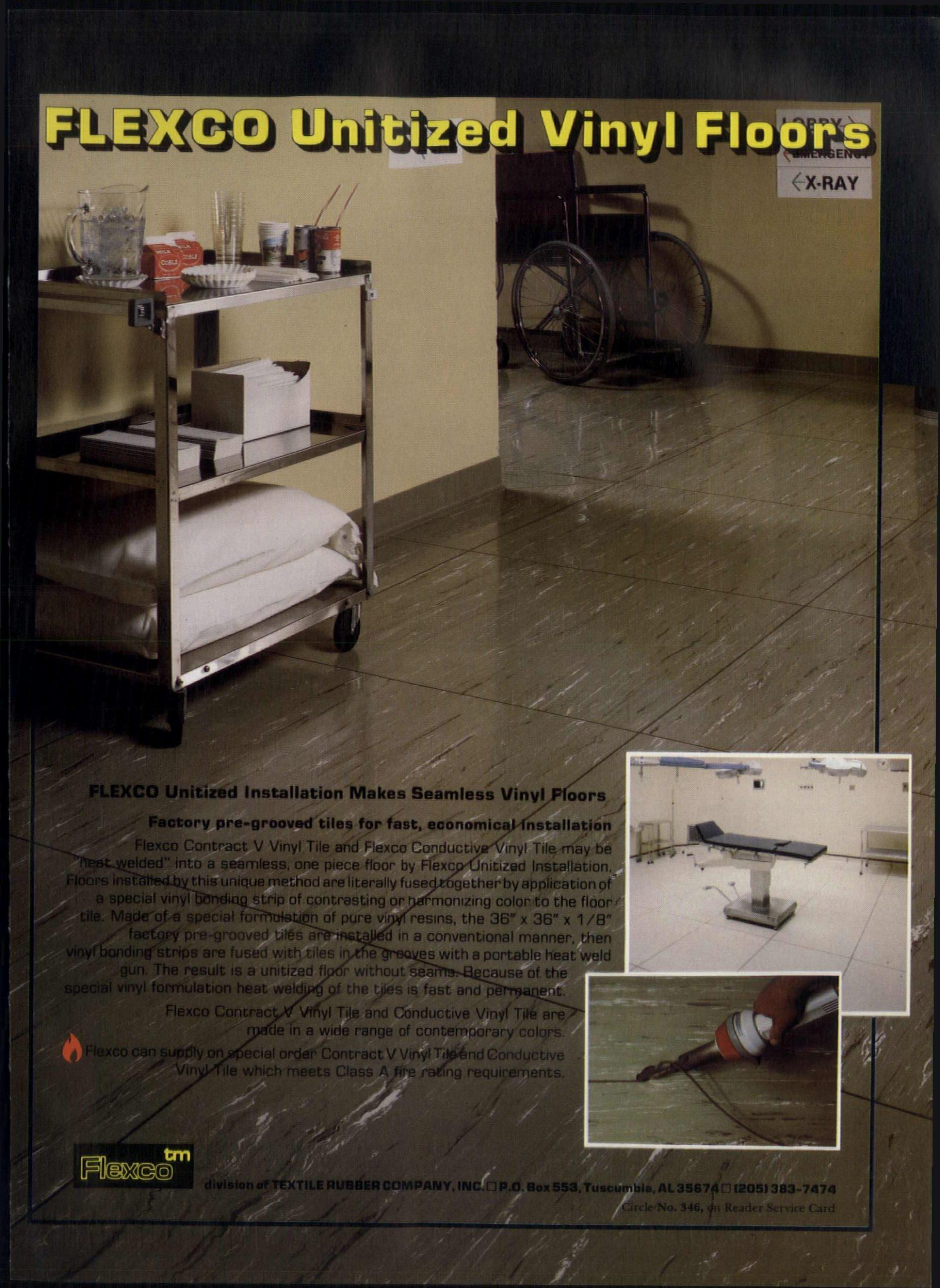
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Flexco Contract V Vinyl Tile and Flexco Conductive Vinyl Tile may be "heat welded" into a seamless, one piece floor by Flexco Unitized Installation. Floors installed by this unique method are literally fused together by application of a special vinyl bonding strip of contrasting or harmonizing color to the floor tile. Made of a special formulation of pure vinyl resins, the 36" x 36" x 1/8" factory pre-grooved tiles are installed in a conventional manner, then vinyl bonding strips are fused with tiles in the grooves with a portable heat weld gun. The result is a unitized floor without seams. Because of the special vinyl formulation heat welding of the tiles is fast and permanent.
Flexco Contract V Vinyl Tile and Conductive Vinyl Tile are made in a wide range of contemporary colors.
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Circle No. 346, on Reader Service Card

Products continued from page 214

Windmills

Make room for wind energy! In modern times, the dream of wind energy in areas of dense population has eluded us. Midwestern farms are ample proof of its viability at a certain scale of use, but we will probably never see wind machines in the suburbs servicing a single-family dwelling. We are starting to use wind power for backup energy use in special building types and in clusters of buildings. The irregularity of small-scale wind electrical production must be accommodated by either regular energy demand, batteries, or conversion to a more convenient form of energy. Direct current must be converted to AC for most conventional uses, an expensive proposition for the moment. Very large-scale installations have plugged directly into the electrical grid through transformers. When wind is used with buildings, equipment is usually isolated structurally to avoid vibration problems. The path for optimum air flow downwind and upwind must be considered. Land formations, landscaping, and buildings all affect the air flow. New designs in the last few years have improved the appearance of the wind generator.

Products

Windstream™ 33 is a second-generation wind turbine generator in the 10–20 kW size range that can be interfaced with an electrical utility. It has three blades with a total diameter of 33 ft. Power output is 15 kW at 24 mph. Windstream and its tower have a 25-year design life. It is intended as a supplemental power source for various applications. Grumman Energy Systems.
Circle 125 on reader service card

Cycloturbine® is a wind turbine that can be tied directly into a utility grid. When the wind is blowing, it supplies electricity; when windpower is not available, power is automatically drawn from the grid. Other systems include one that is used with either an alternator or a generator to provide electricity to run or supplement power for domestic hot water or resistance baseboard heating. Another has a drive shaft to the ground to provide energy to an air compressor, water friction heater, or pump. Pinson Energy Corp.
Circle 126 on reader service card

High Reliability 2 kW (HR2) wind generator is designed for remote, unattended sites where high reliability and minimum maintenance are required. It is built to withstand severe environmental conditions. The generator produces over 2 kW in a 20-mph wind and up to 700 watts in an average wind speed of 12 mph. A variable axis rotor control allows the rotor/alternator assembly to tilt up to a vertical axis in a high wind to prevent stress to the machine. North Wind Power Co.
Circle 127 on reader service card

Literature

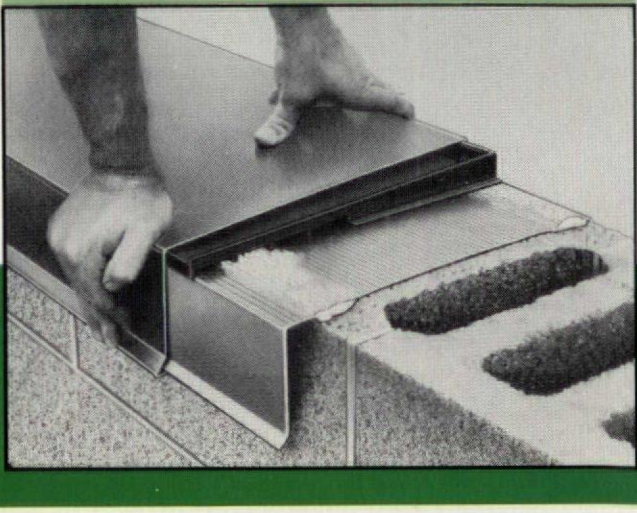
Enertech 1500 wind system, installed at a windy site, can produce up to 60 percent of electricity required by a typical home. It is intended for use where utilities are available to be drawn on when demand is high or wind power is low. A 16-page booklet contains information about the system's features, site considerations, towers, and tax credits, and provides technical specifications. Enertech.
Circle 223 on reader service card

