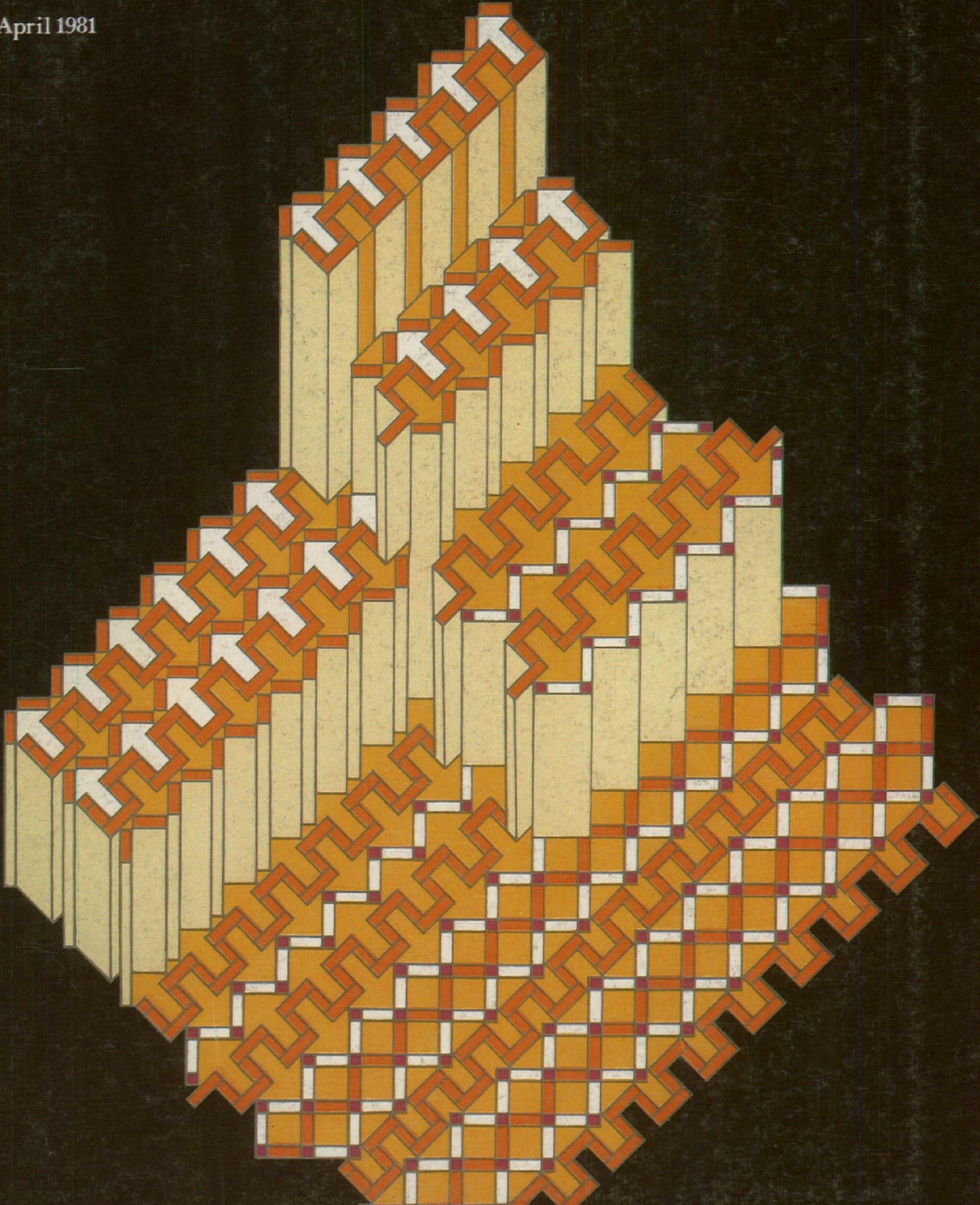
# Progressive Architecture

April 1981



Energy-conscious design

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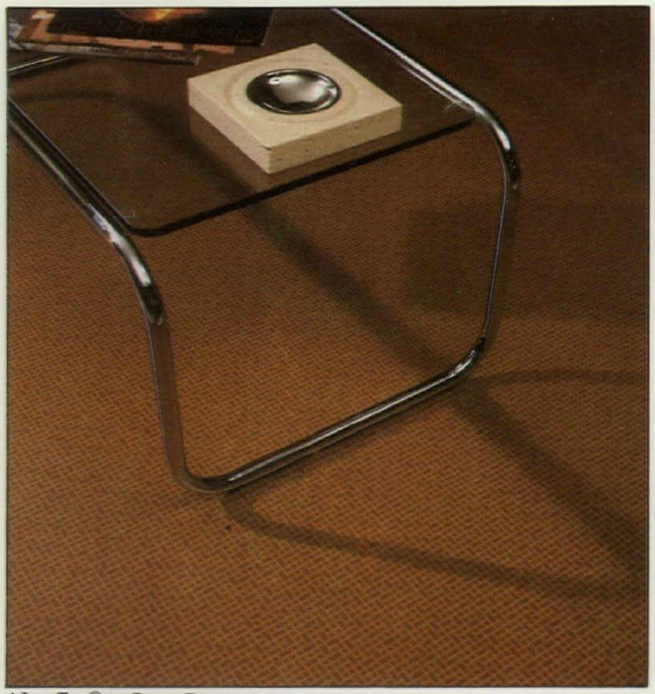

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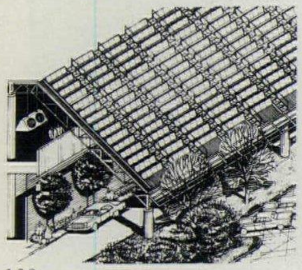

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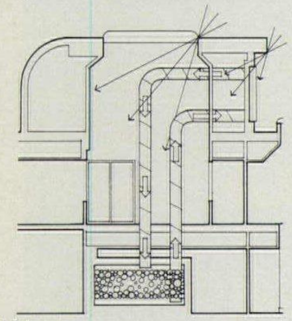

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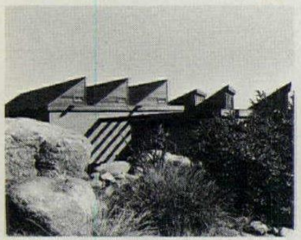

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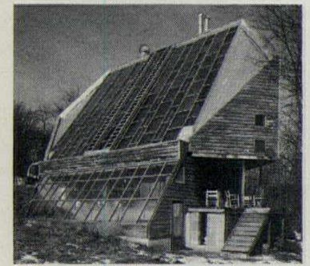

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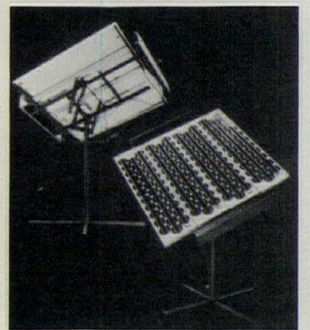

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**Cover:** *Design entitled "The assimilation of energy" by Elizabeth and Richard Rush.*




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Progressive Architecture (ISSN 033-0752) is published monthly by Reinhold Publishing, A Division of Penton/IPC: Philip H. Hubbard, Jr., President; Harry I. Martin, James J. Hoverman, Vice-Presidents; Penton/IPC: Thomas L. Dempsey, Chairman; Sal F. Marino, President; N.N. Goodman, Jr., Benjamin L. Hummel, Paul Rolnick, Executive Vice-Presidents.

Executive and editorial offices, 600 Summer St., Stamford, CT 06904 (203-348-7531).

Subscription information:
Send all subscription orders, payments, and changes of address to Progressive Architecture, P.O. Box 95759, Cleveland, OH 44101 (216-696-0300). When filing change of address, give former as well as new address and zip codes, and include recent address label if possible. Allow two months for change. Publisher reserves right to refuse unqualified subscriptions. Professionals include architectural and architectural-engineering firm personnel and architects, designers, engineers, and draftsmen employed in allied fields.

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| Professional/ year | $15 | $18 | $30 |
| Nonprofessional/ year | $30 | $35 | $50 |
| Single copy | $ 6 | $ 6.50 | $ 7 |

Indexed in Art Index, Architectural Index, Engineering Index. Second class postage rates paid at Cleveland, Ohio, and additional mailing offices. Volume LXII, No. 4. Printed in U.S.A.

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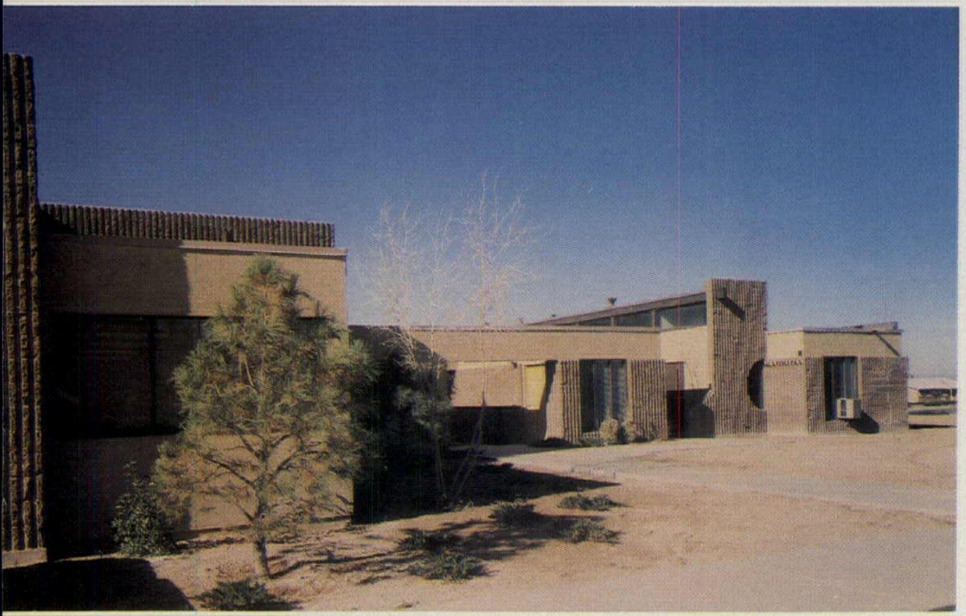
Left & right. Two views of the unique Trombe wall. The left photo shows the Trombe wall under construction. The ducts will distribute the heated air from the wall area to other parts of the building. The right photo shows the split ribbed units. The glass area is comprised of double-glazed standard patio doors located 8" in front of the wall.

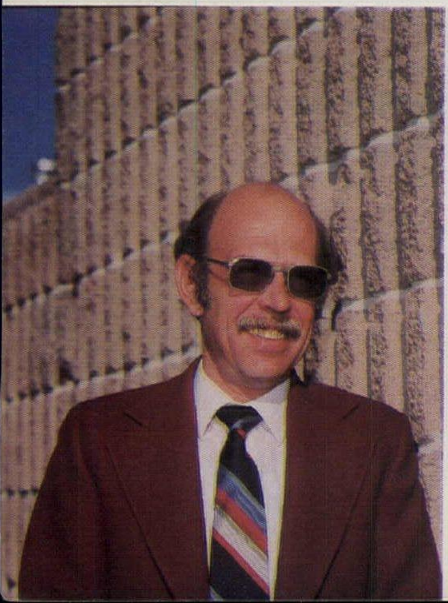


Two of the buildings showing the handsome design effect achieved with concrete masonry split ribbed units. Another of the clerestory windows can be seen.

# Concrete masonry passive solar architecture expected to save 50% in energy costs at Comanche Place,

## Albuquerque, New Mexico

## New building complex features unique Trombe wall.



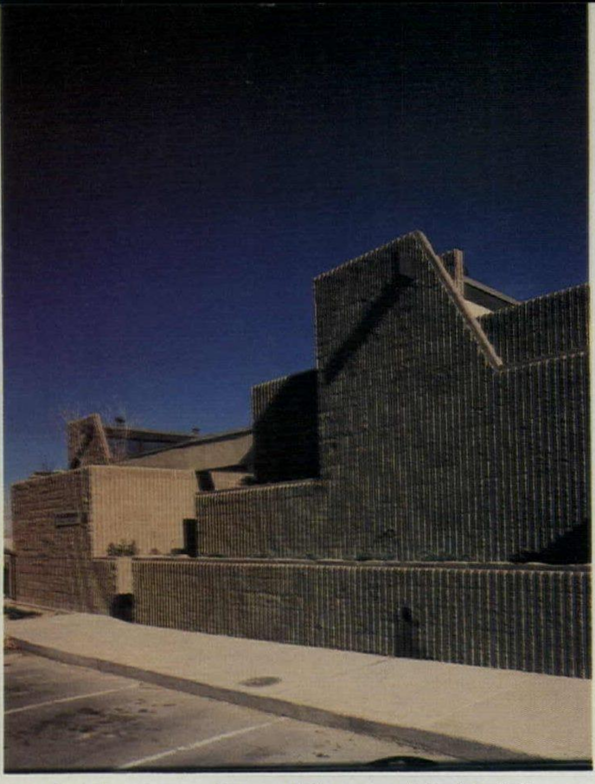
**"Excellent heat storage, aesthetics and structural properties in one building material."**

**Donald A. Krueger, Architect**

"I am most pleased with the performance of concrete masonry as a passive solar system at Comanche Place. The craggy surface of the split ribbed units, in our experience, delivers more heat storage capacity than other surfaces. And with block, you have the advantage of working with a proven, available material."

The mile high altitude of Albuquerque produces a Winter climate of comfortable sunny days and crisp, cold nights—and occa-occasionally, mid-western style blizzards. A good test for passive solar concrete masonry architecture.

Comanche Place, when completed, will consist of nine buildings,



Another view of two of the completed buildings. One of the clerestory windows, which provides sunlight in Winter, can be seen at the top of the picture.

Above & below. The "greenhouse" provides an additional heat sink which employs the floor and concrete masonry walls for heat storage. The diagram below shows the orientation of the building to low Winter and high Summer sun.

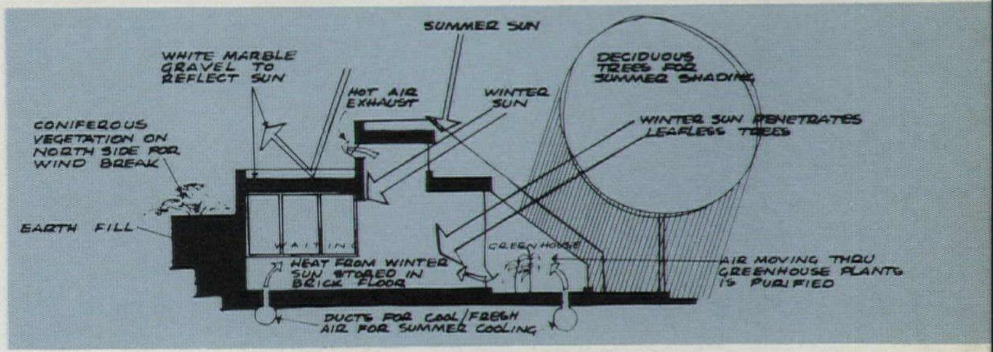
The interior of the "greenhouse" entrance showing the concrete masonry walls and the clerestory window above, which allows Winter sunlight to heat the masonry walls.

totalling over 30,000 sq. ft. Four buildings are complete; another is under construction.

All are loadbearing passive solar concrete masonry structures.

Architect Donald Krueger reports substantial energy savings in the four completed buildings. One of the completed buildings features a unique Trombe wall. Energy savings in this building are expected to be on the order of 50%. This building is the subject of a research study to establish exact energy savings.

At Comanche Place, concrete masonry is the principal component in the passive solar energy system, the principal structural material and provides the aesthetics, economy, fire safety and sound control, as well.

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# Putting energy into practice

**Professional practice must necessarily lag behind the frontiers of technology. Like any concept working its way into real applications, energy consciousness is encountering varying degrees of inertia and distortion at different points in the field.**

In his Conclusion to this special issue on energy-conscious design, P/A Senior Editor Richard Rush speaks of the current "assimilation" of energy concerns into the body of architectural design. We have indeed been impressed as we developed this issue with the way energy strategies are now being integrated into prevailing design vocabularies. This assimilation seems to be part of a more widespread convergence of many streams of thought—about historical precedent, symbolism, and contextual response, for instance, as well as energy performance—into the architecture of the 1980s.

We have been speculating about how long it will be before energy consciousness becomes so much a part of architecture that special editorial treatment of the subject will be superfluous. Clearly, in 1981 it is still possible to identify energy-conscious design examples, but the edges of that category are blurring, as they should.

Developments in architectural design, however, must pass through the medium of architectural practice if they are to become realities. This involves a certain amount of delay, misunderstanding, and exploitation, as well as some valuable testing of premises, means, and expectations.

Architects we have talked with observe a split between commissions for corporate and institutional clients and those for speculative developers. The IBMs and ATTs, they say, are very much aware of the long-term economies of energy-conserving design; they are ready to invest more now for savings in energy demand over the next couple of decades, and they want to include features that indicate a conservation ethic—such as operable windows and natural lighting—whether or not any saving of energy or money can be proved. The speculative builders they encounter, on the other hand, are not ready to invest in anything that cannot be shown to pay for itself in eight years; such developers feel that they cannot risk less competitive rents or sales prices in order to reduce operating costs, which will be borne by future occupants.

Some speculative developers, however, show a much stronger interest in long-term energy performance, because they plan to own and operate their buildings for a long time. Whichever kind of developer one is serving, however, energy conservation strategies have to be shown to yield benefits in hard cash—in the short term or long term (or alternatively to cost nothing at all in the first place). Designing for developer clients tends to weed out the merely symbolic or wishful energy-saving measures.

What about energy consciousness as an *opportunity* for individual practitioners and for the profession as a whole? Many voices in the profession—P/A's among them—have stressed the opportunity offered by our energy constraints to demonstrate the potential of *design* to solve society's problems. Some architects had begun to develop valuable expertise in energy performance a decade or more ago (P/A, Oct. 1971). Others were quick to acquire some of this expertise after the implications of the 1973 energy crisis became apparent. As the profession became acutely aware of the need to market services, some firms inevitably exaggerated their energy capabilities when pursuing clients.

While some practitioners may be rashly assuming the mantles of energy sages, the profession as a body has had to overcome the inertia characteristic of organizations. The AIA and its Research Corporation did move with speed and authority a few years ago to develop and support energy performance standards (P/A, Apr. 1979, pp. 71–73 and Apr. 1980, pp. 92–97) that would give professional skills full latitude in meeting energy goals. Regional and local activities of AIA, as well as its national Energy Committee, have contributed to the development of energy consciousness—professional and public.

The scheduling of the first AIA National Convention focusing on energy for this year (May 17–21 in Minneapolis) must be viewed, however, as a legacy of organizational inertia. Credit is due those who decided upon energy as the topic at Minneapolis (and also of a national AIA design conference to be held in Denver in November), but it would have been more timely back in 1978 or 1979. The Society of American Registered Architects, after all, made energy the theme of their 1980 meeting. The American Section of the International Solar Energy Society was organized in 1954 and will have its fifth annual convention in Philadelphia in May (p. 209).

Consider how much of a time lag in the area of energy-conscious design your own firm may be suffering. Thinking in the profession as a whole should now have progressed far beyond the simplistic hardware-only approaches that still seem to capture the public's interest. In this issue, we have tried to stress the next phase—the buildings that have important qualities beyond just energy performance, the technical efforts that go beyond accepted methods. We all have a lot of catching up to do—catching up to the potential of architecture to deal with energy issues, among others. We hope this issue can provide some acceleration.

John Morris Dixon

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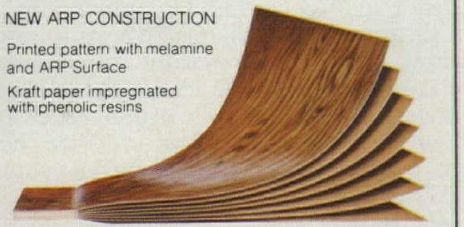

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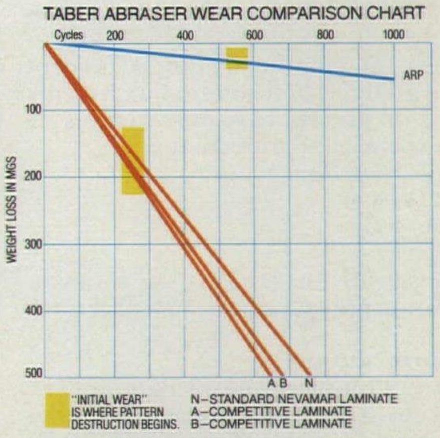


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# Views

### Energy-effective measures

The April 1980 feature entitled "Architectural Energy Analysis" was an excellent article that turned a looming avalanche of information into a concise primer for simulating energy performance. The initial momentum is maintained as we read the energy performance analysis of each month's feature building.

I wish you continued success in keeping the architectural community well informed on the energy consequences of architectural design decisions.

*Robert J. Heidelbaugh*
*Project Director*
*Basco Associates*
*York, Pa*

[See review of Energy Analysis series at completion of first year, p. 154—Editors]

### City form and policy

The trivial nit-picking over Battery Park City (February News Report) clouds the main issue: the project is wrong! It steals the waterfront from existing neighborhoods, and will end up a high density, high income ghetto.

New York should not be indulging in massive expensive landfill adventures. It cannot afford to maintain or secure parks and streets it already has. Having lost well over a half-million people in the past decade, it should consolidate and reduce developed land not create more. The answer for the Hudson waterfront is small-scale incremental growth, and keeping our River where it is!

Limiting your critique to formal design issues and silly jargon ("typology of edge pieces," etc.) shows why architects have no credible voice in shaping City development and environmental policy. It also helps pave the way (literally) for the next boondoggle down the pike—Westway.

*H. Alan Hoglund, AICP*
*Director*
*Public Environment Center*
*New York, NY*

### People the pages

The February issue with good works by Hardy Holzman Pfeiffer, Steve Holl, Helmut Jahn, and Craig Hodgetts & Robert Mangurian is a fascinating look and a good read. The Best Products Company HQ particularly is a kick. I am sure the Moral Majority disapproves of anyone having that much fun in Richmond, Virginia (or anywhere else). Thanks for not doing too much of a head trip on all this P-M!

One strong cavil. In thirty feature pages featuring seven different buildings, your photographers show exactly ten identifiable human beings, and those in only two of the buildings. Were these approximately 193,474 sq ft of buildings designed and built for the sole purpose of being reproduced empty and pristine on P/A's glossy pages? This is carrying the sere cult of Ezra Stollerism to gratuitous extremes!

Please, let's have pictures of buildings in use, being lived and worked in, and inhabited by the people they were (I hope) designed for.

*Jim Burns*
*Planning Consultant*
*San Francisco, Ca*

### Awards Monday

Boy, it must have been a lean year for the profession.

Citations for a neo-classic-cum-sod house ruin in Rapid City, South Dakota, and then for a "replica" of the old Jordan Pond House on Mt. Desert Island, Maine!

The "solution" for the Jordan Pond House you so greatly admire is, in every respect cited, the work of the vernacular "architect(s)" who created the predecessor building complex, and not that of Woo and Williams (as seminally creative as they may be on other commissions). In this case it is appropriate restraint of course, but design restraint should not be confused with originality in design. Finally, a little less lower order centrism if you please. Let's give due credit to the fine work of God Almighty for His park design.

*Frederick W. Lyman*
*American Landmarks, Inc.*
*Belmont, Ma*

[Judging from the submissions, this was far from a "lean year." It would appear, however, that many of those with abundant resources to handle exercise too little "appropriate restraint," in this jury's judgment. As for God's contribution, we may attribute the natural landscape to Him, but we should not forget that the design and maintenance of *parks* is delegated to lowly man.—Editors]

### Good-to-great architecture

One reason that "no architect is producing great architecture today," as W.C. Zoller wrote in your November issue (p. 8), could be the fact that architecture develops and matures within an urban context. Consequently, "great" architecture needs a "great" city, but according to Mel King (the same P/A issue, p. 38), "a city is only great if it meets the needs of its people." Which U.S. city today meets the basic social, technical, and ecological needs of even half of its population? Could it be that the fault is not so much with architects as with our political system?

*Jan Reiner, Architect*
*St. Petersburg, Fl*

A rebuttal and a response to William Zoller's splendid letter (Nov. 1980 P/A): One firm which I feel is producing good (and even great) Architecture at this moment in time is Mitchell/Giurgola of Philadelphia. Their recent work (Tredyffrin Public Library, Fairchild Center at Columbia, Plattsburgh, NY, College Buildings, St. Bede's Worship Building, Phila., United Fund Building, Williams College Dorms, . . . AIA Headquarters Competition Winner) is, I feel, both intelligent and poetic—and not loaded, fortunately, with the hot breath of sensationalism, not full of the cute tricks of the cognoscenti-conscious elite; but rather strong and modest at the same time—and, in a time with so little to admire, admirable. We would all, I think, benefit in attempting to emulate their type of approach and their type of solid, responsible results.

*Robert O. DiSaia, Architect*
*The Ekman Corp., Architects*
*Warwick, RI*

[P/A has published feature articles on several of the cited buildings: Fairchild, Mar. 1978, pp. 54–59; Plattsburgh, Apr. 1975, pp. 66–71 and Oct. 1978, pp. 80–93; St. Bede's, Dec. 1974, pp. 54–61; Williams, Feb. 1973, pp. 56–61; United Fund, Oct. 1971, pp. 104–105. Tredyffrin was shown in *AIA Journal*, Mid-May 1978, pp. 90–95. For an analysis of their Canberra capital design, see March P/A.—Editors]

### Credit extended

Photographs of Chicago housing (P/A, Feb. 1981, p. 22) were the work of Edward West Photographs.

Photographs of the Alcan Corporate Headquarters, Montreal (P/A, Dec. 1980, p. 68) were the work of Fiona Spalding-Smith of Toronto.


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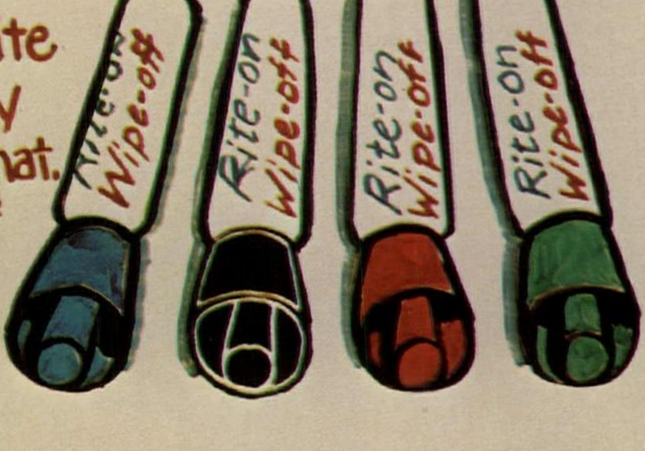

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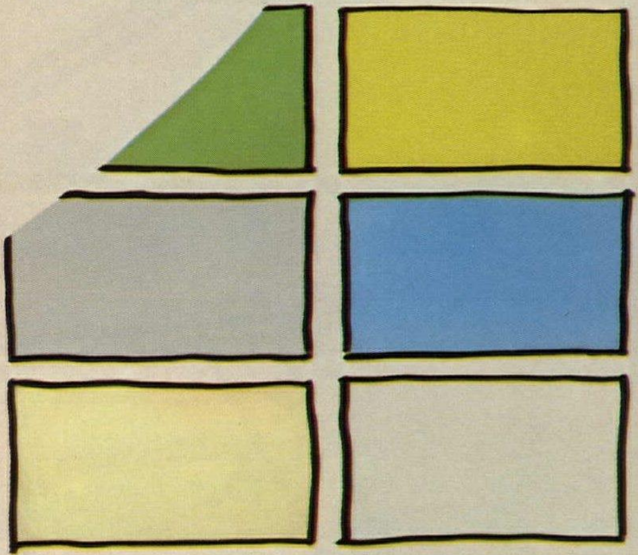

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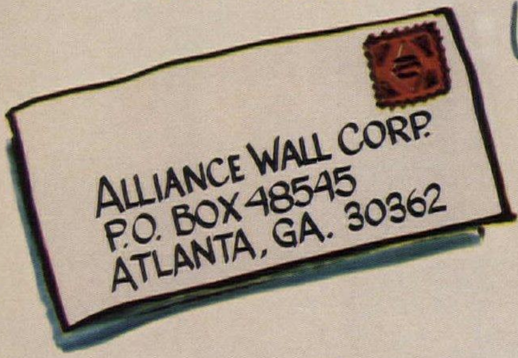


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# Tizio

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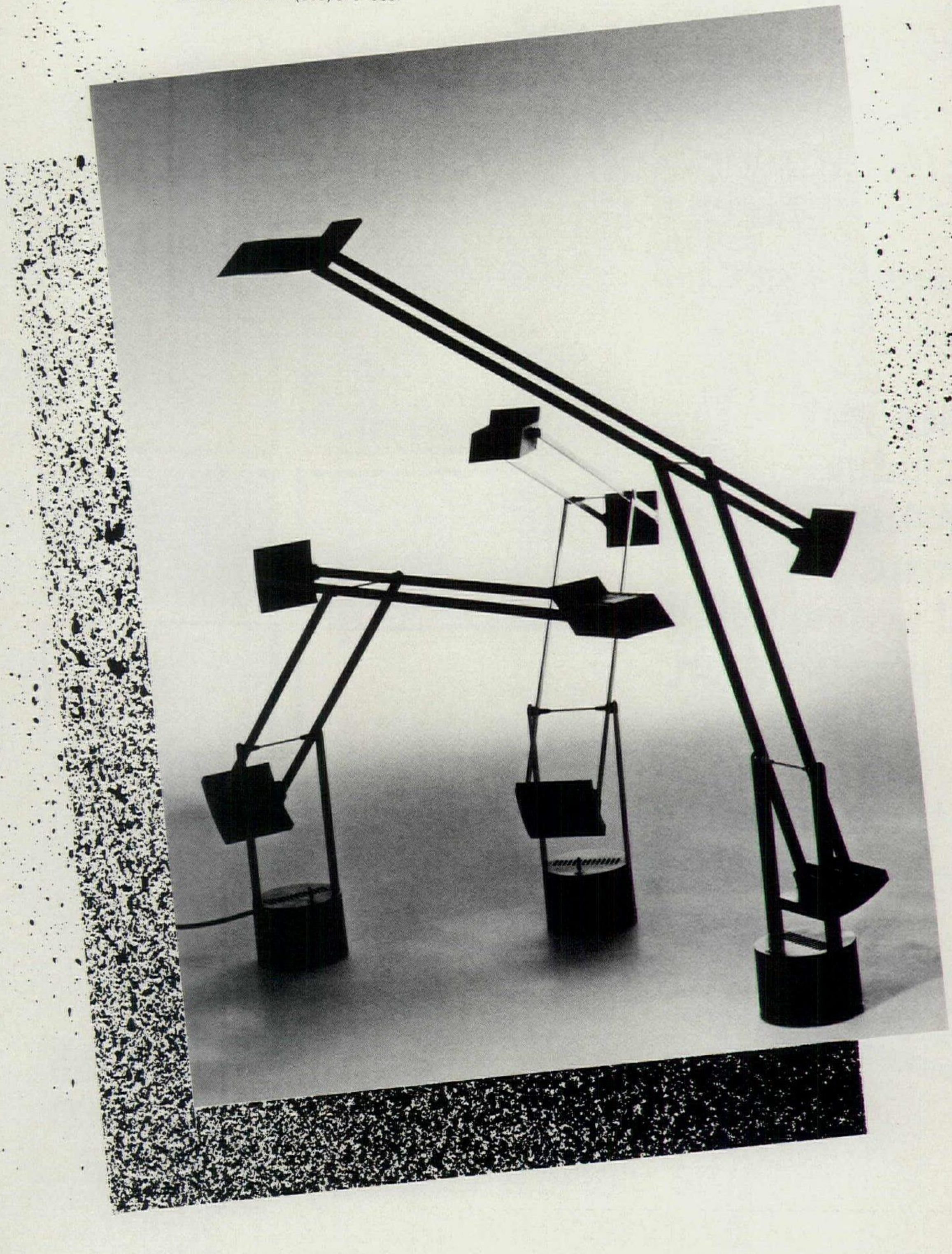

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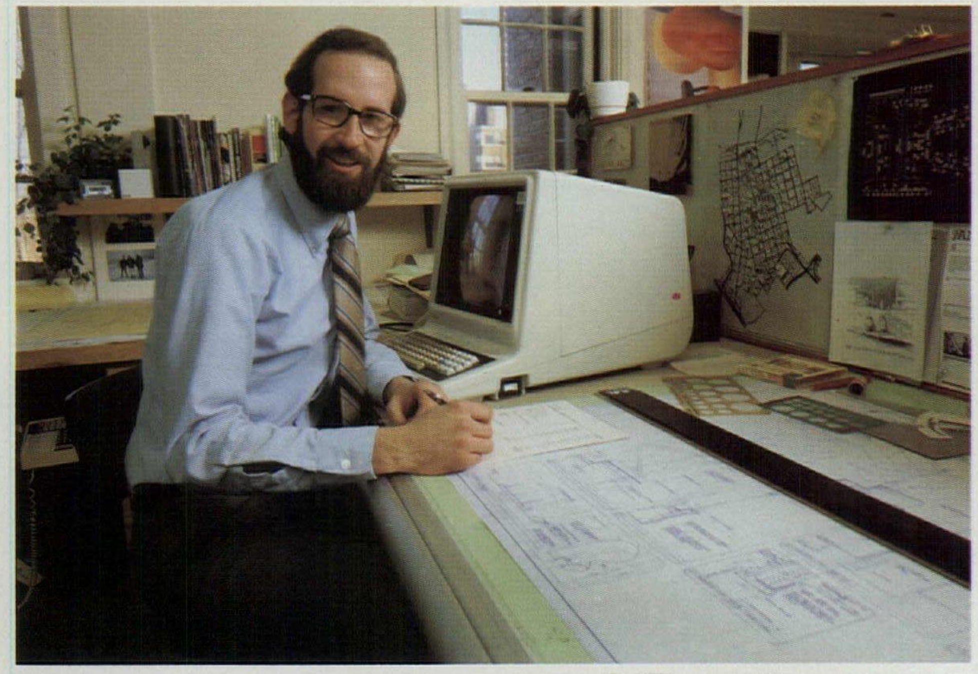
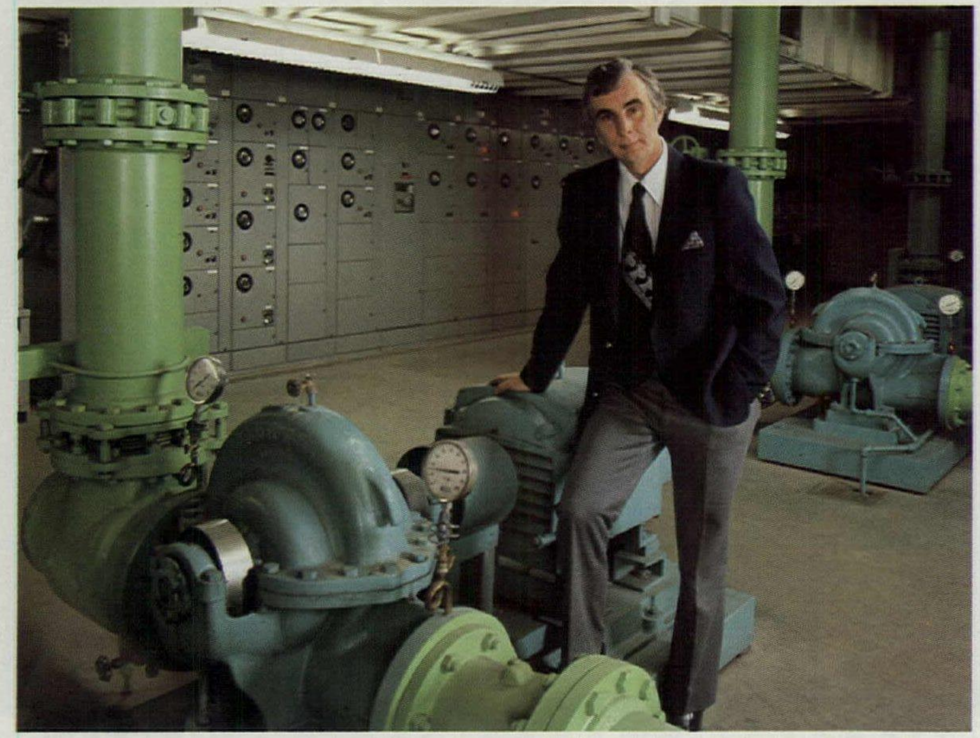


▲ *Tim Dirr of Architectural Alliance in Minneapolis uses a PLATO terminal to model a new building. The PLATO/BLAST program tests the various parameters of construction to determine the optimal design in terms of energy conservation. More and more architects are routinely providing this type of service for their clients.*

*Chuck Branch, Director of Building Services, St. Mary's Hospital in Reno, Nevada: "We were able to reduce our monthly fuel bill by $15,000 without any sacrifice in patient care or comfort by using information gained through a CYBERNET energy analysis program." Beard-Wiel Associates were the consulting engineers.* ▼



Buildings are prime targets for energy conservation, since they consume nearly 40% of the U.S. energy supply. Already, thermal compliance codes have been adopted by most states. This means architects, engineers and building owners must find ways to meet these requirements, and control the expense of escalating fuel costs.

### Computer modeling evaluates energy consumption

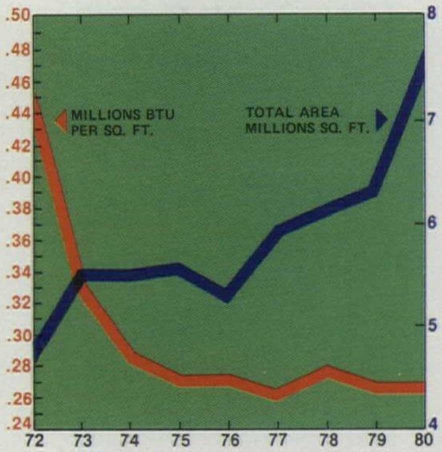
By using proven energy analysis programs available through our CYBERNET® data services network, you can simulate the energy use for a new or existing building. You can calculate energy consumption, compare alternatives, and compute investment, operating costs or payback. You can determine compliance with local building or energy codes, and analyze the interaction between such variables as building components, occupancy and weather.

Our energy analysis library is extensive. It consists of third generation computer programs which are fully supported by program authors and our own consultants.

### Customized solutions from Control Data's Professional Services

But for unique requirements, our Professional Services consultants can tailor a solution. These specialists

# you cut energy costs.




*Control Data's own energy conservation program started in 1972. Since then, our total space increased by almost two-thirds. But our energy consumption per square foot decreased by more than one-third.*

*Three state-of-the-art technologies are represented in this installation of equipment atop the Circle T Girl Scout Center in Ft. Worth. The Lennox active solar/variable air volume HVAC system employing advanced electronic controls was simulated by programs developed for Lennox Industries by Control Data's Professional Services.*

have extensive backgrounds in heating, ventilation and air conditioning, as well as state-of-the-art computer technology. Working with your energy managers, they can help you develop customized solutions for your energy problems.

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Even without extensive experience in computers or energy audits, you can use our new PLATO/BLAST program. It uses the highly interactive terminal of Control Data's PLATO® computer-based education system to guide you through each step of the analysis with text, diagrams and graphics of the building zones being analyzed.

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Since most homeowners lack the skills needed to weigh alternative conservation measures, we developed an easy-to-use residential audit. Available from participating utilities, or as a benefit from employers, it profiles a home's overall energy efficiency and helps evaluate conservation alternatives. As with our commercial energy audits, the home energy audit identifies various conservation measures, their costs, tax benefits and projected savings.

**Our solar energy "collector" is bringing light on this new technology**

With the extensive research into solar technology, we need to avoid costly duplication of effort. That's why Control Data is building one of the world's largest solar data bases. Through our global data services networks, you can access data bases on solar energy, earth sheltered construction and other renewable energy resources.

Knowledge. Services. Solutions. Ways that Control Data is helping people conserve energy and cut fuel costs.

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**Addressing society's major unmet needs**

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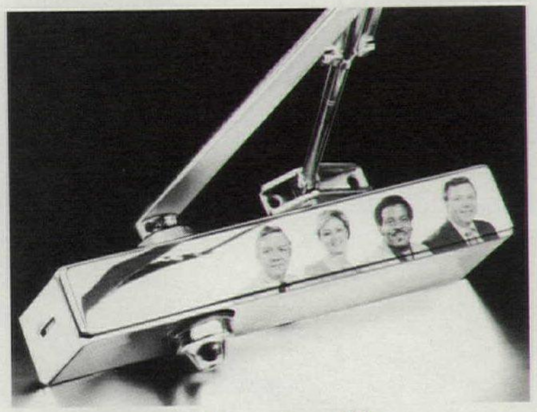

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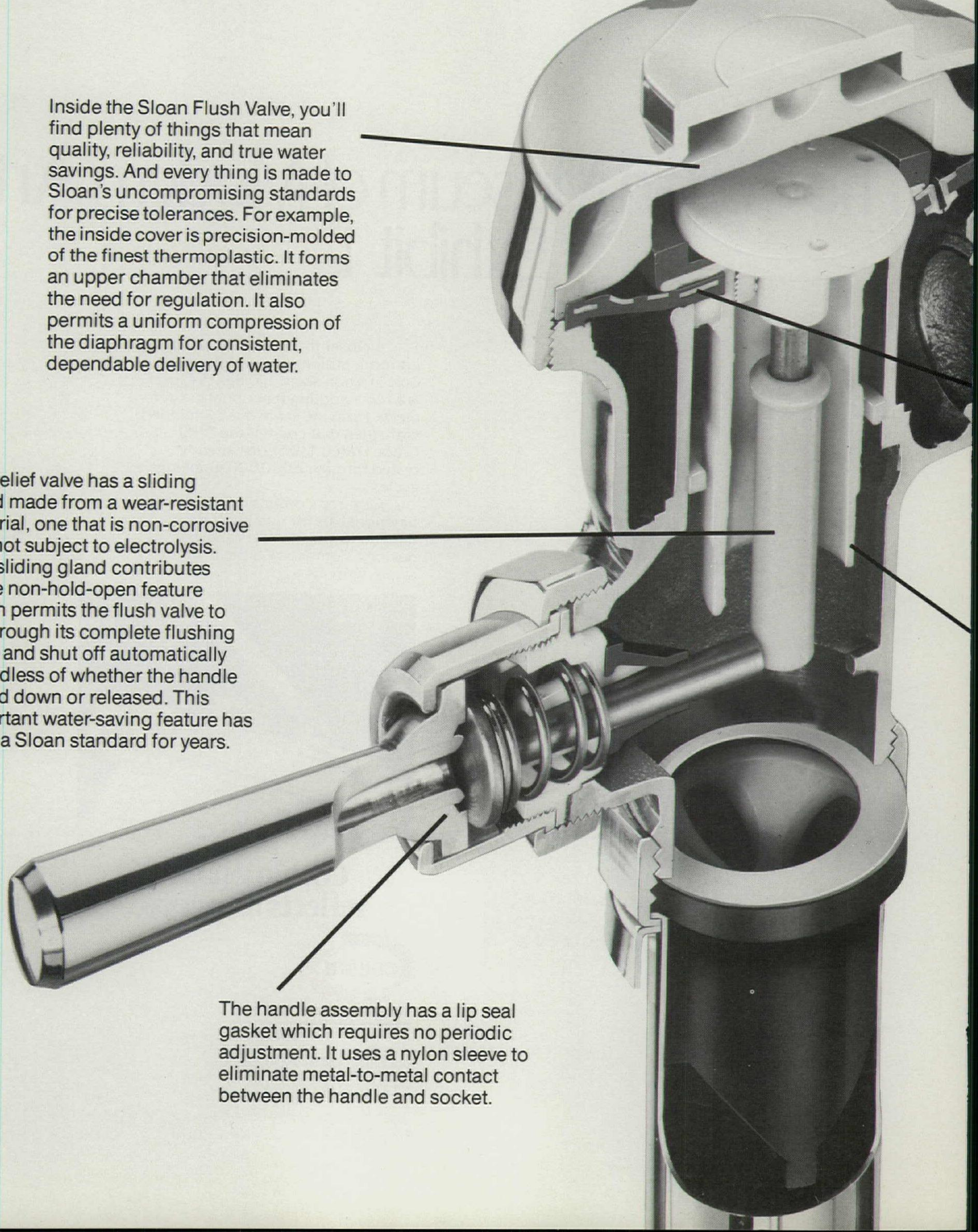
# What to look perfect flush

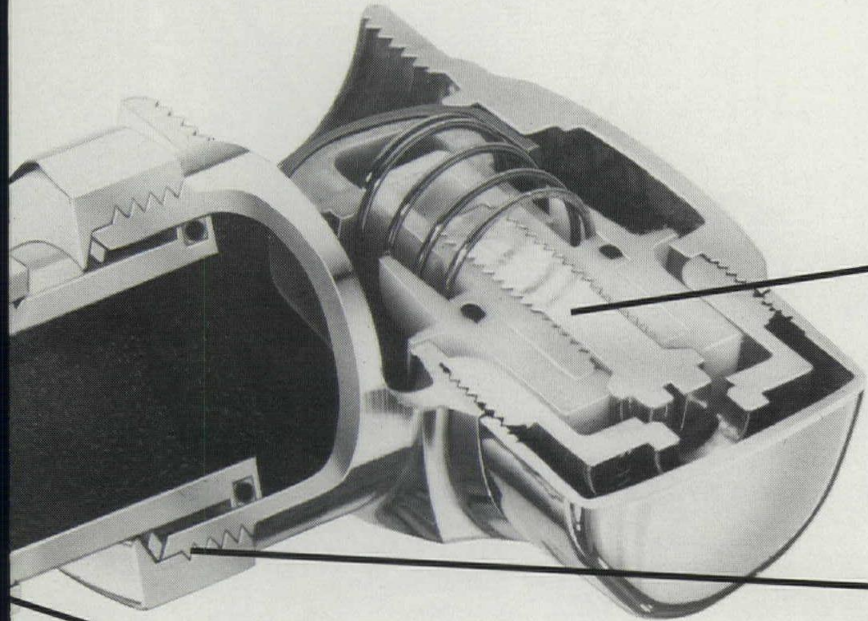
Inside the Sloan Flush Valve, you'll find plenty of things that mean quality, reliability, and true water savings. And every thing is made to Sloan's uncompromising standards for precise tolerances. For example, the inside cover is precision-molded of the finest thermoplastic. It forms an upper chamber that eliminates the need for regulation. It also permits a uniform compression of the diaphragm for consistent, dependable delivery of water.



The relief valve has a sliding gland made from a wear-resistant material, one that is non-corrosive and not subject to electrolysis. This sliding gland contributes to the non-hold-open feature which permits the flush valve to go through its complete flushing cycle and shut off automatically regardless of whether the handle is held down or released. This important water-saving feature has been a Sloan standard for years.

The handle assembly has a lip seal gasket which requires no periodic adjustment. It uses a nylon sleeve to eliminate metal-to-metal contact between the handle and socket.

# for in the valve.



With BAK-CHEK on guard at all times, pressure losses—even to negative pressures—have no effect. When water pressure is restored, the flush valve is again ready for normal use.

The adjustable tailpiece is engineered to compensate for roughing-in error and offers a leakproof connection designed so it cannot be accidentally disengaged.

The segment diaphragm, the heart of the Sloan Flush Valve, is made of high-grade imported natural rubber with brass segments carefully molded into it to assure positive closure of the main seat. Sloan's 75 years of experience have proven that natural rubber, when immersed in water and subjected to flexing action, gives longer, better service.

The guide is made of ABS engineered plastic and consists of the guide proper, a flow ring, and a refill head. The guide assembly, when used in combination with either of two relief valves, will satisfy any fixture requirement.

Any wonder when people think of the perfect flush valve, they think of Sloan first?

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# P/A News report

## Waiting for OPEC

In the strongest bureaucratic whirlwind to hit the capital in years, the Reagan administration's budget proposals have sent shockwaves through Washington and the rest of the country, leaving few interests untouched and some touched very profoundly indeed. Interests concerned with energy and buildings are no exceptions.

**BEPS**
The Department of Energy's building energy performance standards program, which has become something of an industry unto itself, was postponed for implementation in last year's session of Congress and is now given no chance for additional funding under the 1982 fiscal year budget. It seems destined for a quiet but sure demise by the end of the year. Many in industry and government have been uncomfortable with the regulatory mantle that has cloaked the BEPS program from its inception, and even representative Richard Ottinger (D-NY), a strong advocate of the program during the Carter administration, now says he hopes it will be possible to rely on the forces of the marketplace and the solid technical foundation of the BEPS program to bring about voluntary use of the DOE standards or their equivalents.

**Conservation programs**
In its quickest and perhaps most discouraging symbolic move, the Reagan administration has done away with the emergency building temperature regulations instituted by its predecessors, holding to its position that energy prices alone will provide an adequate incentive for building owners to keep thermostats at sensible levels.

The residential conservation service and the energy audit program for schools and hospitals, called by former DOE deputy secretary Thomas Stelson "the most effective of Federal energy programs to date," may stand a better chance than other building conservation programs for funding, as the budget moves its way through Congress; but many programs will be sacked or massively reduced.

**Solar demonstration programs**
With the government's intention to get out of the solar commercialization business and leave the job to industry, the future of passive and active solar demonstration programs is grim. While some officials in DOE believe that the building industry needs continued assistance to convert effectively to the use of renewable energy resources, other observers feel that energy-conserving techniques are ready for widespread application, and they predict a tremendous burst of activity unsaddled by bureaucratic paperwork.


**Fuel subsidies**
The administration's so-called free market approach to resolving the energy situation is not quite that. "How can conservation, solar energy, and efficiency compete on proper terms," asks Roger Sant, former Ford administration energy official and now director of the Mellon Institute Energy Productivity Center, "if nuclear plants and synthetic fuels are going to continue to receive tremendous subsidies?" Energy secretary James Edwards, dubbed the "atomic dentist" by his detractors, argues that the subsidies are equivalent for nuclear and renewable energy systems, if tax credits and other Federal incentives are taken into account.

**The future of DOE**
By all appearances, DOE is being treated by the Reagan administration as a department headed for obscurity, if not extinction. Edwards sees its major function as long-term research. DOE is slated for a personnel reduction of at least 15 percent, and many observers believe that James Watt's Department of the Interior will assume an increasing number of energy responsibilities.

**Prognosis**
All these signs point to an abrupt halt to the Federal energy conservation/solar technology bandwagon, with ripple effects to be felt across the nation. Still, free market forces or not, preliminary statistics for 1980 and early 1981 suggest that somehow energy users are getting a message. DOE reports that overall energy consumption was down 4 percent in 1980 compared with 1979, with oil imports down 20 percent. In the first months of 1981, oil imports were 30 percent lower than for the same period a year earlier.

But Henry "Scoop" Jackson (D-Wa), speaking before a national energy conference in Tennessee last month, said: "Even if we do everything talked about in the way of new production and conservation—wind, biomass, fusion, fission, offshore drilling, solar—by the year 2000, the U.S. will still have to run just to walk with regard to its domestic energy needs." This makes foreign policy, he said, the most important energy issue for the decade ahead.

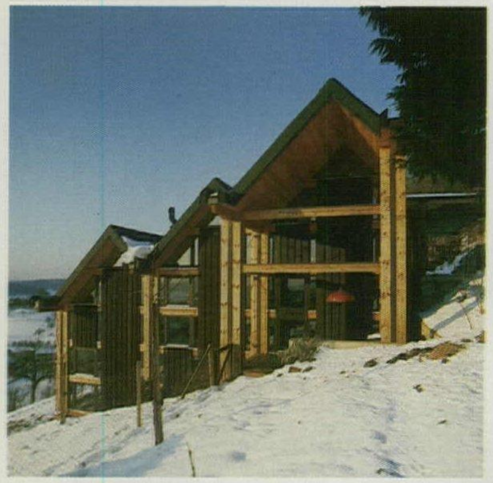
Indeed, in the Washington world of contracting and consulting, many will likely move from "energy systems" to "defense systems" (whence many came nearly a decade ago), following the movement of Federal budget dollars. But for those whose commitments run deeper and whose livelihoods are not so directly tied to government spending patterns, the test will have a different character.

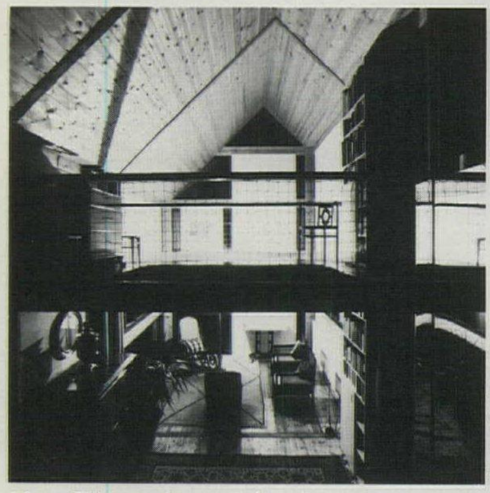
For architects, contractors, and their clients, it will involve a winnowing of energy-conserving design concepts to retain those that have met the test of marketability. In 1976, a Massachusetts builder of solar collectors for domestic hot water systems was asked what his company was doing to improve its position in the marketplace. "Waiting for OPEC," was his simple reply. With decontrol of domestic oil upon us and the specter of gas decontrol not far behind, it would seem that the wait is over. [Thomas Vonier]

*Thomas Vonier is an architect, president of Thomas Vonier Associates, Inc., Washington, DC. He is a member of the AIA National Energy Committee, and follows technical and policy developments that influence the building industry.*

**News report** continued from page 31

# Report from Switzerland





*Heer-Pirinen house (above).*

## Heavenly views, earthly heat

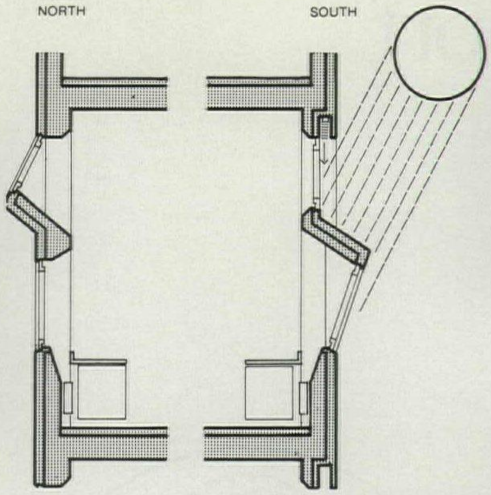
When Anja Heer Pirinen, Finnish-born Swiss-trained architect, planned her family's house high on a slope between Basel and Zurich—complete with an indoor heated swimming pool and a large sauna with magnificent mountain views—she had several goals in mind. She wanted to create an Alpine image with peaked forms expressed both inside and out, achieving the contrast of soaring heights and intimate spaces while meeting stringent local building height regulations. She also wished to develop a repetitive yet flexible building detail system. And she planned to incorporate a solar heating system appropriate to a cold climate.

The 2500-sq-ft house built in 1977 has several costly items: the pool and sauna; many small, double-glazed windows; and pine wood imported from Finland for large structural members and for paneling. Still, by keeping details simple and wood finishes rough, the building costs were 10 percent lower than the average in the neighborhood.

Mrs. Heer-Pirinen rejected the more conventional glass solar roof panels because of their dependence on temperatures higher than those prevalent in the area. Instead she turned to a system which, while collecting some heat on the south-facing roofs (in a water and antifreeze mixture circulating through 3500 ft of half-inch diameter polyethylene tubes), also collects natural heat in similar tubes buried four feet below the ground, distributed in a 3000-sq-ft area in front of the house. The basement heat pump uses pressurized Freon to transfer the heat of the collectors' liquid to the water circulation system, and electronic steering controls regulate the process. When the pump has sufficient heat and the temperature in the roof collector is more than 12 F hotter than that in the earth, the earth collector serves as a reservoir for the roof's heat. The traditional backup heating system has never been needed.

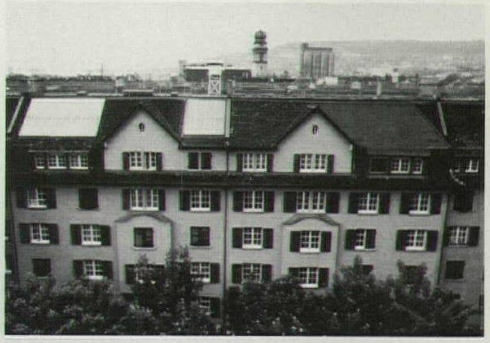
The house has 4 in. of glass wool insulation under its corrugated asbestos roof and behind its wood-clad walls, whose dark-stained color allows heat to collect on sunny days. In 1979, heating costs (electricity to run the heat pump and circulate the water) were under half those estimated for an oil-fueled system, and oil prices are rising rapidly.

Still, there are flaws that the architect plans to correct. She will add a greenhouse to provide an insulating buffer zone along the large living room windows. She will add more insulation. And she seeks a more extensive heat reservoir method (possibly using the pool), since the present system cannot wait to take advantage of nighttime electricity rates, 60 percent lower than daytime prices. She also has energy experiments in mind for future projects: to employ a central wood-burning heater within a double-walled brick chamber, as in traditional rural buildings in Finland; and to recycle heat from household wastes.




Thomas Ledergerber

*PLENAR's Laboratory (above).*



*PLENAR's housing retrofit (above).*

## PLENAR: far-reaching commitment to energy

Plenar (planning/energy/architecture) is a loose association of several independent architects who gather in Zurich to plan energy strategies, develop studies, and design and build energy-saving projects. Since 1972, its size has grown and its experience broadened. Its members investigate possibilities at every scale: from nationwide resource distribution strategies to the development of a superinsulated window, they leave no energy stone unturned.

All energy-producing fuels in Switzerland must be imported, and Plenar feels that the distribution of traditional sources—predominantly oil, but also gas and coal—can be optimized; nuclear solutions may be avoided. It has researched the recycling of waste heat on a national level. It has set up regional pilot projects, for example near Zurich, to define the ecological balance and to conserve energy by improving its distribution and its production technology.

*PLENAR's Turtle housing (above).*

Plenar also looks for methods to motivate individuals to save energy. Mistrustful of the efficacy of laws that must be enforced, it seeks hard-nosed market-wise solutions.