Wind power theory, battery storage, glossary of terms, equipment, site evaluation, and other design information makes up the first part of this 48-page catalog. Products listed include equipment for generating and storing energy, controls, weather instruments, towers, and grounding devices. Catalogs, at $3 each, can be ordered from: Sencenbaugh Wind Electric, P.O. Box 11174, Palo Alto, Ca 94306

'Site Selection and Evaluation Handbook for Wind Energy Systems' provides information about factors to be considered in selecting wind energy sites and choosing properly sized systems. It lists sources of wind data and includes diagrams showing wind patterns. Names and addresses of manufacturers of wind measuring equipment are provided, along with a description of the type of equipment [*Literature continued on page 219*]

Guaranteed Parapet Protection ...it's a "snap" with Hickman.

Hickman PERMASNAP Coping ...it's a "snap" to install.



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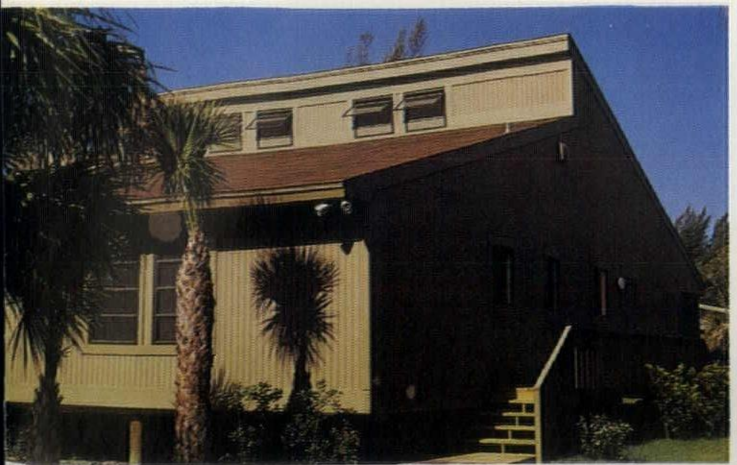
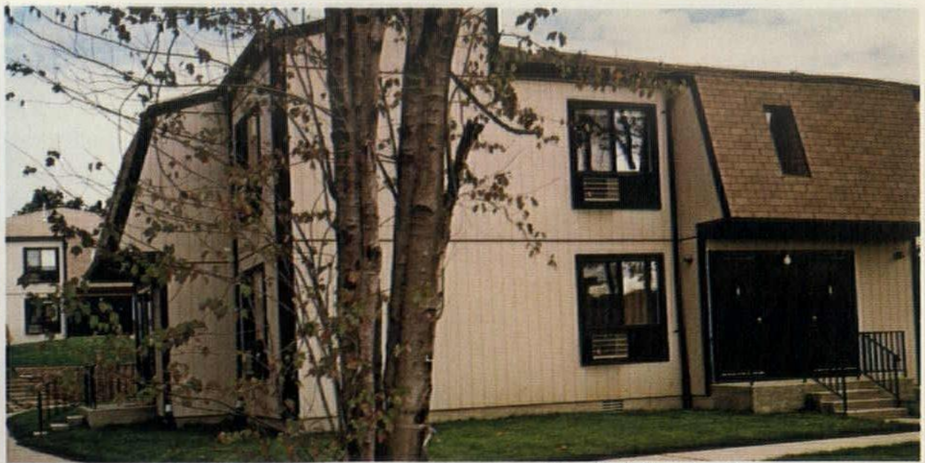
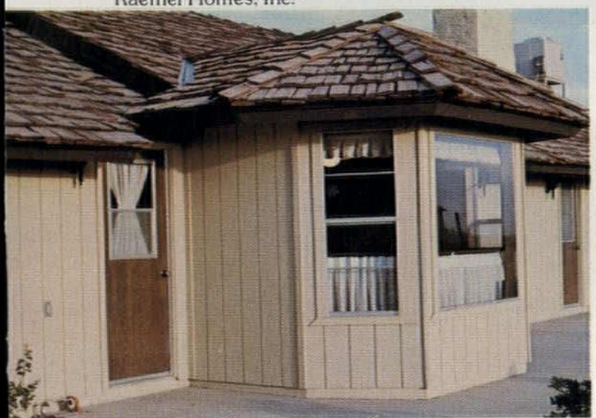


Florida Resort Condominiums,
Raemel Homes, Inc.



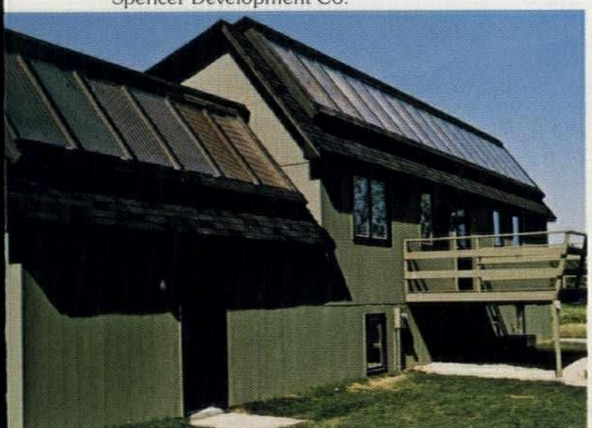
New York Apartments,
Mar-Jef Construction Co.



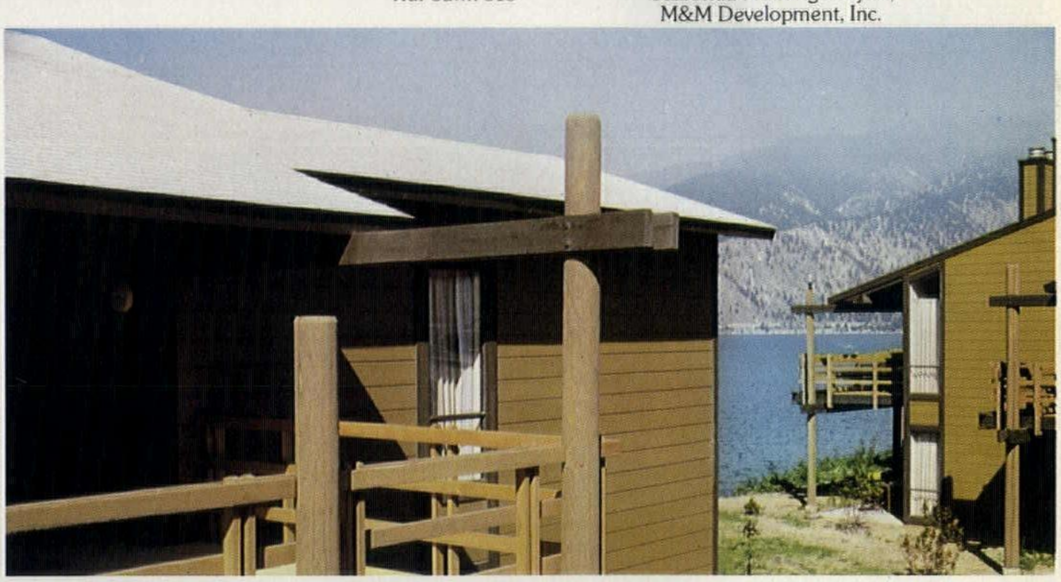
Arizona Residence,
Spencer Development Co.