Switzerland's extensive building stock is old but extremely durable, and Plenar looks for ways to retrofit the rather inflexible stone and brick structures to make them more energy efficient.

Its architectural projects do not rely on formal gymnastics to draw attention to their energy-saving nature. Those illustrated below—a retrofit development, a partial retrofit, and a new housing group—are all low-keyed.

**Laboratory building in Zurich**
The working drawings were already complete when Plenar members Peter Steiger and Hans Hauri were enlisted to improve the energy-consuming strategy of this 2500-sq-ft building, which was to be constructed, despite its heat-generating function, without air conditioning. They had 1½ ft of façade depth to work with, and they devised a corrugated surface that maximizes light on the north side and provides shade on the south, with double-glazed tinted insulating windows, and sun louvers where necessary.

Above-grade rooms are naturally ventilated, except for hoods at individual lab stations. The cooling of the building depends upon the configuration of the exterior walls, which reduces the action of the sun on the considerable internal thermal mass in summer months. At a later stage, water pipes that run through the building will be hooked onto a waste-water heat recovery heat pump, whose function will be extended to cool the laboratories. Heating is achieved by under-window radiators with sophisticated controls, connected to the central university heating plant, and water is heated in a basement boiler, in part by the central oil-fired plant and in part by solar collectors on the laboratory roof.

Plenar has monitored the energy efficiency of the building since its completion in 1978 and has found the façades operating as expected.

**Housing retrofit in Zurich**
In 1908, the City of Zurich commissioned a prominent architect to design housing to upgrade the Limmatstrasse area, a central but decay-prone neighborhood behind Zurich's main railway station. In the 1970s, the process was repeated, as 250 of these units (slated for demolition in the 1960s) were rehabilitated to spark the revival of the area.

Architects Bolliger Hönger Dubach & Hertig Hertig Schoch designed the conversion, which was completed in 1979. Plenar's Conrad U. Brunner directed the energy planning in a process which was as much social, in its involvement of community input, as technological.

The apartments, in 25 row houses built around attractive courts, were treated in various ways. All of them were provided with bathrooms; their shuttered windows were triple glazed; they were insulated; staircases were brought up to fire code standards; and they were centrally heated.

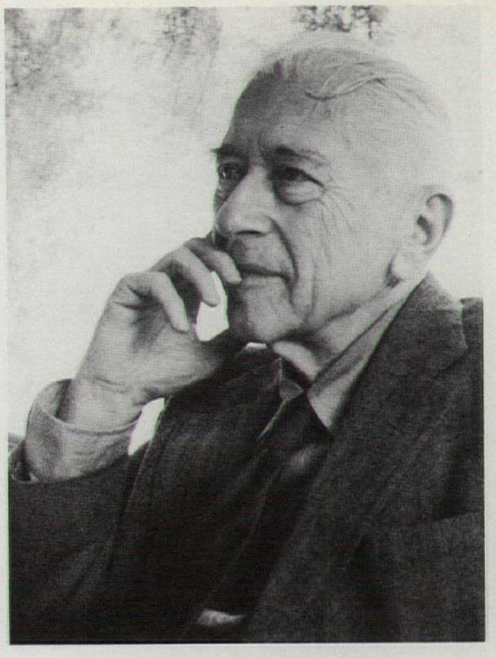
Three of the 25 houses, "super-energy houses," were treated as energy experiments. They have low-temperature roof solar panels energizing a heat pump that incorporates heat recovery. This heating system is backed up by a gas-fired one. The most dramatic features are individual home computers, by which the residents can monitor the temperature in each room, thereby optimizing energy use and minimizing expenditure. Brunner claims that the consoles are easily affordable. Operating costs are negligible.

Tenants in the experimental units were carefully selected, but otherwise resident relocation was minimal.

**Turtle houses near Zurich**
These three houses (two grouped together and one apart) are known affectionately in the area as the "turtles": hard shells, minimum surfaces. They also resemble traditional Swiss farmhouses, and this was Plenar architect Conrad Brunner's intention. The stuccoed brick cavity wall and the tiled roof are more energy-wise than the "modern" Swiss houses of the past 20 years; the 36-degree roof slope is ideal for shedding snow and absorbing winter sun rays.

Solar heat is collected at the relatively low Swiss temperatures in tubes running under the roof tiles and under the south-facing ground in front of the building. A wood oven also provides heat. Heat is circulated through the houses, not by convection, but by radiation: hot water tubes pass through the hollow tile floor slabs, so that the surface temperature is warmer than the air. With this system, an air temperature of 66 F feels 5 degrees warmer if the humidity is quite high, claims Brunner, who lives in one of the houses.

Buffer zones are located on the north side, in the basement, and beneath the roof to moderate the extremes of temperature. All windows are triple glazed, and major windows face south.
[Susan Doubilet]



## Breuer wins AIA Education Award

Marcel Lajos Breuer, FAIA, a former master at the Bauhaus and associate professor at the Harvard Graduate School of Design, was selected by the American Institute of Architects and the Association of Collegiate Schools of Architecture to receive their sixth annual Award for Excellence in Architectural Education. The award was presented on March 24, during the ACSA annual meeting in Monterey, Ca.

Born in 1902 in Hungary and educated at the Bauhaus, Breuer was a partner in Walter Gropius's firm in Cambridge, Ma, from 1937, and opened his own office in New York in 1946. As an associate professor at Harvard, he taught I.M. Pei, John M. Johansen, Paul Rudolph, and Philip Johnson, among very many others.

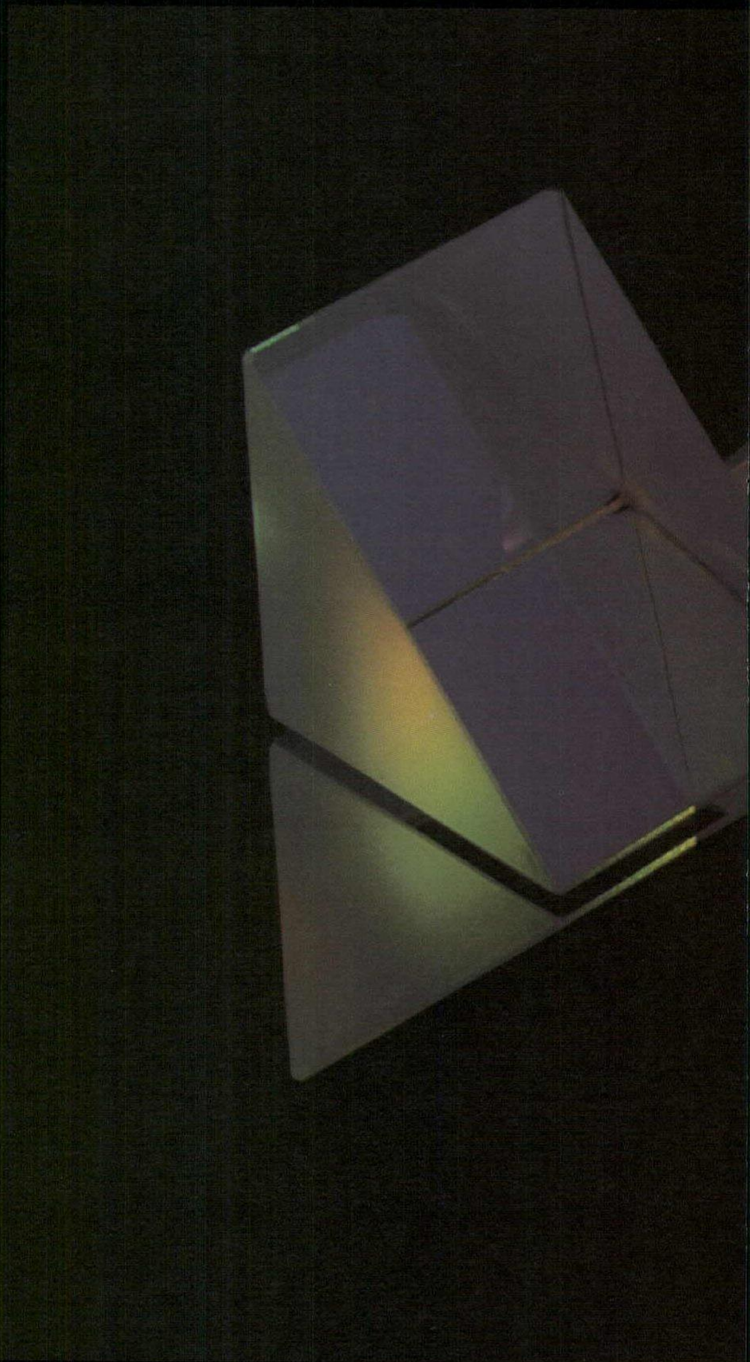
Breuer received the AIA's Gold Medal in 1968, and the French Académie d'Architecture's gold medal in 1978. He was presented with AIA Honor Awards for the Whitney Museum, New York; the Koerfer House in Lago Maggiore, Switzerland; and the St. Francis de Salles Church in Muskegon, Mi. He won the New York Chapter/AIA's Medal of Honor in 1965.

Other American and European works include the St. John's Benedictine Abbey at St. John's University, Collegeville, Mn; UNESCO headquarters, Paris; U.S. Department of Housing and Urban Development building, Washington, DC; and the U.S. Embassy, The Hague.

Marcel Breuer has made outstanding contributions in architecture and in furniture design, but the role he has played in architectural education is also monumental, and the present award recognizes this.

[*News report continued on page 36*]

## “LIGHT IS ENERGY, NOW, MORE THAN EVER, HOLOPHANE



Nowadays, it seems that everyone is talking about things like energy efficiency and planned environments.

We at Holophane are pleased to see this development. In fact, we think it's long overdue. Because we've been designing luminaires and entire lighting systems with those points in mind for years.

Our philosophy has always been that the key to efficient and effective lighting is *precise control*—putting the light exactly where it's needed; keeping it away from areas where it is wasted or unwanted.

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To achieve this end, we've led the way in developing optical technology that shapes light distribution patterns with precise control. Prismatic refractors of glass and plastic. Reflectors of carefully defined curvatures and finish.

The payoff is greater energy efficiency, and a better work or play environment. To put it simply, Holophane luminaires work better because they're designed and built better.

*Holophane Refractive Grid™ injection-molded acrylic lenses for fluorescent lighting use a precise array of hemispherical elements to eliminate glare (high-angle brightness) and to direct light to where it is most needed.*

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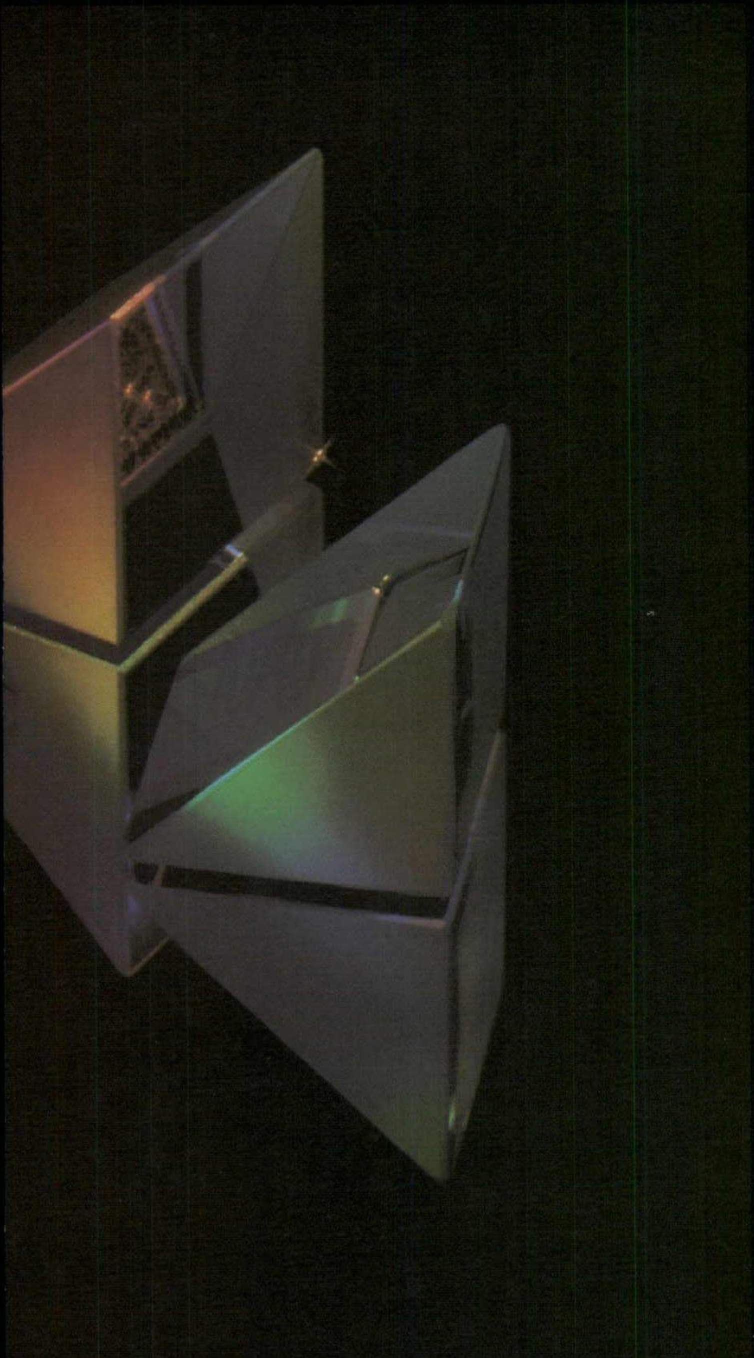

*Holophane Outdoor Lighting Fixtures combine energy efficiency with architectural appeal. Our Caribe Series offers a wide choice of styles and precise light distribution patterns.*

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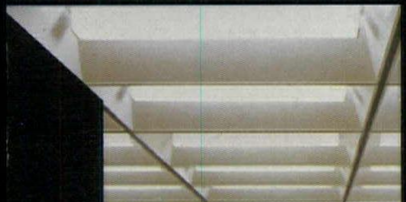
Jim Burke.



*Holophane Interior Lighting Systems combine three functions to let you design an energy-efficient interior environment where light, acoustics and conditioned air are all precisely controlled.*

**“HOLOPHANE. LEADER IN LIGHT CONTROL.”**

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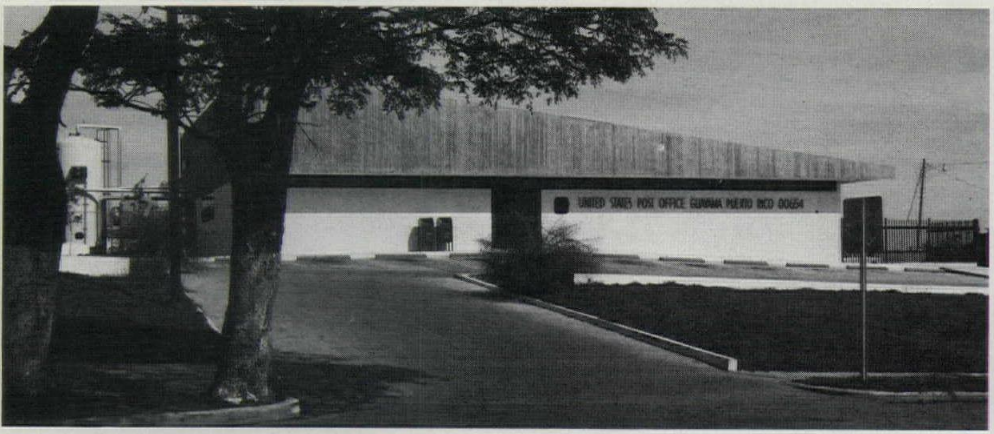

Pedro Martinez

*Puerto Rico Postal Service facility.*

## Solar air conditioning shapes island post office

The ideal angle for collection of solar energy during the warmest months in Puerto Rico has determined the geometry of this post office in Guayama, designed by architect Jorge Del Rio. Designated as an experimental facility by the U.S. Postal Service (see also pp. 122–125), this small structure was intended to demonstrate a solar air-conditioning application.

Given the nearly overhead position of the sun at the latitude of Guayama (about 18 degrees north), the collectors and the roof that supports them have been angled at 6½ degrees from the horizontal, producing an acutely angular roof form. Projecting to form protective overhangs on three sides, the roof floats above the simple rectangular volume required by the client's program. Walls and roof of the concrete and steel structure are heavily insulated, windows kept to a minimum, and all exterior surfaces except the collectors themselves painted white to minimize heat gain.

Air conditioning is provided by an absorption chiller, using hot water from the collectors. Mechanical equipment is separated into two areas: the more sophisticated equipment in an indoor mechanical room; the cooling tower, the huge hot water storage tank, and the electrical substation are frankly exposed outside it, connected by reflective insulated pipes and tubes.

Completed in mid-1980, the project was a winner in the 1980 honor awards program of the Puerto Rico Chapter, AIA. The jury cited its simple, austere response to a technically innovative program and a strict budget.

## Fantasy In Architecture

"Making Dreams Come True: Design in Aid of Fantasy," was the title of this year's conference sponsored by the San Francisco Center for Architecture and Urban Studies and held in San Francisco, Feb. 4–7. The intent of the conference was to reverse the usual pattern of exploring ways in which fantasy enriches design and, instead, to inquire how deliberate design processes may serve the cause of fantasy.

Most of the papers presented dealt with pop architecture, suggesting that architects generally do not consider fantasy a valid goal of design. In part this attitude reflects that of establishment clients who want their buildings to exist in the real world—whatever that is—and in part it recognizes the association of fantasy with leisure as epitomized in resort and theme park design. Wayne Attoe, conference organizer, demonstrated the latter in his introductory paper, "Motives for Treating Towns as Toys."

The projection of the realm of fantasy into everyday life was discussed by Mary Ellen Young and Robert Beckley of the University of Wisconsin in talks titled "Buildings in Popular Fiction" and "Mobile Dreams." The problem of incorporating fantasy into home settings was taken up by Elizabeth C. Romley, SUNY-Buffalo, in "Modernizing," and in "Dunroamin: Suburban Fantasies" by Paul Oliver, Oxford Polytechnic. Anne Schubert's "Humor in Architecture" and Dennis Mann's "Quality in Pop Architectural Dreams" probed the process of promoting fantasy through design.

Wit in buildings is complicated by questions of interpretation. Is it wit . . . or is it kitsch? And who cares? Reyner Banham cares and said so, in a paper that showed fantasy to be an element generated by a highly rational process. This process, he said, finds its most refined expression in structures that employ high tech to produce, for instance, weightless transparency or fantastic scale; Post-Modern efforts, on the other hand, are "quotations glued together in the service of fancy, not fantasy."

Two practitioners, Charles Moore and Ricardo Legorreta, take the creation of fantasy very seriously and have work to prove it. They provided the most convincing evidence that fantasy is worth doing; unfortunately, they did not make clear how to do it well.

Fantasy is capable of pervading our view of the world so thoroughly that we no longer recognize it as such, according to talks by historians Sally Woodbridge

[*News report continued on page 38*]

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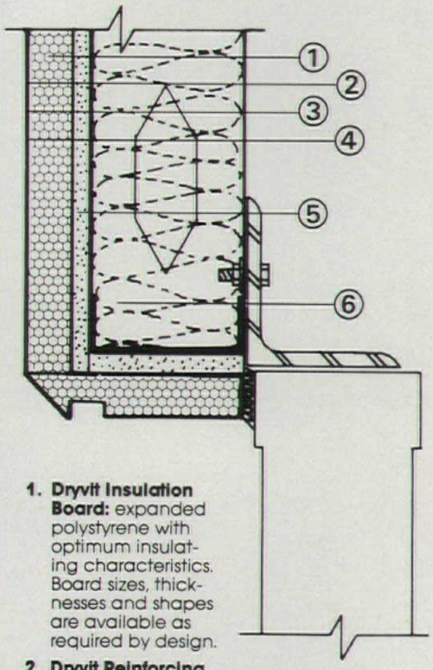


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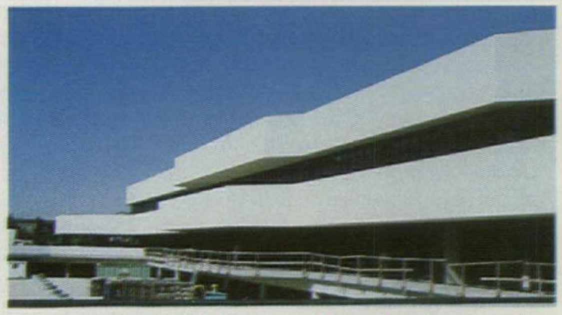

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**News report** continued from page 36

and J.B. Jackson. And Thomas Beeby's paper on F.L. Wright and the "Imagery of Taliesin" revealed sources of fantasy in design.

The 14 papers delivered in afternoon and evening sessions were interspersed with discussion periods moderated by Attoe and Donlyn Lyndon. A symposium on theory and applications of design and fantasy involved Jean-Paul Bourdier, Oklahoma University; Frances Downing, SUNY-Buffalo; Jusuck Kôh, University of Georgia; Lawrence Speck, University of Texas; Peter Schneider, Louisiana Tech; and Eleanor Weinel, Pittsburgh. The conference closed with a masterful "Critique of the Conference Proceedings," by Juan Pablo Bonta, University of Maryland.

For Attoe, who teaches part time at the University of Wisconsin, Milwaukee, this was the fifth in a series of conferences on provocative subjects. The pace-setting nature of the conferences —on criticism in architecture, on borrowings and lendings (architectural and otherwise)—as well as their small size (up to 100 participants), and their generous discussion periods, has produced successful events. Confident of the future, Attoe has projected another conference for February 1982 . . . this time, on "Taste." [Sally Woodbridge]

## Houses for Sale, German style

The Karlsruhe faction is one of the most active among present-day groups of the German Werkbund, the union of architects, craftsmen, and philosophers which was founded in 1907 (and sponsored, among many other projects, the 1927 Weissenhof Housing Exhibit in Stuttgart). In 1979 its members devised a plan to develop an inner-city plot of land, with 12 architects working individually yet in coordination to produce 12 marketable townhouses.

Karlsruhe, the model town with a fan-shaped plan radiating from an 18th-Century Classical "French" castle, was bombarded during World War II and further ravaged, just beyond its core, by urban renewal fever in the following years. Luckily, the city is lavishing care on the replacements, hiring sensitive architects, and in the case of the Werkbund project, cooperating fully.

The city agreed to provide the Werkbund architects with a piece of land in a residential inner-city neighborhood developed in the early 1900s. After the designs were prepared, the city publicized them. They are now being offered for sale (2000–2500-sq-ft townhouses on 1500–2500-sq-ft lots) for 400,000 Marks each, a reasonable price by German standards. As each is sold, it will be built. The publicity brochures were distributed in January, and three were bought immediately.

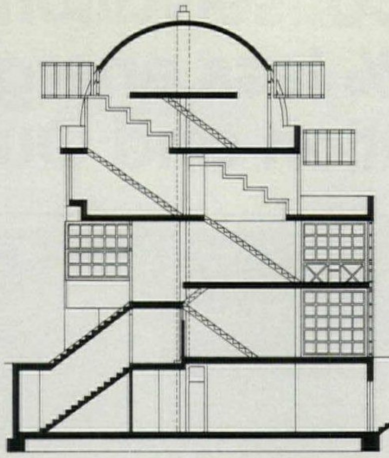
The Werkbund experiment was based on several premises. The architects felt that a more interesting series of houses would result from the separate but coordinated input of 12 designers (or design groups), rather than the proposal of a single one. They wanted to work together not in competition, but to learn from one another.

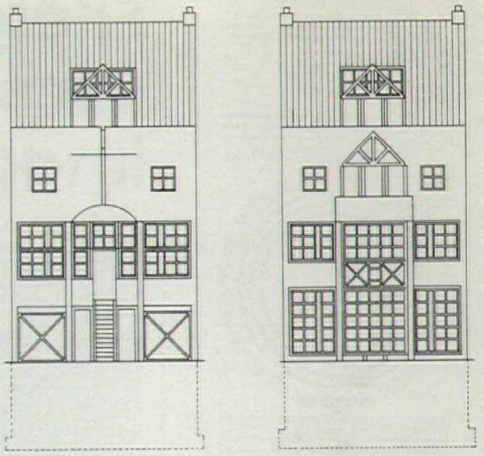
The group laid out guidelines for size, height, and formal configuration—organization of the entry, relationship to symmetry, roof line, roof form, and roof openings. Each member then designed two or three alternatives, for a corner lot, an intermediate lot, and an end position. The group assembled to select the optimum combination, and each architect went on to develop his or her own design.

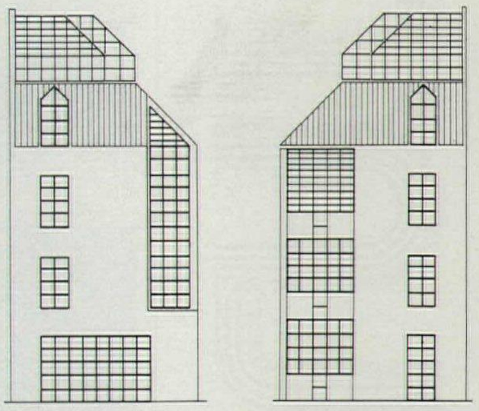
Some of the townhouses are excellent. Christoph Sattler (who designed one of the finest new housing projects in Karlsruhe's Old Town) has produced a very controlled house with a tight arrangement of industrial windows. Heinz Mohl (P/A, Sept. 1980), who is currently building a bank headquarters on the most sensitive site in Karlsruhe—the inner circle facing the castle—and who recently won the commission for an addition to the Art Museum, has designed a clever and intricate vaulted stairhouse. Georg Kasimir and Gerd Gassmann have designed an amusing corner-lot house. And Vladimir Nikolic (see p. 150) proposes a passive energy house for the end lot.

One interesting outcome of the process is the proof that even the weakest designs need not weaken the totality. Group suggestions improved every design, and while some are kitsch and some are awkward, their subordination to a few sensible guidelines makes them all decent neighbors. [Susan Doubilet]

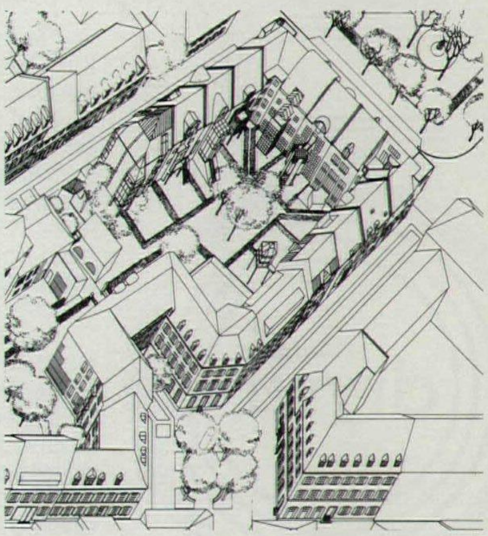
[*News report continued on page 42*]

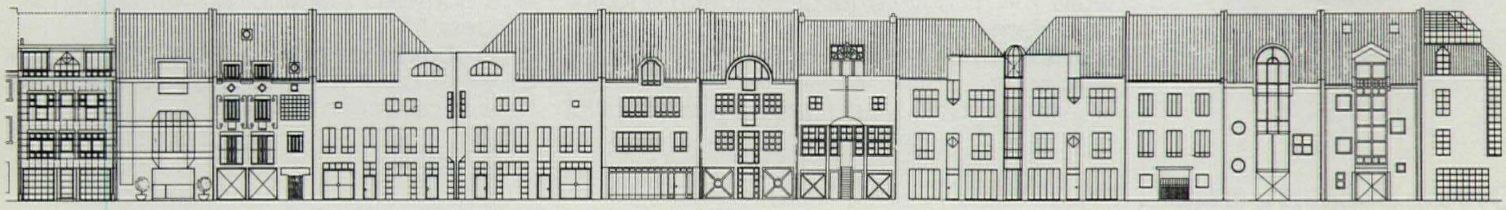


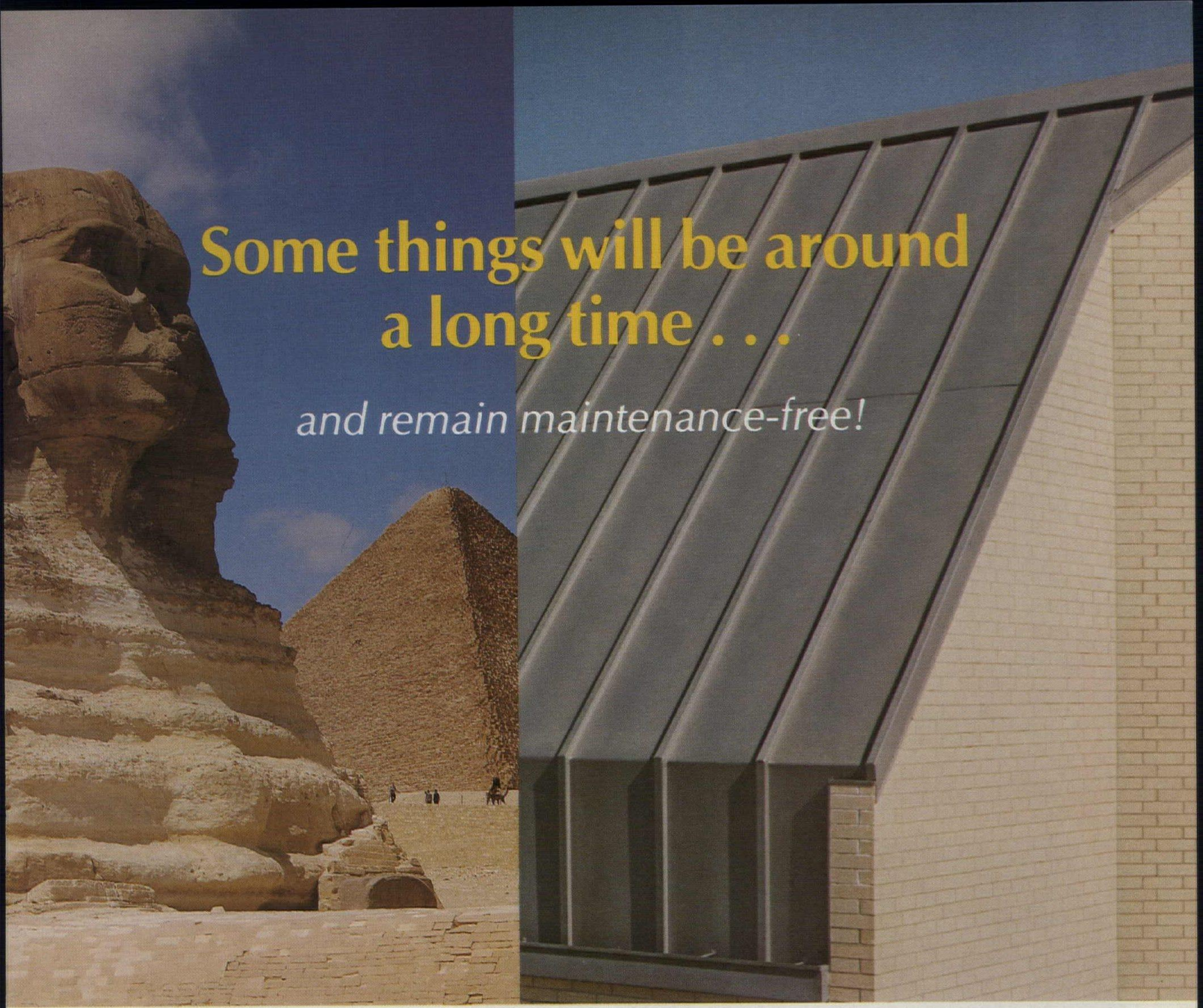




*Mohl's staircase house (top). Nikolic's energy-wise house (above). Three views of ensemble (below).*





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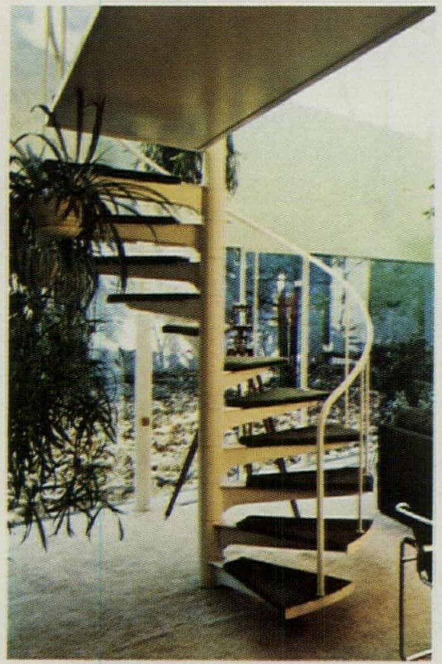

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**News report** continued from page 38

## Calendar

### Exhibitions

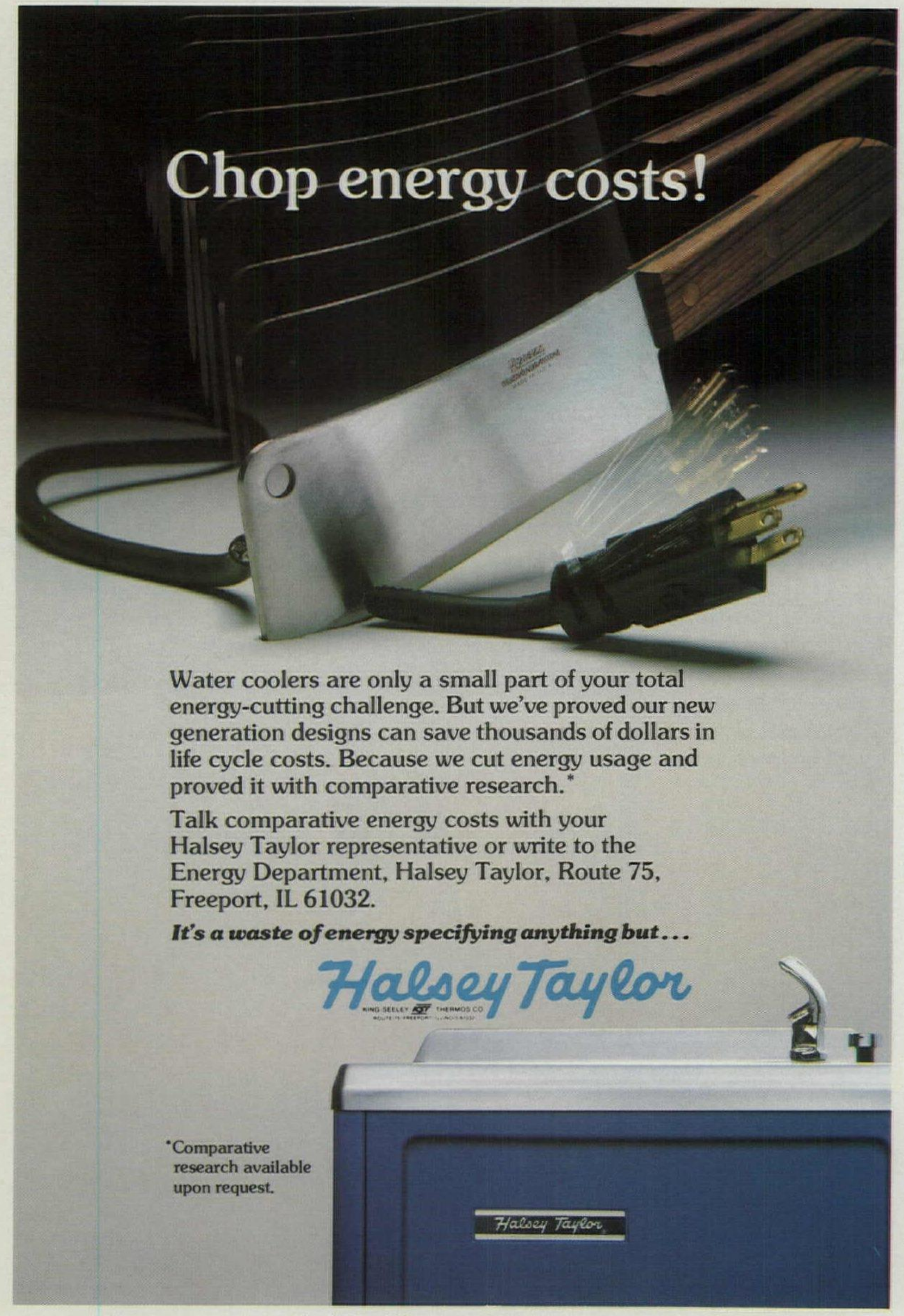
**Through Apr. 22.** Exhibition of 52 watercolors by members of the AIA. The Octagon, Washington, DC.
**Through Apr. 23.** Architectural Drawings from the Cincinnati Historical Society. Gallery at the Old Post Office, Dayton, Oh.
**Through Apr. 26.** Expressionism: A German Intuition, 1905–1920. San Francisco Museum of Modern Art.
**Through Apr. 26.** Function: Contemporary Viewpoints. The Fawick Gallery, Baldwin Wallace College, Berea, Oh.
**Through May 2.** Buckminster Fuller —A Retrospective Exhibition. Getler/Pall, 50 W. 57 St., New York.
**Through May 2.** Romaldo Giurgola projects; Scott Burton furniture. Max Protetch Gallery, New York.
**Through May 10.** Innovative Furniture including pieces by Thonet, Belter, Eames, Josef Hoffman, and Frank Lloyd Wright. Cooper-Hewitt Museum, New York.
**Through May 24.** John Henry Belter and the Rococo Revival, an exhibition of ornately laminated Victorian pieces. Cooper-Hewitt Museum, New York.
**Through May 31.** Architecture in Context—360 Michigan Avenue. Corridor Gallery, The Art Institute of Chicago.
**Through June 7.** Collaboration: Artists and Architects. New York Historical Society, New York.
**Through June 28.** Solar Age Architecture. Natural Sciences Special Gallery, Oakland Museum, Oakland, Ca. Contact (415) 273-3005.
**Through July 31.** P.B. Wight: Architect, Contractor, and Critic, 1838–1925. Burnham Gallery of Architecture, The Art Institute of Chicago.
**Apr. 12–May 31.** Late Entries to the Chicago Tribune Tower Competition. Walker Art Center, Minneapolis, Mn.
**Apr. 28–May 21.** Alvar Aalto—photographs of major designs. Gallery at the Old Post Office, Dayton, Oh.
**May 15–June 28.** Architect's Furniture. Hayden Gallery and Hayden Corridor Gallery, MIT, Cambridge, Ma.

### Competitions

**Apr. 28.** Registration deadline for Eagleridge resort community national design competition. Sponsored by Caltennco Colorado, Inc. Contact the AIA Research Corp., 1735 New York Ave., NW, Washington, DC 20006 (202) 626-7500.
**Apr. 30.** Submission deadline, Women in Design International Competition. WID International, 530 Howard St., San Francisco, Ca 94105.
**May 1.** Submission deadline for California Affordable Housing Competition. Contact California Affordable Housing Competition, Office of Appropriate Technology, 1530 Tenth St., Sacramento, Ca 95814.
**May 19.** Submission deadline for DESIGN + ENERGY student competition. The Association of Collegiate Schools of Architecture, 1735 New York Ave. NW, Washington, DC 20006.
**May 22.** Application deadline for Building Value into Housing Grant Program. HUD, 451 Seventh St., SW, Washington, DC 20410.
**May 29.** Entry deadline for Arizona Passive Solar Design Competition. Arizona AIA, 1121 N. 2nd St., Phoenix, Az 85004.
**June 12.** Application deadline for Red Cedar Shingle & Handsplit Shake Bureau/AIA Awards Program. Contact the Bureau at 515 116 Ave., NE, Bellevue, Wa 98004 (206) 453-1323.

### Conferences, seminars

**Apr. 10–11.** Preservation Alumni annual convocation, Columbia University. Open to public. Write: Preservation Alumni, Fayerweather Hall, Columbia University, New York 10027.
**April 23–24.** Passive Solar Workshop, Denver, Co. Contact Passive Solar Associates, P.O. Box 6023, Santa Fe, NM 87501.
**Apr. 23–25.** Energy 81. School of Architecture and Urban Planning, Englemann Hall, University of Wisconsin-Milwaukee campus.
**Apr. 24–25.** The Design and Analysis of Earth Integrated/Solar Buildings seminar. Arlington, Tx. Contact: Judy Proppe, Architectural Extension, Oklahoma State University, 115 Architecture Building, Stillwater, Ok 74078.
**Apr. 27–29.** Introduction to Plastics Seminar. Valley Forge Hilton/King of Prussia, Philadelphia, Pa. Contact (617) 749-1003.
**May 14–15.** Design for Moving People conference. Biltmore Hotel, New York.
[*News report continued on page 46*]



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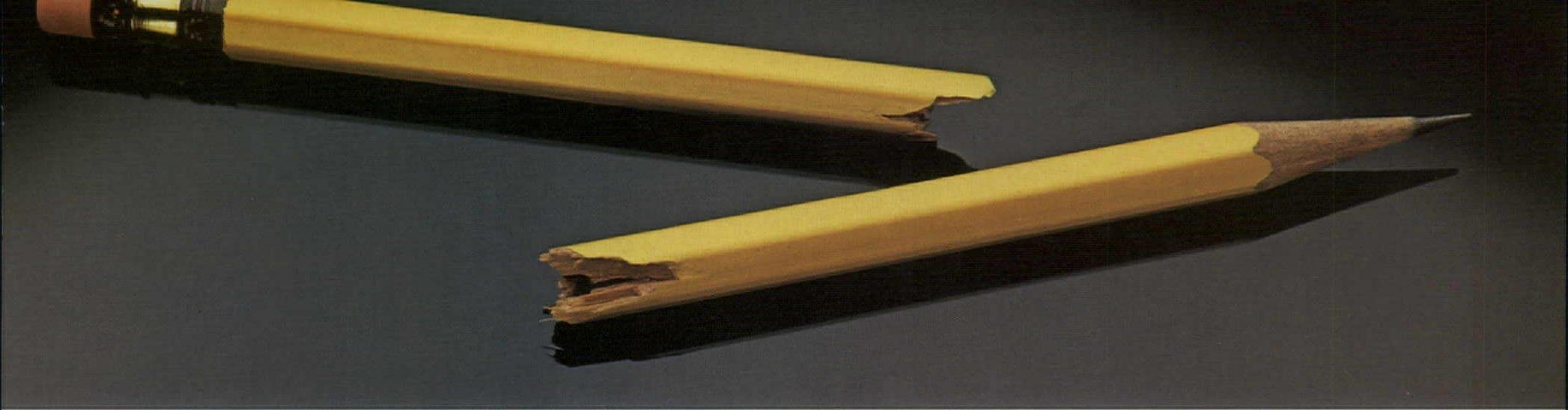


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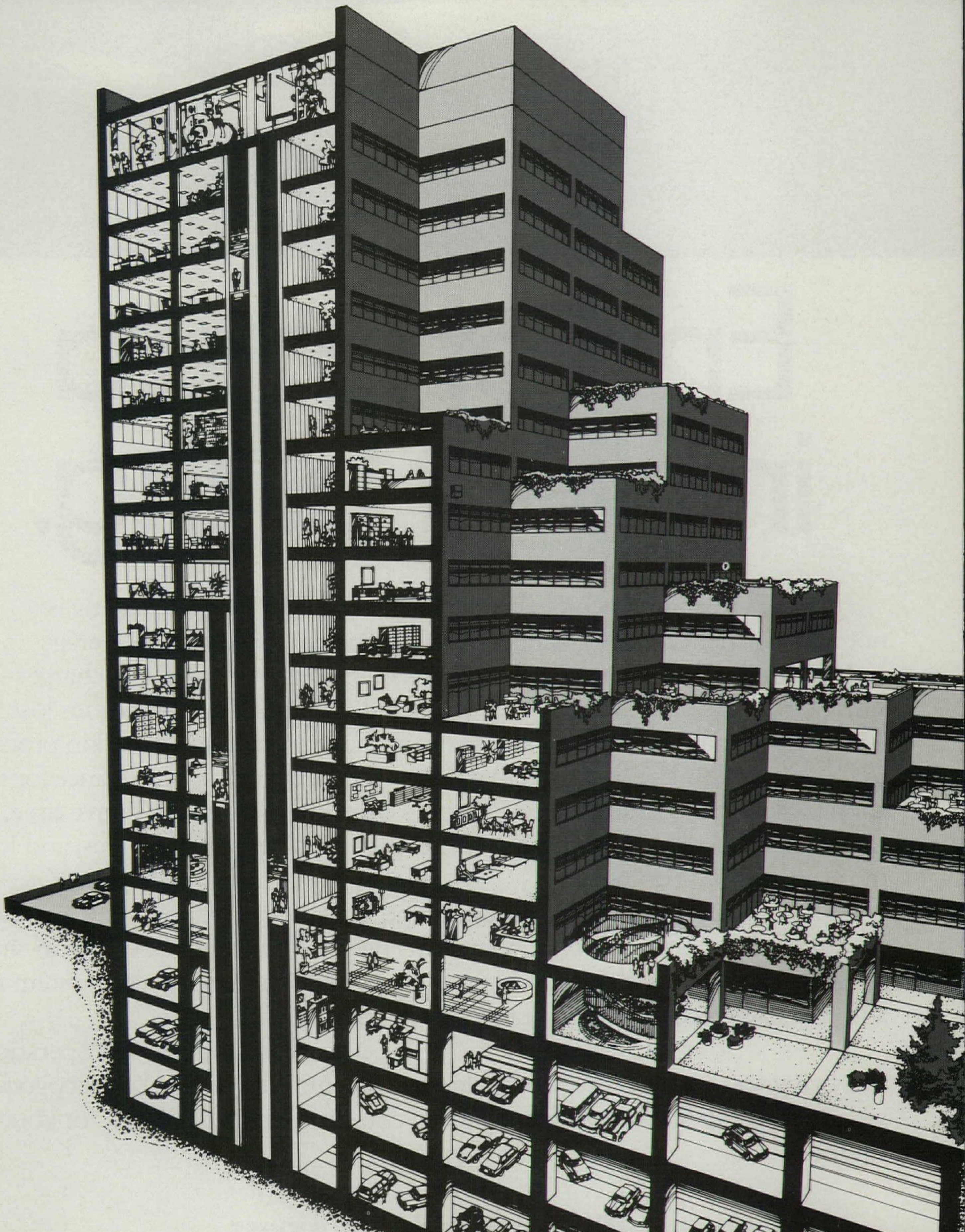

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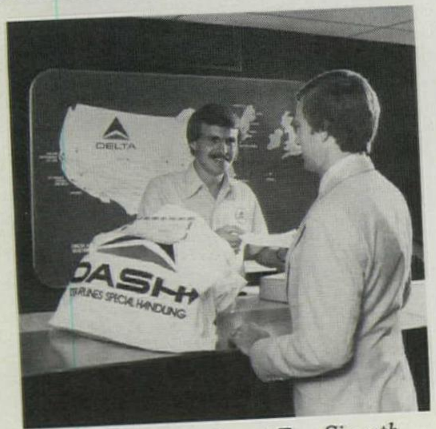


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**News report** continued from page 42

Contact: Helene Overly, Conference Coordinator, Public Technology, Inc., 1301 Pennsylvania Avenue, NW, Washington, DC 20004.

**May 17–22.** AIA Annual Convention. Minneapolis.

**May 25–26.** Energy and Big Buildings. University of Pennsylvania, Philadelphia. Contact M.A.S.E.A., 2233 Gray's Ferry Ave., Philadelphia, Pa 19146 (215) 545-2150.

**May 26–30.** Solar Rising, American Section of the International Solar Energy Society conference, Philadelphia Civic Center. Contact Richard Ross, Bennett Hall, University of Pennsylvania, 3440 Walnut St., Philadelphia, Pa 19104 (215) 243-3211.

**May 27–28.** The Economic Impact of the Arts. Cornell University Graduate School of Business & Public Administration, Ithaca, NY. Contact Jane Cohn (212) 977-9400.

**June 4–5.** Systems '81 International Conference on Production and Management in A/E Firms. Hyatt House at L.A. Airport. Contact George S. Borkovich, P.O. Box 11316, Newington, Ct 06111.

**June 8–10.** Underground Space Conference and Exposition, Kansas City. Contact Ruth Sime, American Underground-Space Association, c/o Suite 900, Minnesota Building, St. Paul, Mn 55101.

**June 14–19.** 31st International Design Conference in Aspen, Co. Contact Pam Arnold, IDCA Office, Box 664, Aspen, Co 81612.

**June 16–19.** NEOCON 13. The Merchandise Mart, Chicago.

**June 22–24.** Construction Specifications Institute, St. Louis, Mo. Contact E.M. Dutchak (202) 833-2160.

**June 25–27.** Eighth Annual National Back-to-the-City Conference. University of Wisconsin-Milwaukee. Contact Bruce M. Kriviskey, AICP, University of Wisconsin-Milwaukee School of Architecture and Urban Planning, P.O. Box 413, Milwaukee, Wi 53201.

## Columbia Architecture School celebrates centennial

Columbia University's Architecture School began as a division of the School of Mines in 1881, and is one of the oldest university-level architectural institutes in America. (MIT's is the oldest: it dates from 1865.) To celebrate the Centennial, Columbia is publishing a book and mounting an exhibition (at the National Academy of Design, New York, beginning in December) which will trace the work done by students at the School and by graduates, many of whom went on to achieve distinction and influence.

Richard Oliver, at the Graduate School of Architecture and Planning, Columbia University, New York, is requesting all relevant material.

[*News report continued on page 51*]


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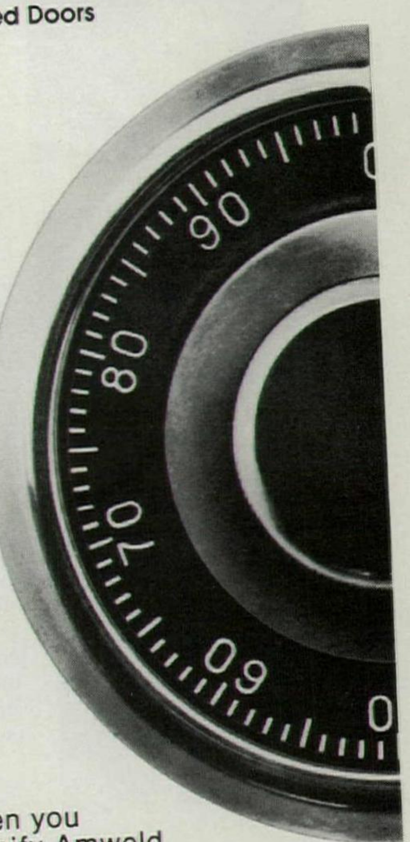


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Magnification 250X of Antron® III nylon showing hollow filaments and round, anti-static filament.

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*Du Pont registered trademark for nylon fiber. Du Pont makes fibers, not carpets.

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Thermospan represents a bold, new approach to insulated sectional overhead doors. This nominal 2″ thick door has a remarkable tested U-value of .11 and is stronger and easier to install than any other sectional overhead door available today.

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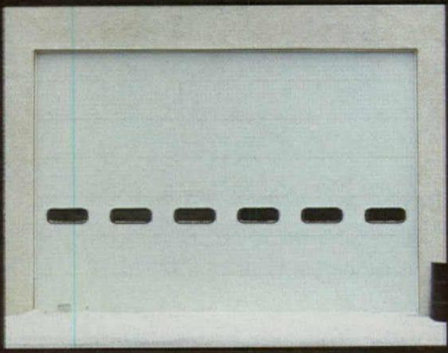

Integral horizontal ribs are built into the inner skin, resulting in exceptional strength to weight characteristics allowing extra wide widths. These ribs also control movement that occurs with any thermally efficient building product.

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Because the outer surface on a conventional door wraps around and becomes a part of the inner door surface, the inside skin assumes the temperature of the outside skin, greatly reducing the effectiveness of the insulating material. That's why the tested U-values for conventional insulated doors range between .33 and .51.

Thermospan features a thermal break within a homogeneous sandwich of steel/polyurethane/steel. This combined with a total system of factory installed joint and perimeter seals results in an independently tested U-value three times better than conventional doors.

### A total insulating system

Efficient, insulating components working together are the key to Thermospan's success. Added to the insulating core, thermal break, and seals, are factory installed, double-glazed acrylic lites to complete the thermally efficient Thermospan system.

If you would like more information on Thermospan, contact Bob Carlson at Dalton International, Inc., U.S. Route 30, West, Dalton, Ohio 44618, (216) 828-2291.


**Dalton**

DALTON INTERNATIONAL INC.

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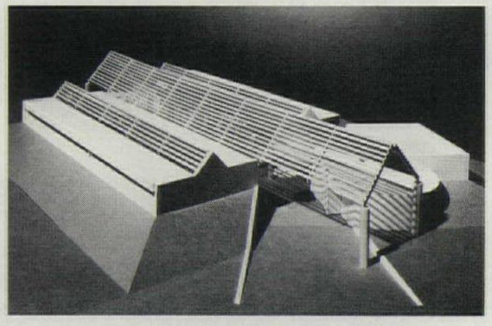
**News report** continued from page 46

# In progress



**Energy Showcase Program Headquarters, Sacramento, Ca.** *Architects: SOL-ARC, Berkeley, Ca.* The Energy Showcase Program, sponsored by the Department of Defense and the Department of Energy, is to have a new headquarters building just outside the main entrance of the McClellan Air Force Base near Sacramento. The 7600-sq-ft structure uses a display gallery as a circulation spine to link a small auditorium, engineering and graphics staff areas, a library, and a computer terminal area. Visitors interested in the energy-saving technologies on the base will come here first to see an audiovisual presentation in the auditorium. Then, after viewing exhibits set up in the gallery, they will tour the actual installations in electric vans provided by the facility.

Since the building itself is a showcase for energy-saving strategies, its designers explored the application of passive and hybrid technologies to every area of consumption. Because of a demanding summer climate, the energy load for cooling is three times that for heating. The contribution of artificial lighting is also significant for a facility of this kind. Instead of mechanical chillers, steel tubes 2 ft in diameter by 10 ft high store water that is cooled at night by a rooftop evaporative cooler. In winter, the tubes store heat from direct gain.

Buried beneath earth berms that protect the walls from external temperatures are ducts or earth tubes that draw in outside air. In summer, cool night air is pulled up through the structure by exhaust fans located at either end of the gallery roof. The same ventilating action occurs during the day, when warm air is precooled by its passage through the earth tubes. In winter, the air warmed by the sun's heat is circulated by the fans.

Concrete block walls are insulated on the outside and stuccoed where exposed. Insulation in the form of concrete over steel roof decking reduces interior temperature fluctuation. Exposed on the inside, the decking serves as radiant thermal storage.

Three skylight monitors shaded by computer-controlled louvers define the east-west axis of the buildings. The louvers allow sunlight to enter on winter days but close at night to insulate the skylights from heat loss. In summer, the louvers block the entry of direct sun rays but admit reflected light. An interior photocell measures the natural light, closing the louvers if light levels are excessive. Automatic dimming in response to available daylight almost eliminates the need for artificial light.

As an educational tool the Energy Showcase Building will communicate its various messages easily to even the most uninformed visitor. Furthermore, the very composition of the structure—louvered monitors, bermed walls, daylit gallery, and steel columns that register temperature changes—express the interaction of the man-made and the natural environment.
[Sally Woodbridge]

**The Golden Gate Energy Center, Fort Cronkhite, Ca.** *Architects: Stoller/Partners, Berkeley, Ca.* The Golden Gate Energy Center, a private, tax-exempt organization dedicated to fostering technical development and public acceptance of energy-saving technologies, has found a new Pacific Coast home in the Golden Gate National Recreation Area. Located at Fort Cronkhite on the shore of the Marin headlands, the Center will occupy 12 historic World War II barracks and support structures to be rehabilitated according to a master plan by the Berkeley-based firm of Stoller/Partners.

Inaugurated in May 1980 under the auspices of the U.S. Department of the Interior, the GGEC is funded by private foundations, government agencies, and industry. All of the above, as well as individuals, are invited to take advantage of a supportive working environment where they may conduct programs either as resident or nonresident clients of the Center.

The Center's major activities will be the demonstration and testing of innovative energy technologies. Programs will be developed for passive and active solar space heating, active solar water heating, building weatherization, energy and water conservation, wind energy conversion, biomass conversion, and waste recycling.

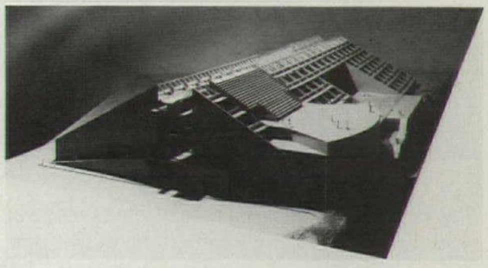
One of the buildings will be left in its original, uninsulated state as a control. The rest will be converted to accommodate different types of energy conservation and/or solar heating systems. A former Army recreation hall will be converted to a conference center with a capacity for 300 people. All structures will be monitored to evaluate relative performance. The south orientation of the cluster coupled with structural simplicity will make it easy to upgrade the buildings with minimal change of architectural character, a specific requirement of the National Park Service, which administers the area.

Other advantages of the site include high wind speeds at nearby locations in the headlands for testing wind energy conversion equipment and a splendid setting near San Francisco and other Bay Area communities.

Educational services will include a technologist-in-residence program offering workshop facilities to inventors, technologists, and students. A general workshop area will be for the shared use of residents, public classes, and training programs in solar technologies.

The central public facility will be the exhibit center designed for visitor participation. Here, commercially available products and models of energy-efficient homes and communities will be displayed.