Ruf-Sawn 316

California Housing Project,
M&M Development, Inc.



Minnesota Solar Home,
Marvin Anderson Homes



Washington Condominiums,
Howard S. Wright Construction Co.

Ruf-Sawn 316: It makes builders all over the country look good.

It's no wonder more and more builders are siding with Simpson Ruf-Sawn 316.

It's all in the overlay. The overlaid surface of Ruf-Sawn 316 has a unique woodgrained texture. It's deeply embossed with a ruggedly handsome real-wood appearance. And it provides a near-perfect surface for paint or solid color stains, with the amazing ability to hold a finish up to 3 times longer than any raw wood surface!

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Ruf-Sawn 316

Simpson

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WINTER	Average Ambient Temperature = 25°F	30.4	27.3	23.2	18.7	13.6	8.1
SUMMER	Average Ambient Temperature = 75°F		37.3	32.3	26.3	19.9	12.9

Circle **No. 314,** on Reader Service Card

Literature continued from page 216

they produce. Copies of the handbook, at $8.50 U.S., $9.50 foreign, prepaid, can be ordered from: Sunflower Power Co., Route 1, Box 93A, Oskaloosa, Ks 66066.

The Helical Wind Turbine (HWT) is an airfoil and rotor design employing four sets of two blades. It allows for high aerodynamic efficiency and high torque capabilities, making it suitable for low to moderate wind characteristics. A six-page color brochure describes the turbine and its power output at various speeds. Also included is a cutaway model of the HWT generator made by GE. Environmental Energies, Inc.
Circle 224 on reader service card

Heat pumps

A heat pump is an ingenious contraption that takes advantage of the heat exchange during a phase change in certain fluids. A liquid which turns to gas at a low temperature takes heat from its environment. A compressor can raise the temperature of the gas still further so that on contact with a cooler environment it releases heat and condenses or returns to a liquid state. The heat pump has been around for over 25 years. It was not until the early 1970s, however, that the business went wild. In areas of the country where electricity is the main energy source, the heat pump can be very effective for heating (above 32 F) and cooling. It competes very well with resistance heating. Pumps move heat from water into air (water source) or air to air (air source). As the environmental temperatures are seasonally reversed, the pump which heats can also be made to cool. Over a half-million heat pumps were installed in homes last year. They are part of every active solar cooling system, or ice maker, for that matter. The reliability of the heat pump has improved greatly in recent years.

Products

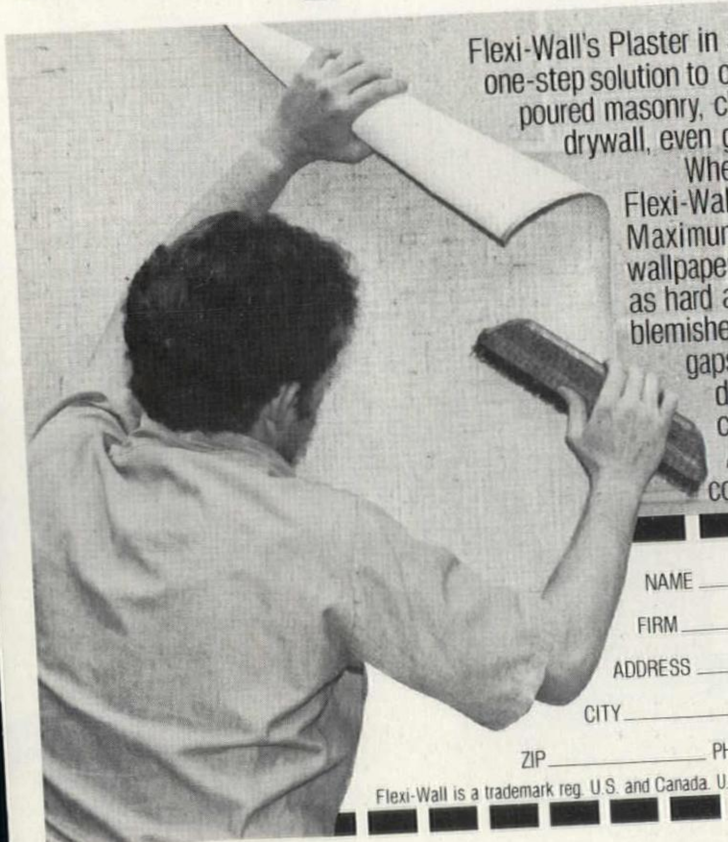
The Space-Pak® heat pump offers year-round heating and cooling where conventional installations are difficult. Air distribution is through preinsulated flexible ducting that can be installed quickly and easily. The interior unit can go in the attic, basement, garage, closet, or similar area. It can be used where add-on or replacement heating is needed and ducts are not available; in offices and professional buildings requiring design flexibility; in multi-unit buildings requiring individual heating/cooling systems; or in older homes with inadequate ducts. Dunham-Bush Inc.
Circle 128 on reader service card

AYB gas chiller-heaters, for year-round use, are available with capacities from three to five tons. Delivered capacities range from 36,000–60,000 Btu for cooling and 90,000–135,000 Btu for heating. They can also supply either chilled water or hot water for a variety of residential or small commercial applications. Functions are changed by changing settings on a room thermostat. Arkla Industries.
Circle 129 on reader service card

The HPII 'Legend'™ two-speed heat pump, for rooftop or ground level installation, delivers cool air in summer, heat in winter. The heat pumps come in two sizes, each suitable for residential or small commercial building use. Since the units operate at low speed most of the year, substantial savings are possible. The 2½-ton model supplies 2½ tons of cooling with an energy efficiency ratio (EER) of 8.7 at low speed. The 4-ton model, operating at high speed, has an EER of 8.2. Lennox Industries.
Circle 130 on reader service card

Split system and packaged heat pumps. EERs of 8.0 to 8.1 and COPs of 2.7 to 2.9 are provided by split systems, which also have a demand defrost cycle that is
[*Products continued on page 220*]

Architects the world over are covering Problem Walls with FLEXI-WALL®.



Flexi-Wall's Plaster in a Roll™ is the unique one-step solution to covering concrete block, poured masonry, chipped plaster, old tile, drywall, even glass and plastic.
When dollars get tight, it's Flexi-Wall to the rescue. Maximum durability. Goes up like wallpaper, but because it dries as hard as plaster, it covers blemishes and bumps, bridges gaps and voids. Comes in 23 decorator colors. Easy to clean, extremely durable. An optional anti-graffiti covering makes Flexi-Wall *perfect* for high-traffic areas.
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Circle **No. 347,** on Reader Service Card

Products continued from page 219

activated only when needed, to save energy. Packaged heat pumps have EERs of 7.6 to 8.5, COPs of 2.6 to 3.1, and a demand defrost cycle. Split systems range from 6¼- to 15-ton sizes; packaged units are 5- to 25-ton sizes. Trane Company.
Circle 131 on reader service card

The Templifier® heavy-duty heat pump for industrial, commercial, and institutional applications captures waste heat from fluid, usually water, amplifies it, and transfers it to liquid, again usually water. It can generate hot water up to 230 F, and ranges in capacity from under 100,000 Btu to 20,000,000 Btu. The system, sources of heat, system efficiency, and some typical installations are described in an eight-page brochure. Use of the system in amplifying a solar collector system called Native Sun™ also is discussed. Westinghouse Electric Corp., Industrial-Commercial Templifier Dept.
Circle 132 on reader service card