The conversion program aims to complete the office space, shop, lab, and conference center in 1982; the exhibit center is scheduled to open in 1983. With the annual tourist count of the headlands already at one million, the GGEC is assured of a good starting audience that is likely to find this an unusual theme park with take-home value.
[Sally Woodbridge]



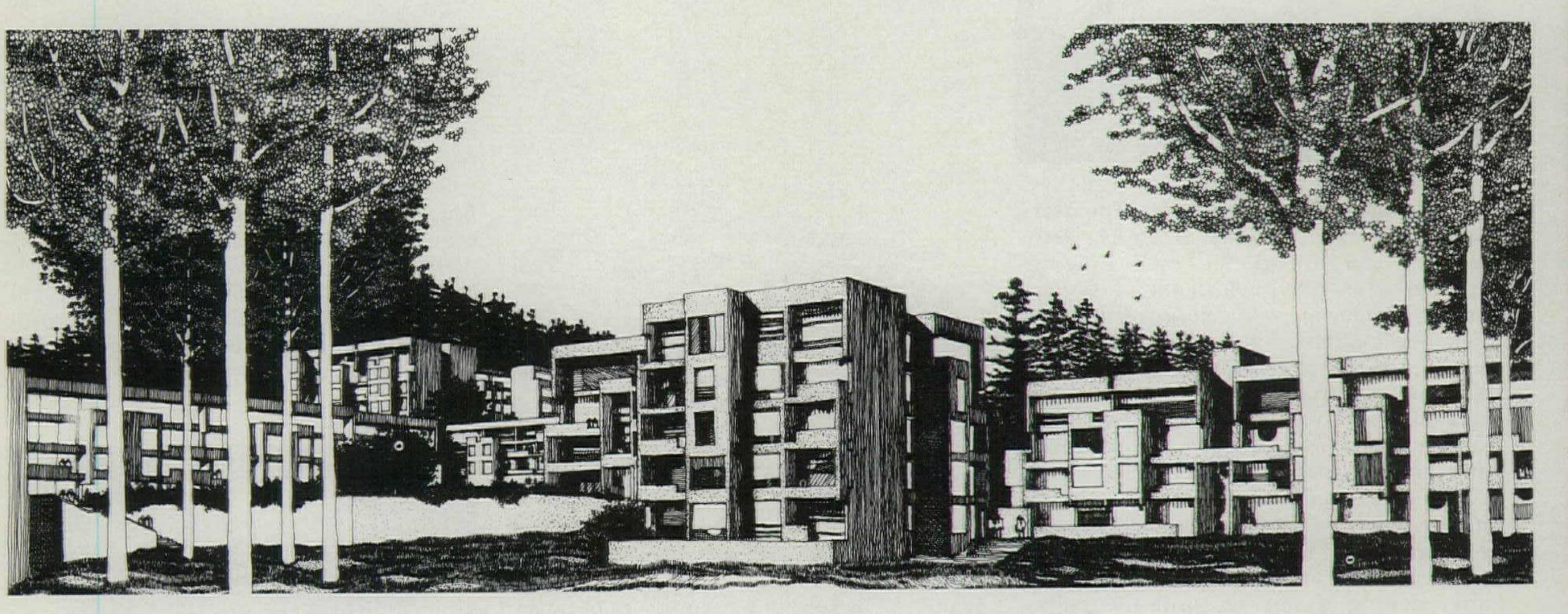
**The Esplanade, Trail, B.C.** *Architects: Paffard Clay, San Francisco, Ca.* An environmental envelope covering two city blocks and containing public and private facilities will be the future downtown core of Trail, a company mining town on the Columbia River in British Columbia. The Esplanade is a stepped, precast concrete structure with garden terraces provided for the public and private housing units, the artists' studios, and the hotel rooms that are located on the building's perimeter. An atrium space unites the public functions—performing arts facilities, a convention hotel, a library, a gallery, and an auto showroom. Retail spaces line the indoor street. The living units insulate the interior common spaces, which include the pedestrian and automobile streets.

This year-round environment will be controlled by solar radiation, as well as by a heat pump that will use the Columbia River for temperature differential and for solar radiation. Within the building, air-to-water and water-to-air heat pump systems will balance energy production with demands. The structure will also utilize the waste energy from giant smelters of the nearby mining operation.

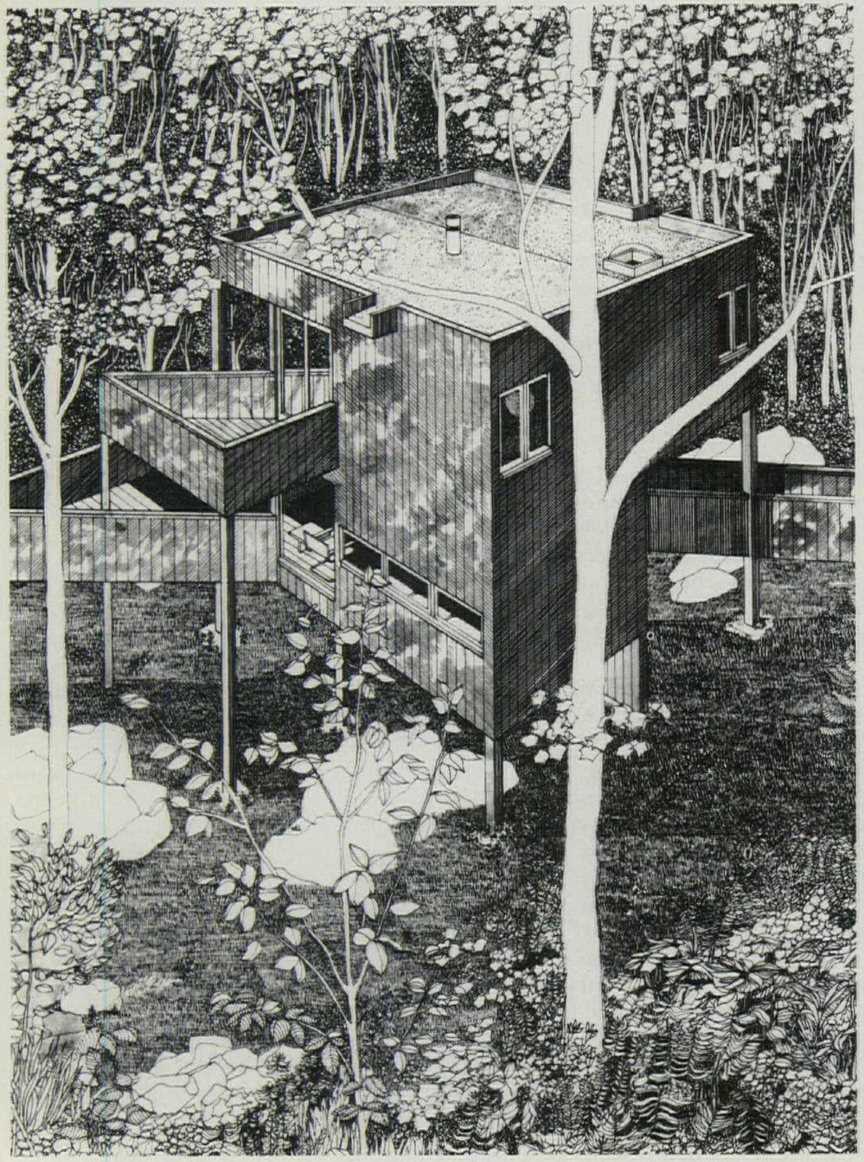
The Esplanade is designed to give physical form to a community that includes the mining company, downtown business people, and the community college. Its residents will live in close contact; functions that are usually scattered throughout a city will be brought together in a cultural and physical environment that should promote civic satisfaction and vitality. Construction will begin next summer. [Sally Woodbridge]

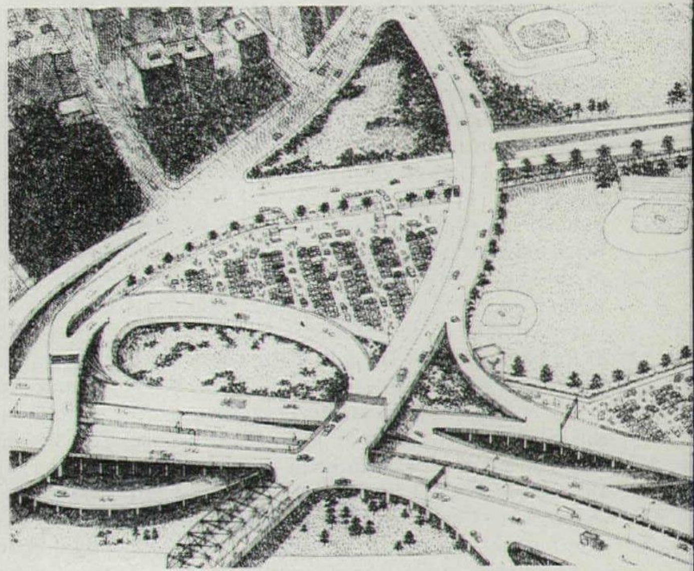
[*News report continued on page 54*]

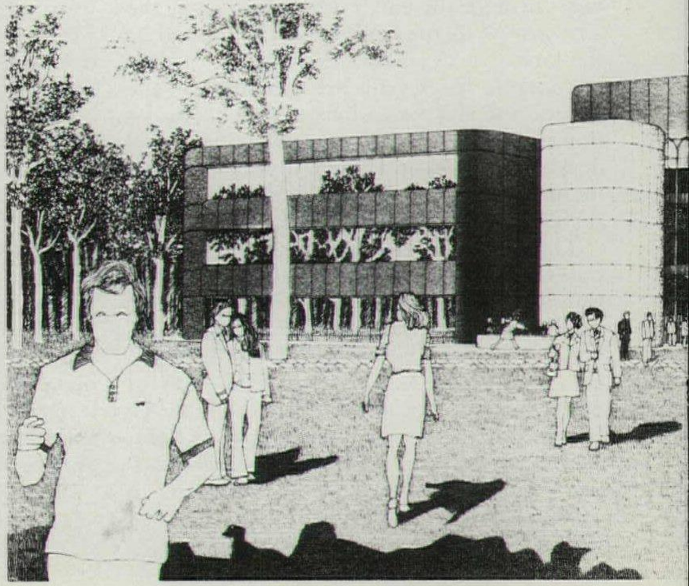
# Rapidograph®



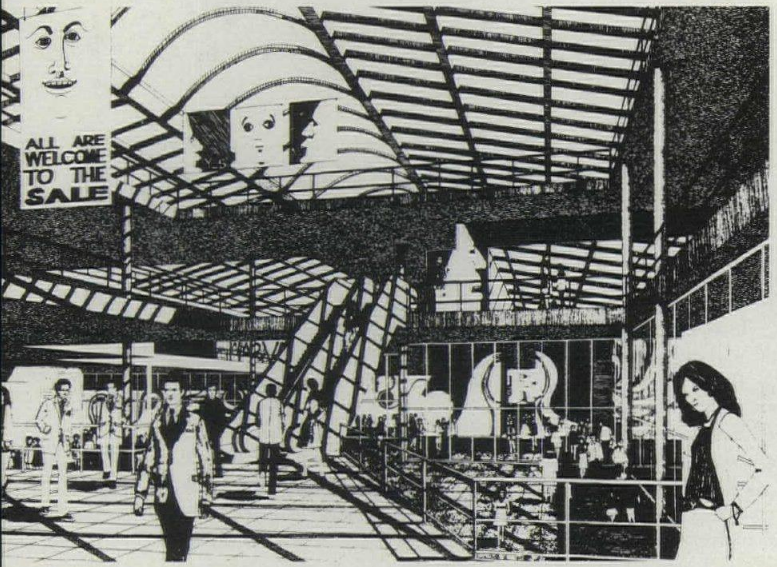
Rapidograph Technical Pen architectural renderings are by Albert Lorenz, Floral Park, NY.

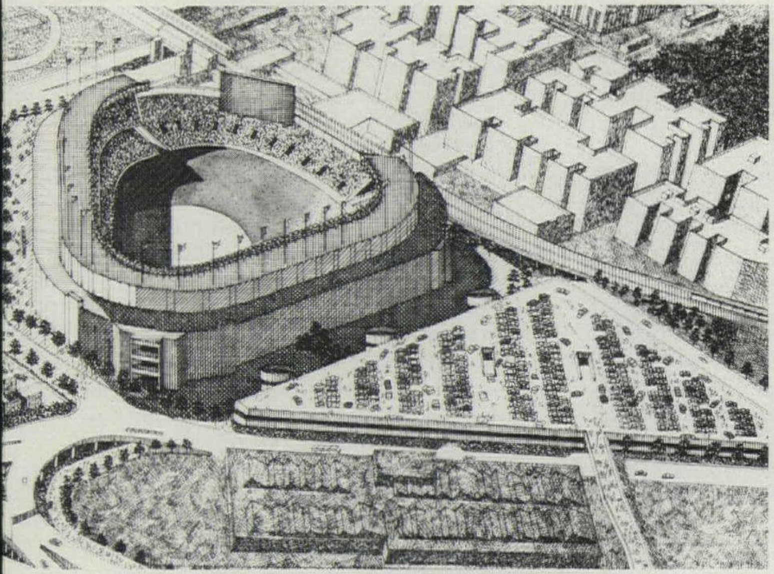


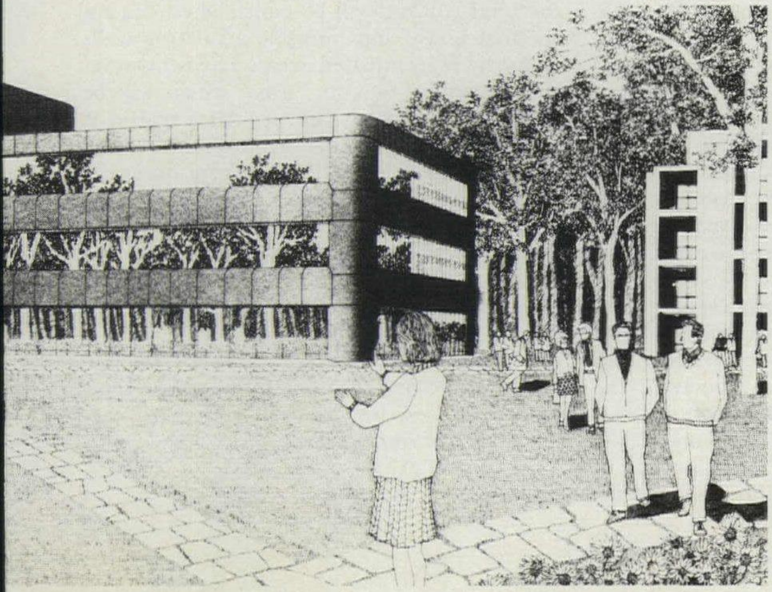




# Renderings





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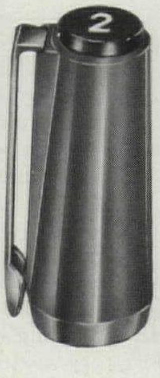



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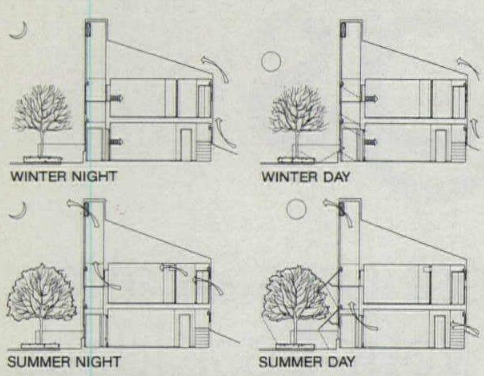
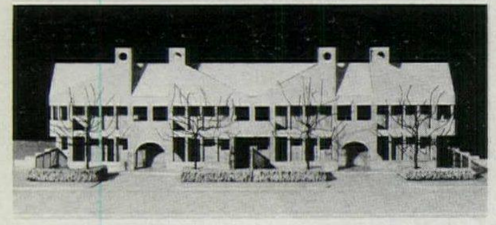
**News report** continued from page 51



**Multifamily rental development, Oshkosh, Wi.** *Architect: Richard Stacy, San Francisco, Ca.* The architect chose simple technologies and standard materials to achieve a marketable prototypical multifamily rental unit, designed for future condominium conversion. Social and market criteria demanded privacy yet identity of expression for each unit, as well as a high level of security. The project incorporates passive solar heating and cooling methods appropriate to its northern location.

Principal materials include cedar shingles, concrete block, brick, composition shingles, full thick batt insulation, and rigid insulation around the foundations. The units have electric baseboard heating, energy-saving appliances, and stock double-glazed aluminum windows.

Large, south-facing windows create solariums, which act as temperature-moderating zones, whose effectiveness is extended in winter by heat-absorbent dark masonry interior walls, and in summer by fans exhausting hot air upward. Furthermore, wood rolling shutters block heat radiation during winter nights, act as awnings during summer days, and provide security and privacy.

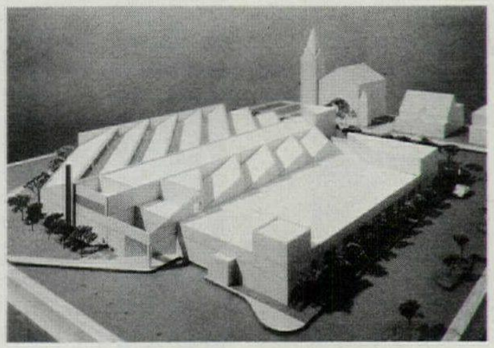
Outside, earth bermed on three sides of the development provides insulation and directs breezes; south patios help reflect additional sunlight into the solariums; and deciduous trees provide summer shade. The solarium "slots" offer opportunities for a variety of exterior treatments, thereby individualizing the units. Internally, however, these spaces are underused, considering their size in relation to the total, rather small floor areas.

Still, the solution represents an interesting and practical approach for meeting the requirements of multifamily housing, even within the rigors of the Wisconsin climate and today's economy.
[Peter Papademetriou]

**Middletown Public Library, Middletown, Oh.** *Architects: Lorenz & Williams, Inc. Dayton, Oh.* At least one aspect of this 40,000-sq-ft library and community center seems to run against the grain of the conventional energy wisdom: its main entrance is placed to the north, well away from the warming sun and presumably exposed to the harsh Ohio winter winds. Prompted by an energy analysis of the firm's earlier Arcade Square project for Dayton (P/A, Nov., 1980, p. 106), designer Stephen Carter wanted to incorporate energy considerations in the library's design. But for programmatic reasons—including the availability of existing parking space—the entrance had to be on the north.

"In the end we may be better off," explains Carter, "because the entryway will be well shaded during the cooling season and we've made careful provisions for screening from the wind." Furthermore, the 1000-sq-ft triangular entry space works as an airlocked vestibule, with beam-activated exterior doors that close before the library patrons reach the inner doors. The vestibule will also house exhibits and may serve as an afterhours meeting area for Middletown residents.

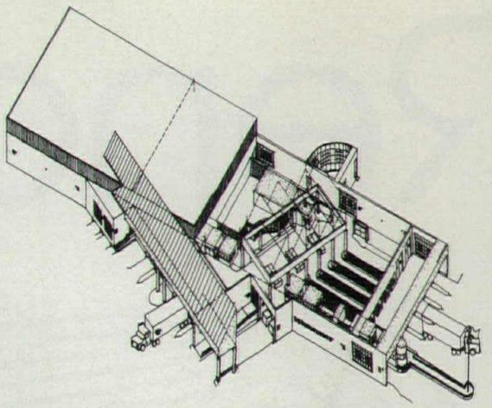
Energy concerns also led the designers to increase the building's apparent scale by adding clerestory sawtooth skylights to the low-profile single-story structure. The skylights will practically eliminate the need for daytime electric lighting, and the higher bay spaces will use the natural stratification of air for heating. In winter, warmed air that accumulates at the peak of the skylights will be redistributed to lower spaces by means of small fans. In summer, excess heat will be exhausted directly.

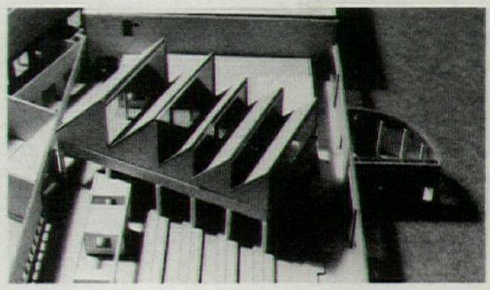


The interest in daylighting also affected the choice of exterior materials: light-colored brick and reflective roof surfaces will contribute significantly to interior illumination levels.

Situated south of the town center near a historic residential district, the Middletown library is designed to accommodate solar collector systems. "We don't really see these systems as being justified economically without subsidies right now," Carter observes, "but this may change, and we're especially encouraged about prospects for the direct conversion of the sun's energy to electricity." As a result, the library's structural systems are designed for later installation of photovoltaic and/or liquid-medium collector arrays.

Atypically (if not miraculously!), the budget for the 200,000-volume library was passed as a bond issue by voters last November. Construction is expected to begin in the fall of 1982. [Thomas Vonier]



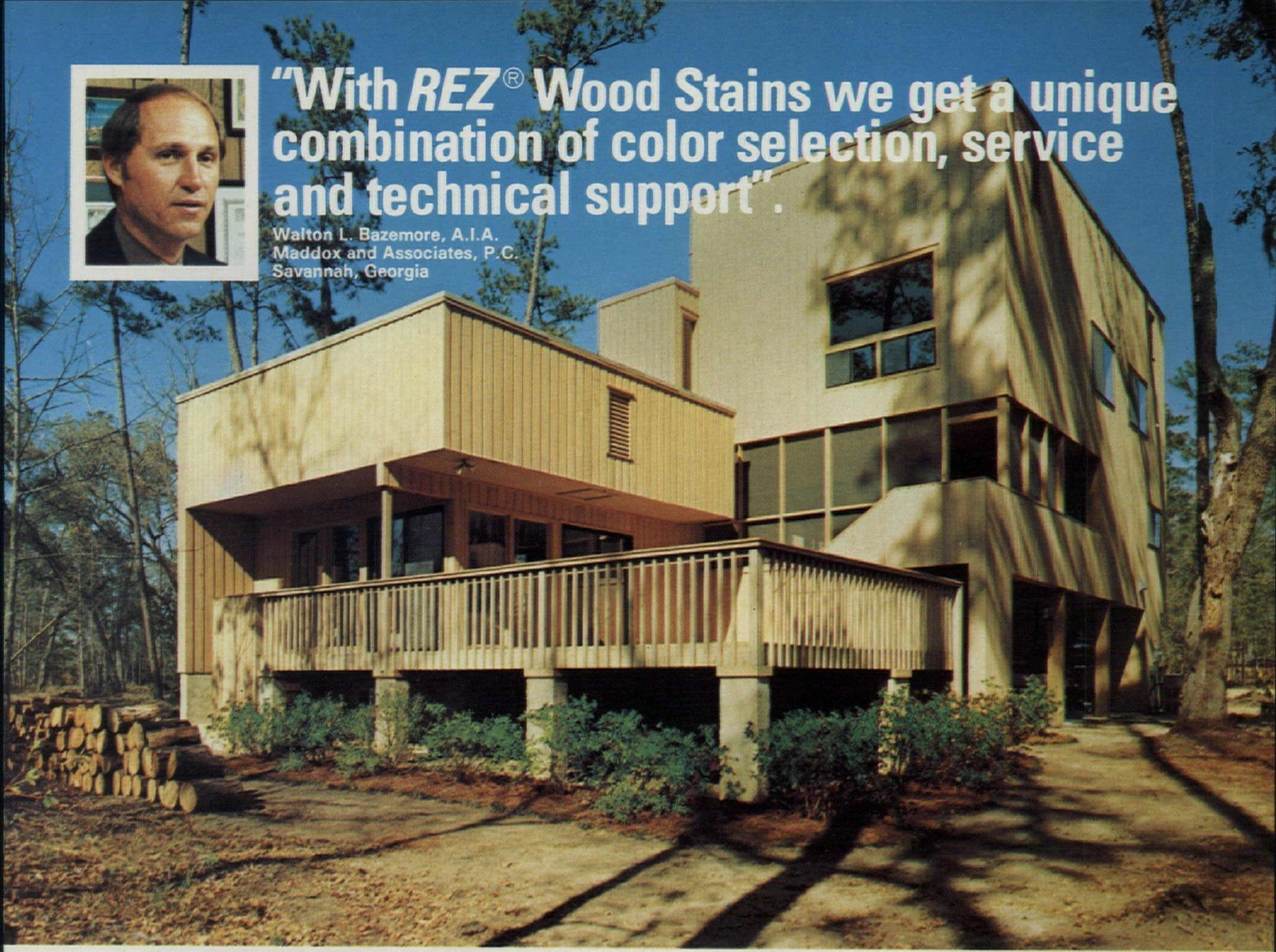


**Central Receiving Facility for West Virginia University, Morgantown, WV.** *Architects: H2L2 Architects/Planners, Philadelphia, and Hoblitzell & Associates, Charleston, WV.* Inspired by 19th-Century cast-iron French market structures in which functions were zoned according to their temperature needs, the architects for this off-campus facility studied the types of goods to be stored and used the attendant temperature and humidity requirements to establish the building's physical layout. West Virginia University (enrollment approximately 22,000) now has over 200 separate receiving points, dispersed over its urban and suburban campuses, handling an average of 120 truck deliveries and more than 900 parcels daily.

To consolidate these functions, the architects devised a floor plan with three main divisions, each given over to one aspect of the facility's operations. Using what H2L2's Burton Miller calls the "thermos" concept, all general office spaces and other areas requiring close temperature and humidity control are placed within the structure's interior, thus using the central receiving and warehouse areas as insulating buffers. The warehouse, where temperatures can be kept at no more than 55 F, is designed for expansion; the total volume will be constructed during the first phase, but movable insulating walls will seal off unfinished areas. The central receiving and "breakout" area, which will be exposed to frequent delivery-truck traffic, is provided with shields against infiltrating winter winds. The loading dock for outgoing shipments is equipped with a radiant heating concrete slab that draws warmth from a rockbed below to temper outside air near the dock doors.

The building may include, when first built or at a later date, an active solar heating system, which will circulate warm air from a rock storage bed to office areas where temperatures must be warmest, and then "cas-

[*News report continued on page 58*]

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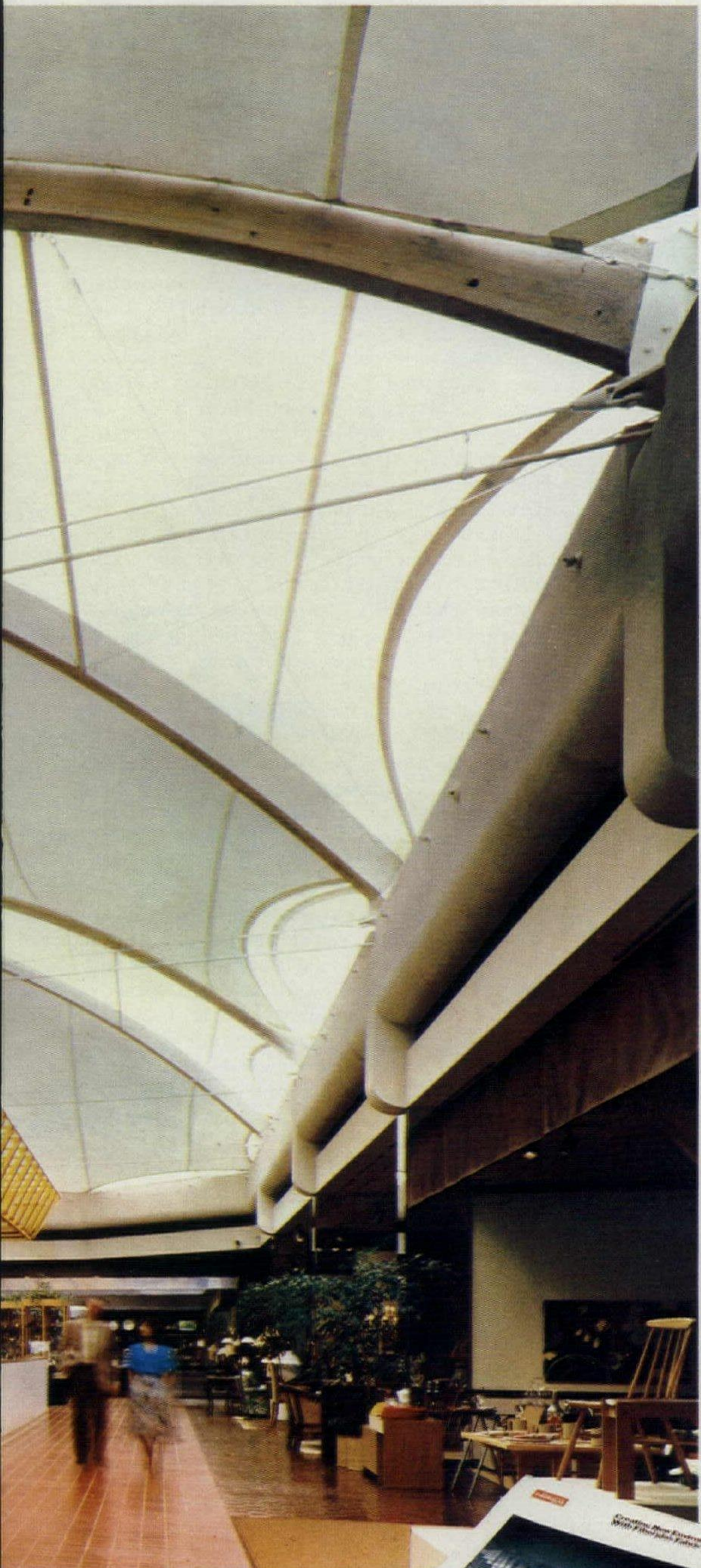

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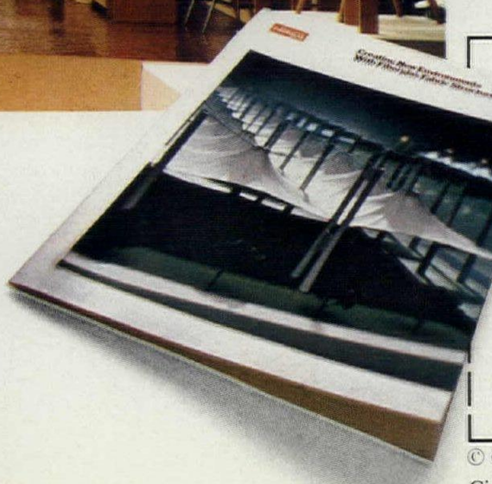

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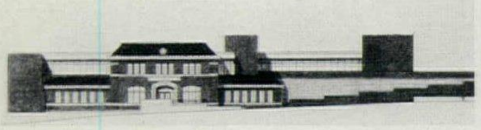
**News report** continued from page 54

cade" cooler air to zones where lesser temperatures may prevail. According to Miller, the university was "open to solar, even in this coal-rich region, provided the paybacks were acceptable. We found that the orientation and layout required for the solar collectors also helped to generate many of the architectural concepts."

The building is expected to have substantial passive solar gains, through use of heavy concrete masonry on receiving area floors and backglazing on north-facing sawtooth skylights. Situated on a 27-acre site near a major new highway just outside of Morgantown, the facility may serve as a working example of solar building technology for the university's students. Tentative plans call for instrumentation and monitoring of the completed structure.

Construction was scheduled to start in late 1980, but the architects are now studying alternate sites for the building in light of the discovery of a nearby abandoned coal mine which will necessitate costly soil-stabilization measures. [Thomas Vonier]

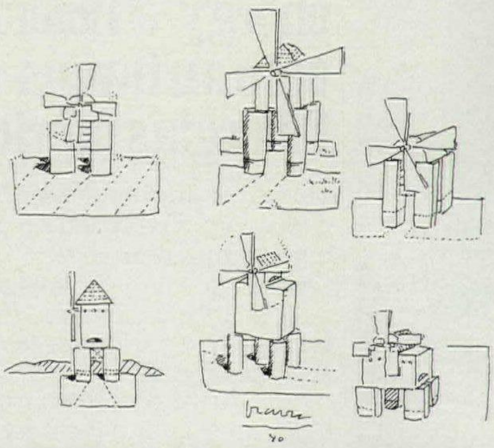


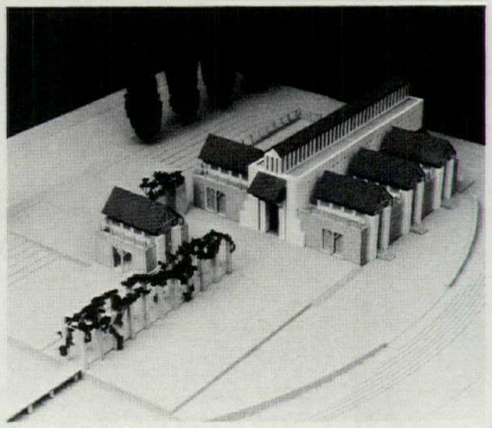
**University of Minnesota Vocational Technical Educational Facility, St. Paul, Mn.** *Architects: Tom De Angelo, Architectural Alliance, Minneapolis.* Teachers in the University of Minnesota statewide network of Vocational Technical schools will be trained in a 97,000-sq-ft building that uses a massive greenhouse wall for passive heating and cooling. The building incorporates a former animal exhibition pavilion with a new overlapping linear wing that will link the facility with other buildings on the University's St. Paul campus.

The two-story 30,000-sq-ft brick and stone Livestock Pavilion, constructed in 1904, is one of several buildings the University decided to recycle for present-day needs. Classroom spaces will replace judging areas for blue-ribbon bulls, and a 67,000-sq-ft addition will accommodate classrooms, offices, and laboratories at the rear. At the juncture of the two buildings, a new central atrium brings "borrowed" light into classrooms and offices in the new addition. A sloping pedestrian concourse with a sawtooth glass-block wall joins the facility to the interior pedestrian concourse system that is part of the overall campus plan.

The Architectural Alliance of Minneapolis has retained the visual character of the old facility and integrated it with the new addition, using common mortar colors, clear glass, and a unifying concrete base; no particular attention is focused on the unspectacular Pavilion.

The passive solar greenhouse, a single-glazed curtain wall built three feet outside a 12-in. concrete block Trombe wall with concrete-filled cores, utilizes a movable insulating curtain made up of layers of Mylar attached to the concrete wall, which is automatically retracted for heat gain or dropped for insulation. During summer, horizontal sunscreens in the greenhouse space prevent direct rays from entering the windows. As part of their training, the building's users will monitor the system. [Joanna Baymiller]

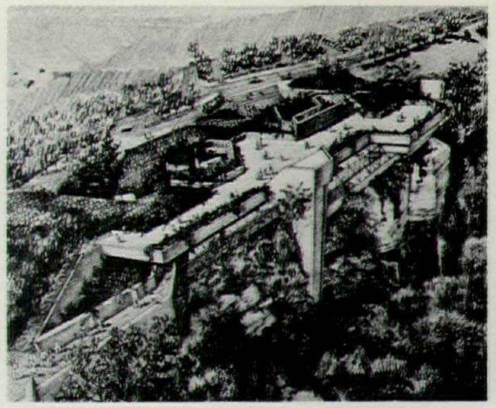




**Environmental Education Center, Liberty State Park, NJ.** *Architect: Michael Graves, Princeton, NJ.* This wildlife interpretive center, situated with views of New York harbor, the Statue of Liberty, and southern Manhattan, will educate the public in two ways: inside, exhibitions, lectures, and conferences will take place; and outside, a path system will loop through the marshy landscape, passing through a series of descriptive out-stations.

These paired functions will be symbolized by paired entrance pavilions with, on one side, the enclosed exhibition spaces, and on the other, the natural outdoor exhibition. The main building organizes an auditorium, meeting spaces, administration areas, and three exhibition galleries around a central entrance hall. The three galleries, expressed individually, will receive natural daylight through openable clerestories and through windows with views of the harbor. The building will be clad in stucco and cedar siding, and will have clay tile roofs over wooden trusses, materials indigenous to the New Jersey shore.

As part of the broader environmental education program, the building itself will serve as a model of energy conservation, taking advantage of the wind-swept, waterside site. A water-to-water heat pump will convert the coldness of the harbor's water into heat for the building; and three small field stations will demonstrate the use of wind energy by generating electricity through traditional windmill action. [SD]



**Fort Snelling Visitor Center, Minneapolis, Mn.** *Architects: Myers & Bennett/BRW, Minneapolis.* In Minnesota, land of six-month winters, severe cold and rising energy costs are continuing to drive architects underground. Myers & Bennett/BRW is one of several firms experimenting with earth-sheltered construction combined with passive and active solar energy systems. The firm's first such project, Williamson Hall on the University of Minnesota campus, is 90 percent below grade. Their recently completed Walker Library on a Minneapolis commercial street is almost entirely underground. And the new Fort Snelling Visitor Center will lie below a roof of waving Minnesota prairie grass.

Currently under construction, the Visitor Center will house Minnesota Historical Society offices and will serve as an interpretive center to introduce visitors to Minnesota's largest historic reconstruction project, the military post built between 1820 and 1825 by Colonel Josiah Snelling and the U.S. Fifth Infantry Regiment.

The scheme, in accordance with state legislation restricting development along the Mississippi River bluffs, is invisible from the bluff. Only a series of terraces are seen by visitors, who are guided into the building through a sloping passage. Upon emerging, the visitor has a direct view of the round stone tower of the Fort, one of the few surviving remnants of Minnesota's first settlement.

A hybrid of passive and active energy systems will create a "sun/earth interdependent demonstration design" that will supply heating, cooling, and electricity, possibly generating excess of the latter to sell to the local power company. A high-temperature concentrator solar collector built at the edge of the site atop a highway overpass will be the source of heating and power. It will generate steam at temperatures up to 650 F, sufficient to drive a turbine generator.

For summer cooling, an ice storage system will be used instead of a conventional absorber. To illuminate underground spaces, a system of mirrors will bounce natural light into office spaces two levels below grade, in an experiment that could prove important in the further exploration of earth sheltered construction. [Joanna Baymiller]

*[News report continued on page 60]*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A broad pedestrian walkway slices diagonally through a square in downtown Nashville, leaving space for a pair of distinctive triangular-shaped buildings. One building is the 20-story corporate headquarters for Commerce Union Bank—Tennessee Valley Bancorp; the other, the 12-story, 350-room Radisson Plaza Hotel. The complex is well served by a total of 18 Dover Traction and Oildraulic® Elevators: 11 in the bank building, 7 in the hotel. For more information on Dover Elevators, write Dover Corporation, Elevator Division, Dept. B, P. O. Box 2177, Memphis, Tennessee 38101.
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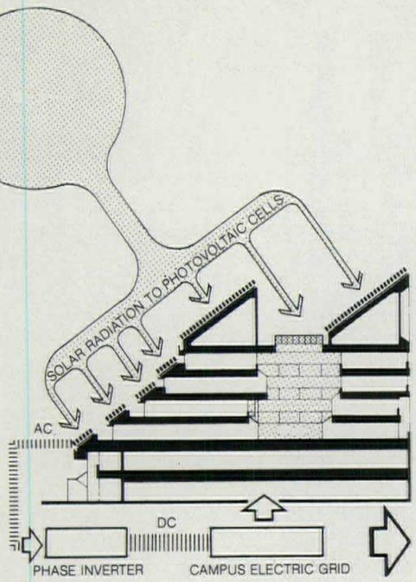
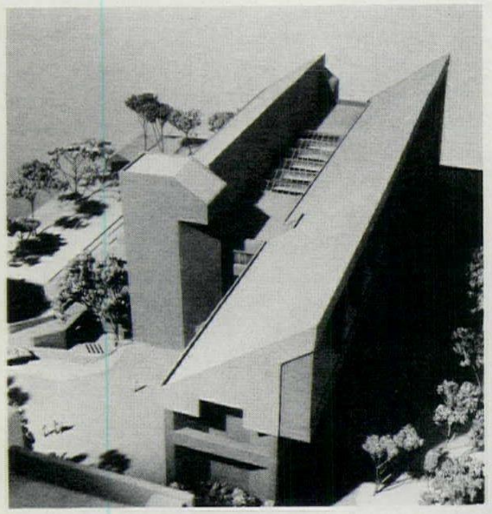


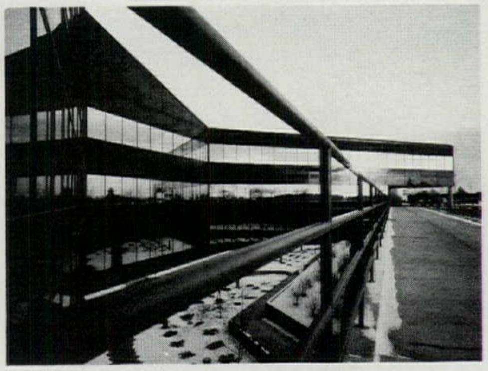
**Georgetown University Intercultural Center, Washington, DC.** *Architects: Metcalf & Associates, Washington, DC (Anshen-Allen, San Francisco, consulting architect).* This unusual educational structure, designed to integrate the offices and classrooms of several traditionally separate disciplines, is the largest solar-powered building ever constructed, according to the architects. Financed in part by grants from the U.S. Department of Education (through its program combining international affairs, languages, and area studies) and from the U.S. Department of Energy (as a demonstration project), the 213,000-sq-ft structure is to open in spring 1982. The unusual shape is a direct function of its energy potential: six sections of roof slanted at 35 degrees and facing due south will be covered with 35,000 sq ft of photovoltaic cells. They are expected to produce 300 kilowatts of electricity, which will be transferred to the campus power grid for distribution to all university buildings. The brick envelope and large overhangs are expected to provide additional energy savings. A four-story skylit atrium/gallery will run through the center of the building, which will cost $20 million. The special solar roof, to be constructed under a separate contract, will cost an additional $10 million of federal funds. [Carleton Knight, III]

**Donaldson Company, Inc., Corporate Headquarters, Bloomington, Mn.** *Architects: Hammel, Green & Abrahamson, Inc., St. Paul, Mn.* Originally a two-man operation in the corner of a St. Paul, Mn, sheet metal shop, the Donaldson Company has become an international corporation with over 3000 employees involved in the research and development of industrial products for agriculture, transportation, mining, and industry.

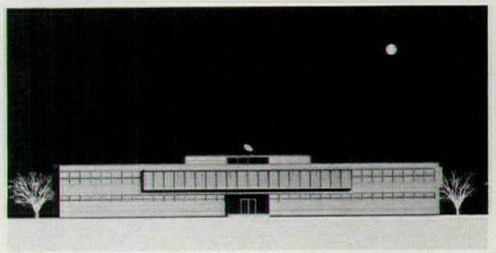
Following a master plan developed and updated by architects Hammel, Green & Abrahamson, the company has completed approximately 400,000 sq ft of buildings. In the late 1970s, the company began planning for expanded testing/research facilities and additional corporate offices. The newest building, which consolidates laboratory functions formerly scattered in rental space throughout the Twin Cities, is a 240,000-sq-ft structure completed and occupied last fall. This latest addition, a testing center for mufflers, filters, and other products, consists of two multistory buildings connected by a four-story atrium and located on the central portion of the 36-acre site.

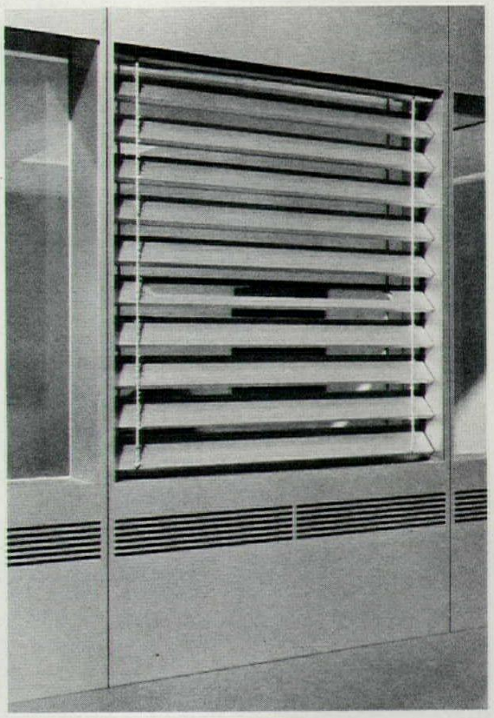
Function, climate, and site orientation have shaped both the exterior and interior spaces. A buff-colored masonry envelope on the north and east elevations encloses the technical spaces and laboratories requiring no natural light and acts as a shield against winter winds. Bright red louvers pop out as sculptural elements on an otherwise subtly patterned surface. On the south and west elevations, a black aluminum and mirrored glass insulated curtain wall wraps the office and public spaces and takes maximum advantage of natural light. Three southwest-facing exterior courtyards are recessed at the building edges to act as light wells, reducing the need for artificial lighting in lower floor offices.

When the addition was built, a 5000-sq-ft central energy plant was added which will eventually serve all existing and future buildings on the site. Cooling costs were reduced by installing a 100,000-gallon-capacity underground storage tank for chilled water, to be cooled during hours of low electrical demand, when rates are lowest. Several additional tanks are planned to meet future demands. [Joanna Baymiller]



*Donaldson Company Headquarters.*





**Comprehensive Vision Care Center, Chicago, Il.** *Architects: Alfred Swenson & Pao-Chi Chang, Chicago.* The challenging problem in the design of this 38,000-sq-ft building, which accommodates clinics, a laboratory, offices, and an educational center on two floors on a long, narrow site, was to provide ample natural light and views while being energy efficient. The solution to this problem lay in the use of manually operated insulated window louvers, as well as the development of an innovative enclosure system.

The enclosure consists of aluminum panels and glass cavity walls, which will produce a 19 percent saving in the heating/cooling load; and the louvers, which are 3 in. thick by 8 in. wide and are made of a lightweight insulating material (possibly balsa wood), can be tilted and retracted by conven-

[*News report continued on page 64*]

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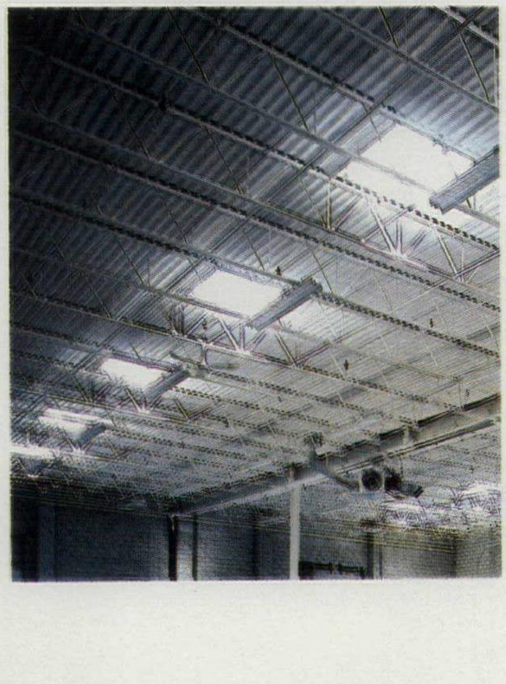

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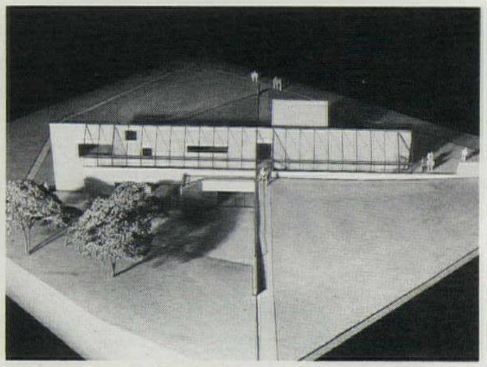
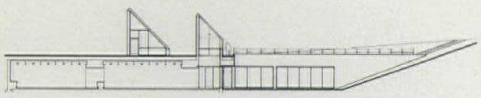
tional venetian blind mechanisms. When the louvers are lowered and closed, they reduce heat transfer by 90 percent; when lowered and tilted horizontally, they diffuse light into the space; and when raised, they permit maximum solar gain.

Lobbies, dining area, and library called for especially large windows; these have movable Mylar drapes for insulation. Other energy-saving features include heavy roof and wall insulation, heat recovery luminaires, and through-wall louvers for natural ventilation. The overall annual energy budget is 51,000 Btu per sq ft.

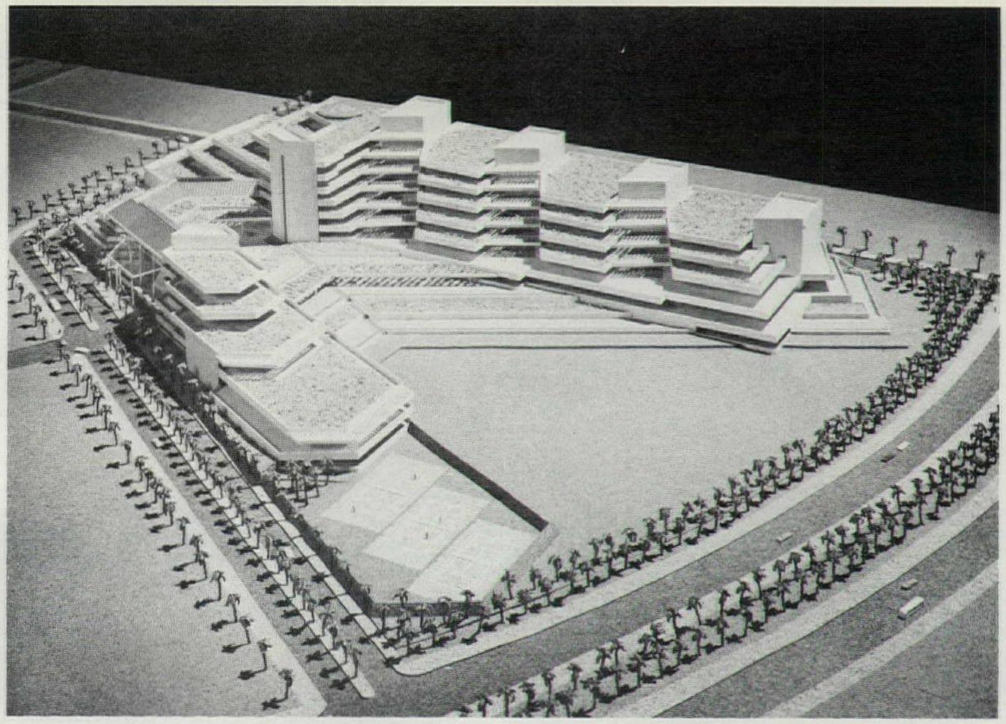




**Marleine Reader Harris Media Center, Mars Hill College, Mars Hill, NC.** *Architects: Six Associates, Inc., Asheville, NC.* Much of this 11,000-sq-ft building is located underground, a fact which helped the architects, working with a difficult site, to locate classrooms and studios on one level. It also helps fulfill the requirements for sound and light isolation in video, storage, and theater areas, and has several energy advantages.

The insulated sod roof eliminates peak loading. Below-grade retaining walls use the steady-state thermal sink characteristics of the surrounding earth to radiate heat in winter and absorb heat in summer. Other energy strategies include the use of south-facing windows to maximize solar gain in winter; the use of the above-ground diagonal spline to distribute, in winter, solar-heated air picked up by its skylight, and to exhaust, in summer, hot air by natural and mechanical means; and the use of cool summer night air to remove heat from thermal sinks.

The diagonal spline aligns with a major campus circulation route, and is designed to be seen as a changing interplay of light and shadow.



*General Services Insurance Systems building.*

**General Services Insurance Systems, Manila, The Philippines.** *Architects: Jorge Y. Ramos & Associates; The Architects Collaborative, Cambridge, Ma.* Launched "not with a slab of stone but with a grove of trees," this 1,350,000-sq-ft megastructure on a 12-acre site on Manila Bay aims to halve energy costs by a series of sun-conscious maneuvers. The V-shaped clustering of pods maximizes daylight and ventilation by its orientation and massing.

To meet "international standards" of air conditioning in a hot, humid climate while minimizing the use of oil-derived electricity, TAC worked with an elaborate mockup and computer models, and arrived at a siting for the two eight-story wings that uses the north-south exposures to take in light but avoid heat and glare. Exterior sun shades further fend off the sun's rays, while courtyards extend the penetration of light, estimated to reach 30 footcandles in the offices during the day with no artificial illumination. Insulation, uncommon in the Philippines, is used on all the walls. During the regularly scheduled brownout periods, fans will circulate the air with minimal electricity.

Landscaping is inspired by the spectacular Banaue rice terraces to the north: a series of stepped irrigation pools collects rainfall in the structure's "V" to supply water for cooling. Inside, a white color scheme, plants, the use of native wood, and fixtures which bounce light off the ceiling will heighten the light, cool effect sought in the overall scheme. [Jane Holtz Kay]

**Crash Fire Rescue/Snow Removal Equipment Building, Manchester Airport, NH.** *Architects: Amsler Hagenah Maclean, Boston, Ma.* Like the New England salt-box that huddles into the land to keep out the winter chill, this large airport garage designed by Boston architects Amsler Hagenah MacLean fends off the cold through shape, siting, and the use of sun and air movement.

The 1200-sq-ft industrial building, which houses equipment for crash, fire, rescues, and snow removal, takes advantage of its southern exposure with a 25-ft-high solar-collecting insulated fiberglass panel wall (Kalwall Sunwall). On the north side, the roof slopes down to an 8-ft-high wall protected by a berm. A radiant air floor system—a honeycomb sandwiched between two concrete slabs—absorbs (with the help of carbon black in the concrete) and diffuses the sun's warmth. The sloping roof guides warm air into the furnace: as the sun-heated air cools, it falls naturally down the slope and into a vent.

The building opened in January, when the protective ground berm was frozen, so a testing of the projected 25 to 30 percent energy savings must wait until next winter. Movable window shades will be installed this summer, and the cooling capacity of the structure will then be proved. [Jane Holtz Kay]

[*News report continued on page 68*]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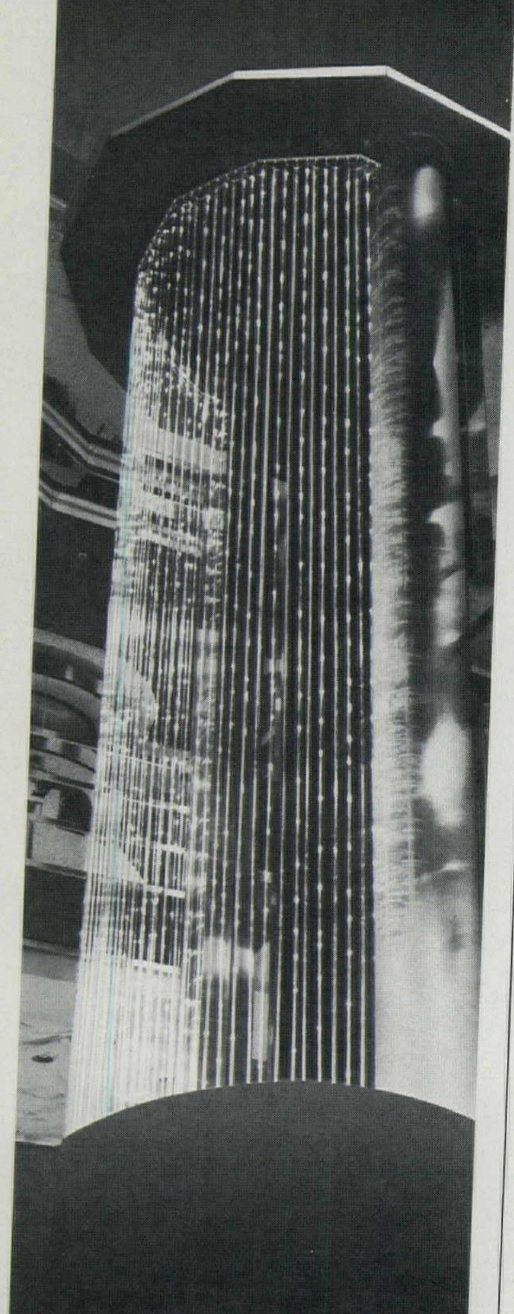

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**News report** continued from page 64

## In perspective

**Architectural Museum Design Charette**

Columbus, In, may still be a pilgrimage stop for architects, but the authenticity of some of its relics has recently been questioned. Four architects, traveling to Columbus in November to participate in a Miami University charrette to design a museum of architectural archives, found the town's old 19th-Century Main Street more appealing than the famous modern buildings which are to be documented in the archives. Three of the four young architects were 1980 P/A Award winners—Susie Kim and Fred Koetter of Fred Koetter & Associates, Boston, and Coy Howard of Venice, Ca. The fourth was Judy Bing of the Cambridge Seven. Each architect led a team of Miami graduate students, and every team developed a scheme that emphasized the small-town aspect of Columbus rather than its monuments.

None of the visiting architect-critics had ever been to Columbus before this occasion, and none of them responded to the *genius loci* the way tourists did a decade or two ago. Visitors used to be disappointed to find that Columbus looked like a regular Indiana town, notwithstanding its churches by Eliel and Eero Saarinen, its library by I.M. Pei, its schools by Harry Weese, John Carl Warnecke, John Johansen, Edward Larrabee Barnes, Mitchell/Giurgola, and its two dozen or so well-known buildings by Robert Venturi, Cesar Pelli, Hardy/Holzman/Pfeiffer, James Stewart Polshek, SOM, CRS, and others.

This year the reaction was very different. The architects were relieved to find that Columbus is a typical little Midwestern town, but were disappointed with the buildings that made it famous.

Those buildings have been sponsored over the years by the Cummins Engine Foundation, which pays architectural fees for public buildings designed by architects selected by its architectural advisory board. The Foundation also cosponsored the charrette, and has been responsible for the rehabilitation of some of Columbus's old buildings, including the one where its offices are located. This building, as well as the façades of Main Street, were redecorated by Alexander Girard in the late 1960s, before restoration was the rage. But preservation is not what has made Columbus famous or unique: its modern buildings are. And the architects were not impressed.

"It's quite a sad situation. The town looks as if it's infiltrated by strange objects that are like from the moon or something," Susie Kim exclaimed.

Her partner Fred Koetter, who wrote *Collage City* with Colin Rowe, made the same point more diplomatically: "Most of the work that's been done here has tended to neglect urbanistic factors."

Coy Howard concurred: "There is a conflict here between what this town is

[*News report continued on page 76*]

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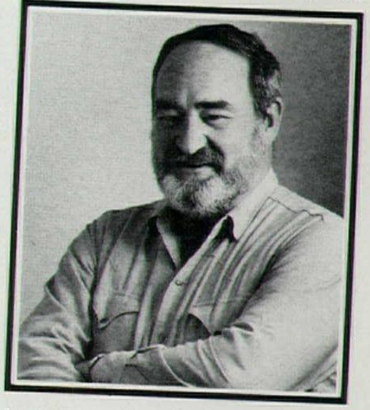

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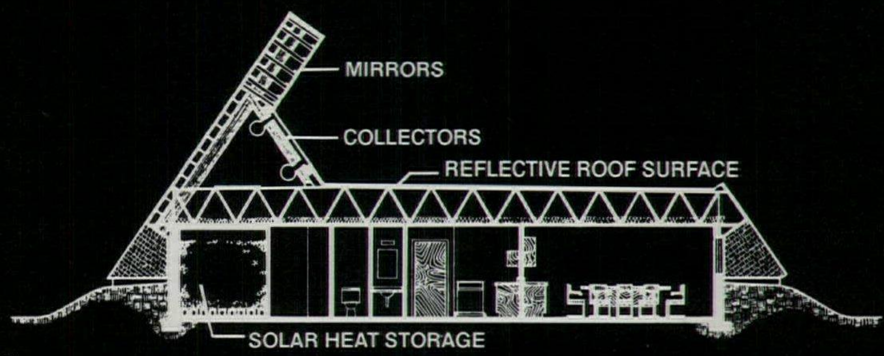


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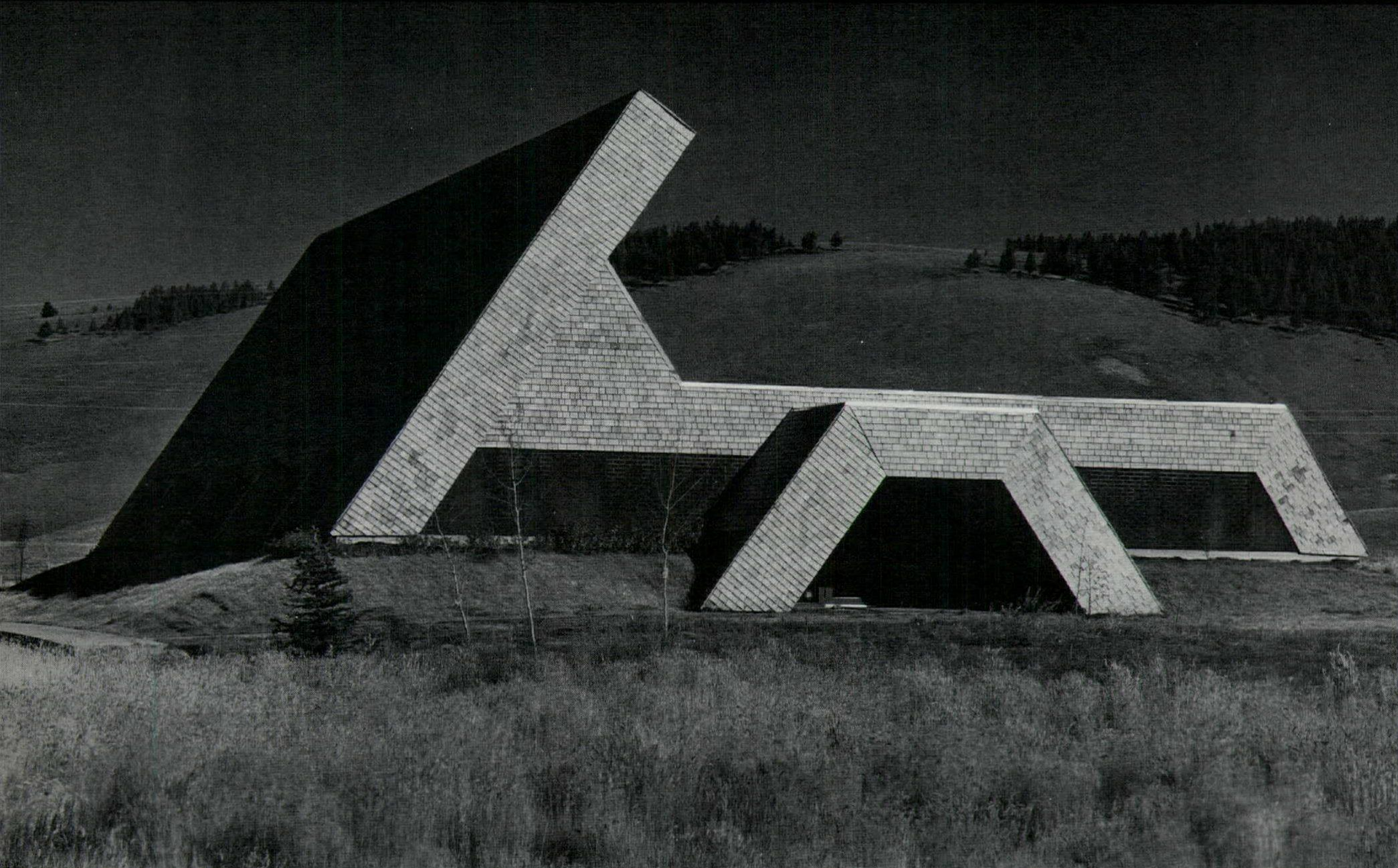

*Solar Plaza Professional Building, Granby, Colorado*
*Architects: Dixon/Carter Architects*

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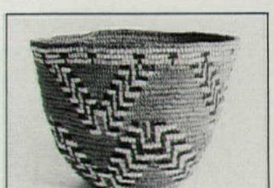

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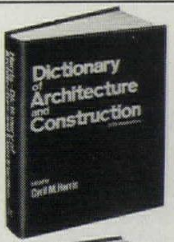


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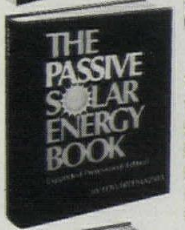


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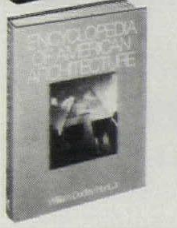


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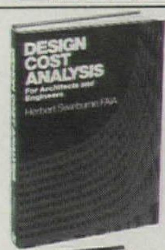


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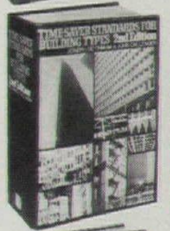

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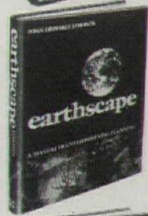


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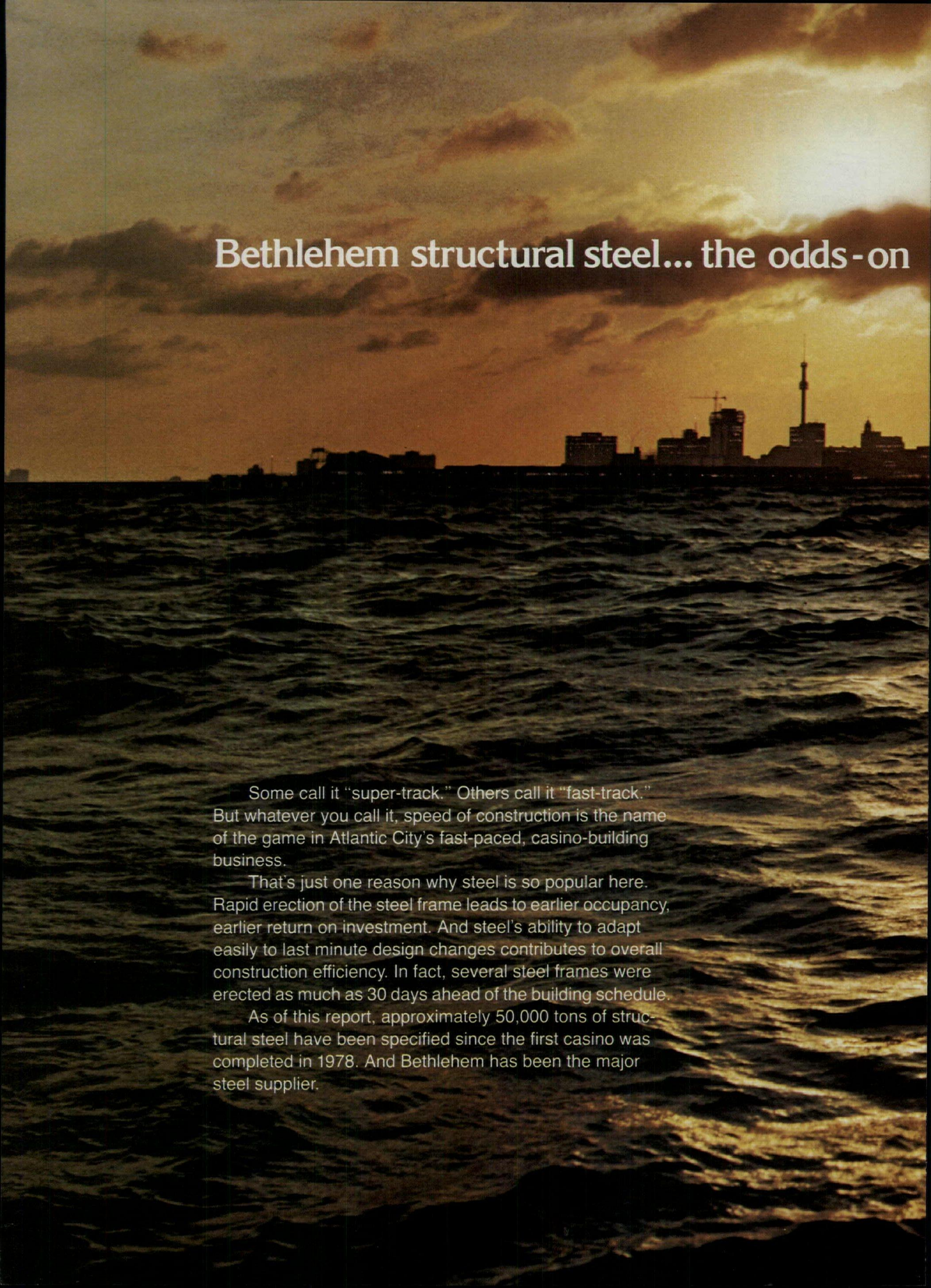
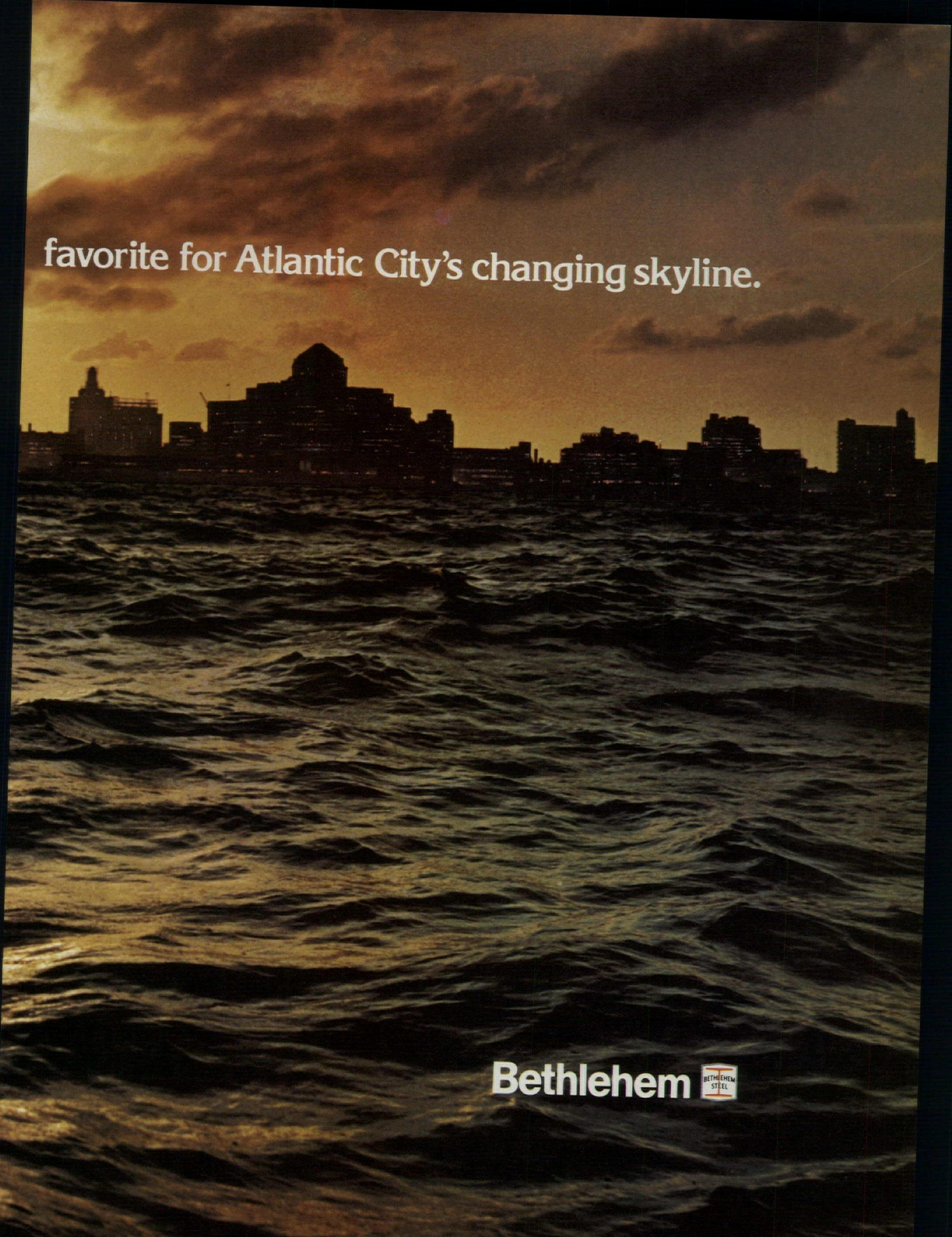

Bethlehem structural steel... the odds-on
Some call it "super-track." Others call it "fast-track." But whatever you call it, speed of construction is the name of the game in Atlantic City's fast-paced, casino-building business.
That's just one reason why steel is so popular here. Rapid erection of the steel frame leads to earlier occupancy, earlier return on investment. And steel's ability to adapt easily to last minute design changes contributes to overall construction efficiency. In fact, several steel frames were erected as much as 30 days ahead of the building schedule.
As of this report, approximately 50,000 tons of structural steel have been specified since the first casino was completed in 1978. And Bethlehem has been the major steel supplier.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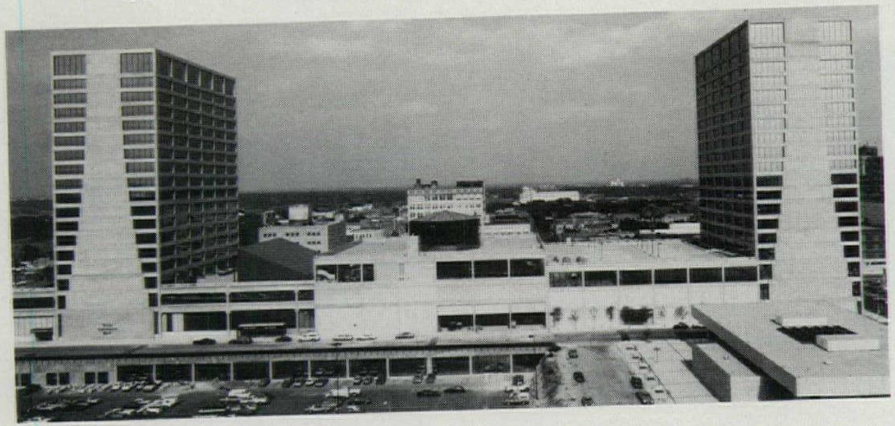
Yes, with reinforced concrete. And energy savings are part of the bargain.



Tandy Center, in downtown Fort Worth, Texas centralizes under one roof the corporate offices of the Tandy Corp., manufacturer and retailer of consumer electronic products (Radio Shack stores). It also expresses a commitment to the community, providing a stimulus for urban renewal, without the use of public funds.

Reinforced concrete's versatility made the project feasible, with the attendant benefits of low cost, fast construction, and energy savings.

Tandy Center has two 20-story office towers, two 4-story retail buildings and an underground link connecting all buildings and supporting the city street above it. These five structures are all site-cast conventionally reinforced concrete using Grade 60 steel, totalling more than one million square feet.

The project includes an ice rink with atrium and restaurants, retail shops, a major department store, a three-level parking garage.

People detraining from a free subway that serves a remote parking area enter the complex through an ice rink atrium with 85-ft. tall sloped ceiling. Exiting the ice rink, visitors encounter another five-level atrium, with free-standing open elevators. The focus of this atrium is a latticed concrete dome, filtering natural light to the bottom level.

All buildings were framed with pan joist construction, to give a uniform structural depth hence making possible a simpler mechanical system. Repetitive framing increased the economy associated with form reuse while increasing construction efficiency.

Exterior shear walls on the East and West faces of the office towers provide lateral load resistance and form a sun shield to help cut heat gain and reduce air conditioning costs.

The North and South faces of the office towers were framed with deep spandrels. These deep beams diminish the exterior glass surface to further reduce energy consumption. And the beams, coupled with the exterior columns, provide the required lateral resistance.

The exterior shear walls, columns and spandrels, and the interior core walls were all formed with textured fin form liners for an excellent finish without architectural treatment or painting.

Thus reinforced concrete gave a simple, economical answer to complex design problems. And the use of local labor gave an impetus to the local economy and a sense of participation to the local building trades involved in the project—both matters of special pride to the owner.

Ask for Bulletin No. 18

Architect: **Growald Architects, Inc., Fort Worth, Texas.**
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Contractor: **Henry C. Beck Company, Dallas, Texas.**
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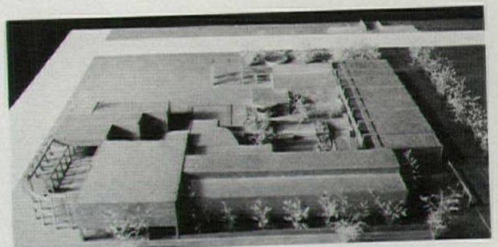
**News report** continued from page 68

and really wants to be, and what the architects would like this town to be."

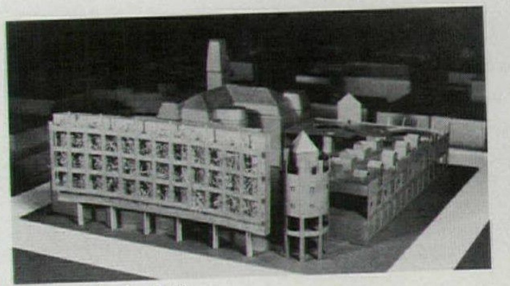
Their reactions are not surprising, since they are all very concerned with context in their own work, and they all have rejected some of the premises of Modern architecture implicit in most of the major new Columbus buildings. But even Judy Bing, whose work is more in the Modernist tradition, spoke favorably only of "Main Street" and "the beautiful Dan Kiley plantings."



*Judy Bing's design.*

**Judy Bing**
In her presentation to Miami University students in Oxford, Oh, after the charette, Judy Bing described her project as "a modest, quiet little building," set back from the street with a sidewalk café to support the life of Main Street. The plain, low-rise structures in her study center/museum complex are dominated by the big Victorian courthouse next door and surrounded by trees on the street line and in an interior courtyard.

The emphasis in the design was on the different functions of the parts—the gallery, the studios, the meeting rooms—and on their relations to the scheme as a whole and to the townscape.



*Susie Kim's design.*

**Susie Kim**
Susie Kim, on the other hand, sized up the site abstractly by studying a map, but ended up creating a scheme that reflected the imagery of the area. Her eclectic addition to the old courthouse has a mansard roof, pavilions, pediments, and moldings. It also has a tower on pilotis, a curved, trellised garden wall, and an earth berm that is "half building, half landscape."

"After a while, you realize that there is an identity to this town and that it is along Main Street. Main Street is a room, an important space. But unfortunately as you come closer and closer to the end, it's very depressing. There, where Cesar Pelli's enclosed shopping mall brings the suburbs into the city, it just peters away."

[*News report continued on page 80*]

Attractive home on Cape Cod, Massachusetts; Architects Bedar & Alpers, Boston, Massachusetts; Wood siding and wood trim treated with Cabot products.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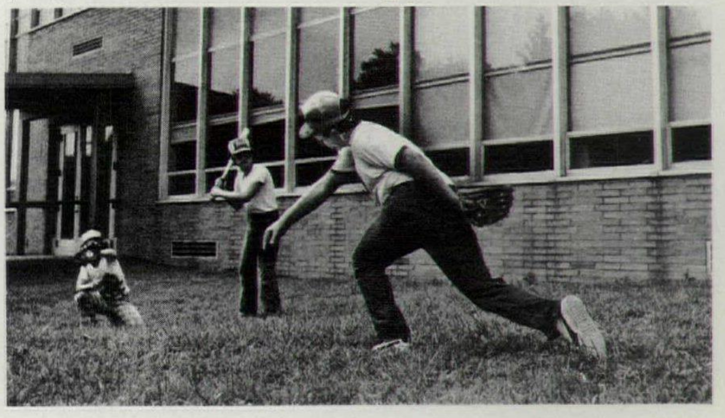

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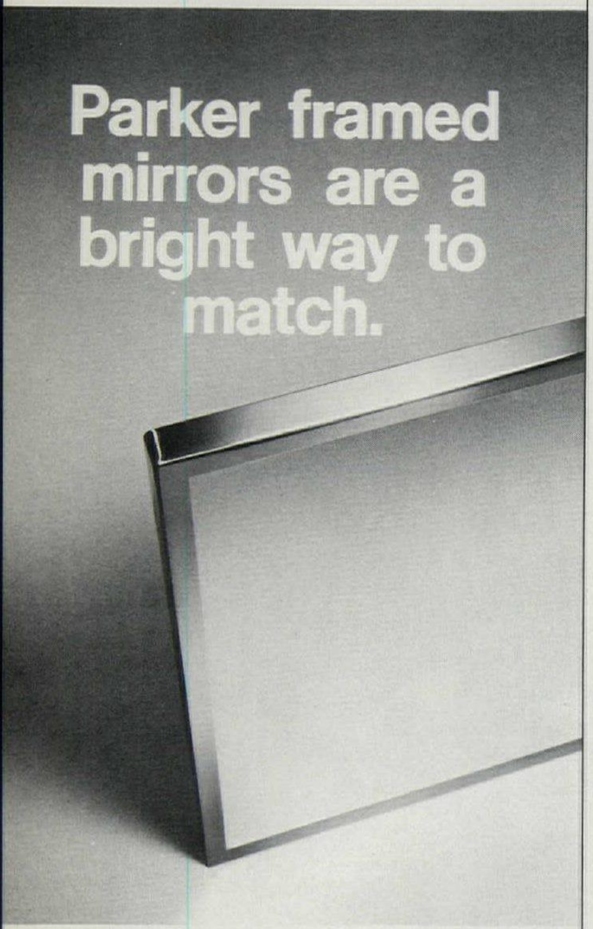


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**News report** continued from page 76

"The secret is: from a very small point, how much can you control?" Kim said, expressing an attitude that was almost diametrically opposed to Judy Bing's. Kim designed her museum as a terminus to Main Street, and its courtyard is to be the link with the river.

**Fred Koetter**

Fred Koetter interpreted the design problem in a manner similar to his partner's, but his solution was less romantic, more witty, and geared less to visual images than to social behavior.

He decided to activate and define Main Street by erecting monuments at either end, bringing back a sense of place and creating a sense of identity in Columbus. "These qualities have been corrupted in Columbus by decay and by the egomania of architects," said Koetter. Small-town America is probably the highest point in American urbanism. In lots of towns, in New England church squares, and in little parks you find triumphant war memorials or monuments to fearless firemen. All there is in Columbus is a rather pathetic little monument to "veterans of all wars."

Koetter's proposed building, like Kim's and Bing's, is grouped around a courtyard, with the old courthouse enclosing the square on one corner. It has four layers of construction, part solid and part void. At the corner opposite the entrance is a round pavilion with a big communal front porch, a device to give the farmers an alternative seating area to Pelli's enclosed mall, where the whole town gathers. It is part of Koetter's attempt to bring old-fashioned small-town urbanism back to Columbus.

**Coy Howard**

"There doesn't need to be an urban space in that town," Coy Howard felt. "All that's wrong is understimulation." Furthermore, he observed, "The town erodes at the edge, and that's a natural feature, which probably should be left alone." He placed his building as far away from the town center as the site allowed, on the riverbank where warehouses are located by default.

The building he proposed is a plain brick warehouse like others in the town, but it is to be covered in sheets of foam green Carrara glass, as is the town's Art Deco movie theater. It is to have cracks in the glass, which are to be filled with Corten steel, guaranteed to rust and reveal the brick masonry underneath, as do other decaying small-town buildings. Even sheets of plywood, that typically board up unoccupied Main Street buildings, are to be used on the structure to further the metaphor of the "real" architecture of Columbus, In. Howard's project is not a critique so much as a poignant celebration: as art should, it forces the visitor to see the town with different eyes. [Jayne Merkel]

*Jayne Merkel is architecture critic of the* Cincinnati Enquirer *and a contributor to other magazines and journals.*


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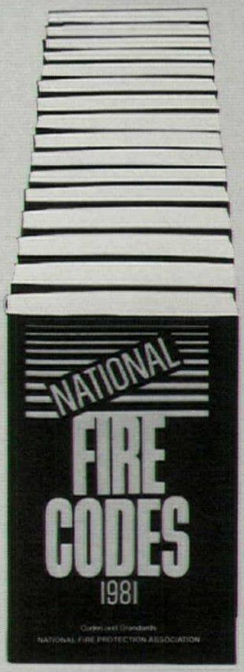


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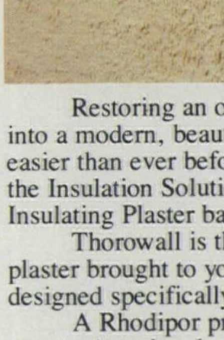


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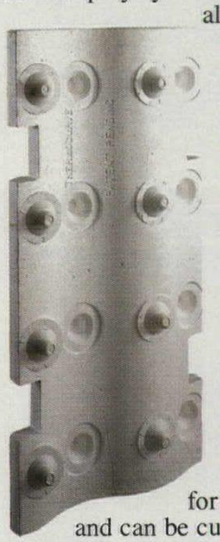

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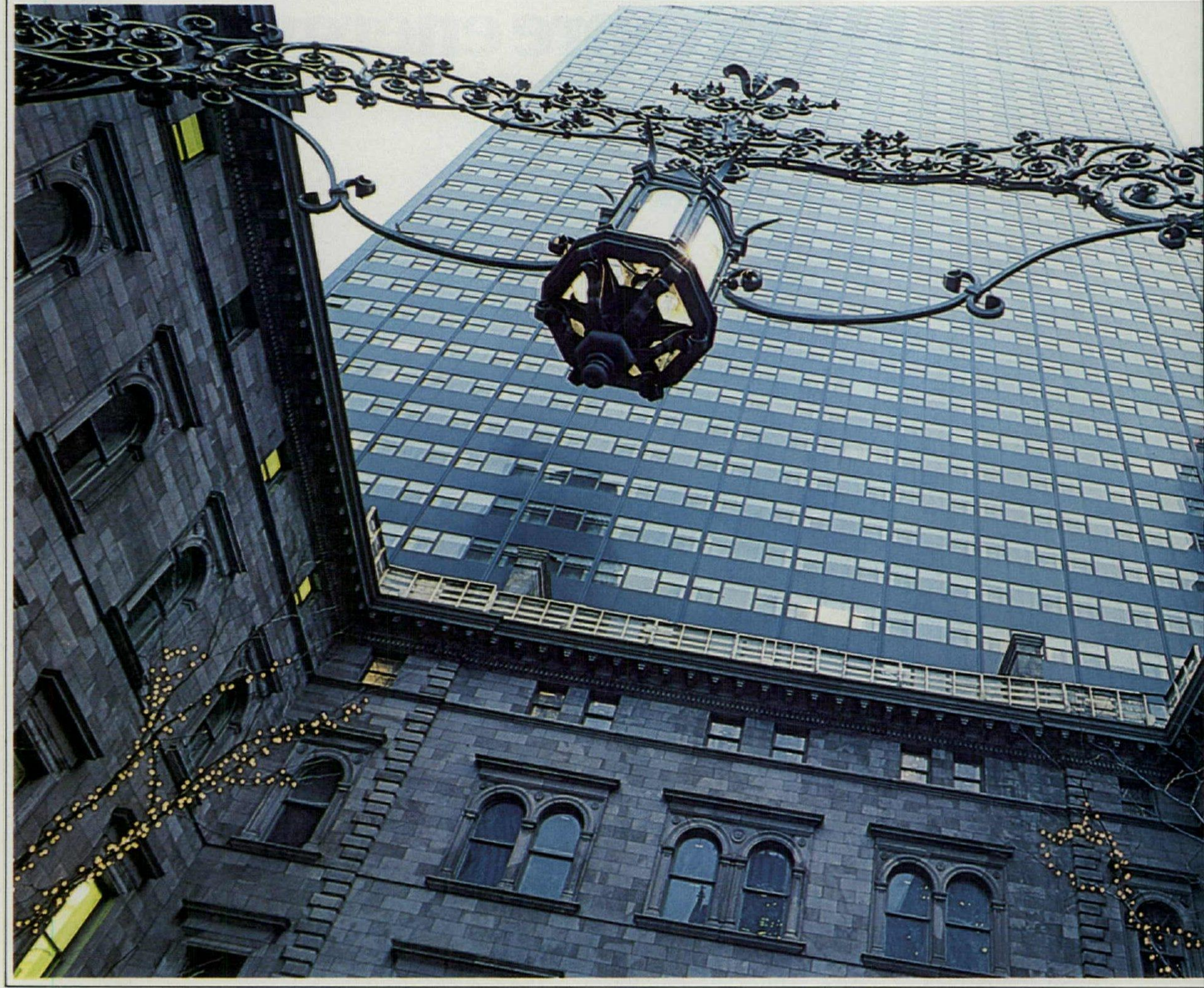
Answers for "Renaissance America."



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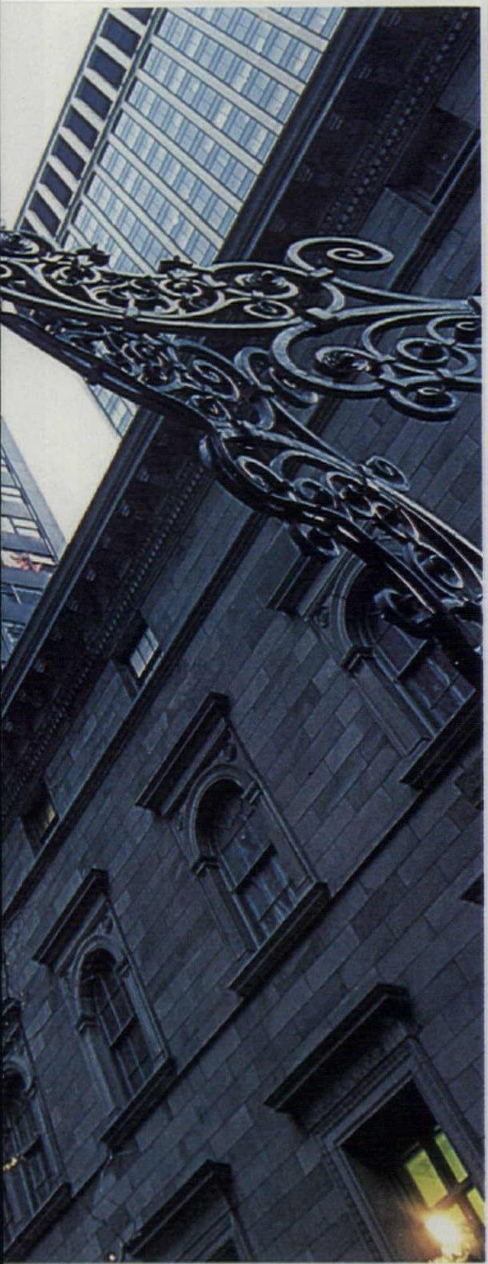

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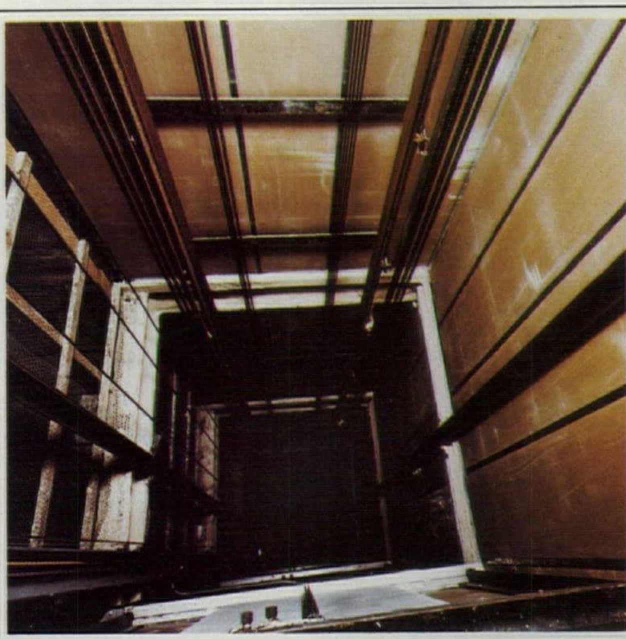
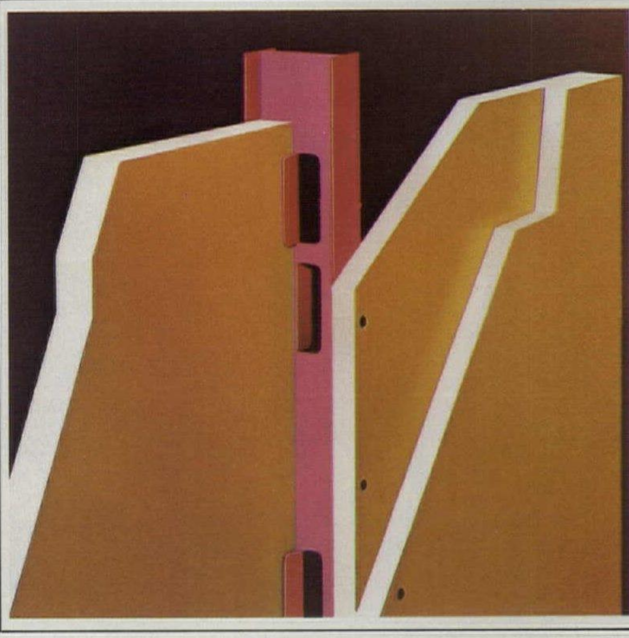
The Palace





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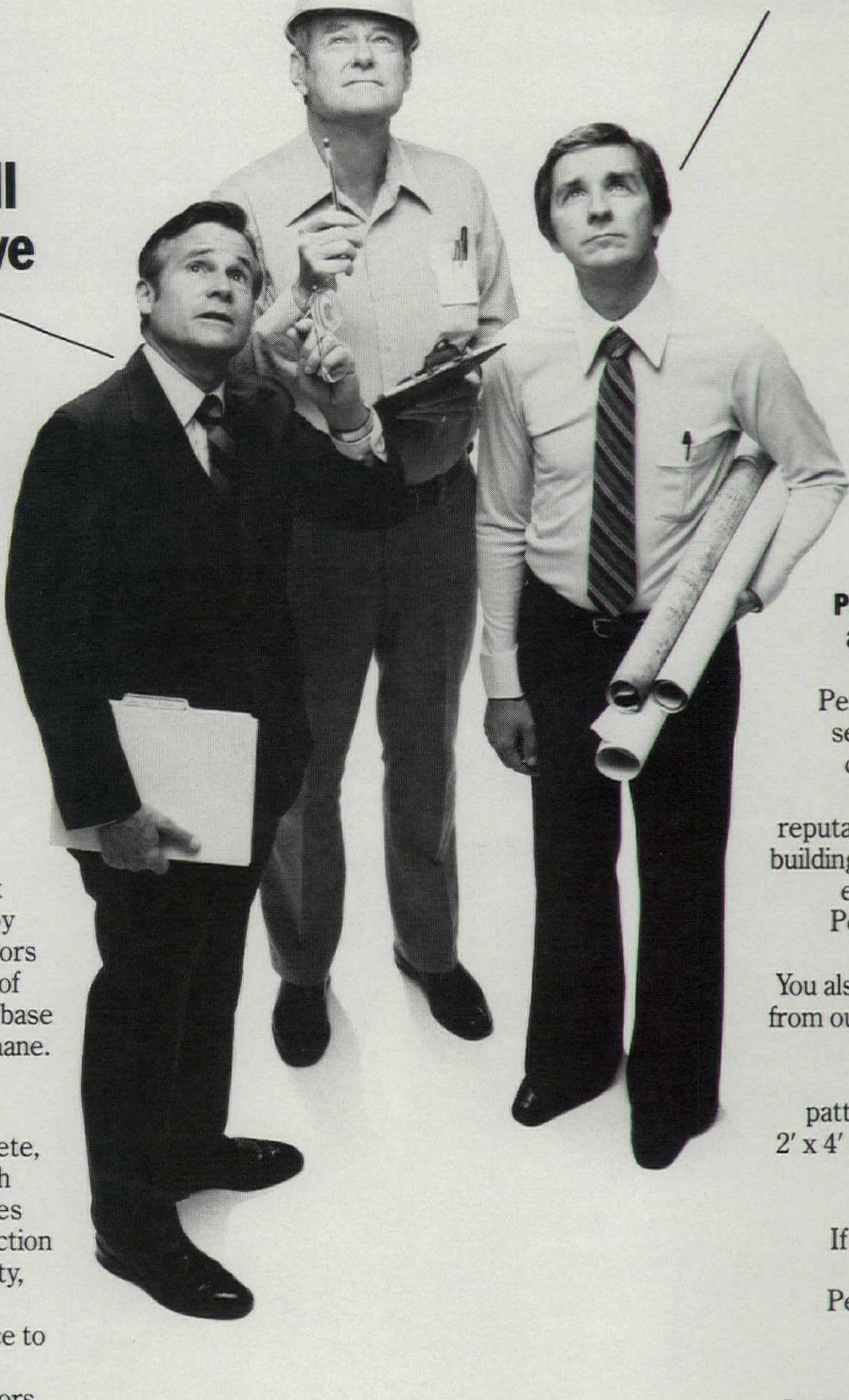

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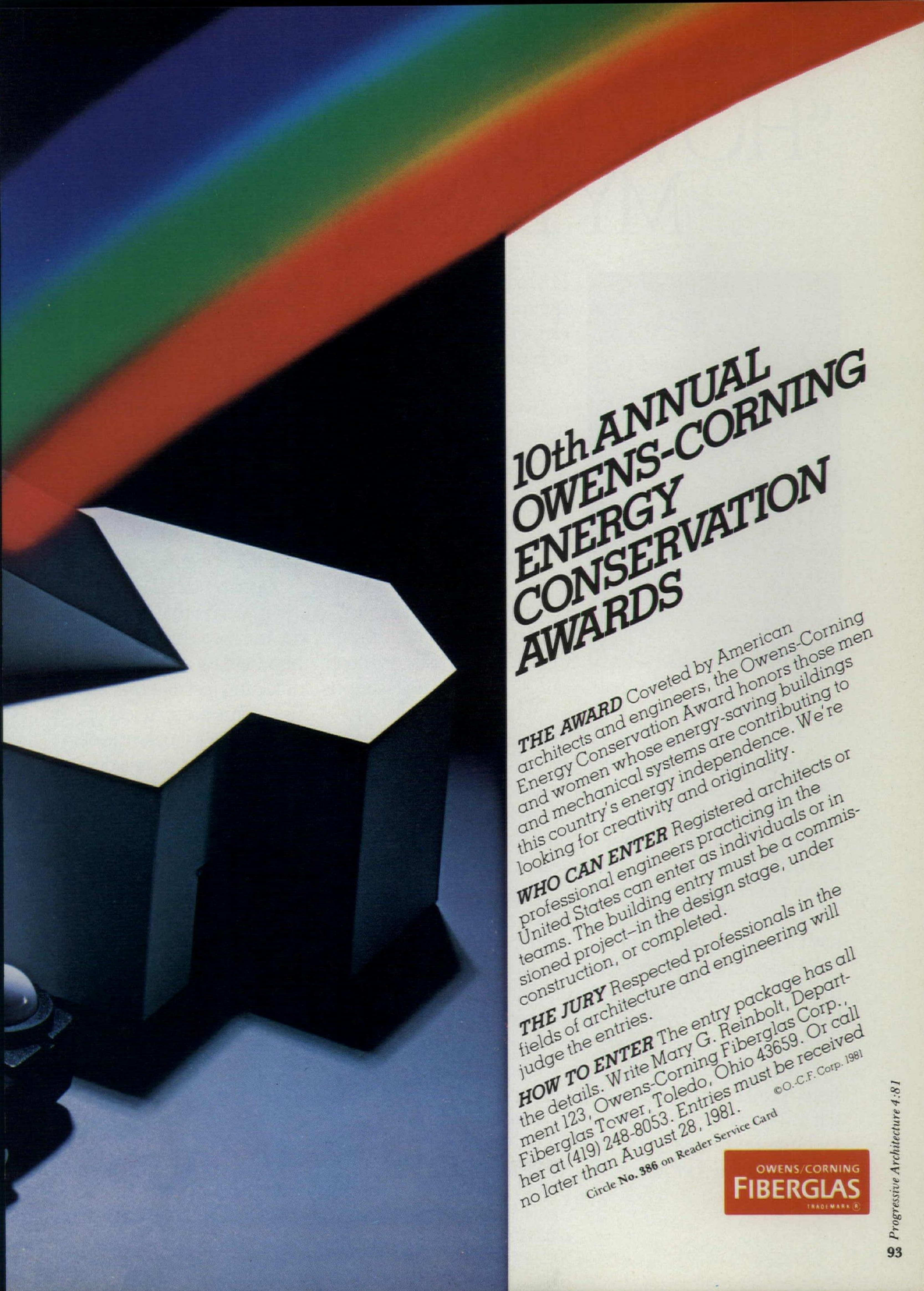
**The technical leader in people-moving systems.**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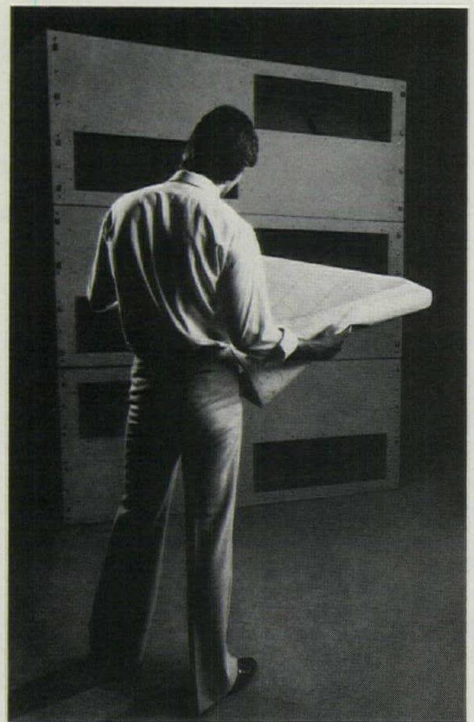
# "HOW I LOST 45% ON MY LAST JOB."



"I'm Gerald M. Fedorchak, the architect.

And Lossnay Heat Exchangers helped me eliminate 650,000 Btu's from what would have been a 1,250,000 Btu heating plant for the Dombey Industrial Center in Portage, Indiana.

The 35,310 CFM Lossnay Heat Exchanger installation I specified will enable my client to reduce heating Btu requirements by 45%, with no penalty in comfort.

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After that, it's all gravy.

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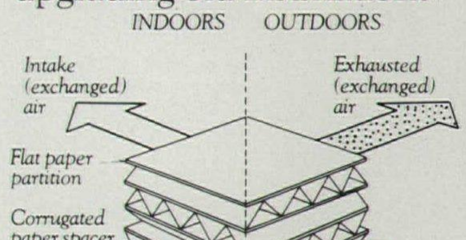


Because there must be thousands of places just like Dombey. That, with very little effort, could easily be turned into losers."

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*Columbia Flier* Building, Columbia, MD. *Architect:* Robert J. Moon, D. I. Design, Columbia. *Contractor:* Jolly Co., Baltimore, MD.

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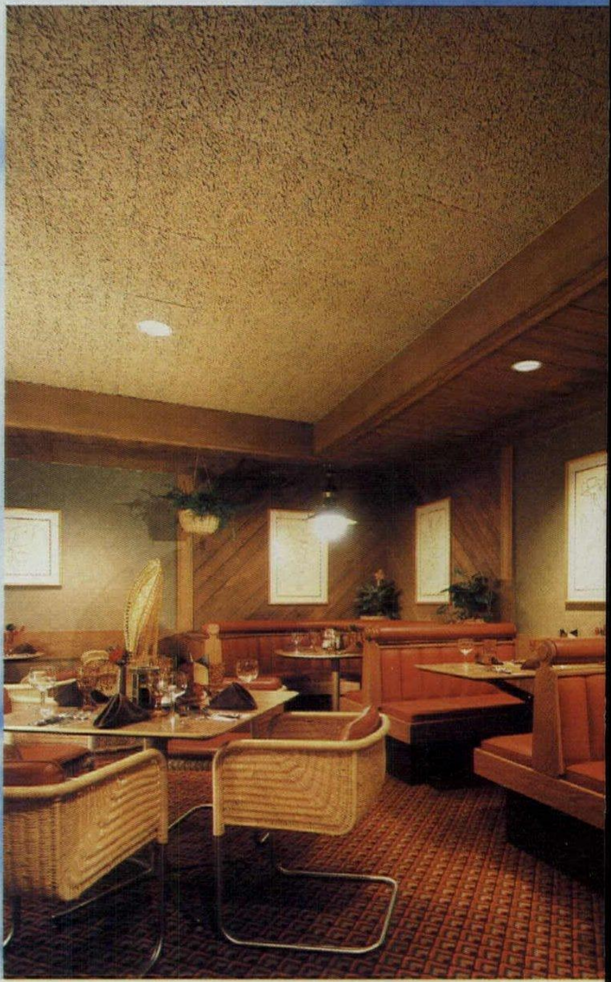
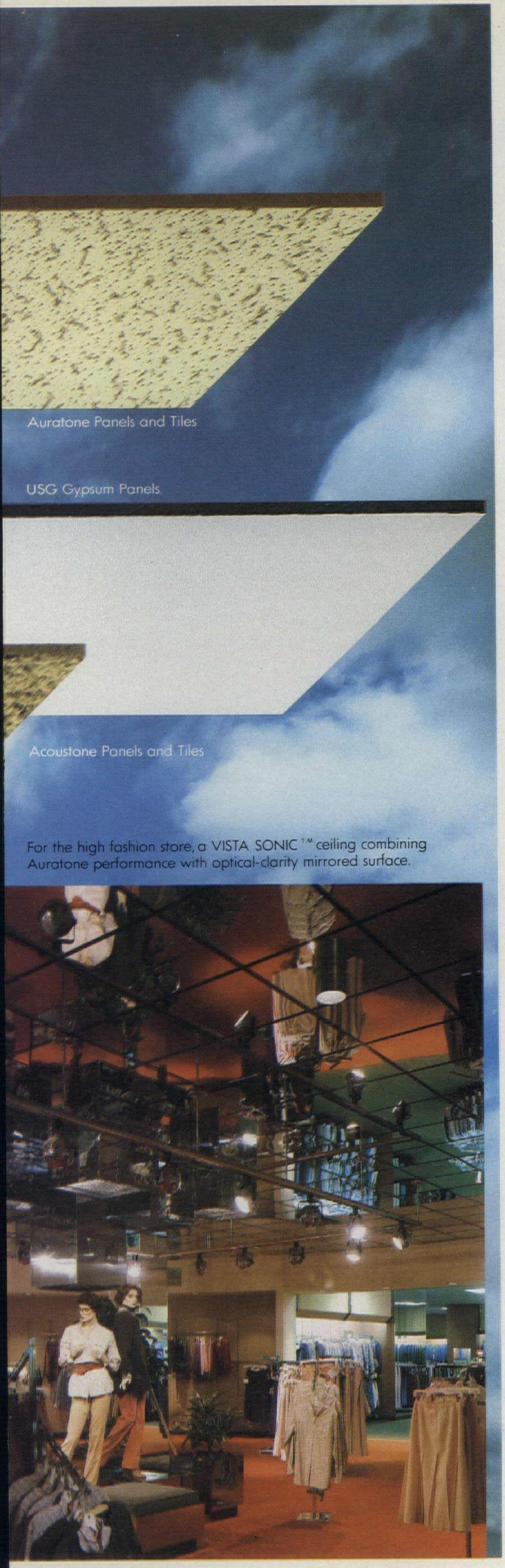


Acoustone ceiling in dramatic earthtone.

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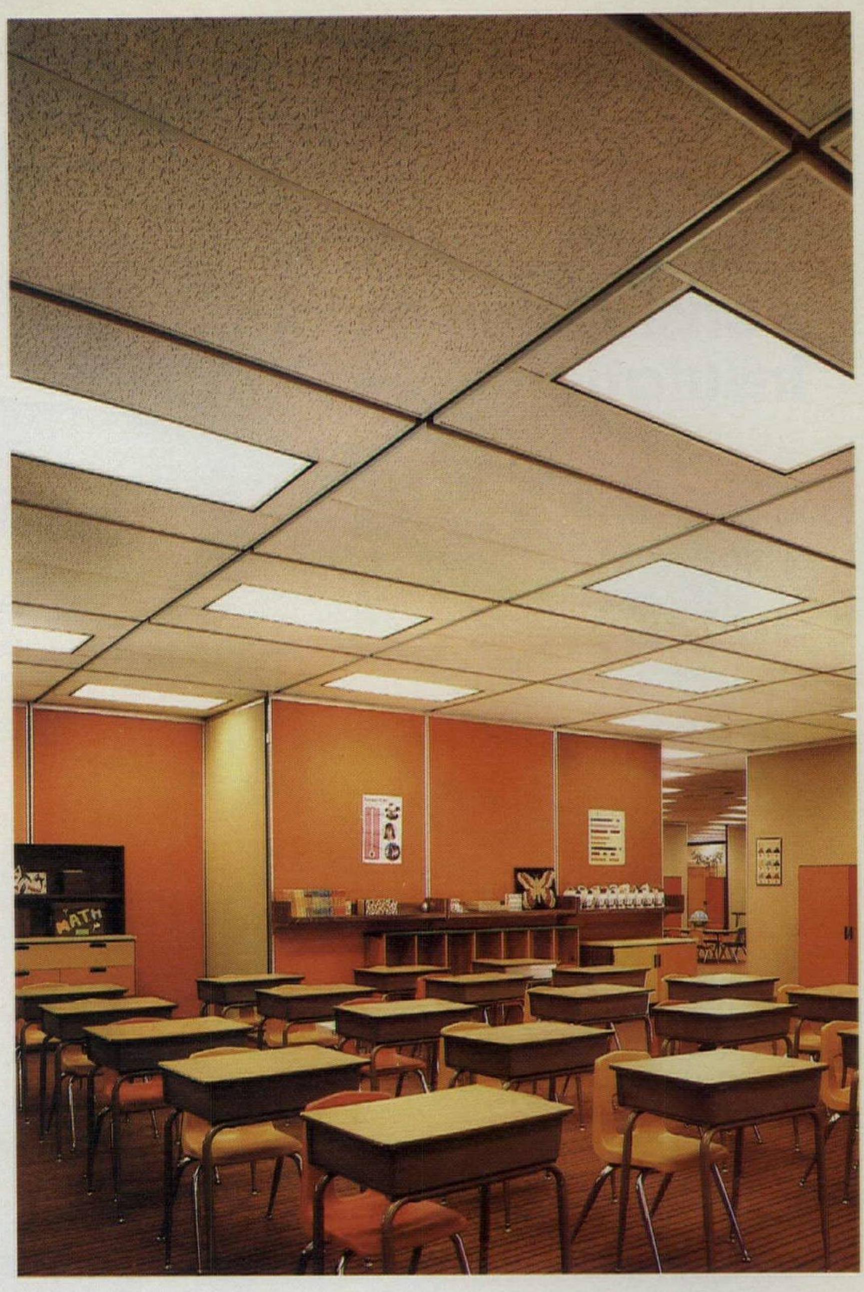


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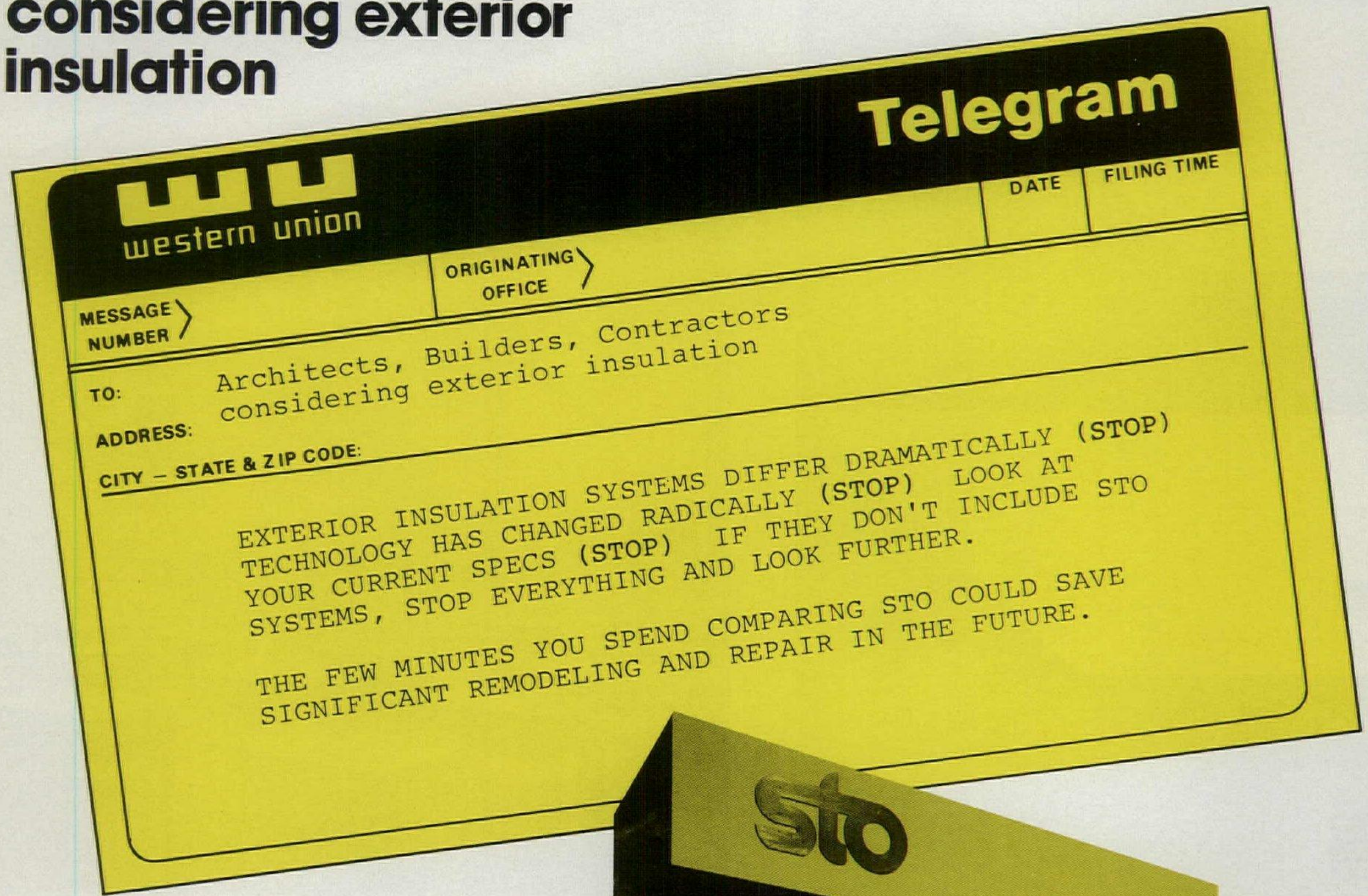
# A timely message to architects, builders, contractors considering exterior insulation

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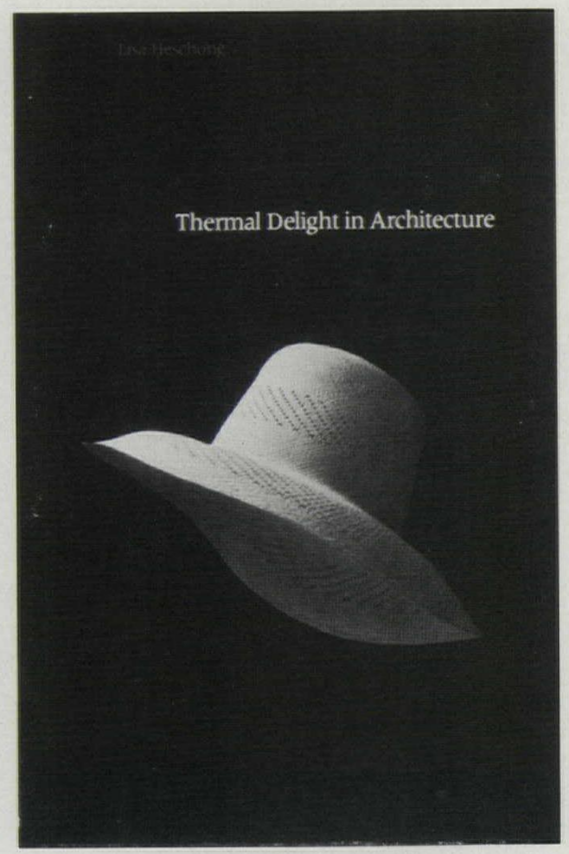
# Form and sense

**Books**




**Thermal Delight in Architecture,** *by Lisa Heschong, Cambridge, Ma, MIT Press, 1980, 78 pp. $5.95 paperback; $12.50 cloth.*
*Reviewed by Doug Kelbaugh, a principal of Kelbaugh & Lee Architects, Princeton, NJ.*

The ancients were not far wrong when they divided their world into the four elements of earth, wind, water, and fire. How to keep the soils of the earth intact, cleanse our winds, purify our waters, and fuel our fires are still some of the most pressing problems facing us today. Fueling our fires is the most topical of these questions and the subject of a whole new literature that is growing up around energy.

Here is a little book, an essay really, that will open your mind and, much to the credit of the author's writing skill, maintain your interest without a single picture or drawing. This is a tough job for any writer in these days of image-ridden media. Ms. Heschong does it by resorting to economy and clarity. Each word is carefully chosen, each sentence carefully constructed. There is no excess baggage, no compulsion to flesh out a longer book. The one image used is on the cover, and it is as delightful as it is poignant: a fresh straw hat floating in a black field in the cool of the night. The hat is an artifact that is at once a symbol and an object of Necessity, Delight, Affection, and Sacredness. These are the four chapter titles of the book; each makes fascinating reading. It is probably best to read the book one chapter at a time, not to rush through the whole thing in one sitting, as is the temptation with a book this short. Like all good books, this one creates its own environment; slowing down and relishing par-

[*Books continued on page 101*]

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**Books** continued from page 99

ticular moments is very much in the spirit of the book. Indeed, speed reading it would be an act of consumption rather than delight. Of consumerism we must beware: we have become consumers of environments as well as of merchandise. We order them up with the turn of a thermostat, little knowing or caring what our buildings must go through to make us comfortable.