Literature

'Commercial Buildings' explains the application of EnerCon water-source heat pumps in commercial buildings. The 10-page brochure discusses how the air-conditioning system reclaims, recycles, and stores energy. Statistical data on life-cycle costing and descriptions of the models available are included, along with illustrations of typical applications. American Air Filter Co.
Circle 225 on reader service card

Sunpath® high-efficiency heat pumps are designed for residential or small business heating and cooling. Eight-page brochure shows features of the solid-state logic module. Charts provide heating and cooling data, wiring diagrams, dimension information, and operating details. Accessories for field installation are described and shown in drawings. York Div., Borg-Warner.
Circle 226 on reader service card

T.H.E. heat pump for residential use is available in seven models with a coefficient of performance (COP) range of 2.7 to 3.1, and energy efficiency ratio (EER) from 8 to 9.2. Technical information, outdoor unit and indoor furnace unit specifications, and performance data are provided in a 12-page brochure. The Coleman Company, Special Products Group.
Circle 227 on reader service card

Energy Recovery System (ERS) heat pump systems are described and illustrated in an eight-page brochure. Diagrams illustrate the energy recovery principle. Features are listed for several air-to-air and water-to-air models. Command-Aire Corp.
Circle 228 on reader service card

WeatherKing® heat pump brochure lists the features of the indoor and outdoor units of a completely assembled, factory-wired split system. Charts show heating and cooling capacities, specifications and ratings of both units, and dimensions. Addison Products Co.
Circle 229 on reader service card

Energy conversion systems. Application engineering manual is a 24-page booklet providing product information about heating/cooling systems. It discusses system design, heat pump installation, and operating instructions. Dimension and performance data and specification guide are included. KoldWave Div., Heat Exchangers, Inc.
Circle 230 on reader service card

Self-contained and split unit heat pumps. Six-page brochure explains briefly how heat pumps work to heat and cool. A drawing of the outdoor unit shows its internal features, and descriptions explain their functions and advantages. Johnson Corporation, Subs. of Magic Chef.
Circle 231 on reader service card

Sun Dial® split system heat pumps for heating and cooling are described in a six-page bulletin. Components are listed as are factors to consider in the selection of a heat pump system. Diagrams illustrate how a split system works in both heating and cooling cycles. The bulletin also provides data about the characteristics of nine models. Square D Company.
Circle 232 on reader service card
[*Products continued on page 222*]

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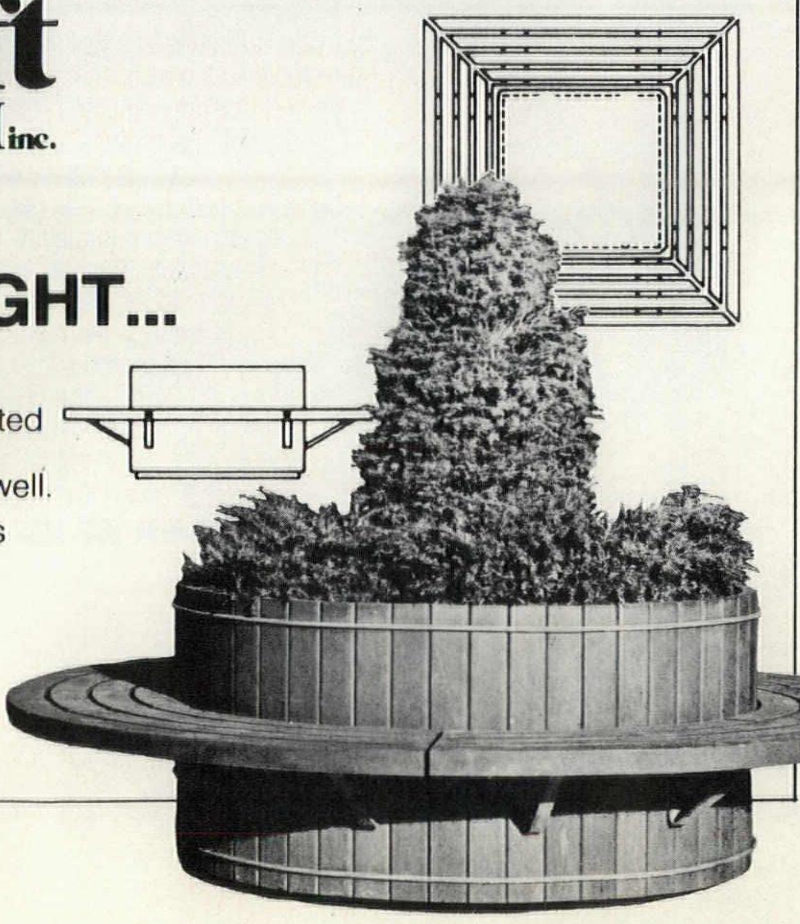

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Tempo 3 delivers. It's the open office system designed to manage the electronics explosion. Easily. Effectively.

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So don't get caught with your power down. Let us show you *all* the advantages of Tempo 3. Call your Shaw-Walker representative. Or write Shaw-Walker, 934 Division Street, Muskegon, Michigan 49443.

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Products continued from page 220

Miscellaneous Products

Rational Energy Analysis Program (REAP BX) in extended basic language can be used with a programmable calculator. The program is based on latest ASHRAE procedures and other industry sources. Using local weather data, it can calculate heating and cooling energy consumed by fans, pumps, air handlers, and other equipment and can do a comparative analysis of system alternatives. Results are provided on an easy-to-read printout. Carrier Air Conditioning.
Circle 133 on reader service card

Wireless Overriding Triple Control (WOTC) is a solid-state control that provides automatic programming of multiple conditioners from a central location to permit nighttime setbacks. When the building is occupied at other than normal hours, however, the system has overriding capacity to return to the daytime mode. It can also provide separate controls for areas having different schedules. Climate Control Div., The Singer Co.
Circle 134 on reader service card

Zero Energy Band thermostats provide heating and cooling setpoints for a range over which no energy is needed to maintain space temperatures. They can be applied to new or existing HVAC systems. There is also a dual thermostat to provide for both heating and cooling ranges. Honeywell, Inc.
Circle 135 on reader service card

The Optimizer is a programmable timer with solid-state logic circuitry to delay heating startup in the morning to the latest possible time based on actual interior and outdoor temperatures. It will interface with existing systems to provide almost immediate benefits. According to the manufacturer, cost of the installation can be recovered within a single heating season in many instances. Robertshaw Controls Co.
Circle 136 on reader service card

The Energy Monitor translates kilowatts to dollars and cents to make the user aware of the actual cost of energy. It also provides heating/air-conditioning cycling when use exceeds a budgeted amount. Digital readouts show accumulating use, use to date, projected use for billing period, "over-budget" alarm, and bill to date. It can be used in industrial, commercial, and residential buildings. The Dupont Energy Management Corp.
Circle 137 on reader service card

Solar energy systems for space heating, hot water, air conditioning, and industrial processing heat provide economical energy for schools, hospitals, offices, factories, and homes. Systems are prewired and preplumbed for ease of installation. Evacuated tube solar collector models with parabolic reflectors deliver energy efficiently even on cloudy and cold days. Sunmaster Corp.
Circle 138 on reader service card

Styrofoam SM sidewall insulation for use in remodeling includes two types for exterior applications and one for interior use. The insulation is attached between metal Z-channels, then covered with siding materials. For a stucco finish, the insulation is covered with expanded metal lath and finished with three coats of stucco. When the outside cannot be insulated, Styrofoam is applied to the inside and finished with ½-in.-thick gypsum board. The Dow Chemical Co.
Circle 139 on reader service card

Model 107 woodstove, constructed of cast iron, has baffles designed to provide heating efficiency. According to the manufacturer, the cast iron conducts nearly 50 percent more heat than steel. The model can be used in a fireplace during the heating season and is easily dismantled and stored in the spring. Upland Stove Co.
Circle 140 on reader service card

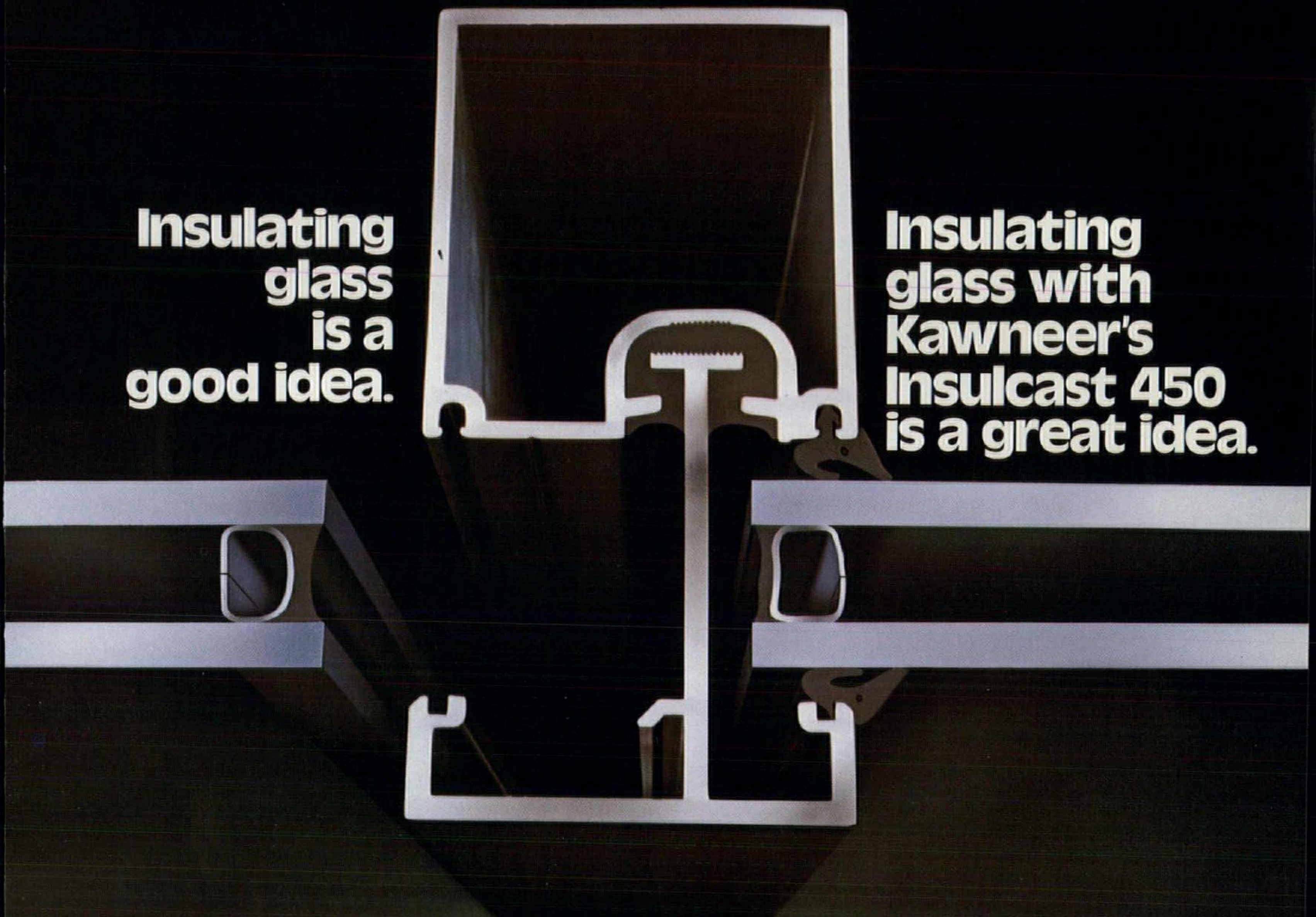
Sun-Center, a solar power package for domestic hot water, requires only two joint connections to begin to operate. [*Products continued on page 225*]

Circle **No. 405,** on Reader Service Card

Circle **No. 414,** on Reader Service Card

Insulating glass is a good idea.

Insulating glass with Kawneer's Insulcast 450 is a great idea.



Insulating glass can be a wise investment since it pays off in terms of heat savings, fuel savings and comfort. Now, carry your good idea a little further and consider the framing system.

Kawneer's new Insulcast 450® Thermal Framing can make a big difference.

By adding Kawneer's new Insulcast 450 Thermal Framing your total investment in the combined system will pay back even quicker. In fact, when compared to a non-thermally broken system with insulating glass, Insulcast 450 can reduce the payback period by as much as 15%.

The faster payback is made possible since the small additional investment in Insulcast 450 can provide an additional 20% reduction in total heat loss.

Not all thermal framing systems are alike.

Kawneer's Insulcast 450 features the exclusive Isolock® thermal barrier. Isolock positively interlocks the interior and exterior metal removing the potential danger of framing failure and glass breakage. It also reduces condensation and its damage since heat conduction is minimized to the point where the framing system stays warmer than the glass.

Insulcast 450.
The designer's element.

The clean, slim framing members of Insulcast 450 present a flush grid appearance which enhances reflective and tinted glass. Combined with seamless face members it's the perfect solution for designs that require the practicality of insulating glass and esthetics to satisfy the designer's eye.

For more information about Kawneer's new Insulcast 450 Framing System write Kawneer Architectural Products, 1105 N. Front Street, Niles, MI 49120 (616) 683-0200.

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Kawneer
The designer's element