Ms. Heschong exposes modern environmental control systems for what they are: "Rather like the Cinderella of architecture; given only the plainest clothes to wear, they are relegated to the back room to do the drudgery that maintains the elegant lifestyle of the other sisters: light, form, structure, and so forth." Thermal qualities are usually not included in the architect's initial conception and are underrated as part of the experience of space. How we *feel* about a space, not just how we see, hear, and move through it, is an important part of experiencing architecture. Sense of place, even *topophilia* or love of place, is emerging as a vital concern of architecture especially as we leave behind the conception of space as universal, Cartesian grid of unlimited equipotential space. Perhaps our place is our sixth sense. As the book points out, we actually *do* have a sixth sense, that of warmness and coolness. It is usually lumped together with the sense of touch, but "we have specialized nerve endings whose only function is to tell us if some part of our body is getting cooler or warmer." Surprisingly, they can't tell what the temperature of something is; rather they monitor how quickly our bodies are losing or gaining heat. They are not thermometers but heat flow meters. This seeming tidbit of physiological information is unknown to most architects, who overlook the importance of the radiant environment. They simply design for air temperature, sprinkle thermostats around their buildings like so many steering wheels, and leave the driving to us.

We are mammals, most of us, and need to maintain a rather precise and constant body temperature. Unlike reptiles, we must enjoy specific thermal strategies, always including clothing, almost always shelter, and sometimes architecture. Most of us know by now about the adaptive and sophisticated thermal strategies of vernacular building around the world, many of which are cited in the book. They are instructive, but arguably a little romantic given today's technical knowhow. This book's point, however, is not that we should abandon modern HVAC, but put comfort in perspective—to realize that "the thermal environment has the potential for . . . sensuality, cultural roles, and symbolism that need not, indeed should not, be designed out of existence in the name of a thermally neutral world." The use of our HVAC systems is directed in a single-minded way to produce standard comfort zone conditions of 69 F to 75 F around the clock, around the building, around the year. Stupid, expensive, and dull; the approach deprives us of such special places as the inglenook fireplace, sauna, Japanese bath, gazebo, Islamic gardens, cool crypt, and porch swing. The book describes these and other examples of thermally delightful architectural traditions. Consider the following paragraph as an example of both how delicious are the traditions and how lucid is Heschong's prose: "Sharing the experience of a pleasant thermal setting may also add an extra bonus to courtship. The gentle cooling breeze of the southern porch swing provided a happy excuse for the couple to quietly sit together. A more technological version might be seen in the type of car that teenagers of the 1950s considered ideal for a hot date—the convertible. The sheer enjoyment of the cool wind whipping by could put a date in the right mood. Slightly more erotic, perhaps, were the atrium and greenhouses that were favorite settings for romance in Victorian England. The lovers could get lost among the leaves of the exotic, tropical plants and possibly mistake the hot, humid atmosphere for their own concealed passion."

Another vivid example described is the hearth. Even if they never use it, people in our culture love having a fireplace. It is, or *was* until that cooler medium TV displaced it, the symbolic center of the house—clearly much more than a place for

[*Books continued on page 103*]


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**Books** continued from page 101

burning wood. It provides not only a physiological experience but an aesthetic one, made all the more acute by sharply contrasting it with cold. Coming inside from, or just seeing, a winter storm outside allows us to savor the fire's warmth. It is around these thermal experiences, not those of an HVAC system, that people develop affection. And it is *affection* that is so sorely lacking in most people's reaction to Modern architecture.

At this moment in history, passive solar architecture is carrying the thermal flag and doing the most toward turning the pumpkin into a carriage. It was while designing a passive solar home that Heschong "became intrigued with the design potential of thermal qualities. . . ." Rather than simply housing an autonomous mechanical system designed by a consultant, the passive solar building attempts from the start to become its own thermal system. It is a giant heat exchanger that collects, stores, and distributes thermal energy, creating dynamic zones of comfort and discomfort, delight and dislike.

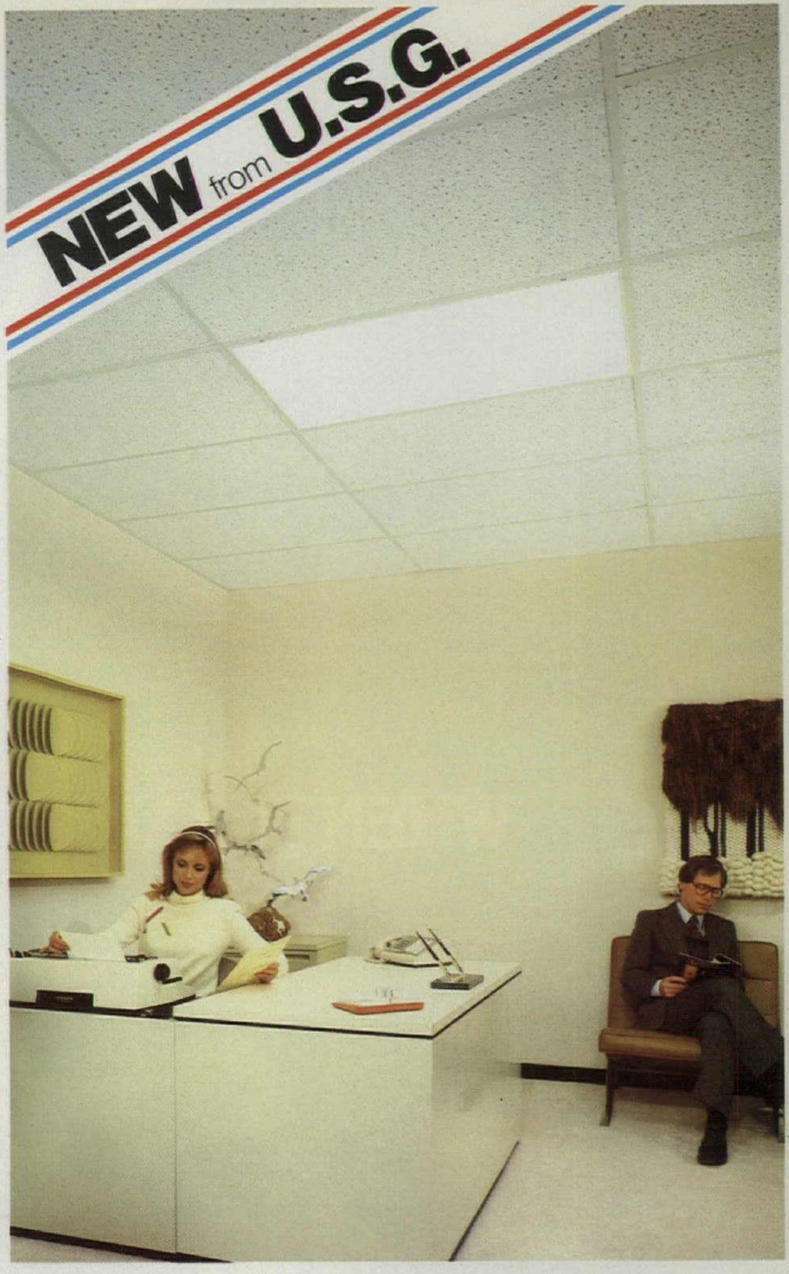
Perhaps it is through delight and affection that solar and Post-Modern architects can converge. Both seem set on developing a friendlier, less austere architecture—the former by manipulating climate and arrows, the latter history and ornament. Both can dip into the architectural vocabulary of earlier periods when energy was expensive and architectural theory less dogmatic and heroic.

In the words of the author, the book is "some background information and a bit of musing." We could stand some more musing on energy and architecture as well researched, readable, and succinct as this. Aside from having a high price per pound, however, the book also suffers from being a bit too charming or precious at times. It occasionally reads a little too much like Kahil Gibran. Its neat division into four cardinal chapters is a little forced at times. The book is a little pavilion, not a major edifice—a jewel-like gazebo or tempietto in one of the gardens so often referred to in the text.

Regrettably, but understandably in a short essay, the book does not take on some of the theoretical consequences of its thesis. Nor does it address issues facing architects who want to abide by or at least learn from these ideas. There are at least four agendas implicit in its ideas: **1** Thermal experience of space should be given more attention; **2** mechanical systems can be cruder and better integrated into buildings; **3** passive solar and other climate-responsive systems should be more widely used; and **4** thermal concerns are the metaphor for energy concerns which in turn are the cornerstone of an ecological consciousness. These are issues that our profession must address, not just because we are running out of fuel for our fires, but because we are losing that ancient respect and affection for our earth, wind, water, and fire.

**Solar Heating Systems: Analysis and Design with the Sun-Pulse Method** *by Gordon F. Tully. New York, McGraw-Hill, 1981. 222 pp., illus., $23.95.*

This practical, lucid book fills an important gap in the literature of solar energy heating system design by making it easily understandable. Without oversimplifying, it reveals a number of truths about system behavior, and takes steps toward correcting a considerable amount of misinformation on the subject that is widely believed, and acted upon, in the engineering community. Using a simple system design as a model, the book explains in detail the overall behavior of systems. It covers all kinds of solar systems, but concentrates on those that are liquid cooled—especially the "drain-back" design that has proven itself to be among the simplest and most reliable of the active system designs. The work also covers air-cooled systems and various kinds of passive systems, and a special feature included is the detailed description of the sun-pulse concept, which suggests a method for simplifying the prediction of solar system behavior. Other topics examined in depth are the design of a simple solar heating system, supply and demand in system behavior, optimizing the system design, heat exchange, space heating and water heating demands, and systems with polarized storage. ☐

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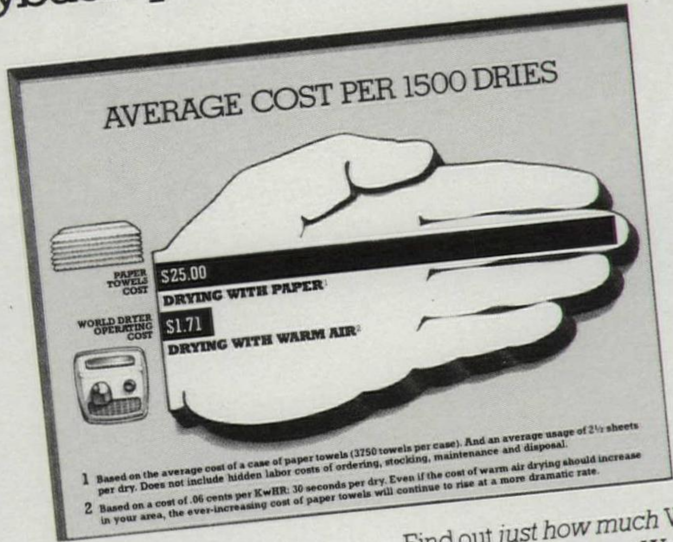


Life-cycle costing (LCC) analyses are being initiated by more and more owners/developers as a part of a disciplined approach to help reduce operational costs of a new building or project. And, smart design firms are looking for design and construction options which offer as rapid an LCC payback period as can be obtained without compromising design considerations. World® Warm Air Hand Drying is just such an option. The comparison chart contrasts the cost of drying hands our way and the other more costly way—paper towels. The cost savings benefit of warm air drying becomes even greater when you add-on the costs always attendant to usage of paper towels: the cost of ordering, stocking, handling and disposing. These additional costs, in fact, are often equal to the cost of the towels themselves. No wonder more and more owners, architects and other key decision-makers are choosing us over paper. Our high-tech units come in an array of fashionable designer colors, too. Economically and aesthetically, World Warm Air Hand Drying makes sense.

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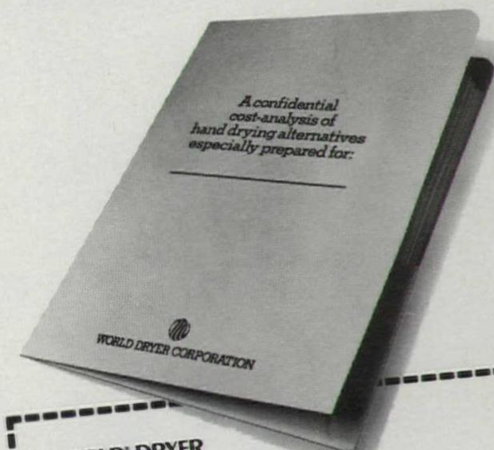


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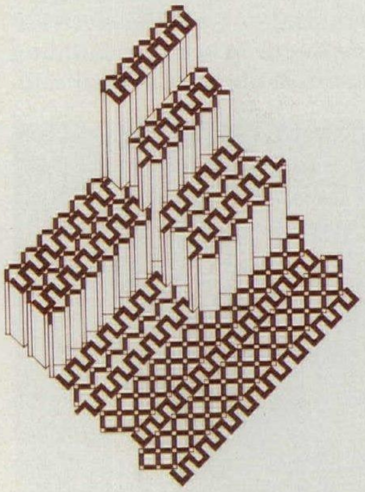
# Technology, talent, and vision

**The architects and designers of the eleven buildings which follow in this issue represent years of dedication and experience in energy-conscious design. Their buildings show a wide diversity of size, use, climatic response, and energy strategy.**



Less talk, more buildings! This is an issue about the present and the future, not the past. There is a nervous sense of victory: the assimilation of energy. After the eight-year plunge into ignorance and inadequacy of design for energy conservation, energy architects shift emphasis, ever so gingerly, away from the thermodynamic technology to its most valid application, the broadest meaning of architecture.

Many of the architects represented by their buildings in this issue are pioneers and leaders of the emergent energy field. Richard Crowther turned exclusively into solar researcher, author, and solar architect almost a decade ago after 30 years of conventional practice. He has built dozens of solar houses, including his own house and office building. His design for a new commercial office building is included in this issue.

Douglas Kelbaugh built the first Trombe wall building in America for his home nearly eight years ago. His place as solar pioneer secure, he now displays his talents as a sensitive versatile designer and as a writer for the book review.

Edward Mazria brings a career of conventional architecture, teaching, passive solar research, and writing to fruition in passive solar design. As a winner in the recent First Annual Passive Design Awards (at the Fifth National Passive Solar Conference), he joins two other winning architects in this issue. Richard Fernau was recognized for the Brodhead House and SOL-ARC was awarded for a solar retrofit, the Berkeley Solar Duplex.

The young Aspen, Co, firm of Copland Hagman Yaw is represented in this issue by the new Aspen Post Office. The firm has been selected twice in the last three years as recipient of an Owens-Corning Fiberglas Energy Conservation Award. Another firm with an impressive record in that competition is Caudill Rowlett Scott. The Bastrop Prison is only one of the two awards it received in the 1980 OCF program. The Museum of Science and Industry by Rowe Holmes Associates, Inc., is also a past winner of an OCF award.

The Levine Residence came to our attention as an entry in our own P/A Design Awards Program for 1980. A six-year continuing effort, the house incorporates both research and teaching efforts by its owner and designer, Richard Levine. Its bold, self-sufficient form is not unlike the Autonomous House, an attempt at a portable solar dwelling by designer/sculptor Michael Jantzen and developer Ted Bakewell III. The effort is Jantzen's third energy-conserving "alternate lifestyle" house. It represents over a year and a half of "hands-on" effort by both Bakewell and Jantzen.

The presence of the Berlin housing project is a product of the combined efforts of architect Susan Doubilet and energy analyst Vladimir Bazjanac on their trips to Germany seeking "state-of-the-art" energy buildings in Europe. Dr. Bazjanac performs an Energy Analysis of the International Meeting Center for this issue and also reviews the past year of Energy Analyses.

The buildings in this issue range from "wood butcher" to High Tech to Post-Modern to Modern, proving beyond question that energy-conserving building is not necessarily in itself a style. They vary in climate from Florida to California, Pennsylvania to New Mexico. With the exception of the German building, they are all built examples and range from a building the size of a house trailer to a prison covering several acres. The uses range from retrofit duplex to office building.

Concentrating on energy for a moment, one will find an impressive array of energy-conserving tactics from active solar to direct solar gain to earth berms. Where possible, we have attempted to present the energy strategy in a diagrammatic form and also with construction details and sections to provide a feel for the physical realities involved.

The designers and firms whose work follows rise above their technological peers because they go beyond energy in their designs. They excel over their design peers because they demonstrate a full experiential base in the technology. There are probably not one hundred such design offices in America today. These people are among the few because they have had the talent, the intellect, and the vision when those around them waited and watched. We applaud them. [Richard Rush]

**Museum of Science and Industry, Tampa, Fl**

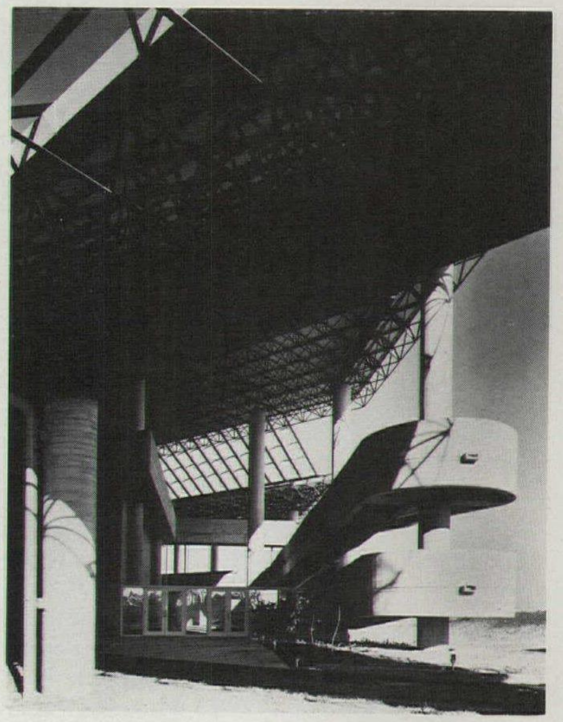
# The elements and form

**A new museum by Rowe Holmes exhibits its area's heritage in science, industry, and social culture, and becomes an instructional device in itself for teaching about energy and the environment.**

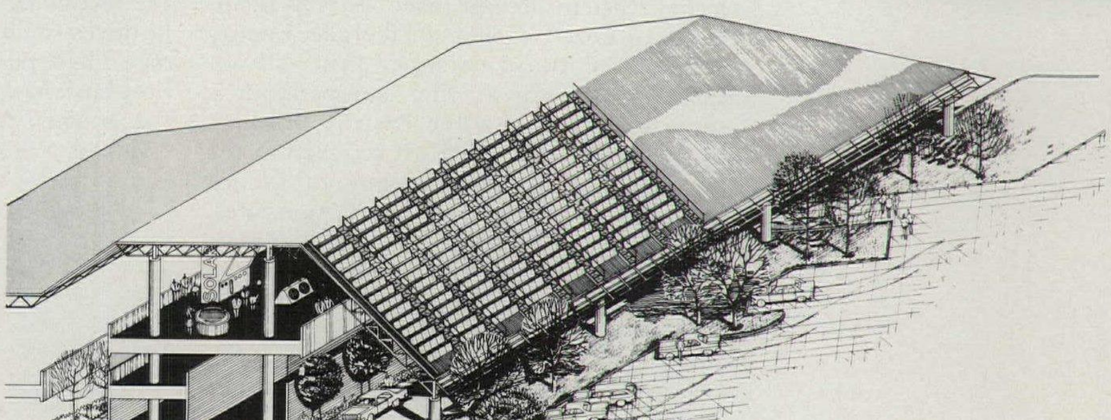
The new Museum of Science and Industry in Tampa, Fl, is not just a container for exhibits about the area's natural, cultural, scientific, and industrial past and present. While these are the primary reasons for the building's existence, a major part of this museum concerns the building itself as an important exhibit and educational tool relating to energy use and its conservation. This involves not only the form and structure of the building, but most of its systems and their design as integral parts of the exhibits and of the learning experience in general.

The building consists primarily of two rhomboidal forms situated parallel to each other but joined by a common, slanting space-frame roof divided by a linear skylight that corresponds to the separation between the two forms. This creates an atrium that brings energy-saving natural light not only into the middle of the building, but also, via ground-floor interior light monitors, into the half of the first floor that is partly sunken into the ground. Here the monitors also allow visitors to peek into such areas as the shop, design studio, and mechanical room, which are the kinds of spaces one usually does not get to see in a museum.

In addition, the roof itself has some very important functions in relation to energy conservation. The north side is sloped for collecting rainwater. The water is directed into a drainage system that carries it to cisterns where it is stored and treated for later use in museum exhibits demonstrating water energy technology. The sloping south portion of the roof, which is a third rhomboid, not only shades the building from direct sunlight, but is designed and angled for the eventual installation of photovoltaic cells. The supplemental electricity they could provide would be used mainly for incandescent and fluorescent lighting and small motor loads, and could provide 10 to 15 percent of the peak-load requirements of the building or 80 percent of the exhibit load. The basic part of the energy converter is designed for a 1500-unit field of collector plates with a louver walk between rows, and it is engineered so that the museum could experiment with different field areas without draining off the electrical power being generated. When the building was named a winner in the institutional cate-

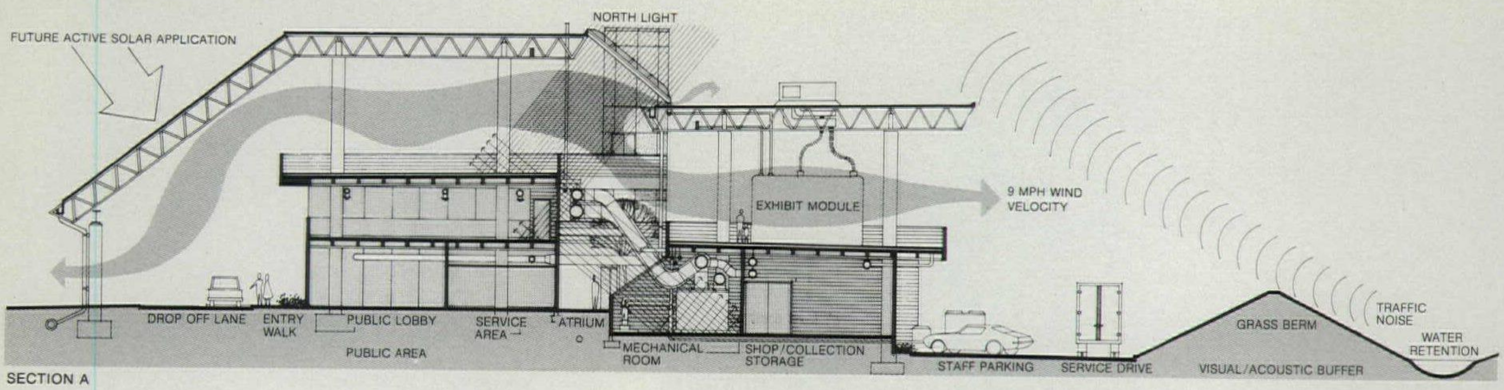


*The extreme south portion of the three-part roof (below) shades the museum from direct sunlight in the hot, Florida climate. It was designed for the eventual installation of photovoltaic cells, but now functions as a covered drop-off area. There are entries at both the east (facing page, top) and west (bottom) ends of the building, with a ramp for large groups and the handicapped at the latter.*



PROPOSED SOLAR PANEL APPLICATION


service only

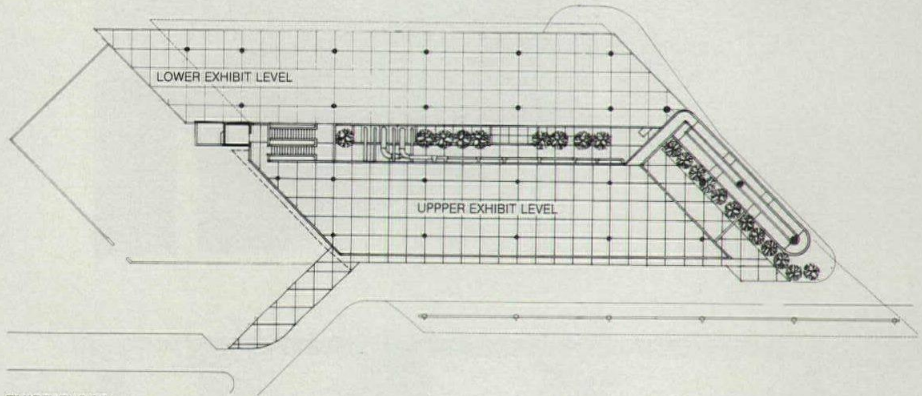


SECTION A

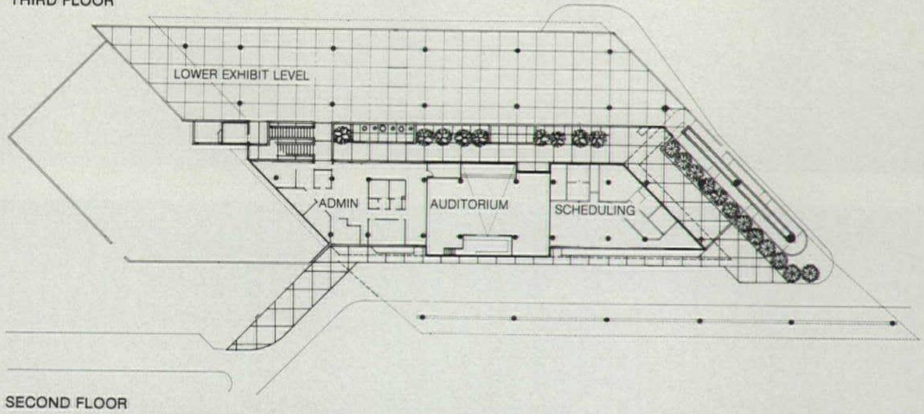
gory of Owens-Corning Fiberglas Corporation's Energy Conservation Awards Program last year, juror Frank J. Powell, manager of the Insulation Program of the National Bureau of Standards, remarked that "the roof design demonstrates how some of the problems of solar systems can be solved through appropriate architectural design."

But there is more to the roof. Its planes are also designed to aid in summer cooling. Because much of the exhibit space is open under the roof canopy, the roof is designed to capture prevailing east and northeast winds and channel them through the building by convection-induced air movement. Vented openings where the planes intersect increase movement, and the system as a whole, which keeps the temperature 20 degrees cooler than outside, becomes one more demonstration of no-cost natural energy. The south sloping portion of the roof, in addition, is designed to function as a cover over the vehicular drop-off at the building's main entrances.

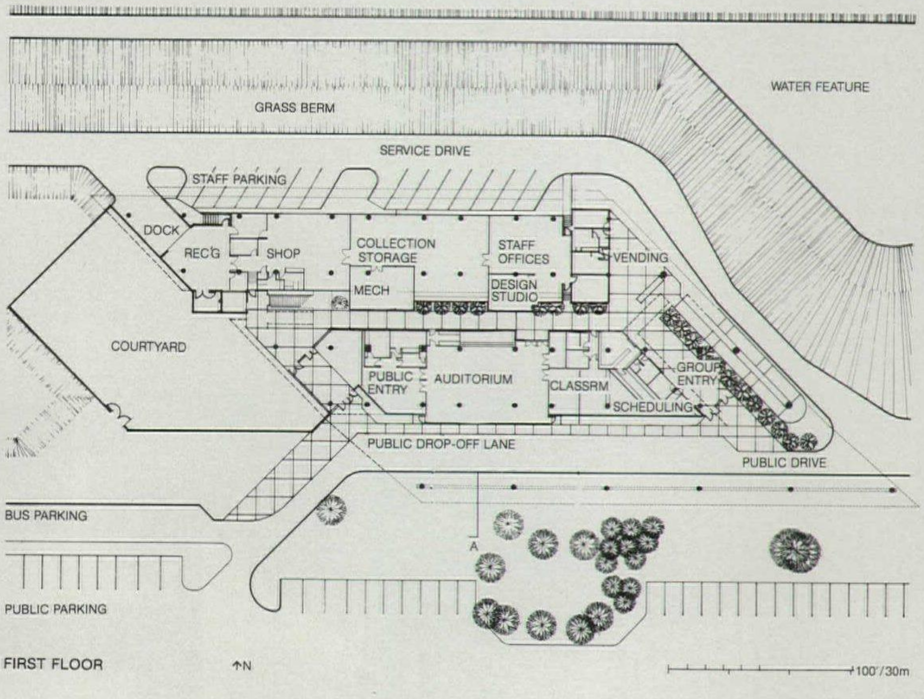
Because of the climate, it was decided early on that this building should not be designed as an enclosed envelope, as might be required elsewhere. Nevertheless, even though two-thirds of the building is open, insulating concrete block has been used throughout as an additional energy conserver. Within the building, there are basically three different types of spaces: those that are completely enclosed, such as the offices, work areas, and auditorium; those exhibition spaces that are completely open under the roof canopy; and those that are in enclosed pods under the canopy. The latter are air conditioned by roof-top units, with clearly visible flexible ductwork dropping down to the pods. This



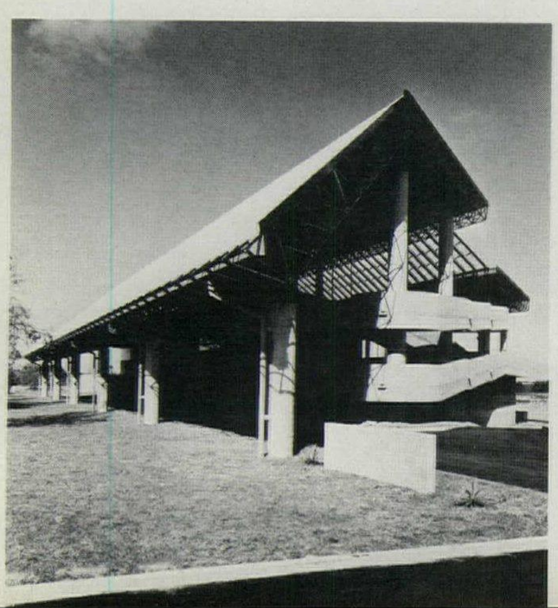
THIRD FLOOR



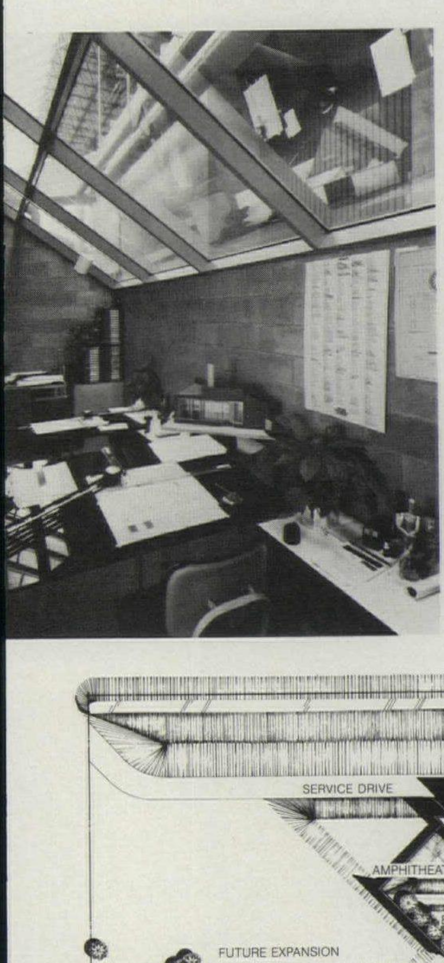
SECOND FLOOR

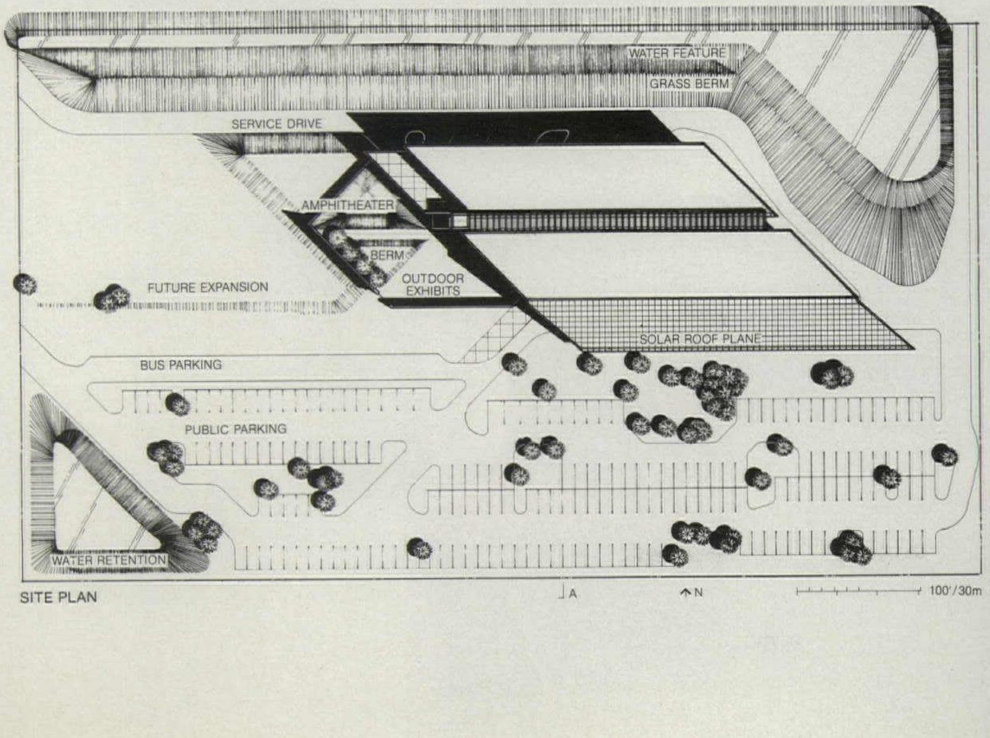


FIRST FLOOR ↑N 100'/30m



*The atrium (right) is the major circulation spine through the museum; light entering from the top passes through main-level monitors (bottom right) and into the offices and shops at the lowest level (below). The building is essentially a pavilion, with major exhibition areas in open spaces under the canopy-type roof.*




device represents an attitude seen throughout the building: many of its mechanical systems are exposed for their educational value. Electrical conduits are exposed and painted bright colors, as are plumbing lines and air ducts. In addition, the structural system is never concealed or hidden in any way, so it also becomes an important instructional device, making up a building that can be used not only for teaching about building technology, but also about the sun, wind currents, rain, and physics in general.

The building was constructed primarily with Federal Economic Development Action grant funding, and the people of Tampa and Hillsborough County have high hopes that more funding will become available so the roof can eventually serve the complete purpose for which it was originally designed. [David Morton]

*The auditorium and lobby (this page) are at the lowest level at the west end of the building on the south side. Opposite them are the shops (facing page, bottom), and above all are the three levels of exhibition space (facing page, top), shown here with new exhibit modules in construction at the middle level.*

**Data**

Project: *Museum of Science and Industry, Tampa, Fl.*

Architects: *Rowe Holmes Associates; H. Dean Rowe, Dwight E. Holmes, John L. Tennison, S. Keith Bailey, Michael A. Shirley, design team.*

Program: *60,000-sq-ft museum for exhibition of county's scientific, industrial, and social cultural heritage; building itself to be instructive about energy and environment.*

Site: *7.7 flat acres bounded by a new university campus and industrial parks.*

Structural system: *precast concrete joists with cast-in-place columns, beams, and floor slab. Roof canopy of steel frame; foundation of continuous strip footings.*

Major materials: *domed plexiglass skylights, insulated concrete block exterior walls, built-up roof membrane with rigid insulation, single-glazed butt-jointed glass, carpet, ceramic tile, vinyl asbestos tile, scored concrete with exhibit hold-down plates (see Building materials, p. 255).*

Mechanical system: *air handler with chilled-water unit and pumps utilizing dualwall, insulated, round metal exposed ductwork, in-line duct heaters, and variable-volume boxes; exhibit floors use roof-top packages with flexible ductwork to exhibit enclosures.*

Consultants: *Rowe Holmes Associates, landscape, interiors; Rast Associates, structural; Ossi Consulting Engineers, mechanical; Hillsborough County Museum Staff, exhibit design and enclosures.*

Construction manager: *C.M. Constructors.*

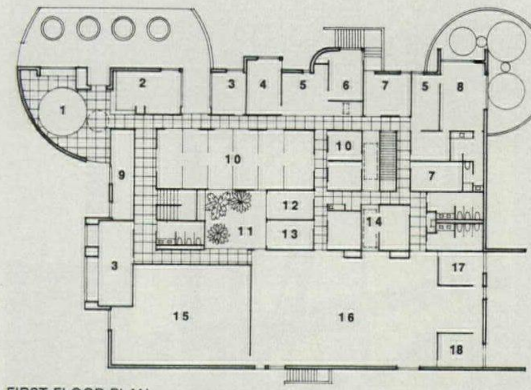
Cost: *$3,987,556.*

Photography: *Gordon H. Schenck, Jr.*

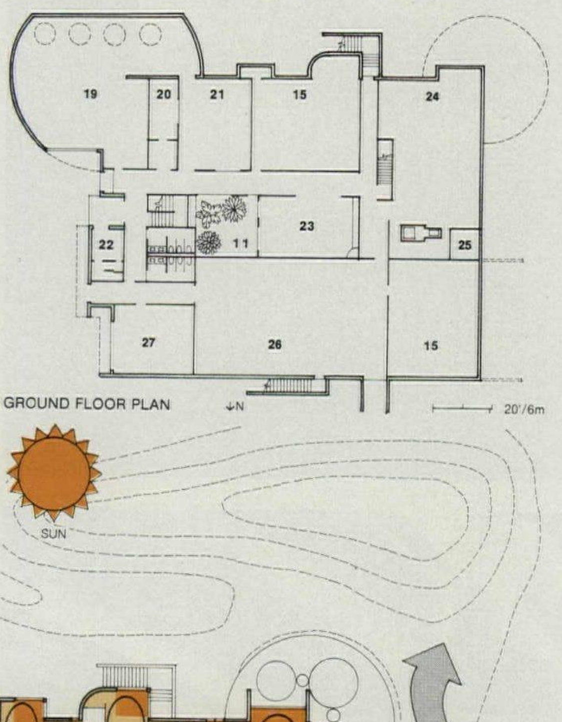
**Hotsy Corporation headquarters, Denver, Co**

# Hotsification

**A new corporate headquarters in Denver offers its architect Richard Crowther an opportunity to display his skills at matching management needs with his extensive energy repertoire of building form.**



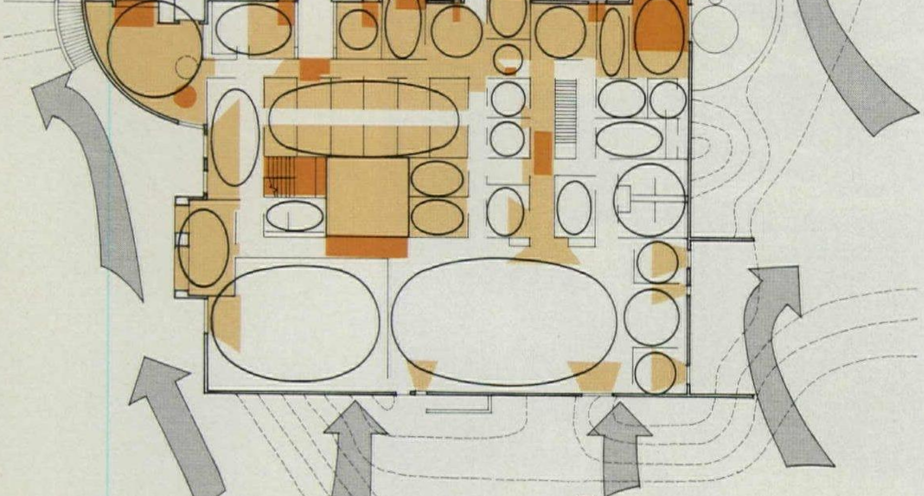
FIRST FLOOR PLAN




GROUND FLOOR PLAN

**Legend**
1 Lobby
2 Reception
3 Office
4 Sales Mgr.
5 Secretaries
6 Sales VP
7 Conference
8 President
9 Display
10 Sales
11 Exterior Courtyard
12 Service Mgr.
13 Purchasing Mgr.
14 Skylight interior courtyard
15 Future expansion
16 Accounting
17 Comptroller
18 Treasurer
19 Demonstration
20 Audio-visual
21 Classroom
22 Maintenance
23 Lunchroom
24 Mechanical equip.
25 Heat storage rock box
26 Storage
27 Garage

*Direct solar gain, daylighting, earth-berming, and wind-shaping combine with planning for thermal zones to save energy.*




KEY
DIRECT SOLAR GAIN
DAYLIGHTING OR AMBIENT DAYLIGHT FROM THE SKY
WIND
THERMAL ZONING

DIAGRAM: FIRST FLOOR PLAN SHOWING THERMAL ZONING AND SOLAR CONTRIBUTIONS (AREAS SHOWN AT NOON FOR AN AVERAGE WINTER DAY)

This is not an "energy" building. It is not focused solely on energy conservation nor is the focus on building per se. It is more cosmic, more humane, and more important than that. It is the studied composition of space, within a built and natural environment, in which people work and interact comfortably with each other. Energy conservation is but one element in the composition.

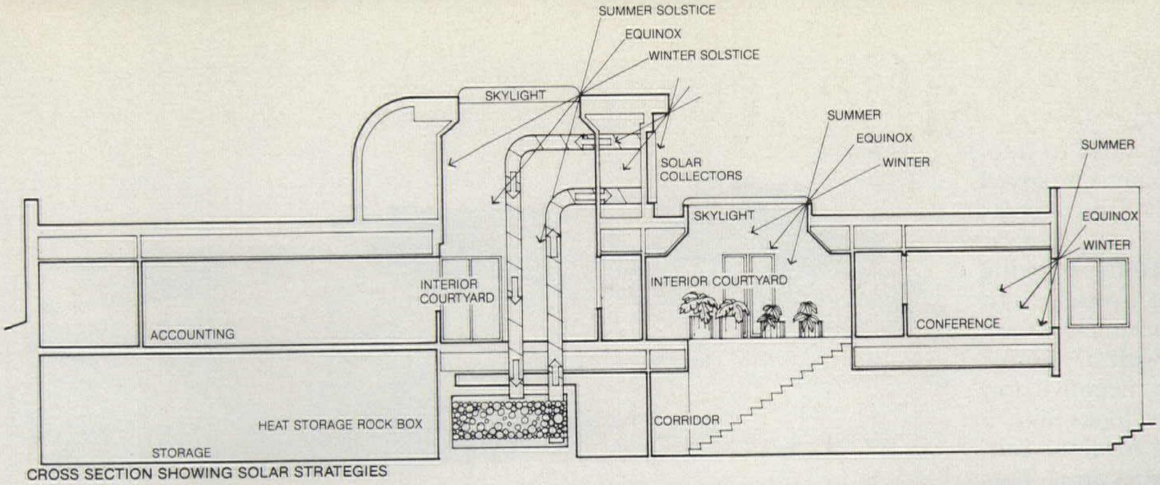
The new Hotsy Corporation building, as a sociophysical organization, is something of a battle formation. The company sales force is positioned in the front ranks, near the entry, aligned to entice and cajole clients with its Hotsy-red carpet and smoke-gray partitions. The "officers" of sales as overseers are positioned deeper into the building. At the flank, the accounting department is poised as a body to follow up the sales initiative. Far back in the ranks, but with direct path to all quarters, is the president, like a general reviewing the battle for commerce.

The second floor below serves as the home camp. Food and refreshment are taken there. It is where training occurs and where important equipment, vital to life support for the whole corps, is quartered.

So effective is this small "army" of corporate workers that it has outgrown its last home in just ten short years and asked its original architect, Richard Crowther, to design the new headquarters. There is even ample space to grow already designed and built into the new building. The corporation has coined a new word to describe their success, "Hotsification": a phenomenal condition which puts money in the bank. The growing company sells industrial (fire-engine red) steam-cleaning machines.

Although the corporate hierarchy is strongly expressed in the building organization, there is also a common denominator of human needs. Each employee has a sense of visual contact, not only with his fellow worker, but with the outside climate as well. Where a direct view is not possible, skylights, and an interior courtyard serve as reminders of the spectacular mountains and sky that are Denver.

The building is but the obedient servant of this human force. It politely gathers solar heat from the long, undulating south-facing



CROSS SECTION SHOWING SOLAR STRATEGIES

*In section (left) the sun is permitted to enter the building for both solar heat and daylight. The air-type solar collectors use the roof as a reflector to enhance solar gain. The exterior entry (below) passes by domed skylights for the demonstration area beneath it. The entry waiting area (bottom) has its own skylight.*

windows and walls, and almost invisible from the ground view, uses vertical solar hot air collectors to receive and store the sun's free heat at the roof. The mechanical system frugally soaks up excess electrical lighting heat and human body heat from the small spaces and adds it to the solar heat to supply the colder northern zones of the building when necessary. Radiant ceiling panels, summer air conditioning, and a variable volume air distribution system (with economizer cycle) add mechanically what the building itself cannot supply.

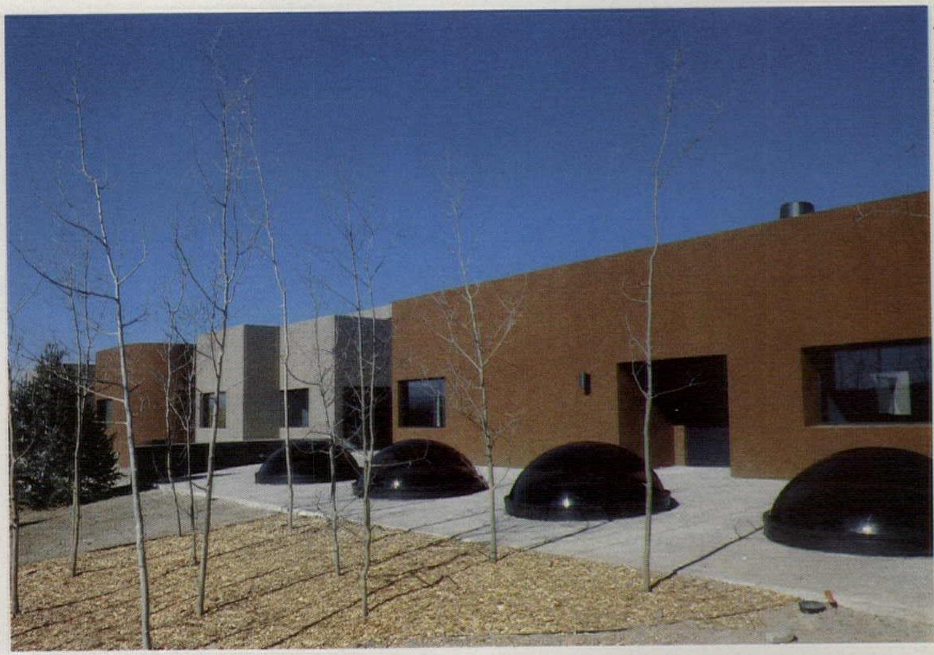
Prestressed concrete floor panels and walls are augmented with cast-in-place concrete and steel framing where the geometry of the building makes precast tactics difficult. The heat or coolness trapped in the heavy concrete mass is held there by the stuccoed and colored exterior insulation, which has become a trademark of Crowther's recent projects (P/A, April 1980, p. 150).

As the building serves its occupants, the site serves its building. The earth is bermed to inhibit heat loss in the winter and to shape the wind away from the building. In the summer, winds help cool the building. The deciduous planting around the building is meant both to accent the building form and to block the summer sun.

A sense of hierarchy prevails in the building interior spaces, even as the decision-making becomes less objective. Colored wall panels are used throughout the building to accent and brighten spaces. In the lobby and prime spaces, the panels are colored as well as modeled in relief. Elsewhere they are flat.

The space occupied by the salesmen is somewhat glamorous and emphasizes the separate identities inherent in such activities. The space for the bookkeepers accents their importance as a congregation of people who must cooperate with each other. By contrast, the president's office is equipped with a private chamber and lavatory, not to mention an exterior covered patio and the prime shot at the view. The president, Robert L. Cohen, has more basic goals than mere luxury. He likes the new office not just for the view, but because, he explains "I get a lot more work done here."

The conference rooms and classroom incorporate state-of-the-art health technology, says Crowther, "to remove cigarette smoke from the air and stimulate the endocrine systems of the occupants." Long a prominent spokesman for "holistic" architecture,


Richard Crowther


Karl H. Riek

## Hotsy Corporation, Denver, Co

Crowther is constantly seeking ways to integrate the various design strategies employed in a building with the most modern concepts of human health.

He detests the idea of cigarette smoking and will not permit it in his presence. In order to control the smoke where it does occur, he supplies such spaces with a positive field resonance source and a negative ion generator. The ion generator looks like a translucent plastic rod hanging from the ceiling with a water-color brush stuck in its bottom. In several of the spaces he uses black metal light fixtures to double as positive field resonators.

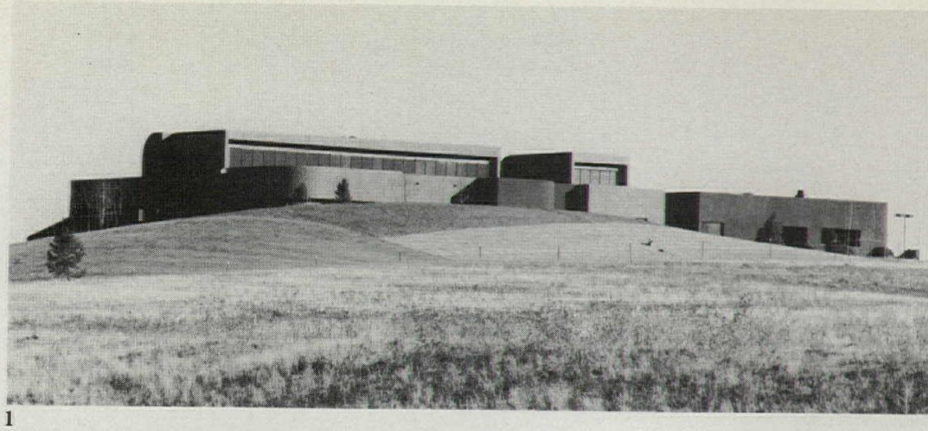
When smoking occurs in these spaces, or any other type of lightweight particulate is generated, it is charged by the field created and travels the shortest distance to the body of its opposite sign. The smoke simply grounds out on the light fixture. The fixtures are black in color so that when the yellowing smoke accumulates, it can be wiped away periodically without a change in appearance.

Last year's April issue of P/A presented Richard Crowther's home/laboratory, a building brimming with innovative energy technology as well as holistic design concepts. The house and the commercial building bear comparison. The site philosophy, structural system, high mass and exterior insulation, hot-air collection, and strategic spatial planning carry from one building to the other.

There are no eutectic salts or greenhouses in the Hotsy building. The scale is too large to permit such local and normally user-sensitive strategies. Although the office lighting fixtures are conventional parabolic baffled fluorescents, they are equipped for three levels of illumination and individual controls. The courtyard, which allows light and exterior reference to the interior spaces, is open to the sky and is not used to collect heat directly. This space suffers visually from its small size, and only time and care will eventually take the sting out of its feeling of an aquarium without fish.

The Hotsy building tries to place its value where it will do the most good. It achieves considerable elegance in its prime spaces and manages to add just enough character to even the basest space. The curved concrete demonstration room on the lower floor still manages to have four domed skylights. They bring natural light into the barren underground space and punctuate the entrance process as bulbous space-age sculpture. The building is two-toned on the exterior, not an energy decision. Why not all the same color? "I couldn't bring myself to do it aesthetically," Crowther explains.

There is another very important difference between the Hotsy building and Crowther's own house: In the house he had to please only himself. He had a single question for the head of the accounting department leaving the building after a day's work and a fortnight of building use: "Are you happy?" [Richard Rush]



1

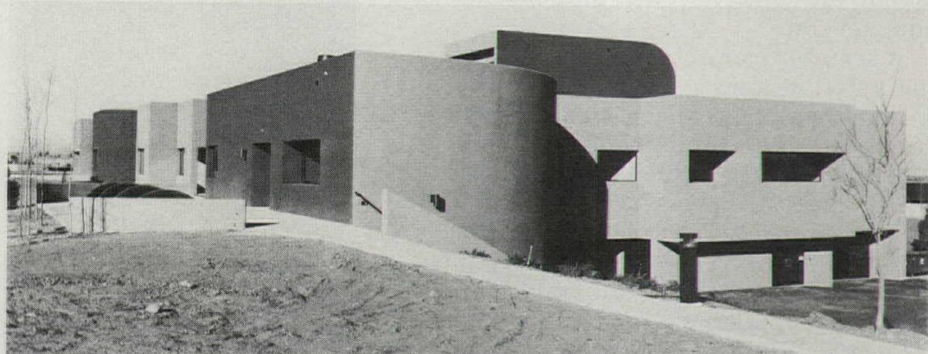
Lee Phillips

2

Karl H. Riek

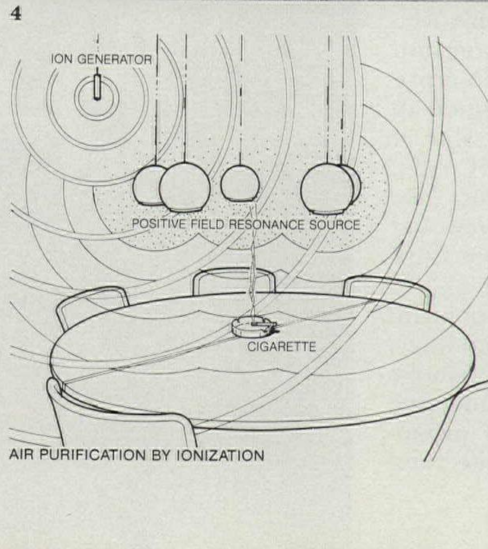
3

Lee Phillips



4

Lee Phillips




AIR PURIFICATION BY IONIZATION

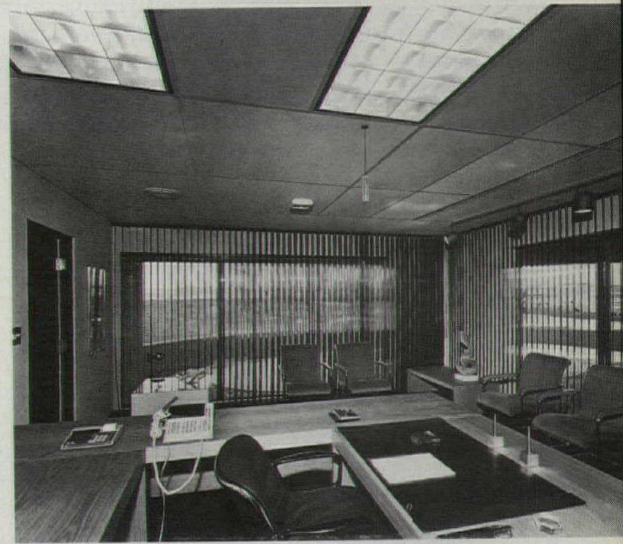
*1 Southern exposure, 2 western exposure, 3 northeast exposure, 4 southeast exposure. 5 Sales force offices, 6 president's office, 7 circulation space, 8 demonstration area below the entry. A Hotsy conference space (left) is equipped with a negative ion generator and a positive field resonance source to free the air of particulates such as cigarette smoke.*

**Data**

Project: *The Hotsy Corp., Englewood, Co.*
Architect: *Crowther Architects Group, Richard L. Crowther, Denver, Co.*
Client: *Robert L. Cohen.*
Site: *hilltop office park.*
Program: *corporate headquarters; area 29,000 sq ft.*
Structural system: *precast concrete, cast-in-place concrete and steel framing.*
Major materials: *steel studs, synthetic coating over polystyrene board, expanded polystyrene roof insulation, glass fiber batt wall insulation, gypsum board (see Building materials, p. 255).*
Mechanical system: *air-type solar collectors with rock bin, electric radiant heating, variable volume air conditioning.*
Consultants: *Cator Ruma & Assoc., mechanical; Structural Consultants, structural.*
General contractor: *Shaw Construction Co.*
Costs: *$1,400,000.*

5

Photos: Karl H. Riek



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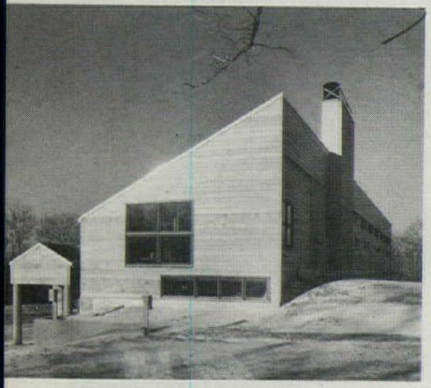
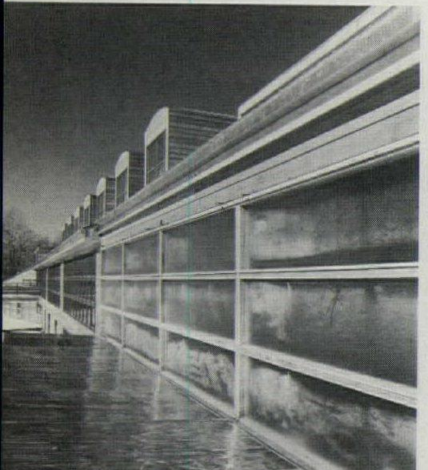
Milford Reservation
Environmental Center,
Milford, Pa

# Passive action

**High in the Pocono Mountains, Kelbaugh & Lee have designed a comprehensive and sophisticated passive solar building.**

*A number of passive solar devices at the south side of the Center (facing page) will provide 75 percent of the building's environmental conditioning: these include Trombe walls at the two ends, direct gain through dormers, large hall windows, a water wall at the lowest level, and a hot water preheating tube under skylights at the pitch of the roof. The north side (below) is partially buried for additional insulation, and the Trombe wall (bottom) is equipped with a hinged insulating reflector.*





The Milford Reservation Environmental Center may be, as the architects claim, "the most comprehensive and sophisticated passive solar building to date, while exploring new architectural imagery." But what is most interesting about the building, and what makes it different from others where the primary concern has been for energy or aesthetics or both, is that this one never becomes aggressive or obvious in its concern for either. Perhaps it is there that the true sophistication lies.

On approaching the building and walking around and through it, one is never forced to confront design screaming for attention, or environmental contraptions vigorously proclaiming their function. The design and materials of the building have resulted in one that is calm and comfortable, and which is probably eminently suitable for those who will use it: inner-city youths who come for two-week stints to learn about energy and the environment.

The building is designed to fit in comfortably with the vernacular of the Pocono Mountains region, and in this respect shows real awareness and respect for the old vacation lodges and rural buildings common to the area. The scale of the 225-ft-long structure has been broken down into three basic components that define the entry/lobby area, the dormitory/classroom area, and the dining hall. Scale modulation is continued and further enhanced through the use of small windowpanes, dormers with quarter panes, and the overall exterior cladding of cedar siding. The vernacular lodge image is carried to the inside and is seen in the lobby and dining hall especially, where bluestone, quarry tile, and yellow pine woodwork contribute to the relaxed atmosphere.

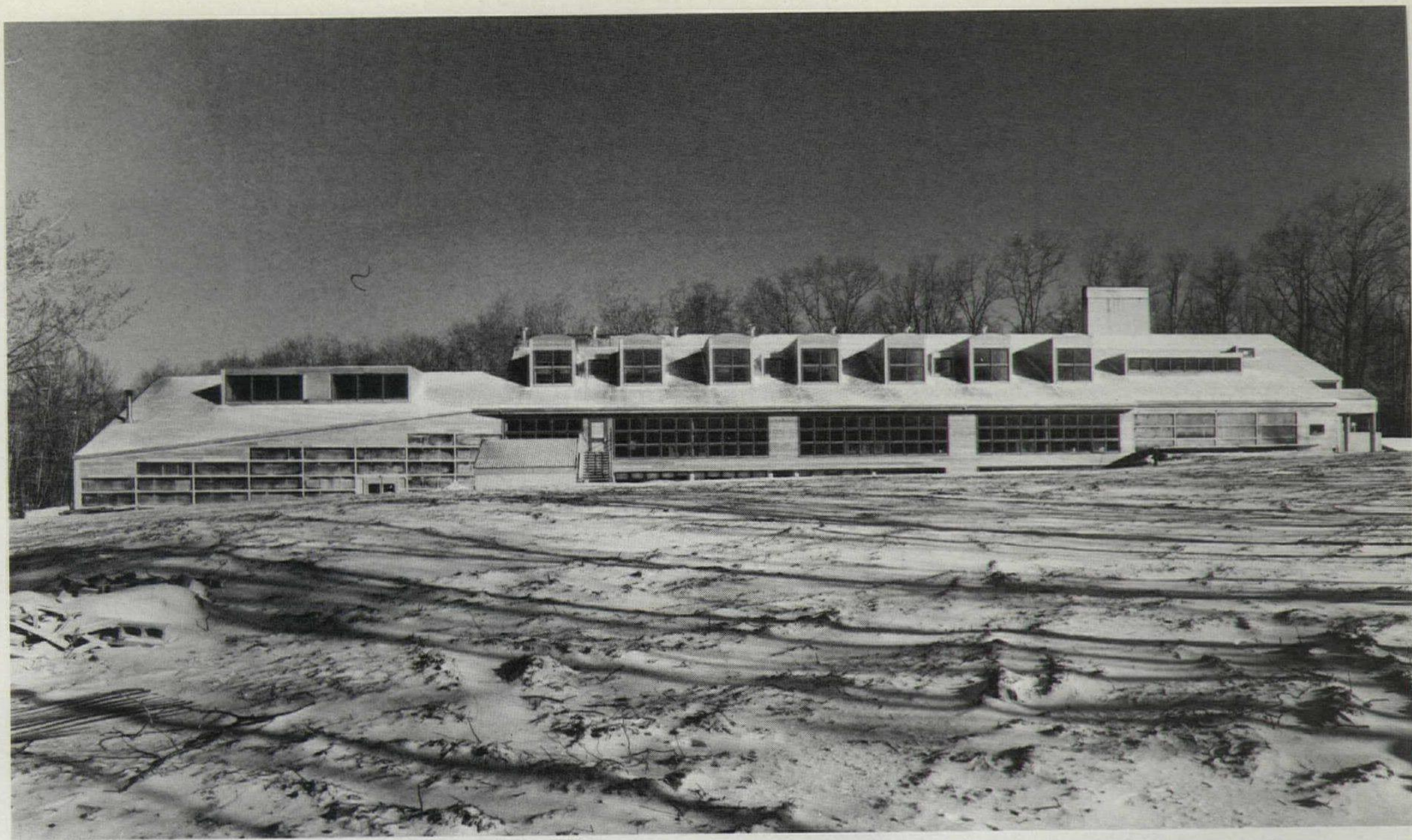
The most dramatic and urbane space in the building is the hallway leading to the dormitory rooms. This is extra wide and is intended, the architects say, as a gathering place or "street." Because of the length of the building and the fact that it will be used throughout the year, the corridor becomes important as the connection to the major social spaces—the dining hall and lobby—which have purposely been placed at opposite ends of the building. "We needed these 'pools of social space' at the ends of the building," Kelbaugh says; "otherwise it would have been static." The corridor is the dynamic connection between them.

The obvious question is why the architects designed such a long, narrow building when it would have been easier to establish dynamic space other than in a linear arrangement. Here is where the energy and environmental concerns come into play in a major way. In this structure, where passive solar energy provides 75 percent of the building's environmental conditioning, it was obviously necessary to have as great a southern exposure as possible. After all, this is not an office building used only part of the day, or a family residence with less energy demand. It is a full-time home for 117 people in an area 1000 ft high where the temperature frequently drops to 0 degrees F or lower during the winter. On extremely cold days, the solar heating system is backed up by a furnace that burns either oil or wood.

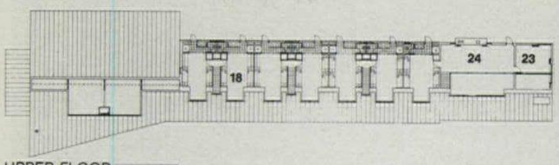
Along the south façade, Trombe walls are located across the front of the lobby and the dining hall. The first is equipped with a hinged insulating reflector, which intensifies solar gain when open but which inhibits it when closed. The larger dining hall Trombe wall is supplied with pull-down shades inside the building. These are hidden from view because of their location in the walk-through space between the south wall and a ramp for the handicapped, which is covered with ventilating wood slats on the side facing into the room.

The middle of the building receives direct solar gain at all three levels. At the lowest, classroom level is a water wall, which simply has large, portable water drums immediately behind low windows underneath work tables. They soak up enough heat during the day to warm the rooms at night. At the middle, dormitory level, light and solar radiation pass through clear windows into the main corridor, and then through glass-block walls into the bedrooms. The hall floors are dark for heat absorption, as are those of the upper-level bedrooms, which receive direct gain through their dormer windows.

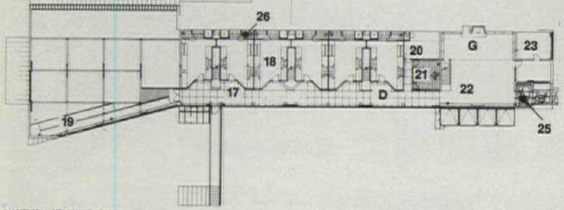
Throughout the building, the internal structure, floors, walls, and some partitions are concrete to create mass for storing solar energy. At the north side, the building is partially buried, and this earth contact, plus a night fan venting system, eliminates the need



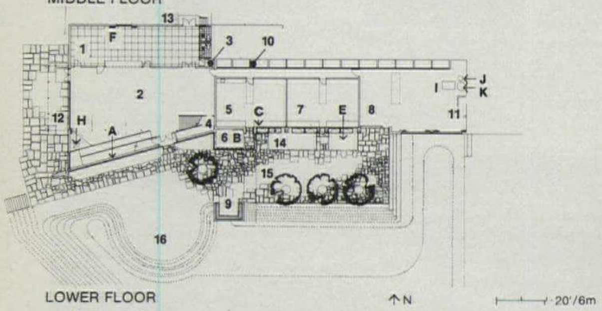
# Milford Reservation Environmental Center



UPPER FLOOR



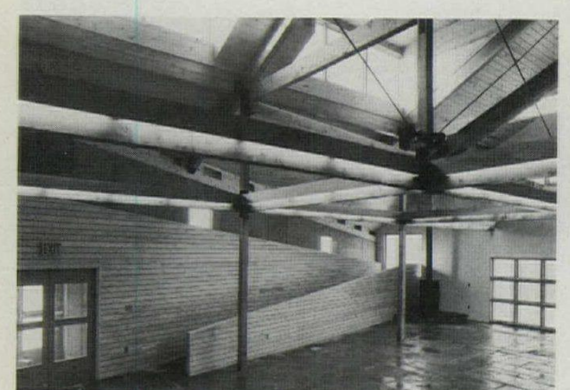
MIDDLE FLOOR

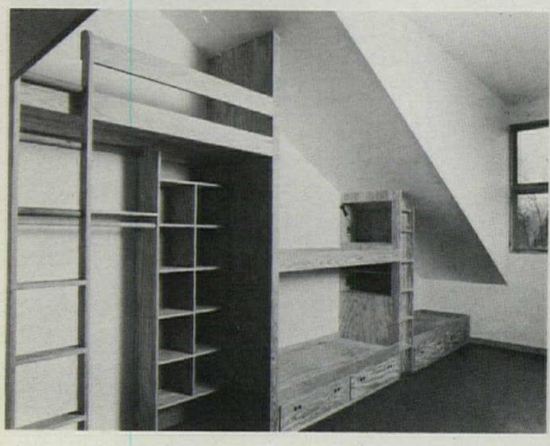


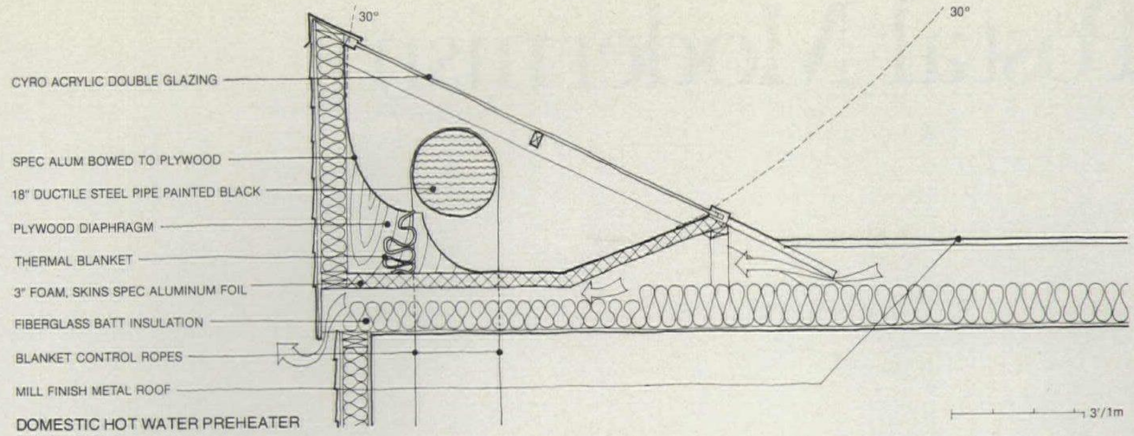
LOWER FLOOR

**Legend**

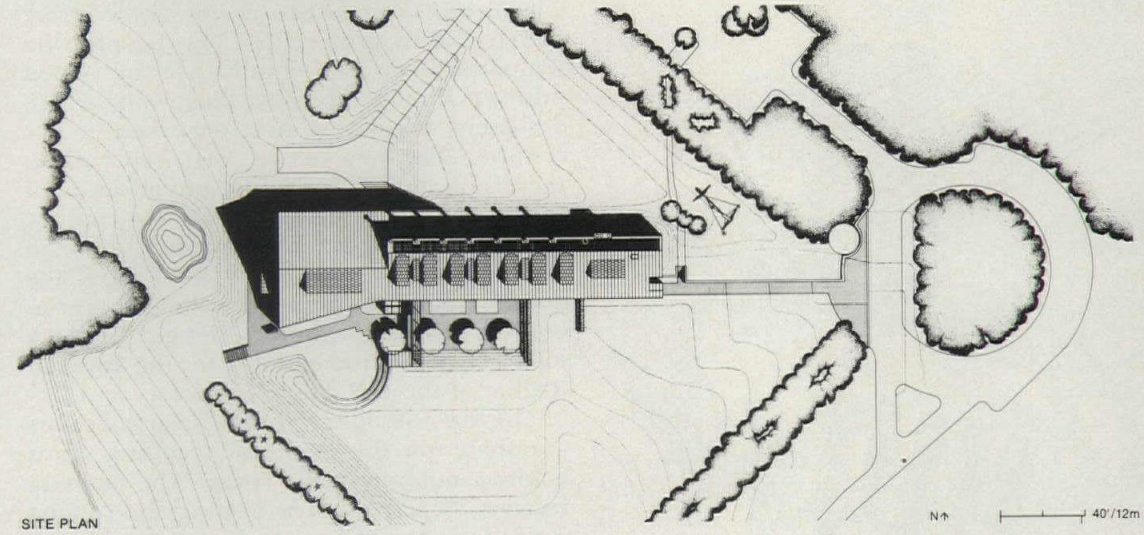
1 Kitchen
2 Dining hall
3 Janitor's closet
4 Storage
5 Classroom
6 Greenhouse
7 Workshop
8 Utility room
9 Pavillion
10 Typical composting toilet tank
11 Clivus multrum toilet tank
12 Porch
13 Loading dock and service road
14 Vegetable garden
15 Courtyard
16 Amphitheater
17 Gallery
18 Typical dormitory room
19 Ramp
20 Infirmary
21 Handicapped/public restroom
22 Lobby
23 Office
24 Balcony
25 Vestibule
26 Typical toilet room
A Trombe wall
B Greenhouse with mass wall
C Water drum cabinet
D Direct gain space
E Reflector/insulating shutter
F Thermal drape/curtain
G Circulating air fireplace
H Wood stove
I Oil/wood furnace
J DHW heater
K DHW storage tank








DOMESTIC HOT WATER PREHEATER




SITE PLAN

for air conditioning. The thermal shutters, curtains, shades, blankets, drapes, and vents that make the whole system work throughout the year will be operated by the youth who use the building as part of the educational program. Director John Hiros is quite serious about changing people's attitudes concerning energy, and he recognizes that the best place to start is with the young.

**Prime determinant**

"It may seem strange to say it," Kelbaugh and Lee admit, "but the composting toilets were probably the main determinant of the building's form. They are difficult to incorporate into a design; they take up a lot of building space; they must be monitored and tended on a regular basis, and kept airtight and insulated at a temperature preferably over 90 F." Given these conditions and the fact that 13 of the toilets had to be installed, the most reasonable arrangement became a linear one, with the units at the back of the bedrooms where waste could drop to composting chambers buried at the north side of the building. Because of this, all plumbing was then put at this side, including one Clivus Multrum (toilet) for the bathrooms for the handicapped, which was installed for side-by-side testing and demonstration. Ironically, it was the toilets that allowed the building to be constructed in the first place, because they cut 40 percent of water consumption in an area with soil conditions unsuitable for construction under normal circumstances.

Because of the linear organization of the building, the architects were able to instigate one additional important energy-saving device. At the crest of the south-facing shed roof, they have run a double-glazed skylight over 160 ft of the length of the building. Directly under it sits an 18-in.-diameter steel tube in a "solar oven"—a well-insulated box of rigid foam insulation board with aluminum foil faces of high specular reflectivity that directs sunlight on the pipe. This tube holds a little more water than the users are expected to use per day, and its 2700 gallons are preheated before the water heater raises the temperature to 120 F. The preheating supplies 62 percent of the hot water needs. To minimize heat loss, a thermal blanket is pulled by rope around the tube at night, and away from it in the morning.

What Kelbaugh and Lee hope is that the Center will demonstrate that responsible building can take place in environmentally delicate conditions such as those of the Milford Reservation area. None of the building's alternative energy sources required exotic materials or hardware in their construction. The logic of the building—the way its design and energy systems work off and with one another—is surely exemplary. The form is subtle and accommodating to its surroundings, never aggressive or overstated, and above all, eminently sensible in all respects. It is not high-style flash, but then perhaps true sophistication, which the architects claim for the building, never is. [David Morton]

**Data**

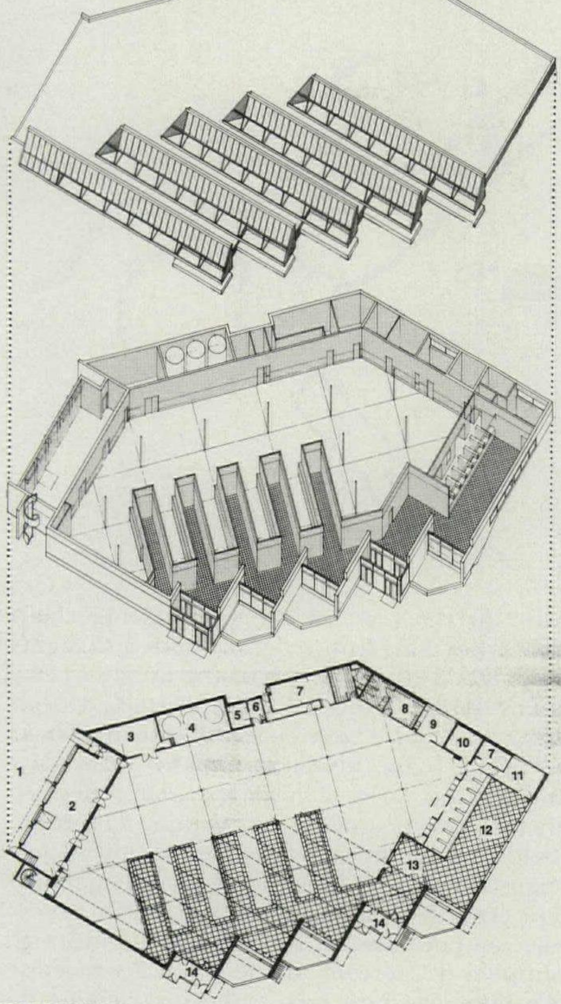
Project: *Milford Reservation Environmental Center, Milford, Pa.*
Architect: *Kelbaugh & Lee, Princeton, NJ, Douglas S. Kelbaugh, project designer; Sang J. Lee, project manager; Tom M. Swartz, Donald Prowler, Harry Hansel, Mark Gray, Terrance Goode, Laurel Lovrek, David Zung, project team.*
Site: *three acres of open land in a 1646-acre semiwilderness reservation 1000 ft high in the Pocono Mountains.*
Program: *a 17,000-sq-ft facility for inner-city youths of Pa, NJ, and NY to come for two weeks, on a year-round basis, for recreation and to learn about energy and the environment.*
Structural system: *concrete spread footings; precast hollow-core concrete slabs on concrete retaining wall and columns/beams; wood roof with steel framing.*
Major materials: *roof of asphalt shingles or corrugated asphalt sheets; exterior walls of cedar siding, double- or triple-glazed windows, "Dryvit" stucco, Trombe walls; interior walls of exposed concrete, painted or natural concrete block, gypsum wall, glass block, finished wood; floors of bluestone, synthetic rubber tile, vinyl asbestos tile, carpet. (See Building materials, p. 255.)*
Mechanical system: *passive solar heating with wood/oil-fired furnace; passive solar cooling; natural/induced ventilation; no air conditioning.*
Consultants: *Kelbaugh & Lee, Alan Goodheart, landscape; Kelbaugh & Lee, interiors; Raval Engineering Co., structural; Robert Bennett, mechanical; Kelbaugh & Lee, solar design.*
Client: *Milford Reservation, Inc., New Lisbon, NJ.*
General contractor: *Dorsan.*
Cost: *$1,120,000; $65.00 per sq ft.*
Photography: *Robert Perron.*

*In the lobby (facing page, top) the Trombe wall is seen with the insulating reflector in open position. In the hall, direct sunlight is absorbed by the mass of walls and floors, and transmitted through glass-block walls to bedrooms (bottom). Upper-level bedrooms (far left, bottom) get direct gain through dormers, while Trombe wall of dining room (far left, top) is screened by slatted ramp, beyond which are pull-down blinds for environmental control.*

**Main Post Office, Aspen, Co**

# Postal Modernism

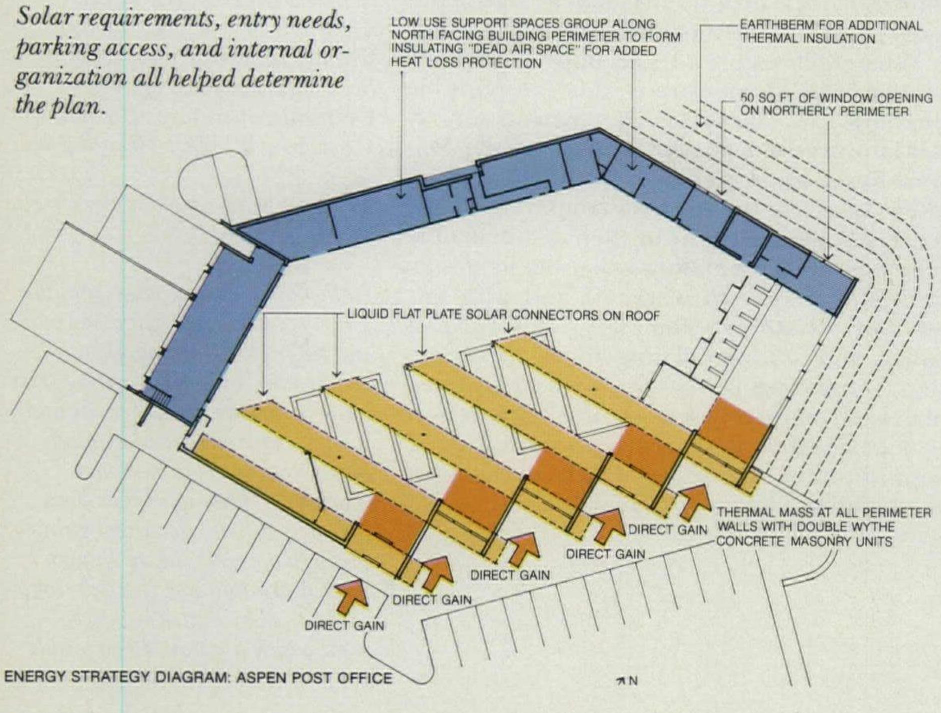
**Within the limits of a snug government cost policy, the architects of the new Aspen U.S. Post Office have provided a solar demonstration building for the Western Region.**




FLOOR PLAN EXPLODED VIEW

**Legend**
1 Ramp
2 Enclosed mailing platform
3 Mechanical equip rm
4 Solar storage
5 Electrical
6 Janitor
7 Storage
8 Lockers
9 Lunch room
10 Vault
11 Postmaster
12 Service lobby
13 Self service lobby
14 Vestibule

*Solar requirements, entry needs, parking access, and internal organization all helped determine the plan.*




ENERGY STRATEGY DIAGRAM: ASPEN POST OFFICE

The Aspen Post Office is no simple street corner U.S.A. post office. The people who temporarily or periodically live in Aspen number among the most illustrious artists, designers, musicians, and sportsmen in this country. The new active solar post office, therefore, must cater to the postal needs of John Denver, the Estée Lauder family, Gerald Hines, Itzhak Perlman, and so on. So if the post office puts on a good show, the odds are good the audience will be appreciative. The project is, in fact, designed to be a solar demonstration building for the Western Region of the U.S. Postal Service.

The 100-ft-long trussfuls of solar collectors are there on the roof, their jutting chins boldly cantilevered into space. The building receives 85 percent of its heating and cooling needs from the collectors. They are meant to be seen not only from the ground, but by school children who spiral up a special viewing stairway to the roof where they can see and touch the collectors if they dare.

The real daredevils are the athletes who show up for the mail in the post office below. The Aspen ski slopes are among the most challenging in America. When skiers return from rocketing down a mountain, they don't need solar thrills, they want their mail. The building shares parking with the adjacent shopping, and is linked to Aspen's pedestrian and bicycle paths. It is open 24 hours a day, but the big rush is at noon.

Aspen's regulars pass through the weather-locking doors, over the (easily maintained) tile floor, past the (light-reflecting and maintenance-free) stainless steel panels to the color-coded corridor of their mailboxes. The soft surface is on the ceiling, out of harm's way, in the form of a suspended wood ceiling. Mail in hand, the patrons come to a pause for a quick reading or a chat and a view from the brightly solar lighted and heated (direct gain) alcoves provided across from the mailboxes for that purpose. In the summer, the planters on the exterior of the building and circular seating surrounding the flagpole are sunlit reading centers in their own right. They also serve the public meeting function as well. The old original post office was used as a meeting place. In the words of architect Larry Yaw, "We did not want to usurp this function by just making an efficient machine." For those

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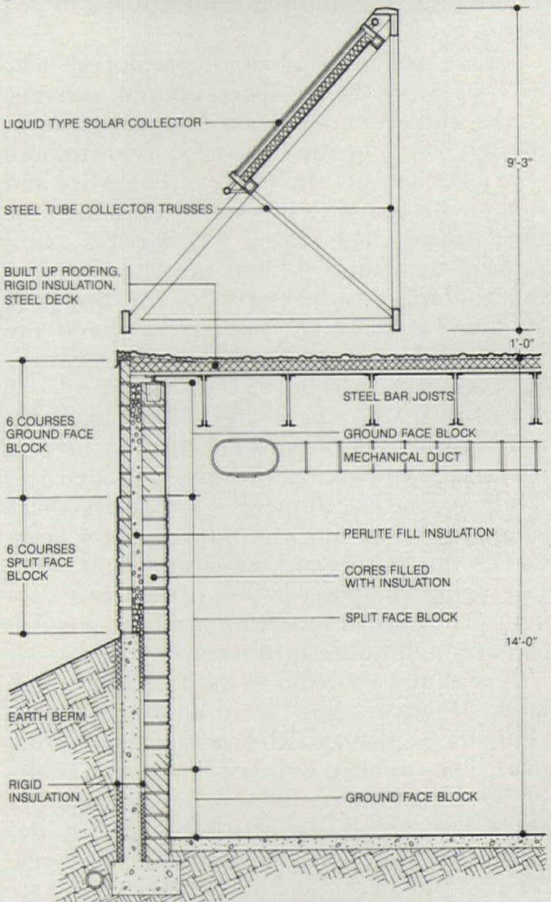
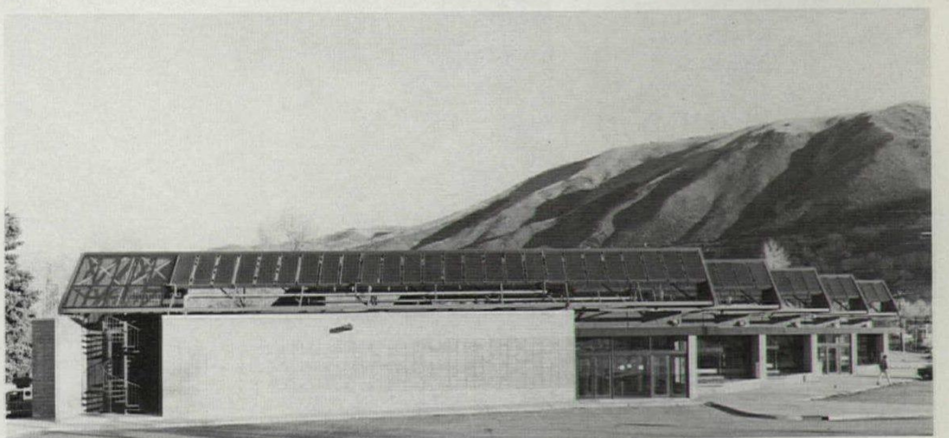



SECTION THROUGH NORTH WALL SHOWING SOLAR COLLECTOR



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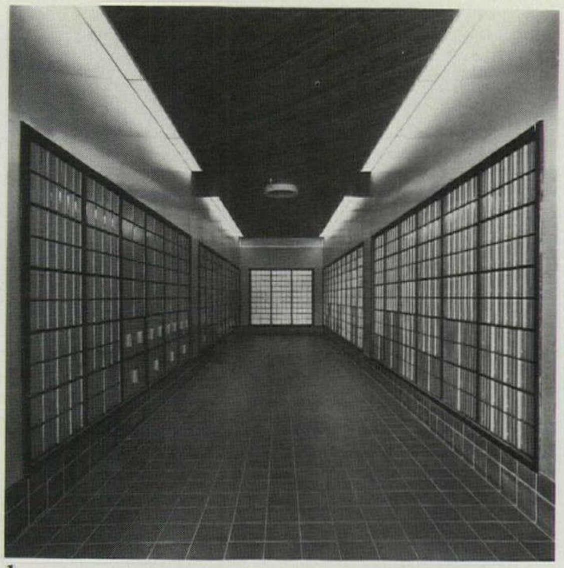
*1 Southeast corner showing entry, 2 southern exposure with south-facing solar collectors, 3 eastern exposure, 4 interior mail reading alcove looking down main circulation. The wall section (above) concentrates thermal mass to the interior.*

4

**Post Office, Aspen, Co**

**Data**

Project: *Main Post Office, Aspen, Co.*
Architects: *Copland, Hagman, Yaw, Ltd., Aspen, Co.*
Client: *U.S. Postal Service, Jerry Reynolds, Western Regional Office.*
Site: *irregular 100,135-sq-ft plot adjacent to 60,000-sq-ft shopping facility.*
Program: *post office for the city of Aspen. Public areas, 5200 sq ft. Work and operations space, 16,000 sq ft.*
Structural system: *steel frame with concrete foundation.*
Major materials: *ribbed and ground face concrete block, built-up roof, aluminum storefront, gypsum board (see Building materials, p. 255).*
Mechanical system: *active solar, evaporative cooling multizone air delivery, electric-fired back-up boiler.*
Consultants: *Design Workshop, landscape; Anderson & Hastings, structural; McFall, Konkel & Kimball, mechanical; Gambrel Engineering, electrical.*
General contractor: *Newstrom-Davis Construction Co.*
Cost: *$1,635,700.*
Photographs: *David Marlow.*



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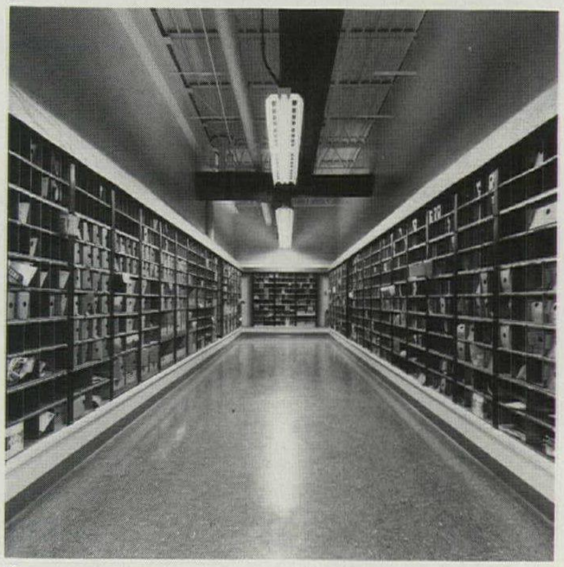

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*1 Mailboxes, customer view, 2 mailboxes loading side, 3 work area "backstage," 4 southeast corner detail, 5 stair for viewing solar collectors, 6 postage and service area in customer area.*

who wish to simply mail a package, the whole mail retrieval sequence can be avoided by entering the northernmost door of the building directly into the service lobbies.

The building shape was derived from solar orientation and entry requirements from shopping, as well as parking needs. It is bermed on the exterior of the north side to retard heat loss and is ringed on the interior with a band of support functions, which provide another wall and serve as a buffer space. The cavity walls concentrate their mass to the interior with the insulation cavity closer to the exterior.

Aside from its geometry, the work in this post office is not unlike that of any post office in America. In fact, the sorting furniture from the previous post office was used here. The Postal Service wanted a large, well-lit, flexible space that it could mold and change to fit the seasons and the mail supply and demand.

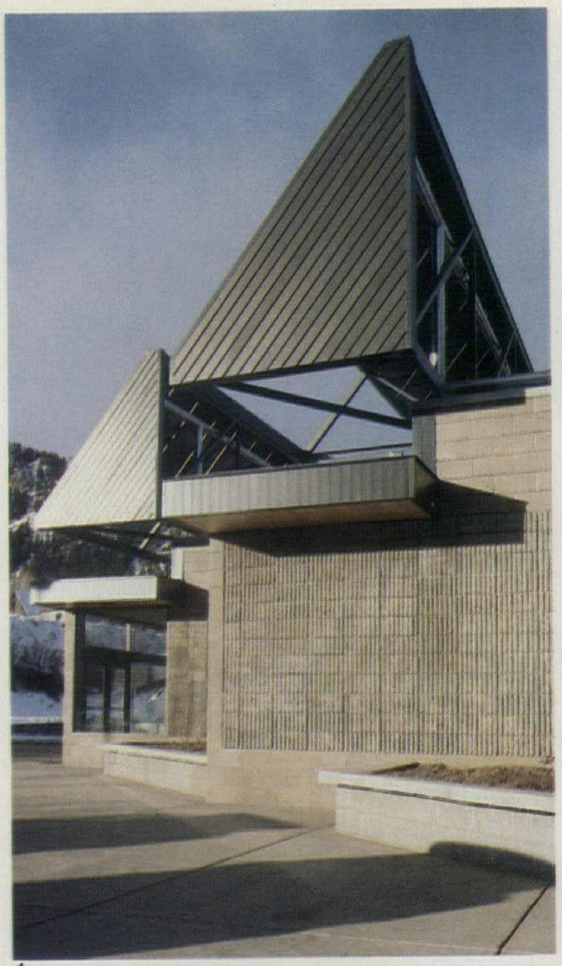
There are three types of employees who use the work room space—postal carriers, clerks, and the supervisors. The postmaster is located where he can have easy access to both the customers and the workers. His office and the lunchroom have the only windows on the north side of the building. The carriers spend most of their time on their postal routes and use the space only briefly for sorting and loading for delivery. The clerks spend the whole working day at the building at a variety of tasks.

Unfortunately there are neither skylights nor natural light of any kind that reaches the backstage work area of the Aspen Post Office. This means that the clerks who work there spend the entire day with no view of the spectacular mountains and no natural light. Very few such work spaces in post offices have daylight. They are lit as economically as possible by bare-bulb fluorescent fixtures.

It certainly occurred to the architects. Copland, Hagman, Yaw were innovative with skylights at the award-winning Aspen Airport. The problem was cost. Economic analysis by the architects proved that daylighting could not pay. Postal officials were also enthusiastic about skylights, but could not scale the cost hurdle.

One problem has duplication. Because the mail is frequently sorted at times when there is no sun, the lights had to be there regardless of the daytime use. This meant that the cost justification had to be based upon money saved from not using electricity during the day. The additional consideration is the heat source that the lights become whenever they are on. In very cold weather, very efficient skylights would prevent heat loss, but they are expensive. In the summer, they can add air-conditioning cubage. Give up on the skylights?

Design decisions, energy and otherwise, are always a balancing process. There are nearly 10,000 postal boxes. On one side, there are



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10,000 waiting people; on the other, more like 10 people who fill the boxes. The 10,000 are in the building, let's say, 15 minutes per week. The others work there 40 hours a week. More important, the people on one side pay for the postal service, and the people on the other are paid by it.

Energy conservation is a very exacting sieve to apply to building ideas. Before the energy problem arose, few people questioned the exclusion of natural energies from human space. Now that our attention is focused on energy, we have come to expect a more natural interface of buildings and climate for good health and work habits. The Aspen Post Office responds well to its climate. It is solar heated and cooled and energy economic to run. It organizes its plan strategically for both energy conservation and work flow. And in all fairness, the building is living, not dead. Alterations to the lighting and roof are certainly within the realm of growth and change, should the future use to which the building is put demand it. We might add that such freedom is not an accident; it is designed into the space and built there. [Richard Rush]

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**Federal correctional institution, Bastrop, Tx**

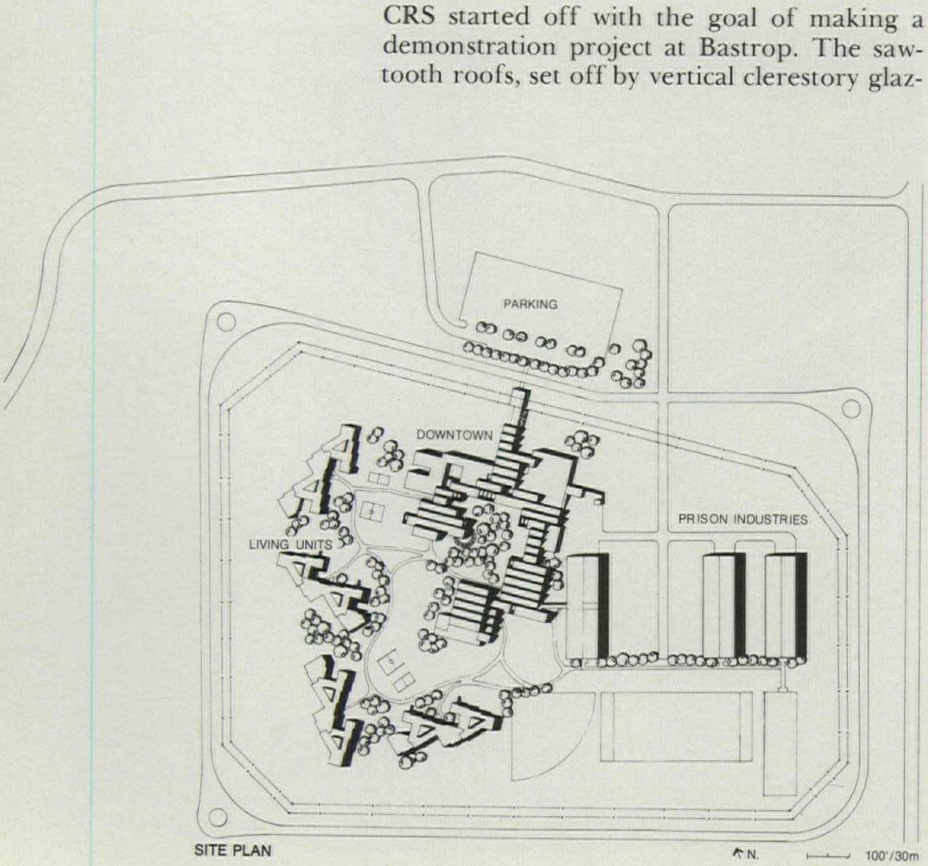
# Corral in the sun

**Built to house youthful offenders, this Texas institution was designed to soften the harshness of prison existence and serve to demonstrate energy concerns.**

Correctional institutions are at best still grim realities. It is hard to *like* a prison. But given the desolate conditions many prisoners endure elsewhere, those interned at the Bastrop, Tx, facility don't do badly. Designed by Caudill Rowlett Scott, this institution began with two basic concerns—rehabilitation and energy.

Naturally, the first consideration is the expectation, implicit in any prison program, that the surroundings can help rehabilitate. But in fact many institutions are numbing, featureless places for nonexistence. CRS President Paul Kennon feels that their design at Bastrop "provides visual and spatial diversity to overcome the inhabitants' inability to change environments, and to minimize the reality of being closed in." The intentional use of a vocabulary evocative of "summer camp" is obviously aimed at deinstitutionalizing a building type that is so often hard, sterile, and inhuman. The result seems to go about as far toward that goal as it could.

Energy hardware fits into the vocabulary admirably. The nearly 25,000 sq ft of solar collectors are both the reason for, and the majority of, the facility's expression. Both the client—the Federal Bureau of Prisons—and CRS started off with the goal of making a demonstration project at Bastrop. The sawtooth roofs, set off by vertical clerestory glazing, function nicely to collect insolation and draw in natural north light.




SITE PLAN

### A microcosm

In concept, the facility is really a campus, viewed by the architects as a microcosm of the needs of a small town. "Downtown," as it is known, comprises administration and all non-housing functions except the prison industries. Included are the entry and visitors' areas, offices, dining, laundry, commission, and educational functions—both academic and vocational. Another cluster houses the security command center, inmate segregation block, a full clinic, and leisure-time activities. Vocational education shares the nearest of the existing buildings on the site with warehouse and maintenance facilities.

Living units are arranged in clusters of single-occupancy rooms around open common spaces, which serve as leisure activities areas for playing pool or cards, making phone calls, etc. Counselors and administrators are located adjacent to these spaces on the first floor. Each inmate has a room key, which provides security for personal belongings; during the day, this key allows admission and exit at will. At night, a master locking system is activated for all room doors on inmates' rooms. Even though the rooms are sparse, they are a far cry from the stereotyped squalor of jail cells, and they provide more humane privacy for toilet and grooming activities. Showers are shared, off the central spaces.

All living necessities are provided, but if an inmate prefers a different brand of soap, toothpaste, or other toiletry item, it can usually be purchased at the commissary. The commissary becomes, in effect, the inmates' bank. Since they are paid an hourly wage, credit for work wages is posted with the commissary and can be drawn against, up to a certain monthly maximum, for purchases of a wide range of optional items. These include cigars, cigarettes, snacks, some clothes, books, and other nonessentials. Products not in stock may be requested and will be ordered if there is enough demand.

### Ancillary services

Educational programs at the institution are broad in scope; offerings range from languages and college-level courses to high school and vocational training. Prison industries manufacture furniture and, currently, carry on production and testing of fiberglass

Richard Payne

*Viewed from near the main security control center (above), "downtown" areas for dining, laundry, and commissary are in the near background from left to right. Beyond that are the academic facilities and (not visible) living units. Key elements in the design (right), concrete columns, wood trusses, angled solar collectors and roof planes, and the glazed or unglazed clerestories develop an ordered rhythm throughout the Bastrop complex.*

Joe Aker

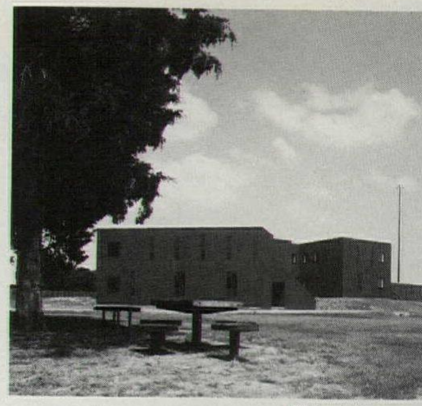
containers for self-inflating navy life rafts. Educational classes are offered outside of normal work hours, with participation urged but not in any way mandatory.

Clinic facilities also provide a wide spectrum of services, including dental, radiology, psychological or psychiatric consultation, among others. The visiting area is not the TV/film version of wire mesh and/or bulletproof glass separations between inmates and visitors. It is a broad expanse of room with individual chairs and small tables, most built in the prison industries. Whenever possible, federal regulations require that these federal projects be furnished in such a way. Throughout most of the spaces in the complex, painted ductwork, dark-stained trusses and siding, steel joists, clear-glazed clerestories, concrete columns and block walls prevail, carrying through the "camp" theme with care and considerable success. The result is informal, noninstitutional, and as cheerful as any place of confinement can be.

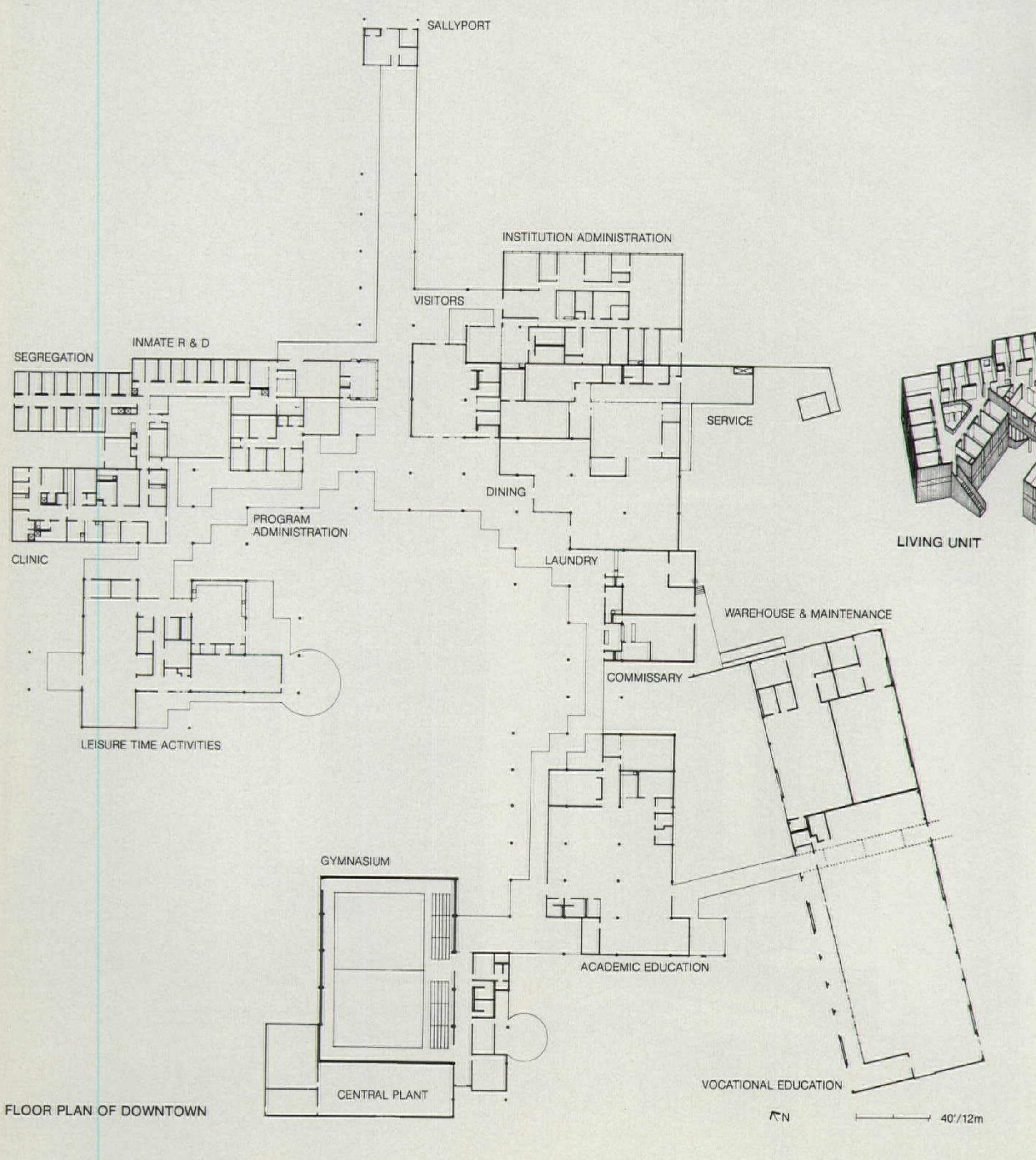
In the "downtown" area for leisure time activities are several large areas, which serve for church services, entertainment, or other special events. From inside these and many of the facility's spaces, it is just possible, at least for a visitor, to begin to forget *the fence.* Surrounding the rolling 43 acres of the compound is not a wall, but a truly vicious two-stage fence with intervening cyclones of barbed—no, bladed—incentives to stay within. Since this is clearly not a maximum security installation, these almost-dematerialized walls give the feeling of uninterrupted Texas plain, within joining without. Preservation of large oak trees on the site also contributes to the continuity of feeling. There is no barren prison "yard," but only rolling intervening spaces; athletic fields adjoin the prison industries area, in a layout like that of many high schools.

### Solar performance

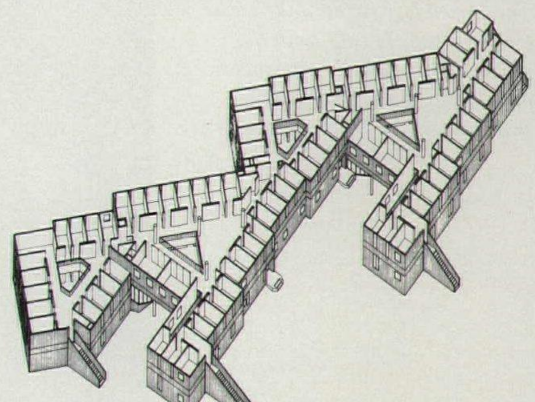
Since Bastrop was conceived as a demonstration project, it has been monitored since its solar collectors began their work. The collector system was designed to deliver heating and cooling water on a priority basis to, respectively, domestic hot water, heating, and cooling demands. Collectors are high-efficiency flat plate type with a selective black coating, using water and heat exchangers to produce heated water for use. The system has an automatic gravity draindown feature, should collector temperature approach the



Richard Payne




FLOOR PLAN OF DOWNTOWN



LIVING UNIT

*Living units (photos and axonometric, opposite) are in separate buildings and are clustered around two-story interior spaces. Two freestanding ends of the same spine (right and below) punctuate the area of the complex that houses leisure-time activities.*

Photos: Richard Payne

freezing mark, and therefore no chemicals are used in the collector circuit. Storage capacity of the system is 40,000 gallons, and the central plant contains two 100 h.p. hot water boilers for heating and one 30 h.p. boiler for "downtown" domestic hot water. Also available are two 250-ton centrifugal chillers and one 120-ton hot water absorption chiller. Heated and chilled water are pumped from the central plant underground to living units, and overhead to the "downtown" buildings.

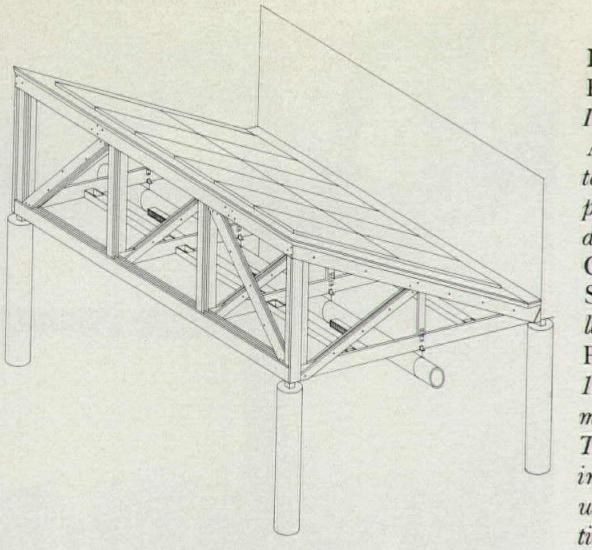
The solar system was designed to supply 96.6 percent of the domestic hot water, 45.5 percent of the heating, and 8.6 percent of the cooling for the entire complex. Currently, it provides 56.2 percent of the hot water, 41.6 percent of the space heating, and 0.4 percent of the project's space cooling. Still, between the time monitoring began in April 1980 and the end of September 1980, savings amounting to 800,000 cu ft of natural gas had been realized. Natural interior lighting and outside air for conditioning combine with high intensity discharge outside lighting to produce additional savings.

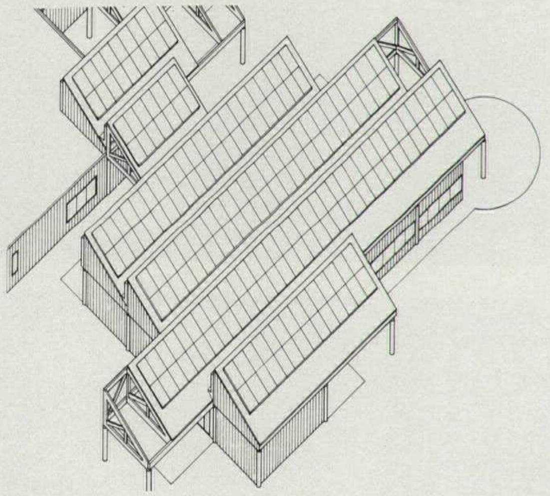
### Successes

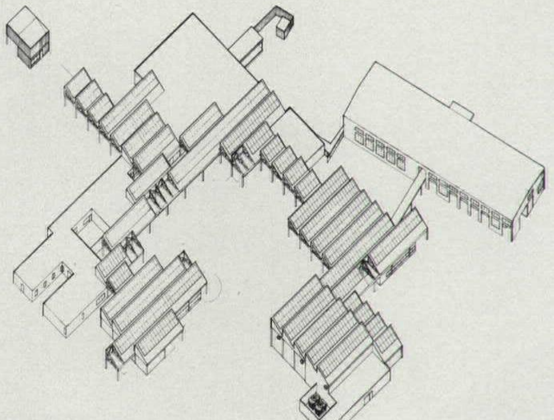
In terms of humanization, Bastrop should make the average two-year stay as productive as possible. In terms of both atmosphere and programs, the client has put a lot of feeling and genuine care into the charge to its architects. The only grumble heard from the institution's administration was about having to dust painted ducts and trusses, and the need to wash clerestory glass. But it seemed to be good-natured chiding, with problems on the way to a solution. The only recent modifications visible are additional bars around the security control center, which Bastrop officials felt was too vulnerable, and one vertical bar in each of the living unit's single rooms, where an already thin window was further restricted. Administration enthusiasm generally seems very high, however, for the facility.

Results of the energy-related features have, in all, been positive. An unexpected high demand for domestic hot water has changed the percentage of solar heat supplied for that purpose. Savings in fuel have been recorded, as noted, and monitoring continues under a contract from DOE, The National Solar Data Network.

Winner of two Owens-Corning Energy Conservation awards this year, one for Bastrop, CRS is firmly established as being committed to the energy issues facing us. What is rewarding, aside from awards themselves, is the equal commitment to quality design which accompanies the pragmatic and social concerns of the Bastrop scheme. All have blended here in what seems to be a cohesive and successful whole. [Jim Murphy]



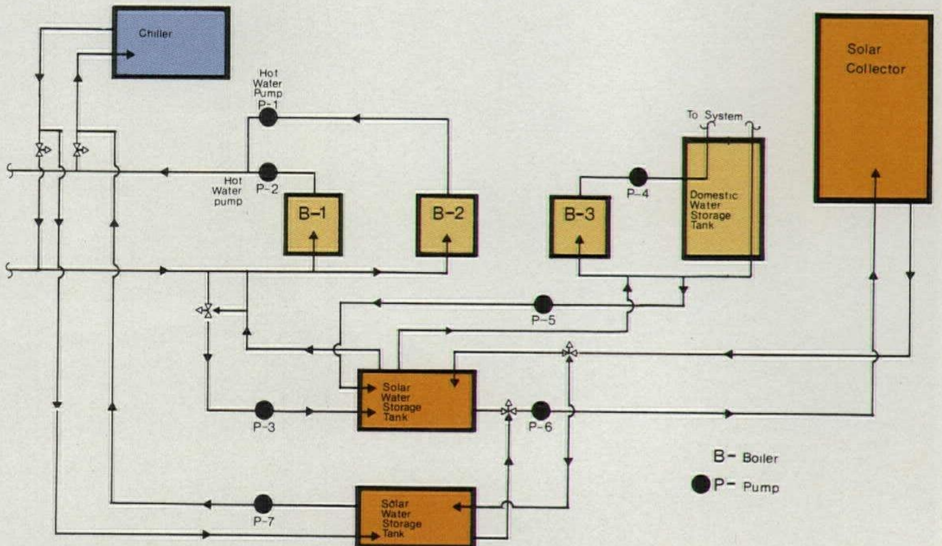




DOWNTOWN

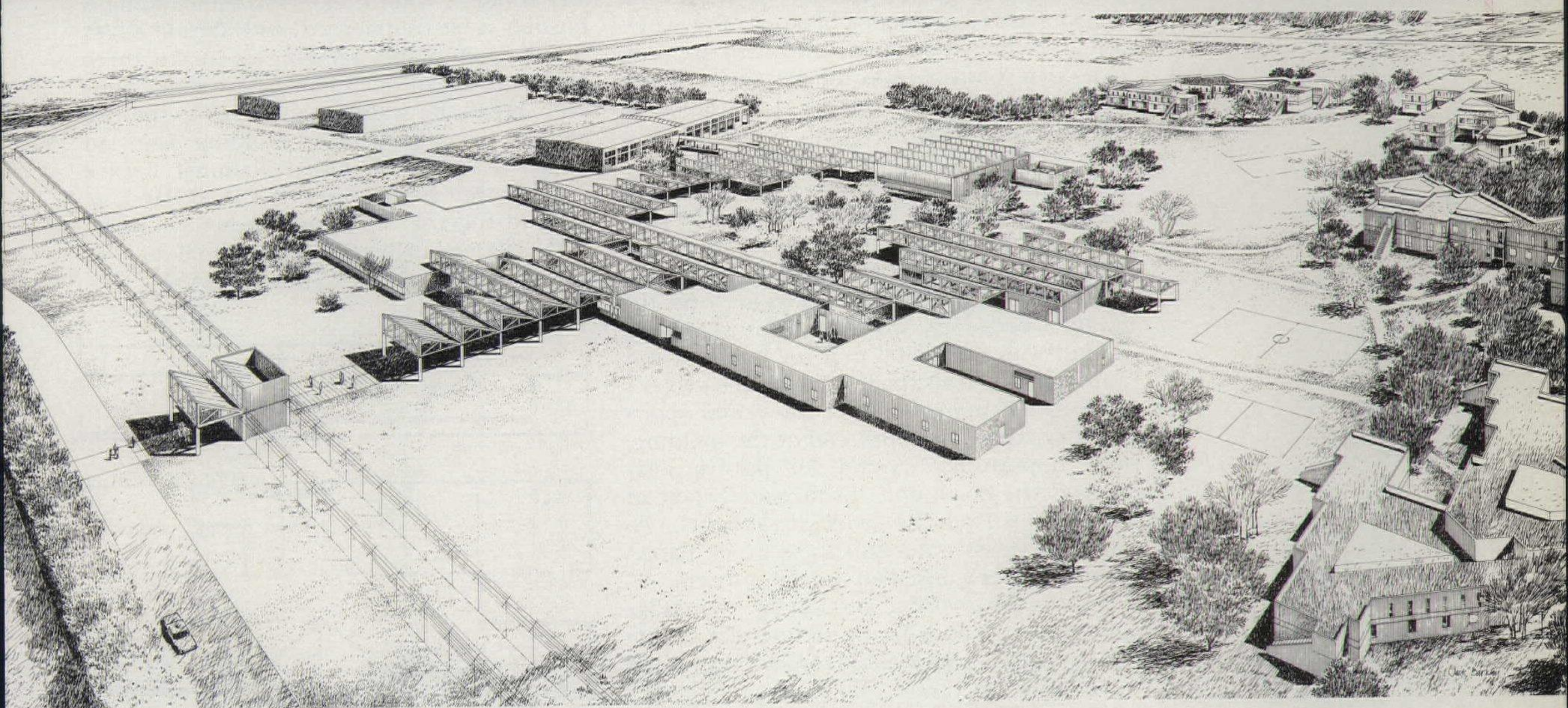
### Data

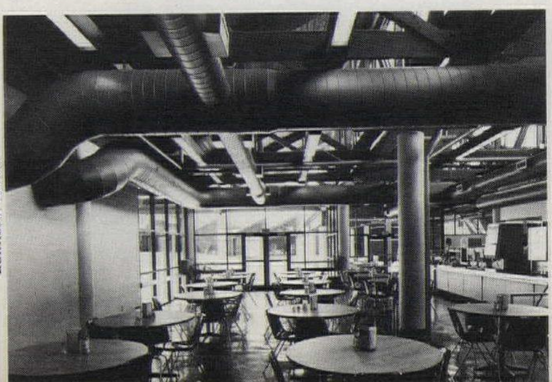
Project: *Federal Correctional Institution, Bastrop, Tx.*
Architects: *CRS, Inc., Houston, Tx; Paul Kennon, design principal; Jim Hughes, project director.*
Client: *Fed. Bureau of Prisons.*
Site: *rural 43 acres of rolling, land 30 miles from Austin.*
Program: *correctional facility of 160,000 sq ft to house 500 inmates plus support personnel. Three existing buildings comprising 56,000 sq ft are retained for use as prison industries, vocational training, and storage. Housing is in separate multiple-unit facilities rather than contiguous with administration and other services. Energy considerations and humane rehabilitation goals were integral with other program demands.*
Structural system: *wood trusses and steel bar joists on precast concrete columns and walls.*
Major materials: *structural components above; glazed clerestories, exterior wood siding, gypsum board and concrete block interior walls, carpet and vinyl asbestos tile on floor surfaces (see Building materials, p. 255).*
Mechanical system: *natural gas-fired boilers (oil standby) and electric chillers, backing up nearly 25,000 sq ft of solar collectors (water-to-water heat exchangers).*
Consultants: *CRS, Inc.; Pat Mann, electrical; Ed Abboud, structural; E. Bruce Appling, mechanical. Energy specialist, David Bullen. Solar system design, Intertechnology/Solar Corporation. Solar design evaluator, Alvin B. Newton.*
General contractor: *Robert McKee, Houston, Tx.*
Costs: *$11,432,342.*




SOLAR HEATING SYSTEM

Richard Payne





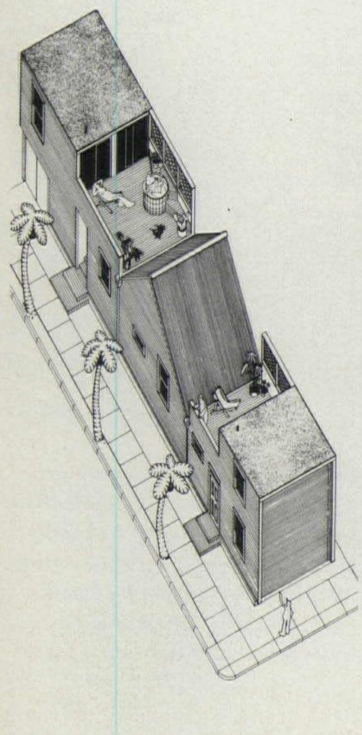
Balthazar Korab

Richard Payne

*Bright daylighted areas are provided for dining (top, and bottom left) and receiving visitors (left). Drawing above depicts the entire complex viewed from the north-northwest, the entrance to the left; on the right are living units.*

# Two in a row

**Rebuilding a 1911 structure within tight constraints, a Berkeley energy firm creates an urban living style at the edge of an existing residential area.**



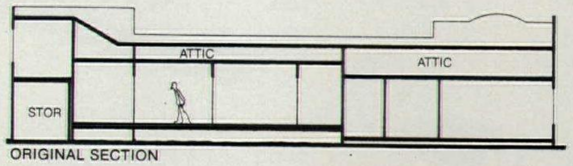
Architect David Baker had been "walking by this funny little building for years," considering its renovation potential an interesting challenge. Located in the Bateman section of Berkeley, Ca, the 1911 building was originally a grocery store with an attached apartment and a detached garage. An addition in 1923 closed the gap with, and added a bedroom over, the garage, and the store became a studio apartment in 1955. Baker, a partner in SOL-ARC—an architecture and energy consulting firm in Berkeley—bought the building in late 1977.