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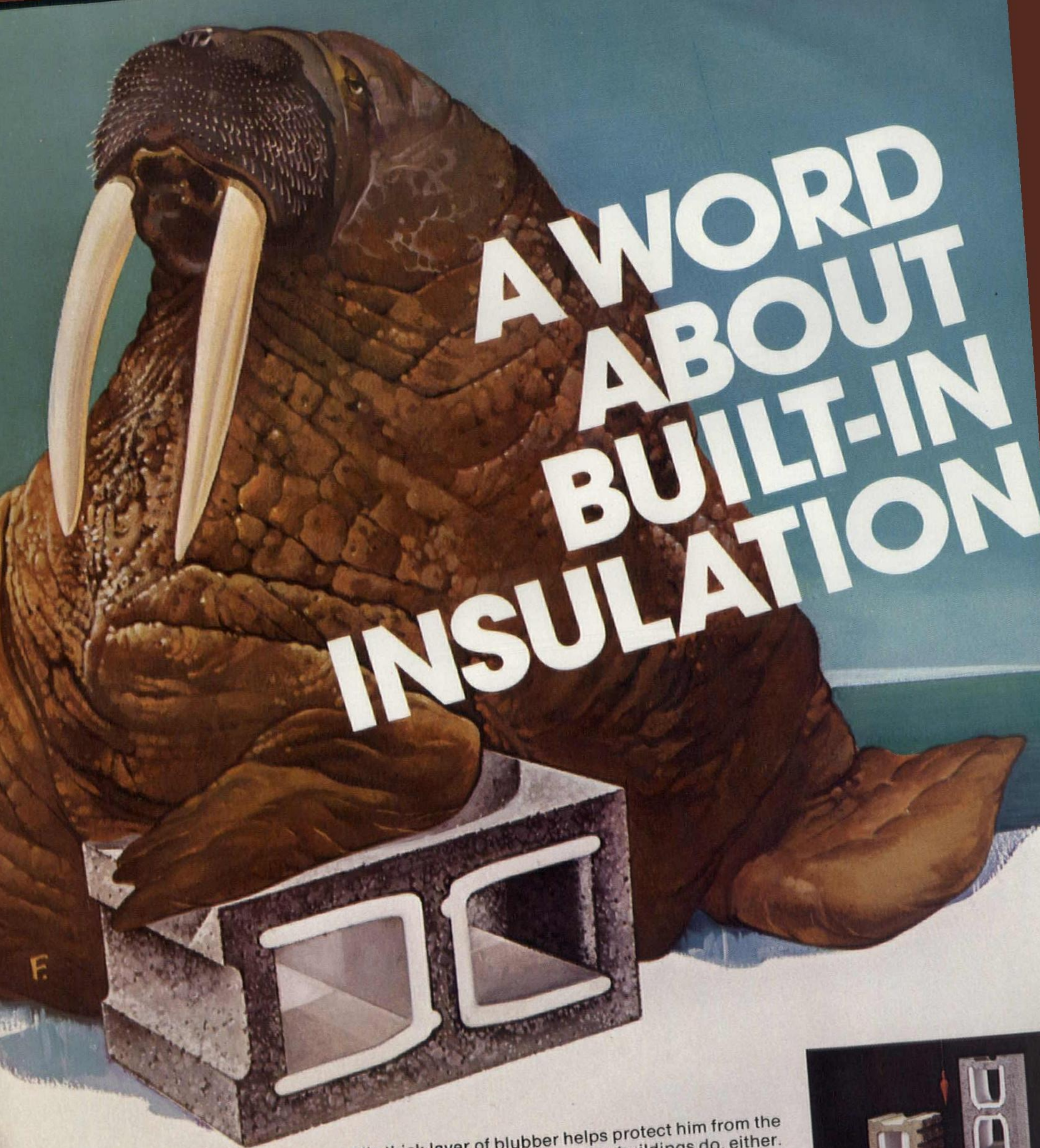

This big fella doesn't need to worry. His thick layer of blubber helps protect him from the elements. Not all animals have this built-in protection. Not all masonry buildings do, either.

Although concrete blocks may look alike when they're installed, there is one pre-insulated block which nearly doubles the insulation characteristics of a masonry wall. Korfil. The concrete block with built-in weather protection. Korfil blocks not only save time, labor and clean-up costs at the site, they save money for your customer as well, by significantly reducing heating and cooling costs on the completed building. In today's energy crunch, that's an important consideration.

For the best insulation, take a tip from the walrus. Specify Korfil on your next construction project and get built-in insulation with guaranteed results.

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Circle **No. 370,** on Reader Service Card

...Because it makes sense.

Products continued from page 222

The unit, which can be hung on the hot water tank or on a nearby wall, is made up of a pump, expansion tank, differential thermostat, float-type air vent, check valve, flow regulator, pressure-relief valve, pressure gauge, and drain/shut-off valve. Revere Solar and Architectural Products.
Circle 141 on reader service card

Literature

'Solar Spectrum,' a newsletter, covers solar installations on a project basis, providing information on funding, historical details, design, installation, and system performance. The newsletter is available without charge to building operators and owners, architects, mechanical engineers, contractors, and plant engineering staff personnel. Write on firm letterhead to: Marvin Goldberg, Managing Editor, Solar Spectrum, Solar Thermal Systems, Division of Exxon Enterprises, Inc., P.O. Box 592, Florham Park, NJ 07932.

The 'Solar Energy Technical Training Directory,' published by the Solar Energy Research Institute (SERI), lists 91 post-secondary institutes offering training programs in technical fields such as solar system fabrication, installation, and maintenance. Many offer associate degrees or certificates upon completion. Copies are available free from: The National Solar Heating and Cooling Information Center by telephoning toll-free 800-523-2929 (in Pennsylvania, 800-462-4983).

'The Solar Energy Design Handbook' is a 52-page book providing information about fundamentals of solar energy, its collection, storage, and distribution for both water heating and space heating. It offers design recommendations for solar systems and designing for heating requirements. Supporting data provided are degree days, installation charts, and collector tilt factors. Copper Development Association.
Circle 233 on reader service card

Architectural glass with Saflex polyvinyl butyral interlayer is discussed in 20-page, four-color brochure. It reviews the heat absorbing, light and glare control, and ultraviolet control properties of laminated glazings. A chart shows the heat and light control characteristics of laminated architectural glass with more than 10 different colors of Saflex interlayer. Monsanto Plastics & Resins Co.
Circle 234 on reader service card

Architectural glasses that save energy in buildings and homes and provide daylight illumination are described in a 28-page illustrated booklet. Products include Solarban®, Solarcool®, Twindow® Xi glass-edge insulating units, and high-strength laminated products. Also included is information about structural silicone glazing systems that provide a seamless appearance. PPG Industries.
Circle 235 on reader service card

Aluminum Curtain Walls, Vol. 9, discusses the use of the walls in energy conservation. The 32-page book reviews the fundamentals of exterior wall design to permit transmission of energy that would otherwise have to be supplied mechanically. Energy factors of curtain wall systems for four buildings are included. Architectural Aluminum Manufacturers Association.
Circle 236 on reader service card

Trocal® roofing systems for energy control can be used on flat roofs. According to the manufacturer, they eliminate problems of cracks and leaks, blistering, and the effects of ponding. A 12-page brochure discusses energy-saving advantages of the system, typical assemblies, and provides specifications. Typical installation details are shown. Dynamit Nobel of America, Inc.
Circle 237 on reader service card

Mass masonry energy brochure provides an explanation of the role of thermal mass in the transfer of energy. It explains the use of the "M" factor graph and includes sample problems. Masonry Industry Committee, International Masonry Institute.
Circle 238 on reader service card

The Solar Attic combines normally wasted attic heat with a passive solar system for space heating and domestic hot water heating. Solar energy admitted through roof glazing is collected and stored in water-filled storage tubes. Low-power fans direct air over the [*Literature continued on page 226*]

Mini Planfile.
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Mini Planfile (requiring 7 sq. ft.) has the same capacity of 12 conventional flat drawer files (requiring 17 sq. ft.).
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Circle **No. 409,** on Reader Service Card

Literature continued from page 225

tubes' surfaces to distribute the heated air where it is needed. The concept, components, and information about how it works are provided in a four-page brochure, along with data on performance of space heating and water heating. Solar Components Div., Kalwall Corp.
Circle 239 on reader service card

Settef exterior wall insulation and finish is described in an eight-page brochure. It discusses installation, thickness, and physical and performance properties, and illustrates installation details. Short form specifications are also included. Compo Industries.
Circle 240 on reader service card

Building materials

Major materials suppliers for buildings featured this month, as they were furnished to P/A by the architects.