Strictly limited by property lines and the existing zoning envelope, the 14-ft-wide building also needed major structural repair. Baker decided to make the most out of the functional and aesthetic possibilities left under the constraints, creating a bedroom over the remodeled studio and thoroughly revising spaces in the other apartment. The added center gabled section serves several functional and aesthetic purposes. It provides a high-ceilinged bedroom and bath area, divides two rooftop decks for privacy, and embodies active solar collectors. In addition to the collector area, the south roof slope is a strip skylight along both north and south walls of the owner's bedroom and at the north end of the studio. The north roof slope provides skylighting in the owner's bath and a strip over the dining/kitchen.

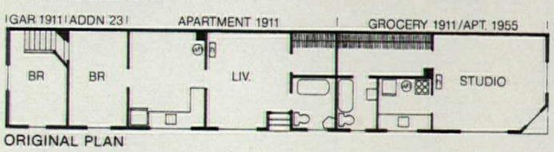
Although the active collectors are over the owner's bedroom, his apartment shares its output with the rental unit for domestic hot water. It also heats the hot tub on the owner's deck in the summer. Since the rental apartment occupies the south end of the building, little opportunity existed for passive solar gains in the north unit. To take advantage of direct gains from the bedroom skylights, two 10-ft fiberglass water tubes (18 in. in diameter) have been installed in the corners, secured against seismic motion by triangular collars. Also, south-facing sliding glass doors on the owner's deck allow insolation into the north unit.

Most prominent of the building's energy features is the Trombe wall, which forms the entire south elevation. It is an 8-in. reinforced concrete block wall, with the block voids filled solid with concrete and finished inside with ½-in.-thick red clay quarry tile. The exterior is covered with the same corrugated fiberglass as the sloped roof surfaces, chosen over glass because of cost, installation, and possible vandalism concerns. The wall is held back from the side walls and down from the roof by 8 in., creating an upside down "U"-shaped strip window. This provides an instantaneous solar gain, and separates the mass wall visually from the walls and roof. The wall is said to provide 90 percent of the rental apartment's space heating. However, Baker says he would provide movable insulation between the wall and the glazing or add a layer of glazing if he were to do the wall again, so that heat radiation to the outside would be cut.

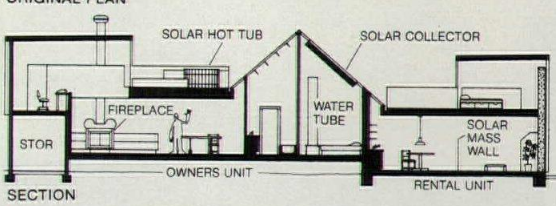
Inside, the apartments make the best of an admittedly tight site. A 14′ x 78′ building with two units doesn't allow for much more than minimum room dimensions, but the compact feeling is alleviated considerably—especially in the owner's apartment—by high spaces and skylights. On the exterior, the building is possibly a bit fragmented, with façade edges colliding at points seeming to make three buildings out of one. This device does, however, break the scale in deference to the residential neighbors. The building won an award in the first annual National Passive Solar Design competition (P/A, Feb. 1981, p. 28) and, together with other projects in which SOL-ARC is involved, speaks well of this young group's abilities. [Jim Murphy]



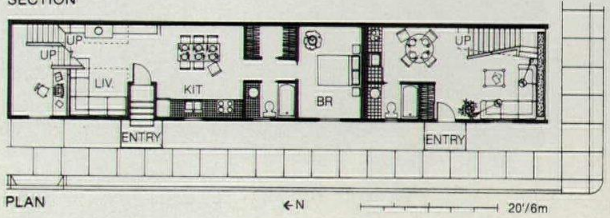

ORIGINAL SECTION



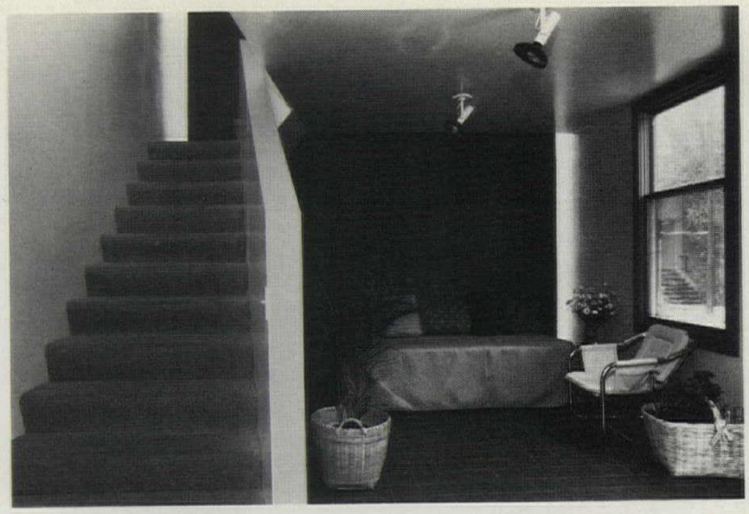

ORIGINAL PLAN

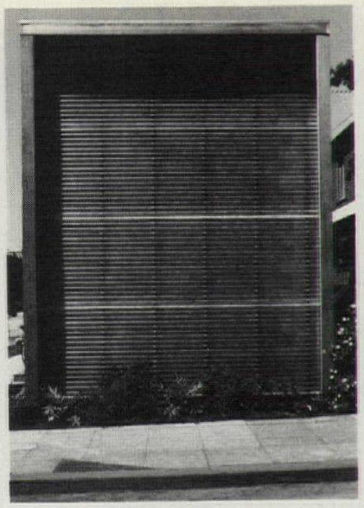


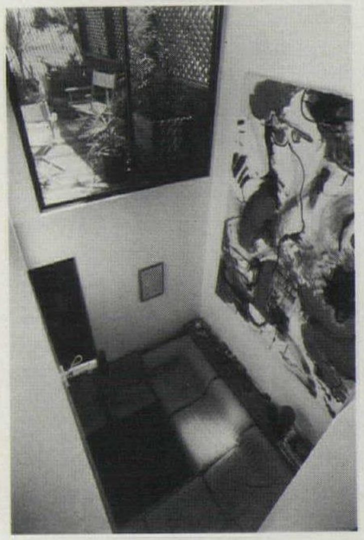

SECTION

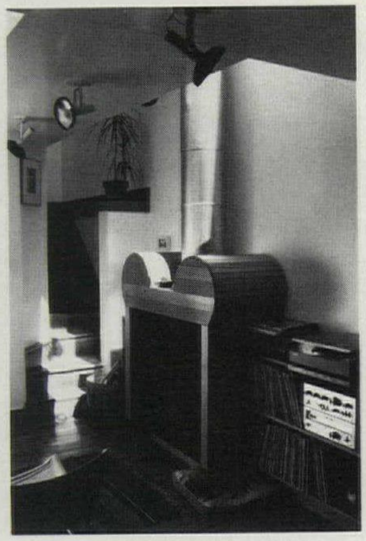


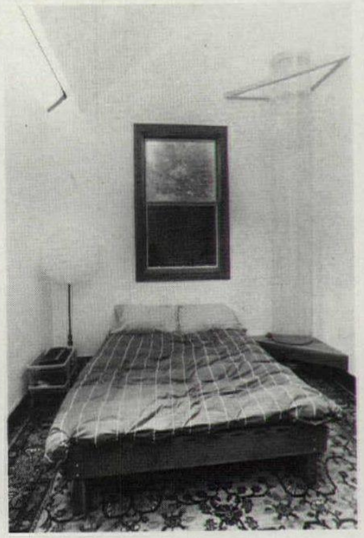

PLAN











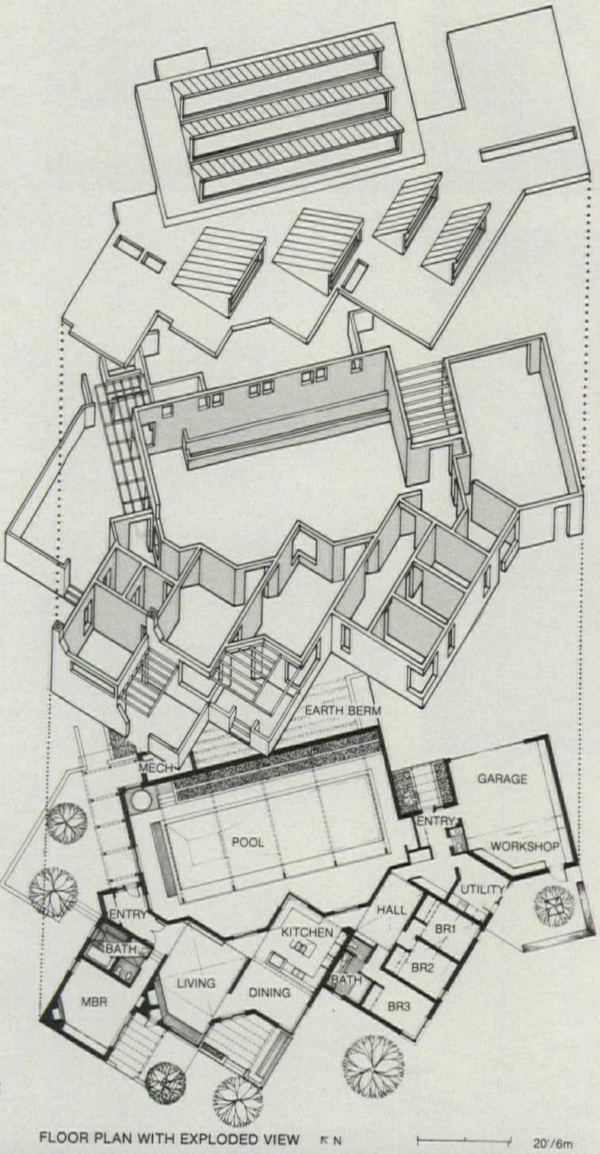
**Data**
Project: *solar duplex, Berkeley, Ca.*
Architects: *SOL-ARC, Berkeley, Ca.*
Client: *David Baker, SOL-ARC.*
Site: *corner lot, 1092 sq ft, containing existing building in a residential area becoming increasingly urban.*
Program: *renovate two existing housing units to provide new private outdoor space and use alternate energy sources.*
Structural system: *wood framing, plywood shear walls.*
Mechanical system: *active solar domestic hot water.*
Major materials: *redwood bevel siding, rough-sawn fir plywood, gypsum board walls, Douglas fir and quarry tile floors, carpet.*
Costs: *$48,000; $40 per sq ft.*
Photographs: *SOL-ARC.*

*South-facing Trombe wall (top photos) rises full height of the building in rental apartment. Owner's living room (far left two photos), while tight, has high spaces; bedroom (left) with water-filled tubes.*

Stockebrand residence,
Albuquerque, NM

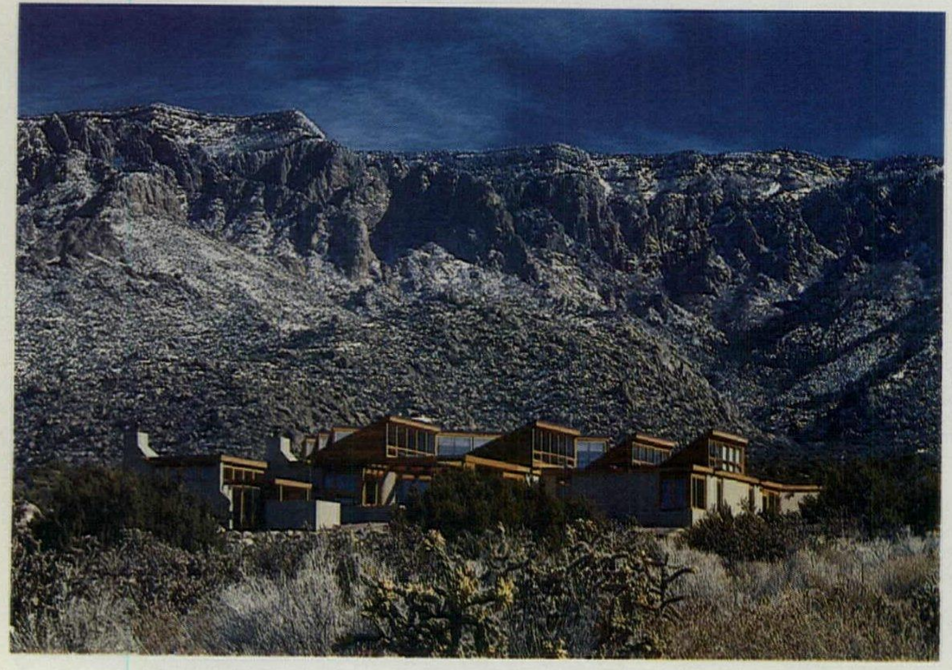
# Sandia sanity

**A large little house in New Mexico supplies its benign client with a dwelling that is nearly energy self-sufficient. Its architect has put solar research and theory into practice.**




FLOOR PLAN WITH EXPLODED VIEW N 20'/6m

*The residence in its magnificent site (below), view from the southwest. Opposite: 1 Detail of pool area skylight, 2 pool looking southeast, 3 southeast exposure, 4 southwest exposure.*



The origin of the Stockebrand residence must be traced from four separate strains of influence: the place, the client, the book, and the architect. The place is Albuquerque, NM, where the climate, utility rates, and informal nature-oriented lifestyle have caused it to perform as a seedbed for energy (especially solar) research and experimentation. The client, Thomas Stockebrand, is a self-avowed "solar freak" and director of engineering for Digital Computers in Albuquerque. He was very specific about his energy goals for the house. The site-built active collectors are his own creation. The book is *The Passive Solar Energy Book* by Edward Mazria. The research for the book yielded the understanding of the passive energy strategies employed for the house. The architect is Edward Mazria, an East Coast transplant whose book, architectural works, and nationwide participation in passive solar workshops have made him a respected leader in the field.

The site is half an hour from downtown by freeway up into the foothills of the Sandia Mountains. Sandia Heights, as the development is called, is "full of solar." The only utility available is electricity, but the view of the mountain range and valley below will knock your socks off. The site slopes to the southwest. The views are roughly to the southeast and southwest. A requirement of the Sandia Heights development prohibits owners from altering the natural appearance of the land surrounding the houses. Mazria attempted to maintain a single floor plane for the house, jogging the plan for the view and sunlight, and breaking the roof plane with jagged peaks in context with the mountains and out of the necessity to bring sunlight into those parts of the plan that do not face south. The outdoor trellised and terraced areas provide shaded exterior protection for the summer. The building color matches that of the ground; the detailing is a variation on the New Mexico adobe tradition.

The client family of five consists of the parents and three daughters ages 17, 15, and 13. Although previous abodes in Massachusetts did not contain a pool, Stockebrand requested that his new house be centered about one. The parents also requested acoustical and physical privacy from the children's living space.

Richard Rush

1

The value of the massive quantity of water as a heat storage medium was not lost on the engineer client. Sixty percent of the pool heat was to be accommodated by passive solar means, and 40 percent by active solar liquid collectors site-built by Stockebrand. The moist air from the pool space is not permitted to enter the rest of the house, but the uninsulated wall which separates the pool from the rest of the building serves as an interior heat source. It was Tom Stockebrand's hope that through active solar pool heating, passive solar house and pool heat, and wood heat (a drive of 40 miles is needed to find the wood), only a small remaining quantity of electricity would be needed. The roof of the garage has therefore been left for the bank of photovoltaic cells which will one day make this house 100 percent solar.

The extensive research into the solar building vocabulary for the book and the 1½ years of writing yielded for its author a clear perception of the problems and possible solutions for providing passive solar heat for a residence. Trombe walls did not seem the answer because of the spectacular view. Direct solar gain through the windows in New Mexico must not fall on "bleachable" surfaces. Mazria's answer for passive solar heat gain was the combination of sawtooth clerestories, some south-facing windows to balance the daylighting, and light-colored surfaces to bounce the light and avoid overheating.

Mazria discovered that dark-colored masonry surfaces often receive too much heat to absorb when placed in direct sun. They are slow to heat up and then can overheat. By reflecting the sun's heat from light-colored masonry walls to the masonry floor and other masonry interior surfaces, the heat each surface receives is more attuned to the rate at which it can accept the heat, and overheating is avoided. This same heat is avoided in summer when the overhang and angle of the roof exclude the sun from the interior spaces.

Mazria also follows his own recommendation from page 259 of his book: "When using a masonry wall [exposed to the exterior] for heat storage, place insulation on the outside

2

3

Richard Rush

4

Ed Mazria

of the wall. Also, at the perimeter of foundation walls, apply approximately 1½ to 2 ft of 2-in. rigid waterproof insulation below grade. This will prevent any heat stored in the walls and floor from being conducted rapidly to the outside."

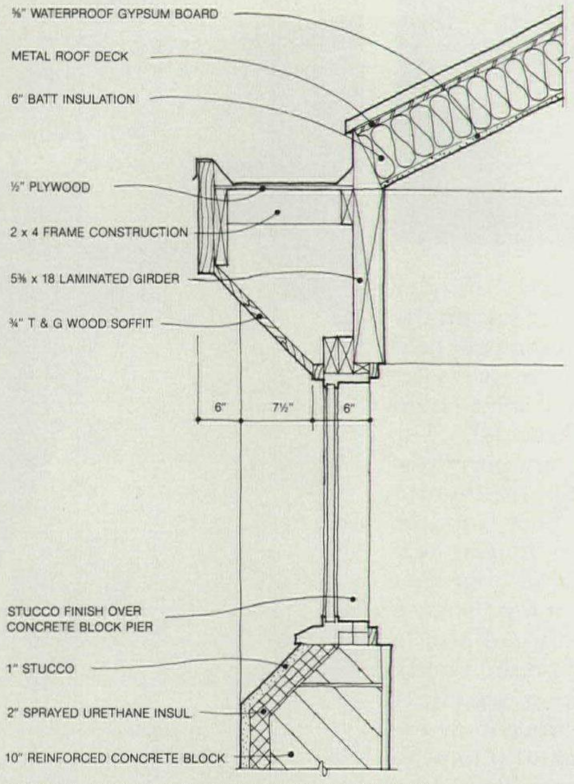
Equipped with the client's active systems and enthusiasm and his own passive solar knowledge, Mazria was left to organize the spaces to match the needs and make architecture out of it all. Indeed, as he expresses it, "The architecture in this building does most of the work." He refers of course to the passive systems. He is quick to add, however, that he deals with all of the other traditional architectural elements with the addition of solar.

The pool is the center of the house. The plants, brick pavers, and highly reflective skylit surfaces give it the warmth and quality of a healthful place. The pool area is on the north side of the house (where the neighbors are) and, as mentioned, yields a warm wall interface with the rest of the house. A view of the pool is possible from all of the non-private places in the house. It is even on display at the entrance of the house from the exterior. The pool centers on itself; there is no view of the mountains. It truly has a feeling of refuge where one recharges from the demands of the environment outside.

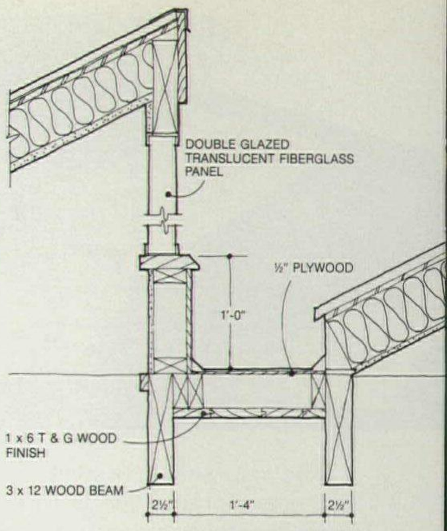
The sleeping spaces do not directly face the pool area. Two of the children's rooms are equipped with bed lofts, blasted with sunlight from the clerestory above each bed, almost like sleeping outdoors. The older child's bedroom and the master bedroom are heated by direct solar gain from vertical windows.

How does the building perform? The family has occupied the space for over one year but all of the systems have yet to be made fully operational. An early leak in the pool has delayed the active solar until the remedy for the pool is found. The temperature in the pool is therefore entirely from passive solar heat, and it and the wall between this space and the rest of the house are cooler than designed. Therefore, the spaces that depend upon its heat are cooler in winter than expected. Nevertheless Stockebrand is pleased. In a letter to the architect he explained: "It is now clear that a house of this general design in this climate can in fact be made to do all of its heating with solar, and that almost entirely passive." He adds, "It makes me sad, as an engineer, to see all of the houses going up around here that have a complete heat-pump system as backup."

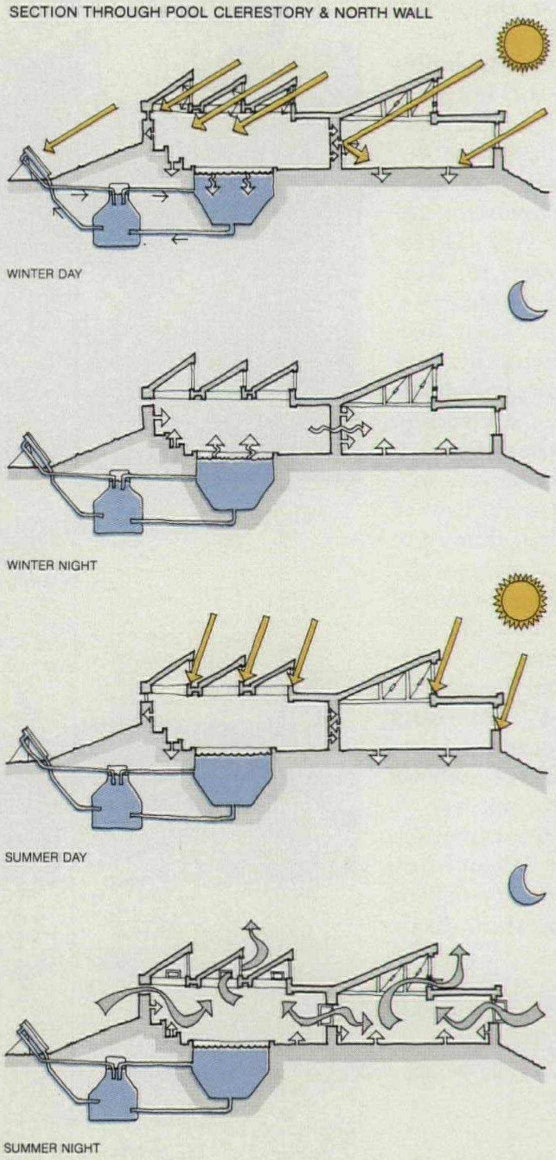
How does living in a solar house change Stockebrand family life? "Our lifestyle hasn't changed much, though we are more aware of changes of seasons and the weather in general. We tend to run around with less clothing on, because of both the evenness of temperature and the privacy."




SECTION THROUGH POOL CLERESTORY & NORTH WALL




*The key to the passive solar system is the use of clerestories to bring light and heat deep into the house.*




ENERGY STRATEGIES EMPLOYED IN THE STOCKEBRAND RESIDENCE

## Data

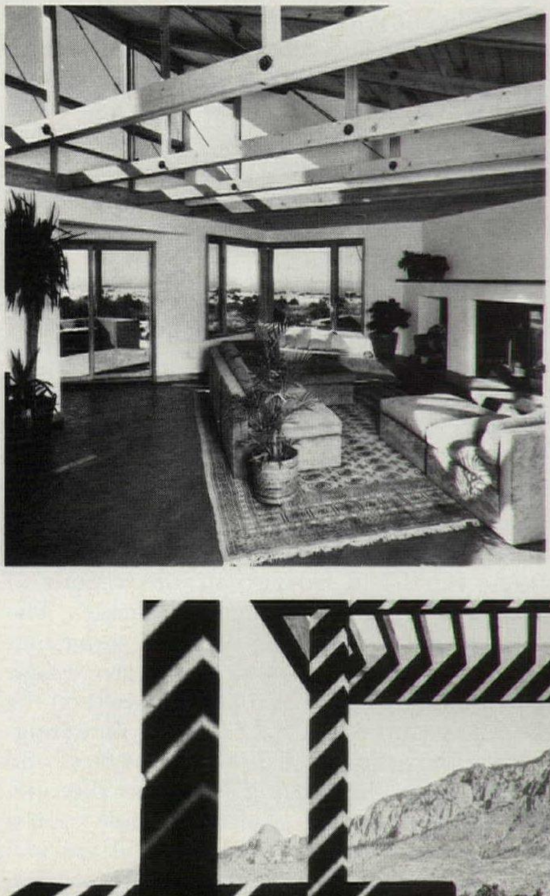
Project: *Stockebrand Residence, Albuquerque, NM.*
Architect: *Edward Mazria & Associates, Inc., Albuquerque; Edward Mazria, Marc Schiff, Rob Strell, design team.*
Client: *Thomas Stockebrand.*
Site: *two acres in the foothills of the Sandia Mountains.*
Program: *5500-sq-ft residence for family of five including: pool/greenhouse (2250 sq ft), master bedroom/bath (504 sq ft), children's bedrooms (819 sq ft), utility (195 sq ft), garage/ workshop (860 sq ft), entries (138 sq ft).*
Structural system: *concrete grade beams on piers, load-bearing concrete block, wood joist/truss, laminated wood beams.*
Major materials: *expanded polystyrene insulation with textured exterior surface, brick on sand and tile on slab, redwood fascias and trellis, tongue-and-groove aspen and gypsum ceilings, built-up roof on metal panels (see Building materials, p. 255).*
Mechanical system: *electric strip heaters, active solar.*
Consultants: *Robert Strell, interiors; Engineering Associates, structural.*
General contractor: *Jim Bishop Construction.*
Cost: *$250,000.*
Photographs: *Tim Street-Porter, except where noted.*

There are problems unrelated to the pool heat. The master bedroom has three walls exposed to the exterior and no skylight to heat it during the day. Although it is well insulated and receives sun from the windows, it has been cool in mid-winter months. Insulating shutters, designed but omitted in the built building, have now reappeared, fabricated by the client.

In the summer months the house has been occasionally hot. Stockebrand has installed mechanical fans in the ceilings to destratify the hot air and has succeeded to his satisfaction. Ducts have been designed and placed for a simple evaporative cooling device, should the need arise.

The children's loft rooms have also proven to be warm in the summer months, and as the girls grow older, they complain about not being able to close shutters and sleep in the mornings. Direct gain is always limited in that when light is shut out, heat is also omitted.

To an easterner the interior spaces are very bright. The morning sun penetrates the living spaces enough to water unshaded eyes. New Mexicans don't even notice. All of the sunlight has the psychological effect of making the occupant feel warmer than he or she is. As the building nestles low in the barren landscape, the sun reaches over it and casts angular stripes onto the north-facing entry. The sun seems to like this house.
[Richard Rush]



*The master bedroom (top left) receives direct solar gain from windows. The kitchen (top right) with a view to the living room. The living room (left) with direct solar gain from windows and skylights (and wood heat from the fireplace). The entry (below) is to the north, but captures sun over the flat roof.*

Richard Rush

Brodhead House,
La Honda, Ca

# Half-and-half

Sally Woodbridge

**A consciously vernacular-style house borrows from some unusual historical prototypes for an award-winning energy-saving scheme. Only half the inspiration for the form is energy.**

Making the house a "machine for living" has acquired new meaning in these energy-conscious times. If our bodies are, on one level, heating and cooling systems, our houses too may reflect the integration of these functions along with the other functions "home" brings to mind.

Designers Richard Fernau and Laura Hartman used this building-as-system approach in the design of the Brodhead house located near La Honda, a rural-suburban area in California's coastal range about 60 miles south of San Francisco. Although the climate is benign and free from extreme heat and cold, a critical winter day reaches a low of 36 F while summer heat may build up to 104 F before the late afternoon breezes begin. Last October, the project, now nearing completion, was one of 20 award winners of the First Annual Passive Solar Design Competition staged during the Fifth Annual National Passive Solar Conference (P/A, Feb. 1981, p. 28).

### Initial input

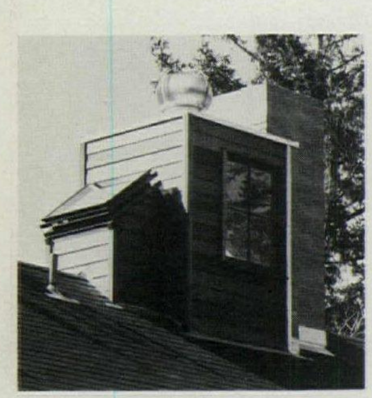
During the formative period of design, Fernau and Jim Axley worked with "The Admittance Procedure," the British building thermodynamic analysis method. Later they used ADMIT, a computer program based on the British method, to fine-tune the design by analyzing the building's response to a critical winter and summer day.

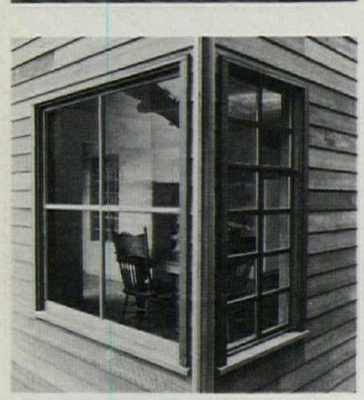
A previous interest in generic American house types had led Fernau into a study of their modifications for regional climates. The client's preference for simple vernacular forms encouraged him to take seriously the creation of a local hybrid design based on the Georgian grand hall plan and the New England saltbox organized around a fireplace and utility core. The starting form was the one-and-one-half-story, wooden, gable-roofed box. It was then modified by local thermal criteria and the architects' concern for solving the convection and ventilation problems of the passive solar house.

The Brodhead house is a throwback in more than one sense. It is not your ideal typical California see-through house. Instead it has distinct rooms—or discrete thermal spaces. The return to rooms makes it easier to control temperatures. Also, as critics of the open plan have observed, there is a flexibility in living that comes with being able to open up or close off rooms. Even in a small house of 1400 sq ft, there is no compelling reason to have all of the space available all of the time. And though it is a compartmentalized box, the Brodhead house does not lack spatial interest. But the spatial drama takes place in the unheated entry hall and does not involve the whole envelope.

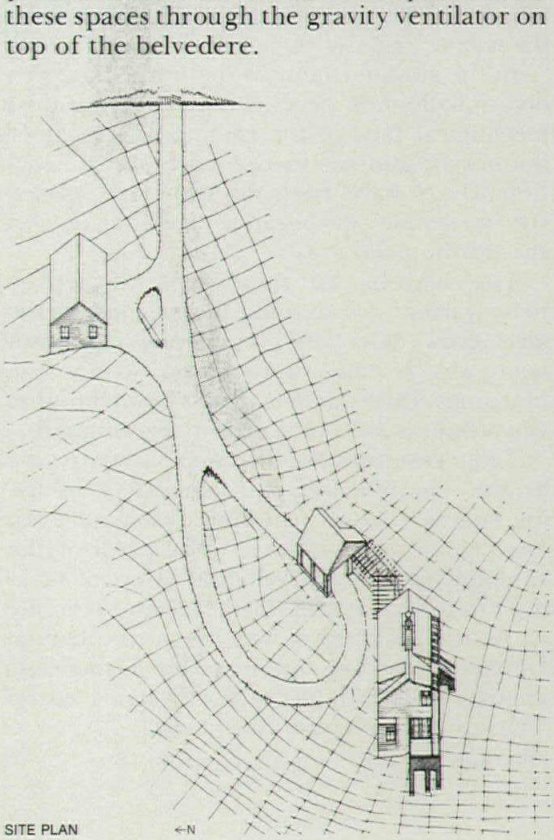
A masonry "invasion" of the house begins with a striped concrete block wall laid up with tan slump stone and smooth gray block. The wall incorporates a ceremonial pergola leading to the entrance on the east side. Outside, the wall continues as a foundation along the north side. Inside, it crops up to frame the entry hall and massive fireplace. Finally, it projects through the roof as the chimney.

The masonry wall receives the sun's heat through the south-side doors and windows on the first and second floors, creating what the designers call the "hot hall" below and the "warm hall" above. As places of temporary use, the halls may exceed comfortable temperatures, but heat can also be expelled from these spaces through the gravity ventilator on top of the belvedere.





*(Top) Vented skylight, ventilator, and chimney as roof sculpture; (below) corner window detail.*



SITE PLAN ←N

The hillside site permitted a largely subterranean space that tends to overcool. Fans, linked to the living spaces by means of a masonry duct extending through the full height of the building and controlled by a differential thermostat, can pull the cool air up from the basement and exchange it for the warm air of the belvedere. When there is a need for heat, the same system can recirculate the hot air collected in the halls and belvedere.

### The hall

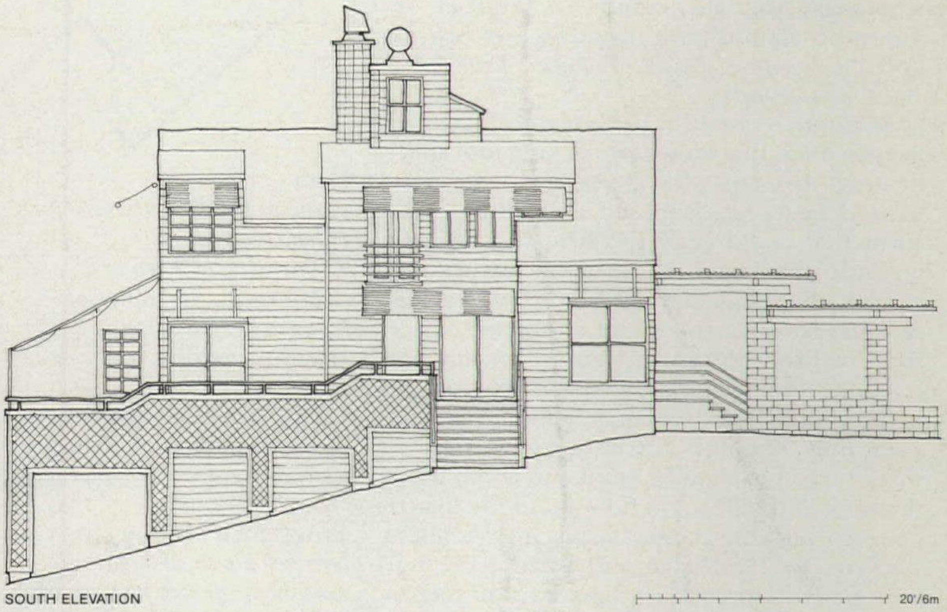
The walled entry hall functions as a thermal buffer zone, an interior lighting, heating, and cooling well to which all rooms are connected either by doors or by interior windows that function as dampers. The hall, which has double-hung windows, is sheathed with horizontal redwood beveled siding that pokes through the roof as a cupola, capped with a turbine ventilator as finial, displaying a deliberate outside-inside ambiguity. In part it is inspired by a Bay Area landmark, the Winchester Mystery House, famous for the insanity of its internal arrangements. The towered and gabled 19th-Century rambling house, created by the widow of the inventor and manufacturer of the Winchester rifle, struck Fernau and Hartman as more than the aimless transposition of outside windows and walls to inside elements. They perceived how the outside pieces could be made useful inside for lighting and ventilation because of their incorporation with skylights and vented cupolas and with the retention of operable sash and foundation vents.

The next most important space in terms of its contribution to the passive system is the living room at the west end, which has a direct gain from south- and west-facing windows. The great fireplace provides necessary auxiliary heat; electric baseboard heating has been installed as a backup measure.

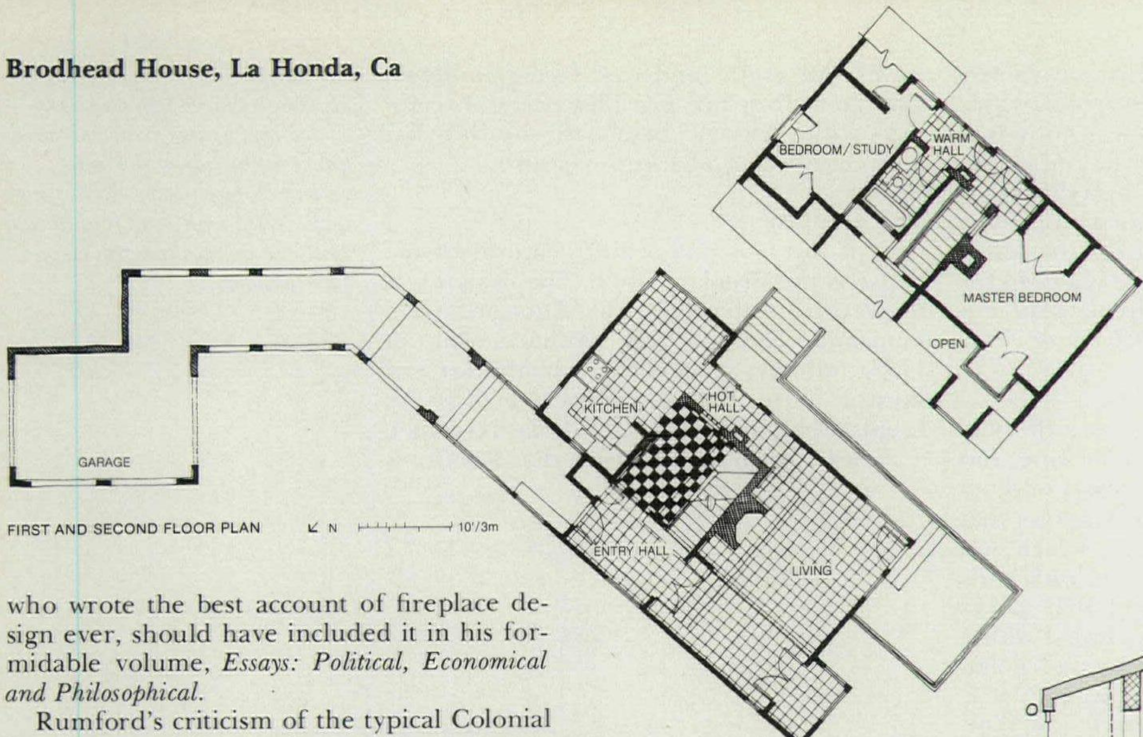
### The fireplace

One of the most interesting features of the house is the fireplace itself. The design was derived from that of Count Rumford, born Benjamin Thompson in Woburn, Ma, in 1753, and later made a count by the King of Bavaria. Since, in the era of cheap energy, the fireplace had been reduced to a status symbol, it comes as a surprise to learn that Rumford,

*Architects R. Fernau and L. Hartman placed this passively cooled and heated redwood-sided house in the side of the west-facing slope (below). Retaining wall, trellis wall, and foundation wall run along the north elevation (bottom).*




SOUTH ELEVATION



FIRST AND SECOND FLOOR PLAN

who wrote the best account of fireplace design ever, should have included it in his formidable volume, *Essays: Political, Economical and Philosophical.*

Rumford's criticism of the typical Colonial fireplace was that it was for cooking, not space heating. Instead of a deep box that internalized heat, he proposed a shallow, coved form that could send the heat rays directly out into the room to warm the bodies and objects they touched. Since fireplaces also sent smoke into the room along with heat, Rumford solved this problem by introducing a smoke shelf where the throat narrows to become the flue. Heavier than air, smoke rises only through force of convection. A weak force permits the smoke to come down the back of the flue and flow out of the hearth opening into the room. By placing a shelf at the back of the throat and leaving the flue unimpeded, the smoke's downward passage is interrupted at the point where it can be caught again in the upward draft and carried out the chimney.

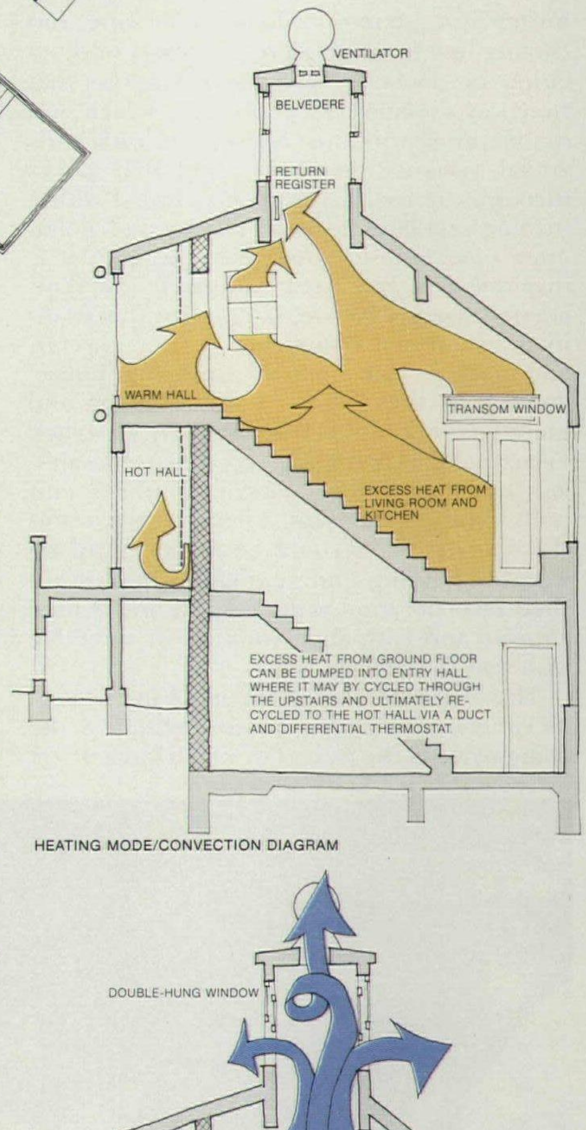
The Rumford-type fireplace that Fernau and Hartman built into the Brodhead house has a 4' x 4' x 1'8" opening with slanted sides and back. Though it looks too shallow to hold enough wood, the heat from even a small log can be felt at the back of the room. The marvelously efficient Rumford fireplaces are tricky to build. The good Count did not make relative dimensions explicit; the designer must do that.

In the Brodhead house, the direct heat gain from the fireplace and masonry core is augmented by the tile floors. The floors of course not only help store the intermittent solar heat in the winter months, but work as cooling storage for night ventilation in the hot spells.

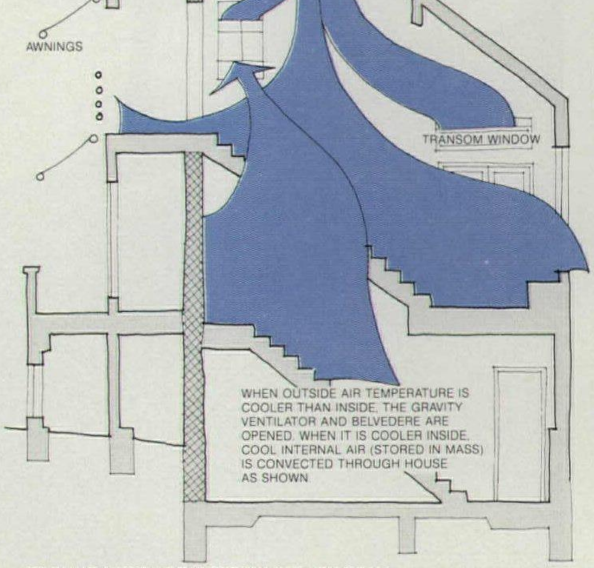
In their effort to create an aesthetic that communicates the new idea of the house as a machine for living, the Brodhead house designers have tried to leaven practicality with wit. Both the design process and the product testify that energy conservation need not be an exercise in mechanical engineering that stifles art. □

**Data**

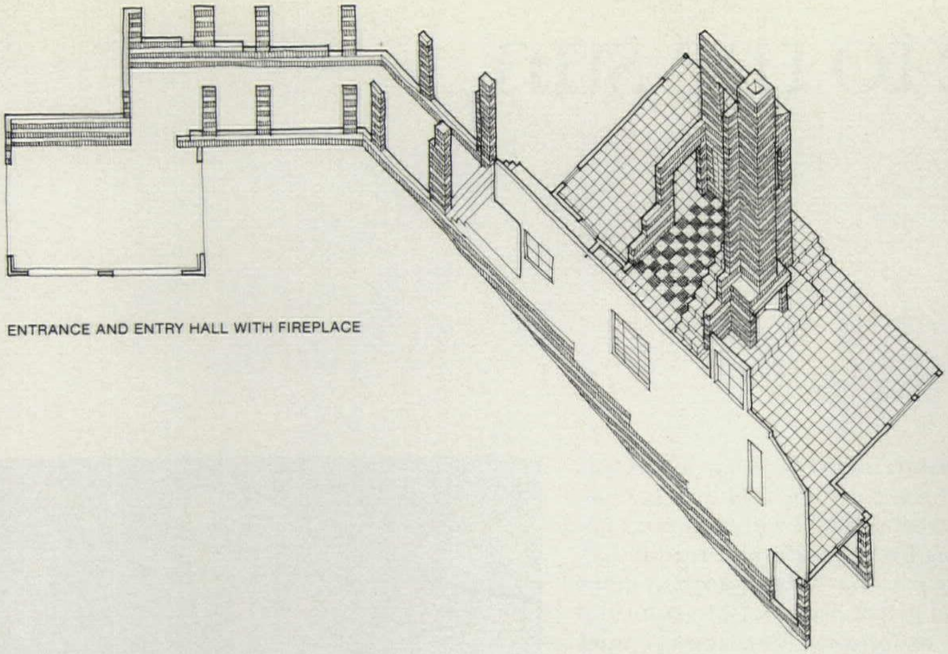
Project: *Brodhead House, La Honda, Ca.*
Architects: *R. Fernau & L. Hartman, Berkeley, Ca; Richard Fernau, Laura Hartman, and Jim Axley, design team.*
Client: *David Brodhead.*
Site: *heavily wooded 30-acre west-facing slope, 60 miles south of San Francisco.*
Program: *a 1400-sq-ft two-bedroom house, with garage/workshop, carport, covered walk, vestibule entry hall and study, plus typical living spaces.*
Structural system: *wood frame construction on grade beam foundation with a masonry core able to withstand seismic forces.*
Major materials: *concrete block ("slump stone"), redwood bevel siding, redwood lattice, canvas and horizontal metal shades, R-19 walls and ceiling, gypsum board, quarry tile (see Building materials, p. 255).*
Mechanical system: *heat stratification is combated by a differential thermostat duct and fan, which link the "hot hall" with the belvedere. On a 36 F day, 69 percent of energy needs should be supplied by direct gain. Electric baseboard heating provides backup.*
Consultants: *Raymond Lindahl, structural; Fred and Ted Jacobs, mechanical; Jim Axley, thermal analysis; Phillip Ceasar, domestic hot water.*
General contractor: *David Brodhead; Norm Nelson, masonry.*
Costs: *withheld.*
Photography: *Lewis Watts, R. Fernau.*



HEATING MODE/CONVECTION DIAGRAM

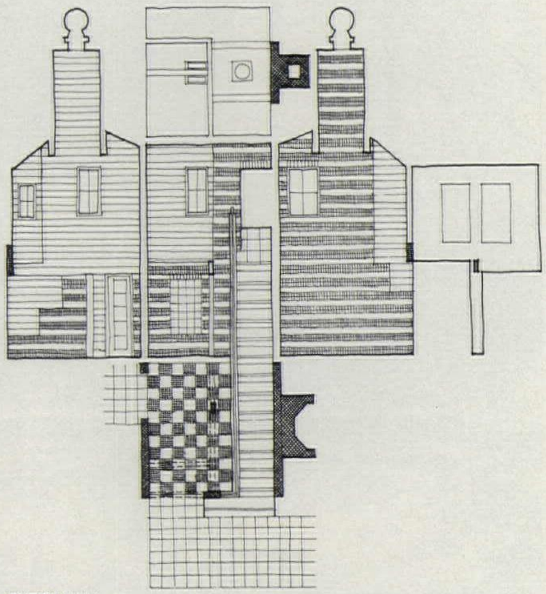


COOLING MODE / CONVECTION PATH DIAGRAM

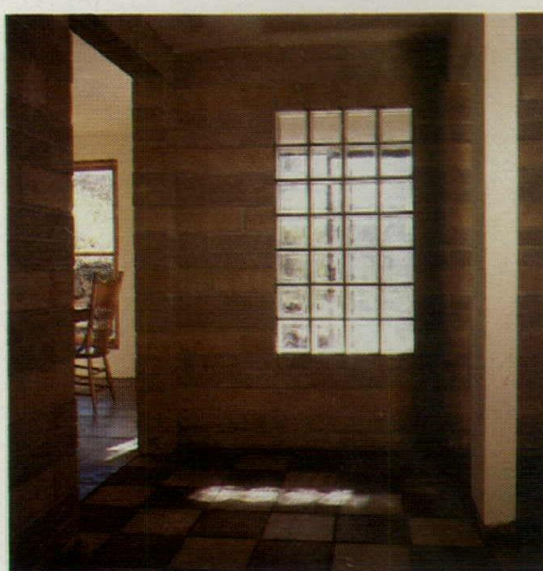


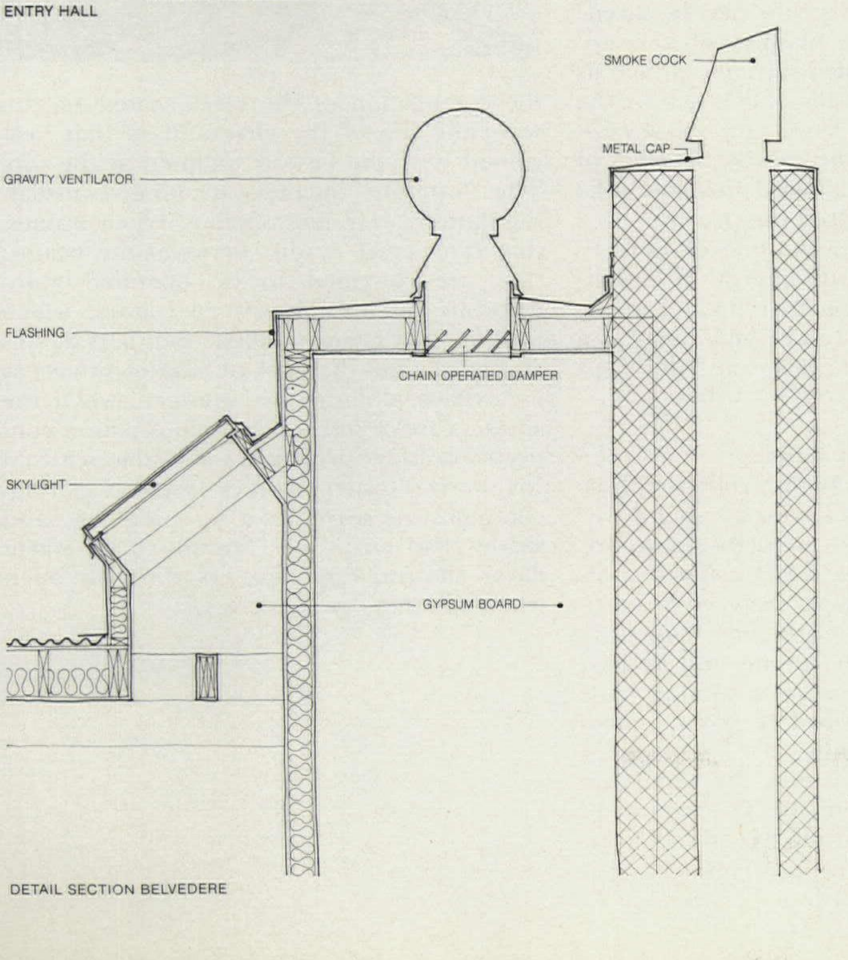
ENTRANCE AND ENTRY HALL WITH FIREPLACE

*Both the shallow masonry fireplace (right top) and the spacious entry hall function to heat the house naturally on cool days. The architects see the hall, which may vary in temperature beyond the usual comfort ranges, as analogous to a Trombe wall, but with more explicit architectural advantages.*

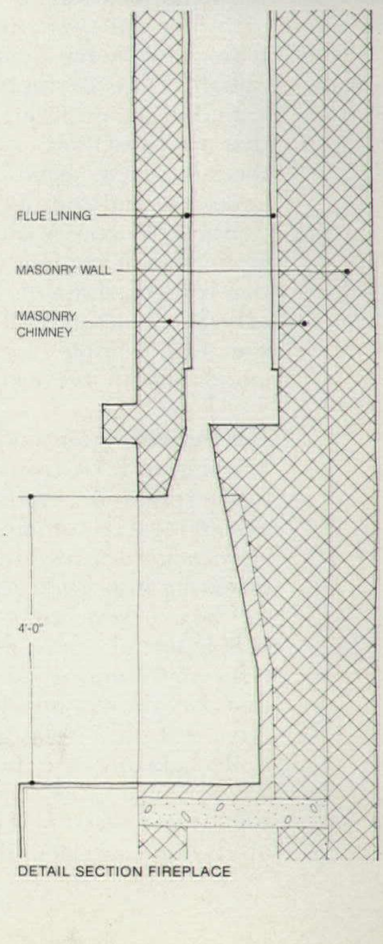


ENTRY HALL






DETAIL SECTION BELVEDERE

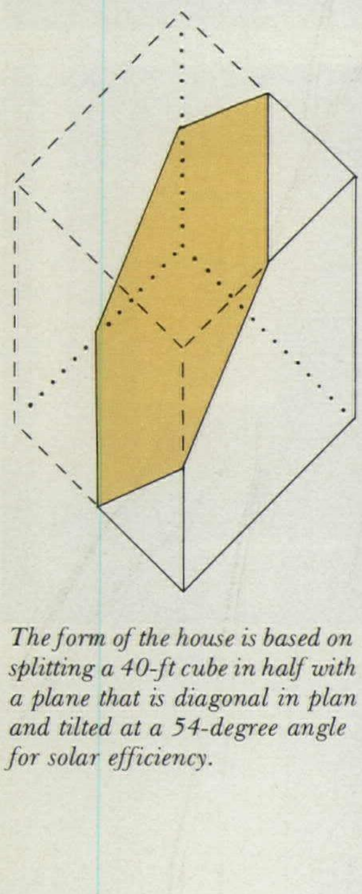



DETAIL SECTION FIREPLACE

Raven Run house, Lexington, Ky

# Face to the sun

**Its unorthodox geometry determined by a solar collector plane, this rural house-studio nonetheless presents an image of domesticity.**



*The form of the house is based on splitting a 40-ft cube in half with a plane that is diagonal in plan and tilted at a 54-degree angle for solar efficiency.*

The angle requirement of solar collectors conjures up a vision of new building geometries that are irreconcilable with accepted notions of building form, Modern or traditional. One genuine fear is that solar energy systems will become the *pretext* for a lot of sculptural exhibitionism, disfiguring our communities and discrediting energy-conscious design in the process (see *Formal dynamics,* P/A, April 1979, pp. 116–119).