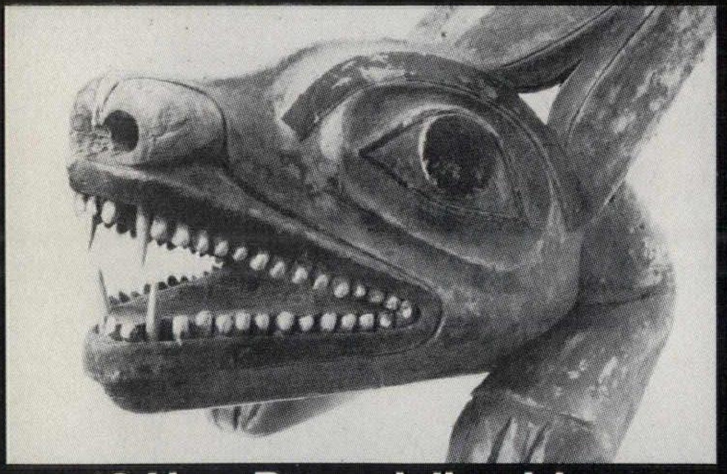
New Rochelle Public Library, New Rochelle, NY (p. 136). *Architects: Pomeroy, Lebduska Associates, New York and Fred W. Lyon, New Rochelle, NY.* Vinyl wall covering: W-G Vinyls, Inc. Aluminum and acrylic glazing skylights: Wasco Products, Inc. Hollow metal doors: Williamsburg Door. Overhead doors: Overhead Door Co. Carpeting: Mohawk. Built-up roofing: Dow Chemical. Insulation: Dow Chemical. Sliding coil grille, folding partitions: Modernfold. Locksets: General Lock. Door closers: Norton Door Control. Panic exits: Von Duprin, Inc. Theater seating: Ideal Seating. Elevator: Burlington Elevator, Inc., Parkline Corp., Amlift, Inc. Specially designed stairs: Adler & Neilson, Inc. Interior lighting: Contemporary Ceilings, Inc. Hanging light fixtures: Contemporary Lighting. Furniture: John Adden, General Fireproofing, White Woodworking, Steelcase, Stow-Davis, Andrew Wilson Co. Horizontal surfaces: Dupont.

Crowther Solar Residence, Denver, Co, (p. 150). *Architect: Richard L. Crowther, Denver, Co.* Concrete foundation: Stanley Structures. Exterior wall surface: Settef. Fixed double glass: Pella and Lexan. Skyshafts: Plasticrafts. Insulating doors: Pease. Garage door: Overhead Door Co. Wood flooring: Perm Grain. Single-ply roofing: Koppers KMM. Polystyrene insulation: Drew Foam. Interior and exterior paint: Moore Paint Co. Locksets: Schlage Mfg. Hinges: Hager Mfg. Co. Kitchen and laundry surfaces:Formica Mfg. Co. Intercom: NuTone. Surface, recessed lighting: Staff Mfg. Pendant lighting: Columbia Mfg. Bath fixtures: American Standard. Sauna: Viking Sauna. Water-to-air heat pump: Vanguard Mfg. Control system: Horizon Mfg. Carpets: Watson and Smith. Vertical plastic draperies: Norbar Fabrics.

Shenandoah Solar Recreation Center, Shenandoah, Ga (p. 158). *Architects: Taylor & Williams, Atlanta.* Fiberglass skylights: Kalwall. Aluminum roofing: Alcoa. Solar collectors: Revere Copper. Absorption A.C.: Trane. Special-design theater: Viscount Production, Inc.

Milford Reservation Environmental Center, Milford, Pa (p. 162). *Architects: Kelbaugh & Lee, Princeton, NJ.* Concrete: Widener. Trombe walls: Ergenics. Windows: Caradco. Skylight: CY/RO. Doors: Raynor. Rubber tile: Novament. Roofing: Onduline. Waterproofing: Volclay. Thermosote: Homasote. Concrete block: Soundblock. Glass block: Pittsburg Corning. Hardware: Stanley; Schlage; LCN; Von Duprin. Signage: Simple Space Rite. Lighting: Moldcast; Lightolier. Plumbing: Du Pont; American Standard; Eljer; Bobrick; Western; Main Tank; Clivas Multrum. HVAC: Riteway; Bow and Arrow; Heatilator. Carpet: Wellco. Blinds: Riviera. Drapery: Solar Energy Construction; Duracote.

Prototype passive solar townhouses. *Architects: Kelbaugh & Lee, Princeton, NJ.* Windows: Caradco; CY/RO; PPG. Doors: General Products. Paving: Hastings. Roofing: Onduline. Insulation: Owens-Corning; Dow. Hardware: Stanley; Schlage. Preheater: Ergenics. Lighting: Moldcast. Plumbing: Architectural Complements. Furnace: Sears. Drapery: Duracote; Insulating Shade Co.



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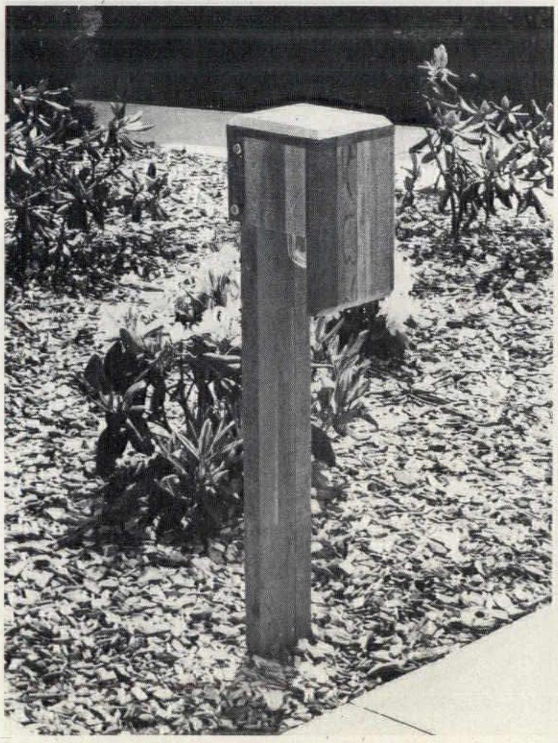

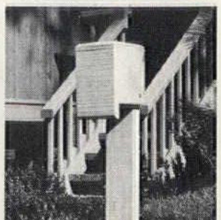

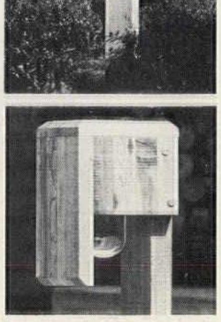

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Introducing Sunglas® Reflective, it blocks up to 65% of the sun's heat.

New Sunglas Reflective blocks the heat to help reduce the high cost of air conditioning.

Installing Sunglas Reflective can, over the lifetime of your building, amount to a saving of thousands of dollars. Because it blocks up to 65% of the sun's heat, it can aid in cutting air-conditioning operating costs and may allow for the use of smaller air-conditioning units.

A new concept – blocks the heat. Yet lets in the daylight.

While Sunglas blocks the sun's heat, it lets in more daylight than most other reflective glass products. This means reduced solar heat load while permitting the use of natural daylight for illumination – this unique property presents another big saving potential. It also helps minimize hot spots so room temperatures remain more uniform and comfortable.

Ford Sunglas Reflective for a natural color view of the outdoors.

Sunglas Reflective lets in the beauty of the outdoors without noticeably affecting its natural color. The neutral silver coating reflects the surrounding outside environment and provides a full-color view of colors throughout the day.

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Ford's new computerized S.A.V.E. program (Systems to Analyze Value and Energy) can help you determine your solar glass requirements and savings quickly. Find out more about the S.A.V.E. program and Sunglas Reflective so you can take the heat off you *and* your budget. Sunglas Reflective is available now and it can be cut, tempered and fabricated locally. You'll find that choosing Ford Sunglas Reflective will be a nice reflection on you.

Sunglas Reflective is backed by Ford experience and a 10-year warranty.

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Faculty Position in Design and Housing: Faculty Member, The University of Iowa. Ph.D. or M.F.A. preferred. Responsibilities: teaching undergraduate and graduate courses in interior design; advising students; conducting research and/or creative work; directing M.A. theses. Ability to work in the interdisciplinary context of a home economics department within a liberal arts college. Position for August 1980. Salary and rank commensurate with experience and qualifications. Equal opportunity, affirmative action employer. Send resume to Dr. Margaret N. Keyes, Chair, Search Committee, Department of Home Economics, 24 Old Capitol, The University of Iowa, Iowa City, Ia 52242.

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Job Mart continued from page 228

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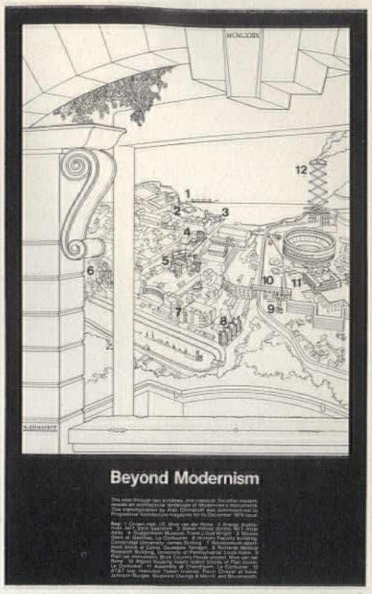

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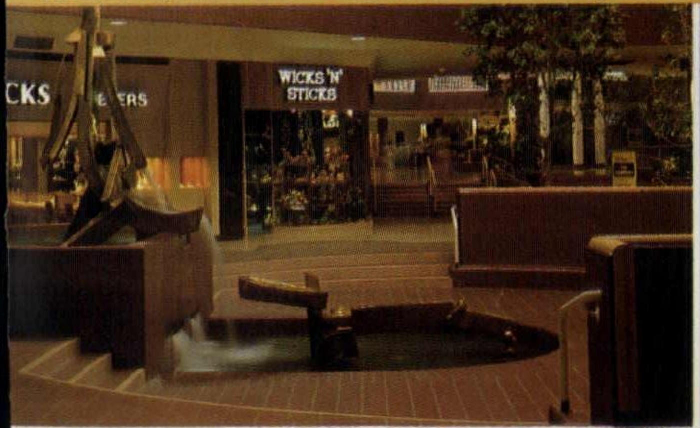
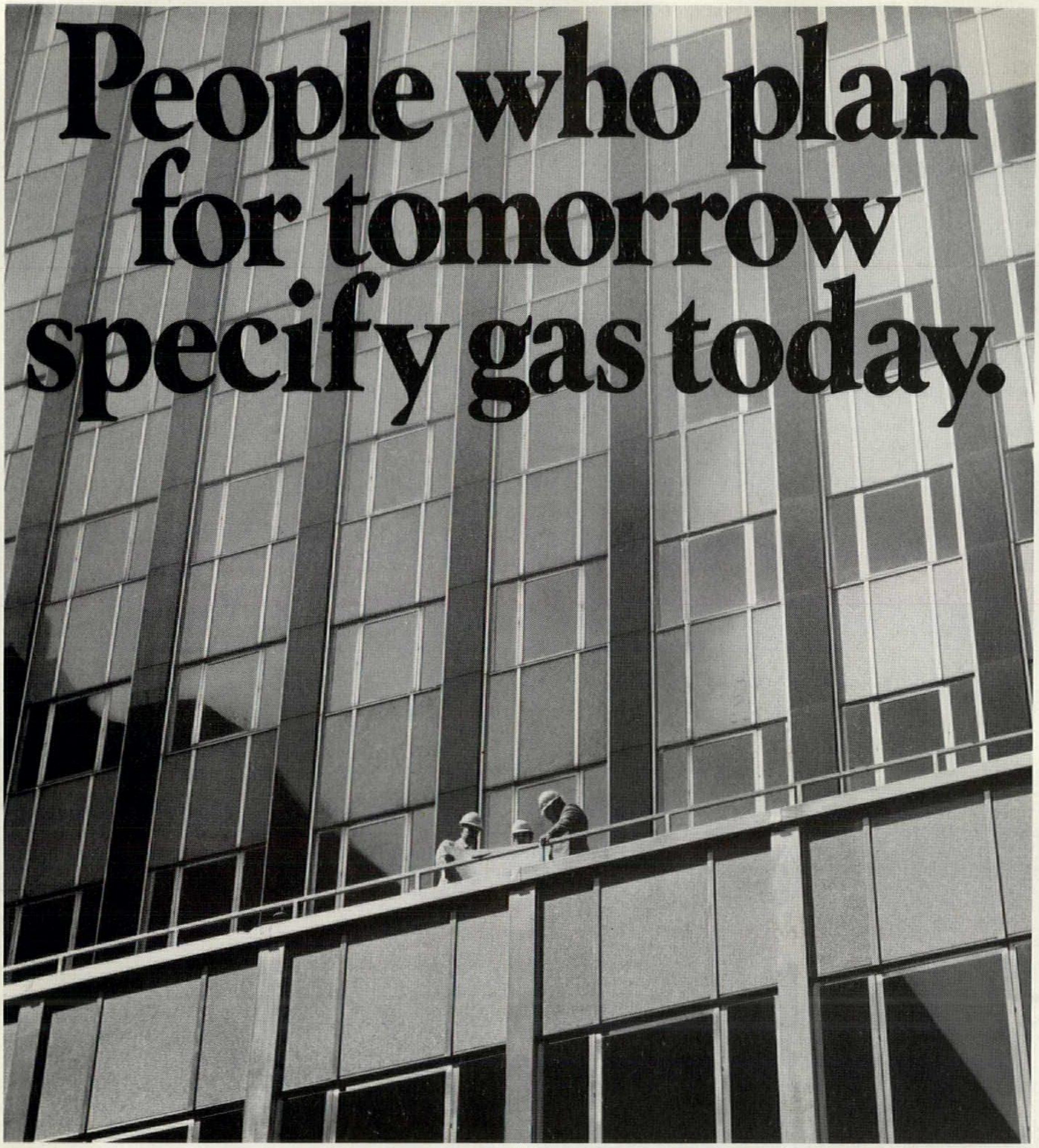
Shown above: 1. Greenwood Park, Indianapolis, Ind. Over 93,000 Sq. ft. of Gail Unglazed Brickplate installed; Architects: Charles Kober Associates; Developers: Melvin Simon Associates, Inc. 2. The Meadows Shopping Mall, Las Vegas, Nevada; Over 45,000 sq. ft. of Unglazed Brickplate (English Red and Leather) specified for floors by architects, Charles Kober Associates; General Contractor: Ernest W. Hahn, Inc. 3. Lougheed Mall, Vancouver, B.C., Canada Architects: Dirrassar, James & Jorgensen; Developers: Trizec Corp., Ltd. 4. Woodland Hills Mall, Tulsa, Oklahoma Architect: Charles A. Kober Associates; Developer: Dayton-Hudson Properties. Gail Unglazed Brickplate on floor surfaces. 5. Capitol Mall, Olympia, Washington; Architects: John Graham & Co., Seattle; Developers/General Contractors: Ernest W. Hahn, Inc., El Segundo, California.



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