The house that architect Richard Levine has built for himself and his sculptor wife confronts these concerns directly. Its unconventional form is clearly derived from an effort to obtain the maximum solar exposure plane for the most compact volume. Admittedly, Levine had the benefit of a rural site, out of view of even his nearest bemused neighbors; dropped into a more densely built area, his house would look disconcerting. But given the opportunity to unleash geometry, Levine has shown an obvious concern for creating a place that feels like home.

To get the large plane facing south, at an angle of 54 degrees appropriate for the Kentucky winter, Levine took a 40-ft cube, with one *corner* pointing north, and split it "the most complex way that a cube may be sliced" (drawing, left). In the manner of a brainteaser test, he has divided the cube so that its initial form is perceptually obliterated by the varied facets—three-, five-, and six-sided—that are presented to the viewer. Specifics of the site have been allowed to alter the geometry and complicated the puzzle.

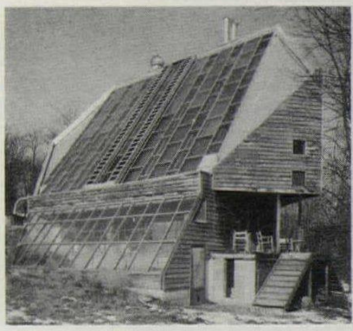
But geometry is only the first of Levine's strategies for dealing with energy. His attention is focused mainly on creating an energy-efficient structure that can be built on a rural site with simple materials and unskilled labor—mainly his own and his wife's.

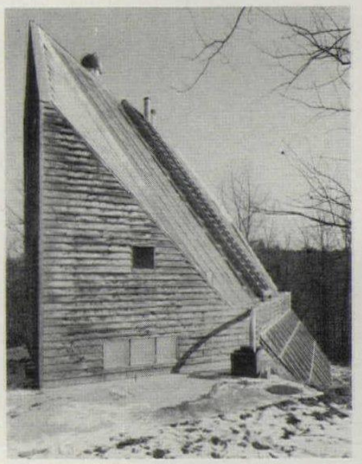
### Having your gain both ways

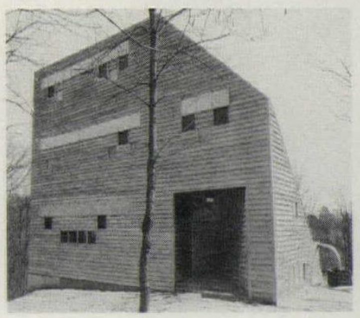
Sloping up 32 ft from its rain-collecting base to the roof, it illustrates Levine's "integrative" design ideal by combining structural support, active solar devices, and passive collectors. Alternating in uneven stripes between its vertical box beams are "multistage" collectors supplying an active air system and vertical rows of "Sundows," devices of window scale that Levine has developed for complementary "real time" solar gain.

Recognizing the potential for significant temperature increases in the 32-ft course of the active collectors, Levine has added layers of glazing (see detail drawings) and changed the corrugation of the black-coated foil toward the top of the channels, so that heat gained near the base is retained at the top. The "Sundows" incorporate hinged insulating shutters in frames, similar to door frames, that can be set readily between the beams; they are designed to be operated automatically by sun-sensitive activators, which have not yet been installed. Dampers at sills and head allow the stack of Sundows to act as an exhaust chimney in summer, when the shutters are closed. An ingenious pair of connected ladders provided a movable scaffold for the two owners as they installed glazing, continues to serve as a washing rig, and shades two strips of "Sundows" on warm days—allowing their shutters to remain open when all others are closed.

*The actual house presents a different image from each angle (east, facing page; south, right; southeast, southwest, and west, below). Basic geometry is altered by porch recesses and asymmetrical plane over greenhouse at base. Some portions of exterior are not complete, and untreated cedar boards are in the process of turning gray.*



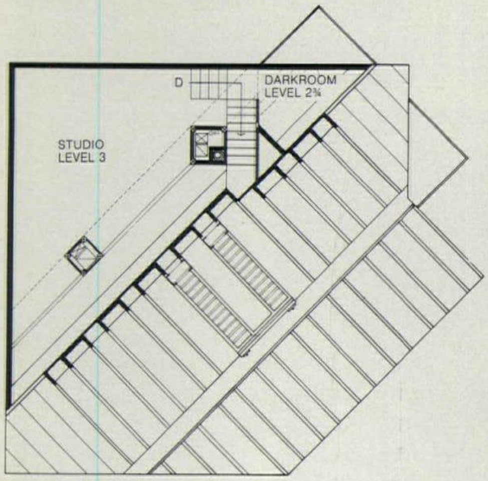




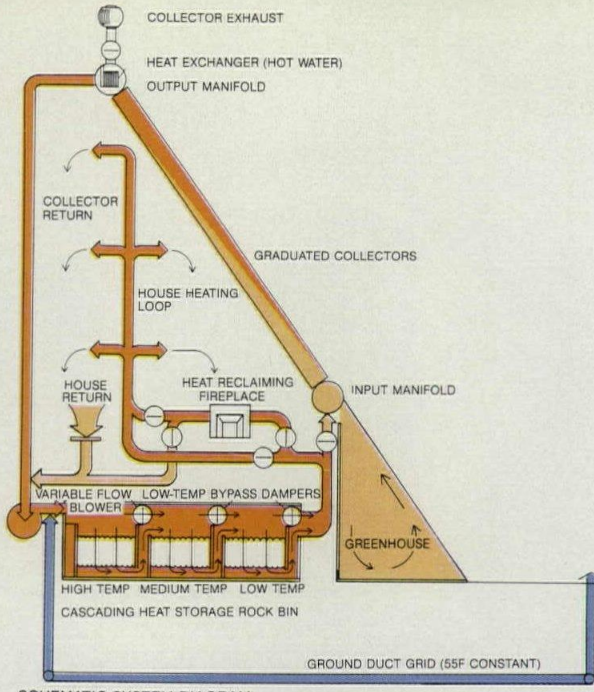
*Two living levels and two levels of studios above are all linked by switchback stair through center of house (above). Oak handrails and balustrades, without newel posts, hold some of the landings in place.*

# Raven Run house, Lexington, Ky

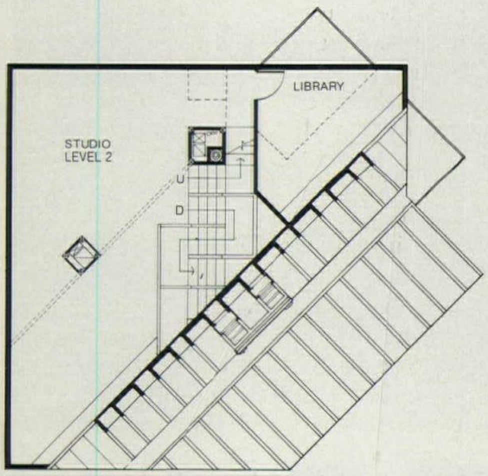
*Opposite: View of studio (upper left) shows canted "Sundows" open, closed, and shaded by ladder. Fireplace in living room (middle left) acknowledges both orthogonal and diagonal plan alignments. Kitchen (lower left) illustrates deployment of various 2-ft-square window types; kitchen table (bottom photo) overlooks central lightwell.*



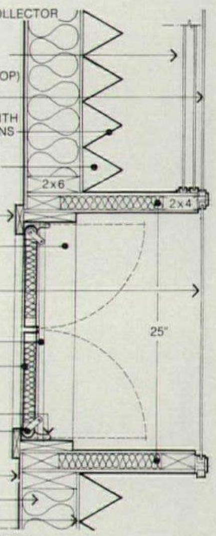

PLAN LEVELS 2¾ & 3



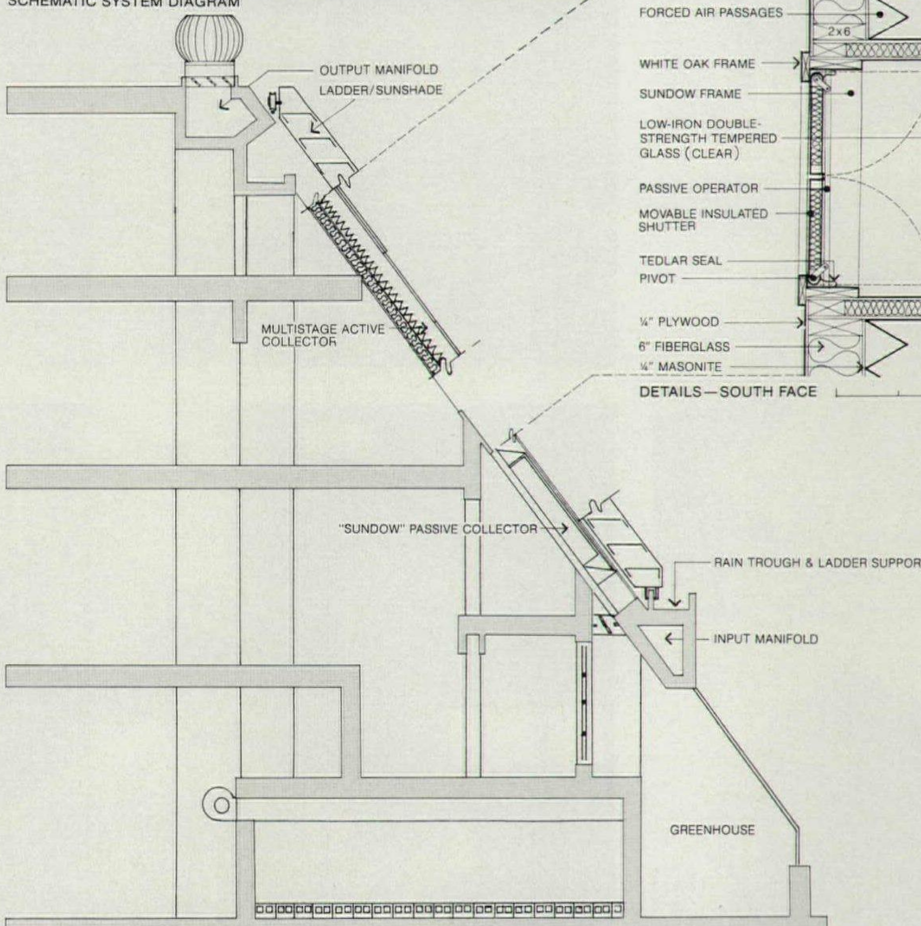

SCHEMATIC SYSTEM DIAGRAM



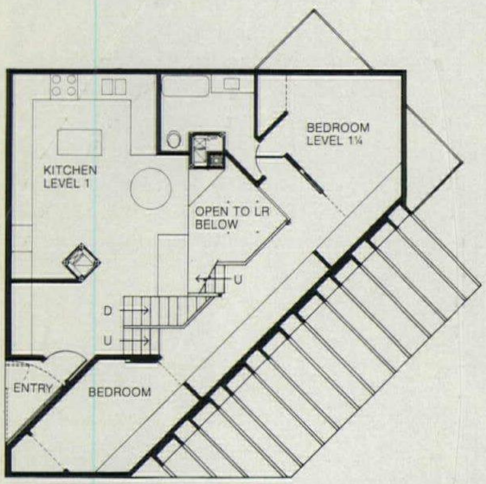

PLAN LEVEL 2



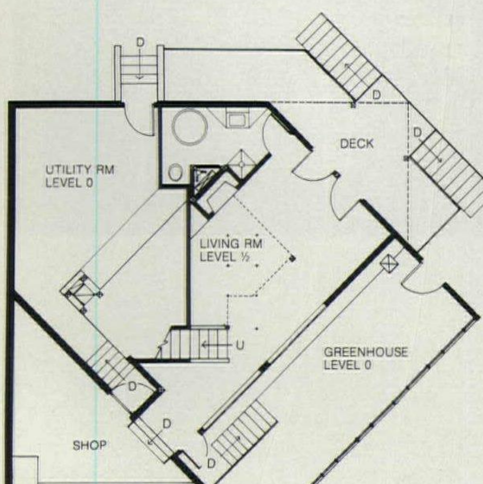

DETAILS—SOUTH FACE



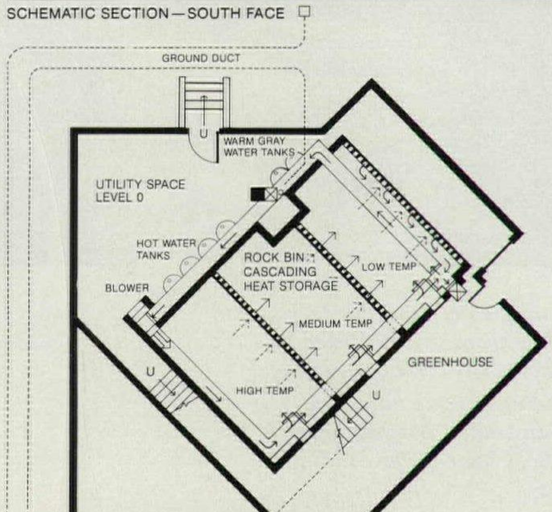

SCHEMATIC SECTION—SOUTH FACE



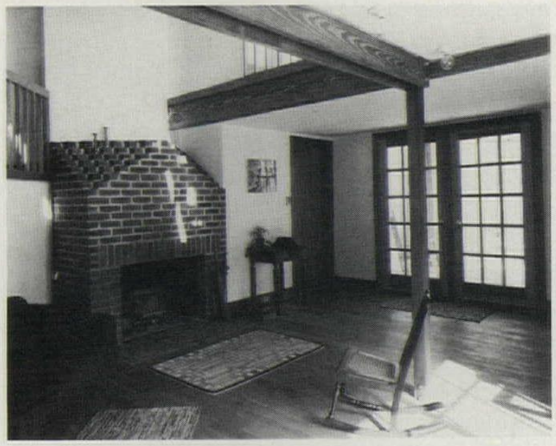

PLAN LEVELS 1 & 1¼ NOTE: EXTERIOR WINDOWS NOT SHOWN IN PLANS

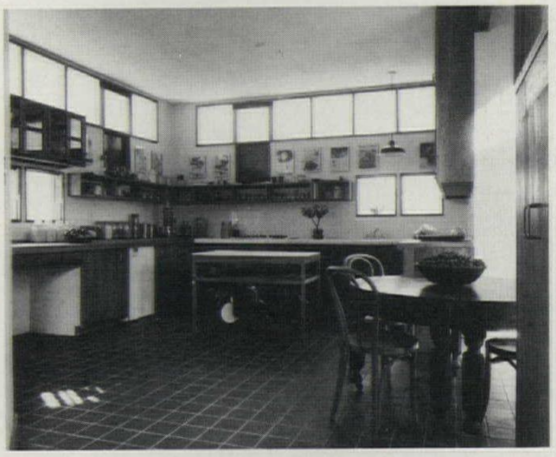



PLAN LEVELS 0 & ½ N 10'/3m




PLAN LEVELS 0 & −½





**Data**
Project: *Raven Run house, Lexington, Ky.*
Architect: *Richard S. Levine, Lexington, Ky.*
Clients: *Anne Frye and Richard S. Levine.*
Site: *30 acres of woodland, sloping about 100 ft from house site down to creek.*
Program: *3700 sq ft, including 400-sq-ft greenhouse and 1600 sq ft of studio spaces for sculptor and architect; 1700 sq ft for dwelling proper, including shop and utilities.*
Structural system: *slab on grade, with concrete block foundations and rock bins; wood frame with 2 x 6s, 24 in. on center, plywood box beams on 4 x 4 cedar posts supporting south collector wall.*
Major materials: *untreated red cedar siding, white oak trim, tile and oak floors, low-iron tempered glass on south face; insulation includes urethane foam, fiberglass, polystyrene foam, isocyanurate foam, and vermiculite (see Building materials, p. 255).*
Mechanical system: *passive—direct-gain "Sundows" and greenhouse; active—multi-stage air collector supplying 3-stage rockbin, controlled by minicomputer. Backup system is draft-controlled fireplace; hot water from heat exchanger in collector output manifold.*
Consultants: *V. W. Murrell, H.E.R. Oexmann (controls); D.W. Colliver (modeling).*
General contractor: *clients.*
Costs: *not available.*
Photography: *Dennis Carpenter, except as noted.*

With the vertical sides of his house, Levine was not content to be conventional. The height and the insulation specs of these walls called for 2 x 6 studs, 24 in. on center. The architect reasoned that windows that would fit between the studs could be inserted without disrupting the framing and could be disposed freely; in fact, the locations of his openings were not determined until interior spaces were framed in. He developed easily built, inexpensive windows of three types—for light, view, and ventilation—all in equal squares. The light-source types, made with two layers of plastic-fiberglass sandwich material for insulation, are placed in bands near the ceiling; the view windows are spotted at eye level and have pressed board blinds, of home-workshop simplicity, that drop from pockets; the ventilating windows have sturdier shutters that rise to expose squares of window screen. Visually, these squares, scattered with functional logic, give the interiors intriguing small-scaled incident; on the exterior, they work with the strange geometry to obscure the structure's scale.

**Stairway to the sun**

Inside the split cube is a series of odd-shaped spaces, linked by stairs that twist up to the topmost studio following an underlying geometry that the user cannot—and need not—easily grasp. The main living spaces on the two lower levels are thoughtfully shaped for domestic needs; fitted into odd-shaped spaces under the big slope are rooms, such as the library off one of the stair landings—retreats that are made uncramped by the unorthodox placement of openings.

The complex volumes of the interior are defined by clean white wall and ceiling planes, wood floors, and fine-scaled oak woodwork, recalling the severity and craftsmanship of Shaker buildings near Lexington. Light from many sources, some hidden from view, reflects from white and natural wood surfaces to produce a warm glow.

On the exterior, as on the interior, the use of natural wood and other vernacular materials, such as sheet metal roofing, juxtaposes a familiar, unpretentious surface quality to the rarefied geometry and technical intentions at the base of the design. Standing in the midst of its pretty wooded landscape, the compact but intricate structure sums up the confrontations between our environmental, aesthetic, and technical intentions—and indicates one way to solve them. [John Morris Dixon]

**Autonomous Dwelling Vehicle**

# Earthling capsule

**Complete independence from utility connections, with provisions for every domestic function, make this sophisticated artifact the ultimate mobile home.**

*Designers Ted Bakewell III (on ladder; also client) and Michael F. Jantzen pose at west end of vehicle.*

It seems remarkably apt that the little dwelling shown here has been published previously in both *Domus* (Oct. 1980) and *Popular Science* (April 1980). For this object—not a building—embodies both the down-home ingenuity that appeals to American home mechanics and the high-tech artifice dear to the international design elite.

The Autonomous Dwelling Vehicle was developed through the fortunate collaboration of two non-architects: Ted Bakewell III, scion of a family of developers, and Michael Jantzen, a fine arts graduate who has become an expert on energy-responsive dwellings by building them himself out of industrial parts. Bakewell, whose daily work involves such mundane constructions as suburban warehouses, wanted to act on some of his ideas about low-energy living systems; he also wanted a dwelling that could be moved from one construction site to the next. Published reports of houses assembled of light industrial parts, by Jantzen, 65 miles away in rural Illinois led him to propose the collaboration.

The dwelling design seems to have been generated—without forcing—out of the stringent program and the available parts the designers could obtain. The demand for mobility set limits of 14 ft in width, 13 ft in height, and 10,000 lbs in weight. Jantzen had already been using the lightweight silo components—interlocking with watertight joints to form cylindrical and spherical surfaces for houses—and they seemed a natural choice for the shell. These were mounted on a reused mobile office chassis, which fit requirements for dimensions and strength. The dwelling was in fact assembled on Jantzen's property, then towed to its present location.

Weight limits lay behind the choice of mechanical systems: an active solar air system for space heating, thermal storage in phase-change salt cylinders, and a compact heat-exchange fluid solar water heating system. Duct space was virtually eliminated by placing the thermal storage in two well-placed bins—under dining table and bed—from which they radiate directly to the interior space. Significant passive solar gain is obtained through the miniature "sunspace" that also serves as entrance air-lock. Backup systems, if solar energy is inadequate, include an incinerator that will heat water for a shower with a fistful of junk mail and one of the world's smallest wood stoves, which can provide the charm of a visible fire while heating the interior quickly on a winter night.

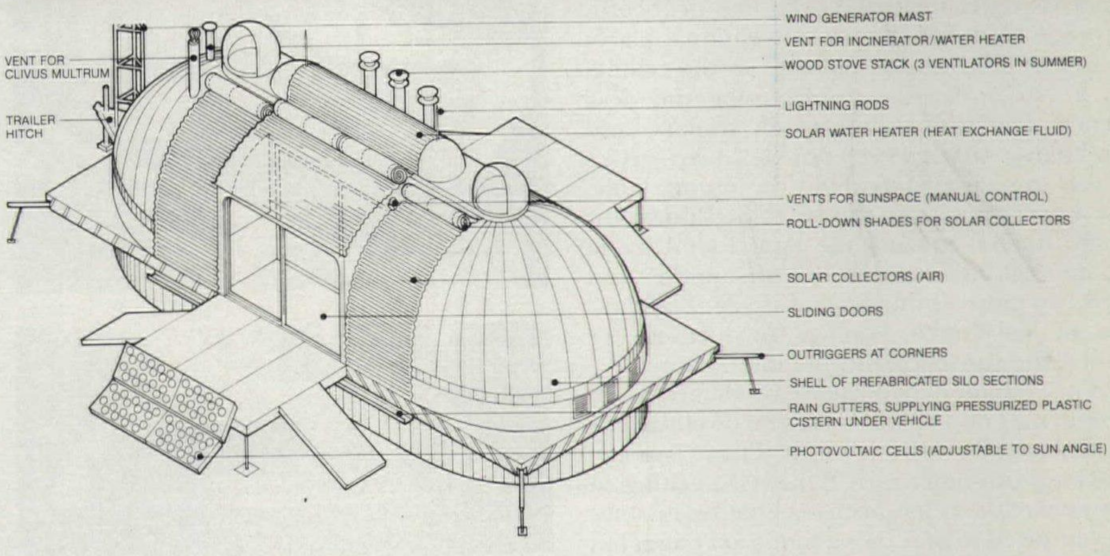
Obviously, winter heating depends as much on retaining heat as generating it; the silo sections make an infiltration-tight shell—with auxiliary caulking where other components are introduced—which is then insulated with 3½ in. of urea formaldehyde foam, covered with a 1-in. interior layer of cellulose-based fireproofing and sound-absorbing material. Cooling is achieved by the ancient method of drawing in summer night air and minimizing heat gain during the day. It has been possible to maintain a temperature 12 F below outdoors, with comfortable air movement.

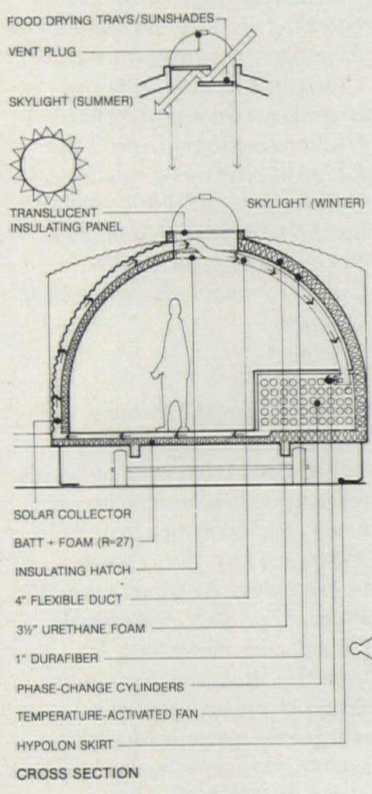
The principal strategy for electrical power is "micro-loading," an approach that Jantzen considers critical for future buildings. In this case, dependence on photovoltaics and battery storage of limited weight required the designers to hold down power demand. Low-wattage lamps developed for the Space Program (with 20 W and 12 W settings, equivalent to conventional 100 W and 60 W lamps) plus a few small, efficient ones borrowed from aircraft interiors take care of lighting needs, with the help of a light-diffusing interior treatment and effective use of daylight.

Food preparation—even for one—calls for strict energy-conserving measures. The designers developed a custom-designed refrigerator, superinsulated, with a curtain of clear plastic strips inside its door to reduce air exchange when an item is removed; outside air, when cold enough, is automatically tapped through a heat exchanger. Cooking is done over an alcohol burner (no electricity) with a tiny electrical fan-and-filter device mounted above it to cleanse fumes without sending interior air outdoors.

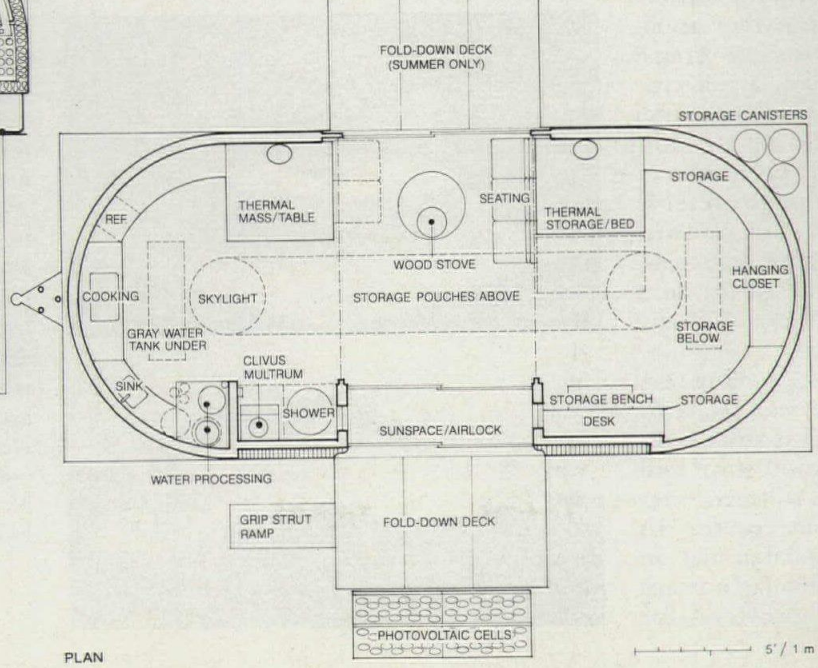
Water is obtained from rain directed from gutters to a flexible vinyl "bladder," which can tolerate frosts, under the floor; a 15-minute rain can capture 55 gallons, which will last for months. Once in the dwelling, water is reused—returned to an underfloor gray water storage tank, filtered and used for washing and bathing; filters and iodine treatment make it possible, if necessary, to restore the gray water to potable condition. Pressure to move the two types of water through filters and deliver them at the tap is generated by human power, using a high vol-

*South side of dwelling displays numerous energy devices (see drawings). Basic volume is composed of 7-ft-diameter silo sections set on a 1½-ft bulkhead.*




CROSS SECTION




PLAN

ume (bilge) pump to draw rainwater in through filters and a foot pedal under the sink to adjust water pressure by filling air bladders in the tanks.

Use of human power and manual adjustments are other strategies the designers consider invaluable for true energy conservation. Only a few controls, such as those on fans in the active solar system, are automatic. Effective operation of the capsule requires seasonal alterations: removal of stove and installation of ventilators, refitting of skylights, covering and sealing of north doors. Some other steps, such as rolling down shades over solar collectors and plugging or unplugging vents for the sun-space at the entry, would be most effective with an ever-present occupant who could respond to unpredictable weather conditions.

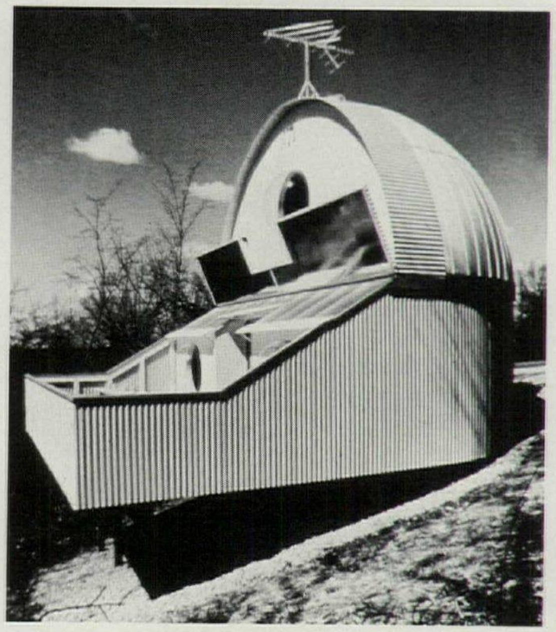
**Components found and transformed**

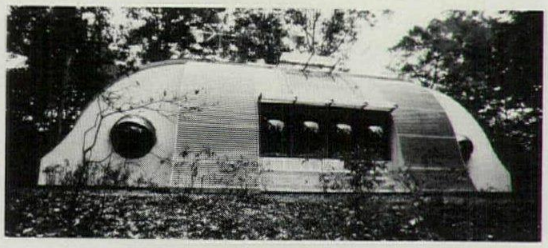
The resourcefulness of the designers is illustrated best in their tracking down and adapting components from outside the architectural world. In addition to the silo parts and the space vehicle lamps, they employed lattice-like plastic swimming-pool decking as both doormat/flooring for the entry airlock and wallcovering that works like pegboard. Storage is tucked into unconventional places —in zippered canvas pouches in the ceiling, in a bin under the floor, inside the desk bench. In the tradition of trailers and pullmans, space does double duty: when leaves are raised to extend the dining table, clever pull-out seats can be folded down for three diners; moving the light foam "living room" seating makes room for another leaf and two more dining seats. Circular "pillows" on the bed double as plugs for openings between the sunspace and the interior.

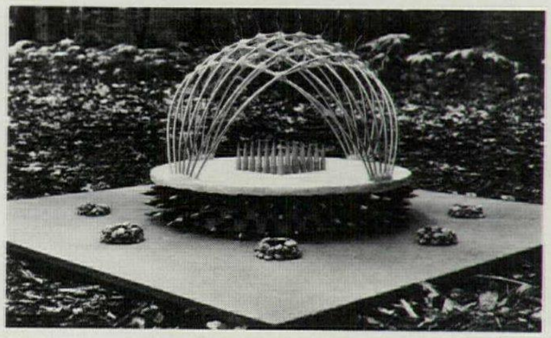
The designers had plenty of chance to revise details on the site since the dwelling was assembled by Michael and Ellen Jantzen, working full-time, with Bakewell pitching in on weekends. It has been occupied ever since it was towed to St. Louis about a year ago, but like any really experimental work, the capsule is continually evolving. Since its earlier publication in *Domus* and *Popular Science*, a vertical wind generator has been added; a reflector attached to the original photovoltaic panel has been replaced by a second set of cells. Now that the wind device has been added, Bakewell hopes to have enough reserve power to operate a blender. (Not satisfied with the efficiency of charging batteries, Bakewell plans to link the wind device to a compressed air system to operate rotary equipment.)

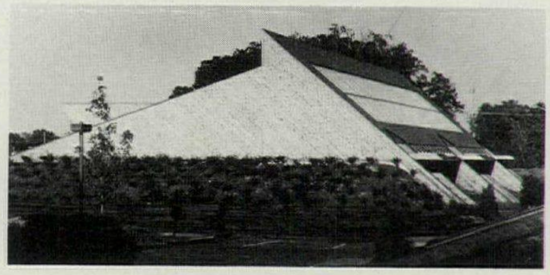
While the designers made the dwelling very close to autonomous, Jantzen is well aware of other ways in which it is not: it is still necessary to bring in fuel for the wood stove and the alcohol-fueled cooker; it is still necessary to cart away much of the user's refuse. His wife, Ellen Jantzen, who has collaborated on earlier houses with him, is particularly aware that the dwelling offers little provision for home-grown food—an area in which she is experimenting; even the food-growing potential of the sunspace here is not being exploited because Bakewell is not always around to water plants and to prevent overheating.

The designers emphasize that this capsule is by no means a prototype: it was meant to serve Bakewell's specific needs. The American family would need larger dwellings, with some privacy, and Jantzen is at work right now on a design for a system of portable, connectible modules to meet those needs. Bakewell, meanwhile, is working on a rehabilitation system for old houses that promises remarkable energy savings. Both view their collaboration here proudly, as a demonstration that design itself is one of our most effective energy resources.
[John Morris Dixon]





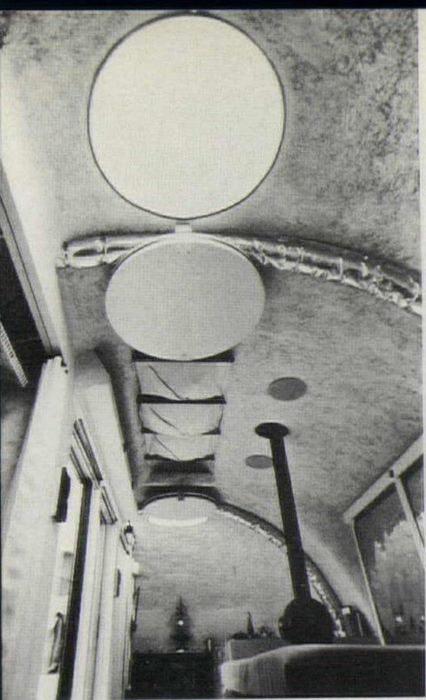


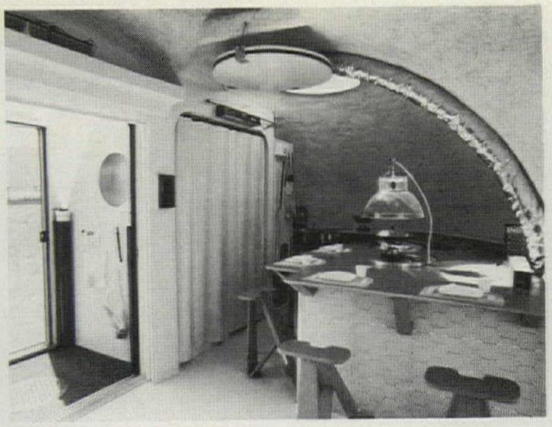


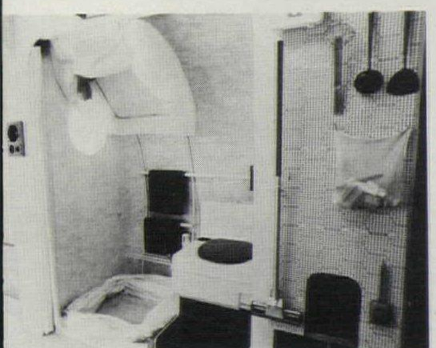
**Data**

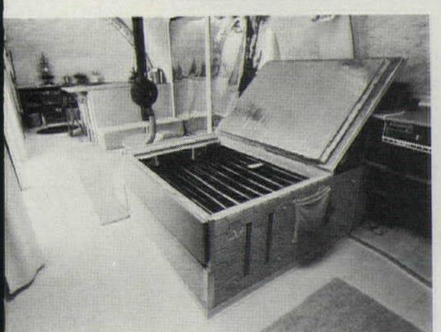
Project: *Autonomous Dwelling Vehicle, suburbs of St. Louis.*
Designers: *Ted Bakewell III, St. Louis; Michael Jantzen, Carlyle, Il.*
Client: *Ted Bakewell III.*
Site: *located at one of client's commercial construction sites; to be relocated as needed.*
Program: *450-sq-ft (gross) mobile dwelling unit for single person, including adequate provisions for food storage and preparation, personal hygiene, etc., with no utility connections.*
Structural system: *steel silo components, wood floor framing on reused chassis of conventional mobile office.*
Major materials: *silo components, white enameled; sliding glass doors; acrylic skylights; V.A.T. floors; urethane foam insulation; cellulose-based interior fireproofing (see Building materials, p. 255).*
Mechanical system: *active air solar collectors (fiberglass over black-coated silo sections); phase-change heat storage (84 cu ft of rods); solar hot water heater with heat-exchange fluid; wood-burning stove; waste-paper-burning incinerator/back-up water heater. Solar photovoltaic cells, vertical-axis wind generator, 12 V storage batteries. Pressurized flexible rainwater cistern; gray water storage and filtering system; composting toilet.*
Consultants: *Schultz Group, Engineers (structural); Dave Hudson (intelligence devices).*
General contractor: *designers.*
Cost: *approx. $20,000 (1979) not including design and labor.*
Photography: *Kristen Peterson, except photos left, courtesy of designers.*

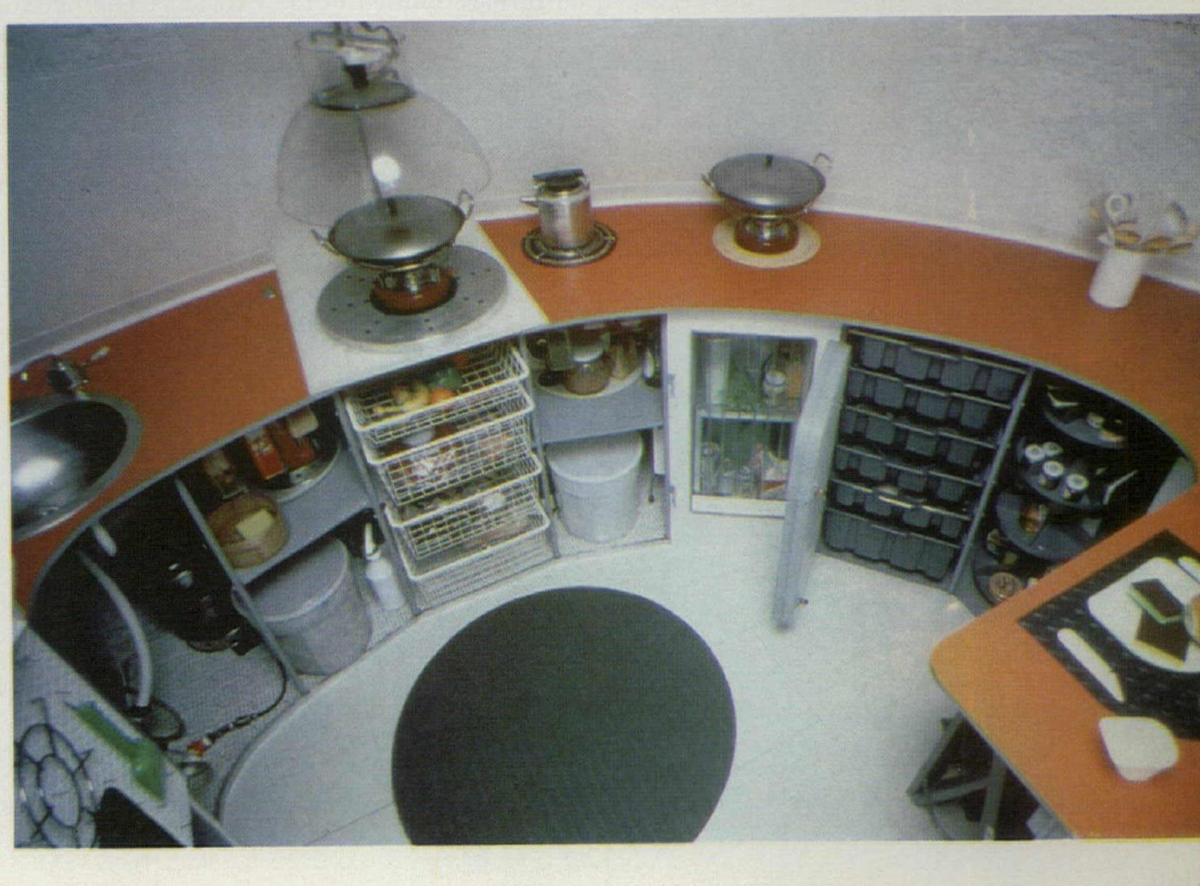
*In the late 1970s, Michael Jantzen and his wife Ellen designed and built a vacation house for a client (top) and their own house (2nd from top; P/A, April 1979, p. 118). Jantzen continues to work on environmental sculpture projects, some visibly related to his structures (3rd from top). Bakewell previously designed and occupied a low-energy environment inside a warehouse and has recently completed a 6000-sq-ft office development (bottom) with architect M. Thomas Hall, which includes active and passive solar features.*











*Ceiling of dwelling (top) has skylights with insulated hatches and zippered storage pouches. Dining table over thermal storage bin (top middle) can seat five. Entry space (top right) can become sun porch with hammock. Focal point of interior is woodstove (middle right) made of 13-in. gas canister with umbilical air supply, suspended over folding table. Compact kitchen (right) has alcohol burner with filter hood, custom-made undercounter refrigerator; headroom in front of counters is ample for 6'-2" Bakewell. Composting toilet (above, middle) shares curtained compartment with shower, which has collapsible fabric enclosure. Open hatch (above) reveals thermal cylinders under bed.*

# Energy in context

Susan Doubilet

**Energy measures reinforce traditional forms and promote resident contact in an International Meeting Center for the University of Berlin.**

Susan Doubilet is a Montreal architect and journalist doing graduate work in architectual preservation at Columbia University.

Three considerations directed the design of the International Meeting Center (Internationales Begegnungszentrum), an 80-unit apartment building for visiting faculty members of the University of Berlin. The first of these considerations is an energy concept so strong as to eliminate all direct openings to the exterior. The second is the goal of architectural harmony within a residential quarter possessing a strong formal identity. And the third is the encouragement of communication among inhabitants, who are all short-term visitors from foreign lands.

The architects have used the formal restrictions imposed by each of these considerations to enhance the other goals: "wintergardens" are energy-conserving buffer zones as well as forms which relate to the projecting bays of the older buildings; and the roof garden collects heat, repeats the neighborhood roof profile, and provides a meeting place for residents.

## The energy consideration

Eighty percent of the heat needed in the building is collected in the glass-enclosed roof garden, which contains the air-to-liquid heat pump. The remaining 20 percent is produced by an oil furnace located in the basement. All the major rooms in the apartments are warmed by hot water circulating through pipes in the hollow-core concrete floor planks; fresh air (20 cu m per person per hour) is drawn directly from the outside and heated in "warming closets."

All doors and windows open off vestibules and glass-enclosed wintergardens. (In a very few cases, the wintergarden is reduced to 20 in., the thickness of the "Poroton" tile wall.)

The functions of the roof and wintergardens vary with the climate, from day to night and from season to season (see sections, opposite page).

## The 'context' consideration

The area around the Rudesheim Square in West Berlin was developed within a few short years—1911 to 1915—as a predominantly residential neighborhood, and it remains strong and homogeneous to this day. A group of planners, preservationists, and community members recently drew up guidelines to retain these qualities, and the architects of the International Center were able to use the guidelines to arrive at the following conclusions about formal properties:

The pitched roof is the salient architectural element in the neighborhood. The International Center repeats this form in a glass and aluminum greenhouse springing from the prevailing eave line.

The new building is set back, providing front gardens.

The building mass is broken down by the grouping of wintergarden projections along its main streetfront and expressed as five distinct, symmetrical houses, in keeping with the terraced yet individually expressed housing units in the quarter. The wintergardens have a certain variety of form: pitched and vaulted roofs; flat and bowed windows. Furthermore, the wintergarden is a traditional element in Berlin: the apparent bay windows of older buildings are often, in fact, sun porches.

Streetcorners are given definition in the neighborhood by the projection of corner buildings as sturdy pavilions, often with a bar or café located within. The International Center follows this pattern.

Walls are stuccoed and painted ochre, a traditional Berlin color.

## The 'communication' consideration

As the inhabitants of the International Center are strangers in the community, the architects wanted to provide them with opportunities for contact with one another. This is accomplished not only by the programmatic provision of social rooms (café, party rooms, day-care center), but by the location of these rooms and their linkage.

*Perspective from streetcorner.*

*Sections (right) show the various functions of the roof garden and wintergardens, in response to changing climatic conditions:*

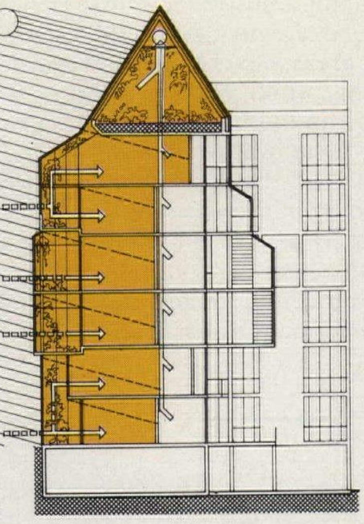
*During winter days **1**, the roof greenhouse, containing the heat pump, collects the sun's heat. The wintergardens serve as buffer zones between the extremes of exterior and interior temperatures, and on sunny days extend the apartments by providing living spaces.*

*On winter nights **2**, window shades are drawn to prevent heat loss through radiation.*

*During summer days **3**, the roof serves as a garden and meeting place for residents. The wintergardens again moderate the temperature, and plants grown here provide shade.*

*As units have two exposures, through ventilation can be achieved on summer days and nights **4**.*

*The axonometric (far right) shows units organized along an exterior court-side corridor, for the most part single-loaded. Vertical circulation is through a continuous staircase along this corridor, or through five interior circular staircases. The first four floors contain one-story units, from studios to three bedrooms, and the upper two stories hold two-level apartments. On top is the roof garden.*



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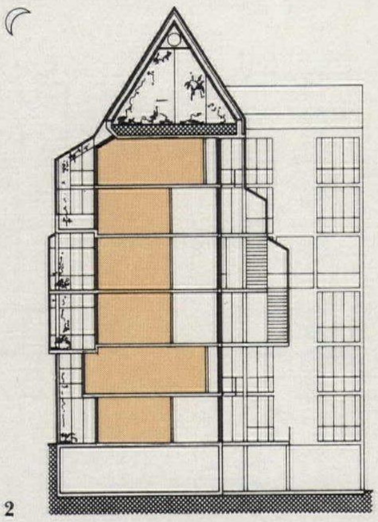

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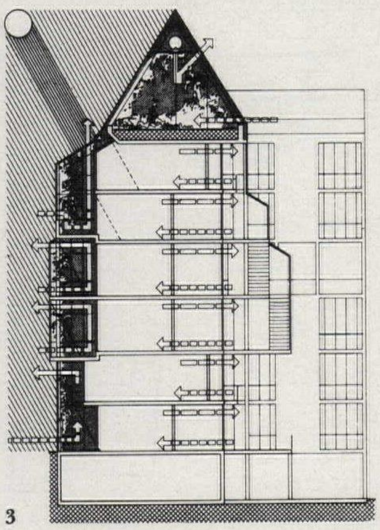

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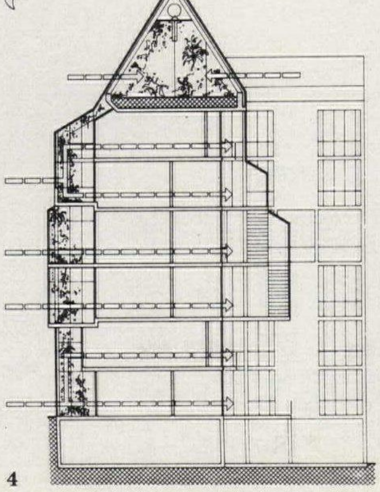

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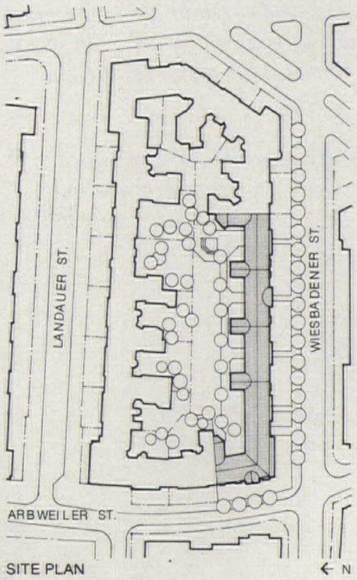
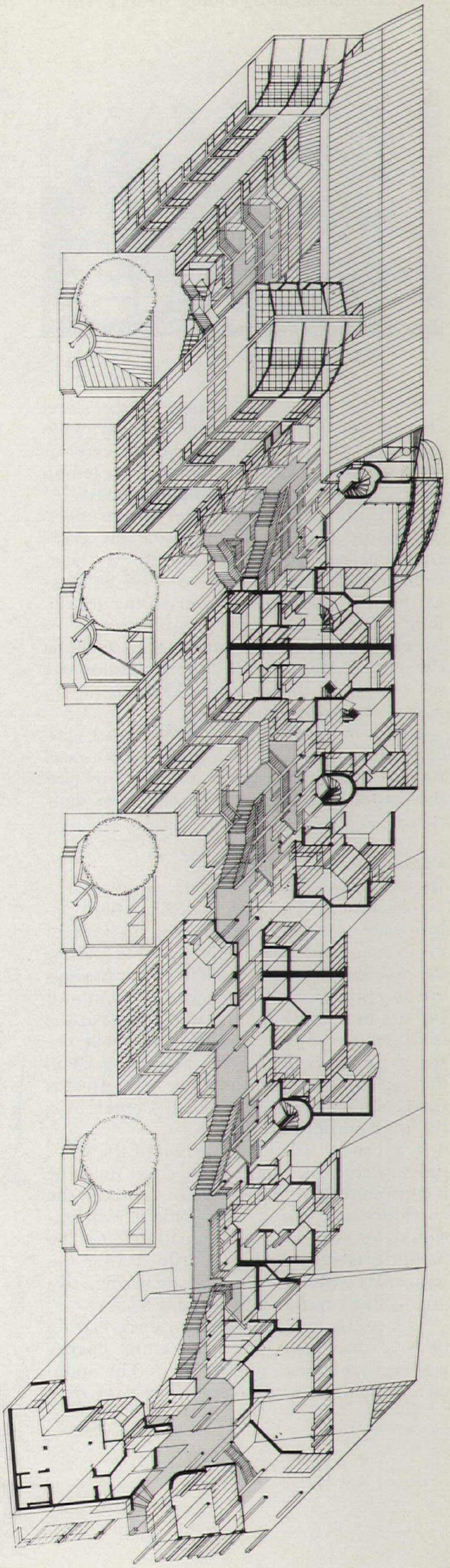



SITE PLAN ← N



**International Meeting Center, West Berlin**

*An existing building.*

One can enter the building at the street corner, passing shops and a café/bar; then proceed up the building via an exterior stairway/corridor, which continues the length of the building, overlooking the court. At major landings, one passes the various meeting rooms. Finally, one arrives at the glass-enclosed roof, which (besides its heat-collecting function) can be cultivated as gardens by the tenants from spring to fall. Rainwater is collected for this purpose.

A further communal provision is made at the corner apartments, where studios are self-contained, but share a kitchen, dining room, and living room.

And a final small but sensitive detail: garbage rooms are placed opposite the social rooms, so residents have an excuse to pass these communal areas as part of their daily routine.

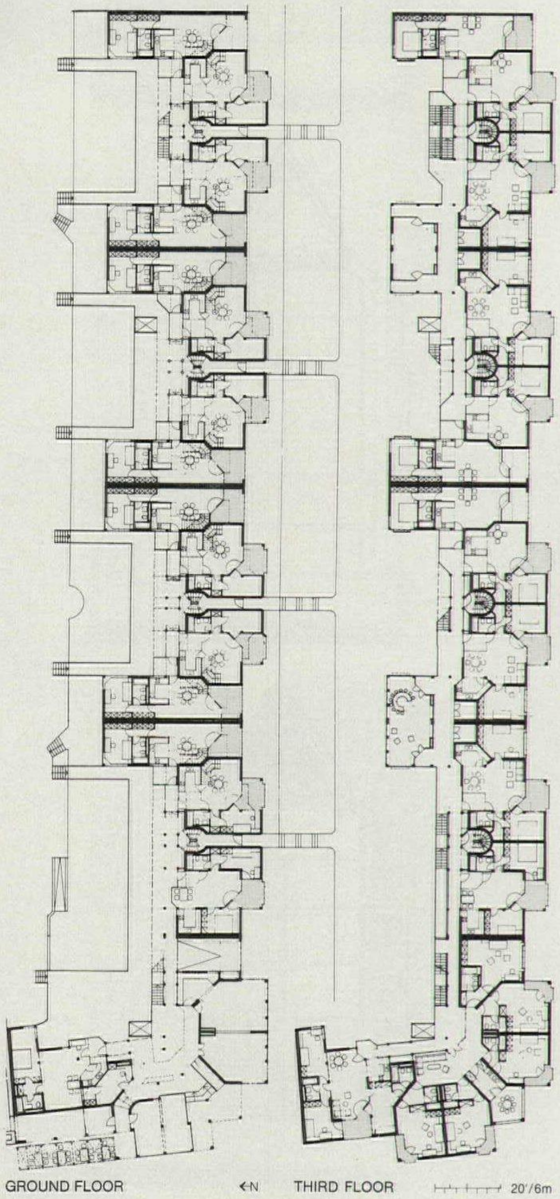
**Commentary**

In terms of context, the drawings of the International Center show a lively and appropriate interpretation of the rhythms of projections and recesses in the area. Above the eave line, of course, the fine line drawings are deceptive, as the glass and aluminum roof will not in real life cap the stucco walls as the traditional roof materials do. And while the street corner is defined by projecting pavilions, in the traditional manner, the effect is weakened in the International Center by a receding corner entrance.

The communications function of the social stairway/corridors along the court may be compromised by climatic factors: though the corridors face north, they could not be enclosed because of fire regulations. As the building is inhabited primarily during the University session from fall to spring, this area is likely to be under-used.

The energy-saving wintergardens create an obvious drawback (and a potential energy waster): inadequate natural light. The architects hope that this problem will be overcome by a slight adjustment in living patterns: during the day, activities should occur close to the daylit areas, next to the wintergardens. In the evening, when artificial lighting is necessary in any condition, activities can move inwards, towards the warmer areas.

Living in these unusual circumstances, removed from direct sunlight, can be viewed as an experiment in the interest of energy conservation, carried out, in any case, over a short term: the longest stay permitted in the International Center is one year. □




**Data**

Project: *International Meeting Center for the University of Berlin, West Berlin.*

Architects: *Otto Steidle & Partner, Munich; Vladimir Nikolic, Kassel. Walter Hötzel (project manager).*

Program: *80-unit apartment building (studios to three bedrooms) for visiting faculty members of the University of Berlin. Shops, café, and social rooms provided.*

Site: *an open corner lot in the early 20th-Century residential neighborhood of Rudesheim Square, in the Wilmersdorf area of West Berlin.*

Structural system: *load-bearing masonry walls; pre-fab concrete floor planks.*

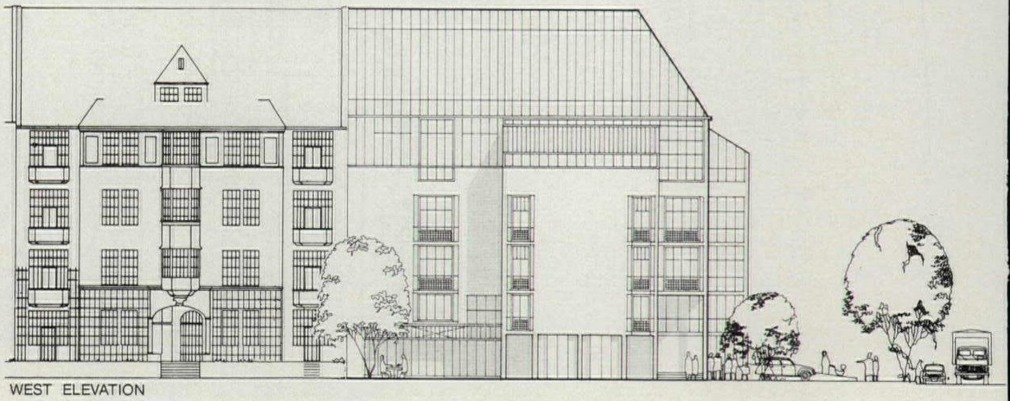
Major materials: *exterior walls: "Poroton" tiles, gypsum board interior finish, stucco exterior (total thickness 20 in.). Wood windows. Glass and aluminum roof greenhouse.*

Mechanical system: *air-to-liquid heat pump in roof provides 80 percent of heat needed. Oil furnace in basement furnishes remainder. Hot water pipes pass through the hollow-core floor planks in major rooms. "Warming closets" heat fresh air (20 cu m per person per hour).*

Consultants: *Dr. Lothar Rouvel (energy engineering). Stefan Polonyi, H. Fink, & P. Koch, structural engineers.*

*As the plans (left) indicate, all openings in the units are through vestibules or wintergardens (shaded). The continuous stairway and corridor along the court act as meeting places, with social rooms at the major landings.*

*Wintergardens are grouped to create projections in rhythmic harmony with the existing buildings (below).*



# Energy analysis

**This analysis was prepared in the Center for Planning and Development Research, College of Environmental Design, University of California, Berkeley; Vladimir Bazjanac, Ph.D., Project Director. The work is funded by the U.S. Department of Energy.**

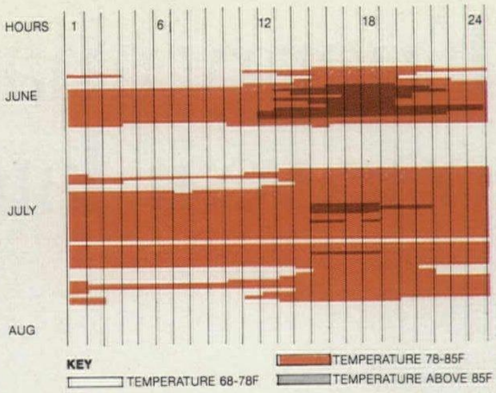
The International Meeting Center in West Berlin is representative of contemporary European urban housing and of the state-of-the-art of energy conservation in European buildings. The building employs heavy thermal mass and glazing not available in the U.S. It also demonstrates the typical European willingness to extend the range of thermal comfort: no mechanical cooling is planned.

The absence of any cooling load makes the building quite energy efficient. If air conditioning were to be added, the total load in the building would increase by 11 percent. The building is very sensitive to heat loss. Its energy performance improves when nighttime shutters are employed, reducing the heating load by almost 25 percent.

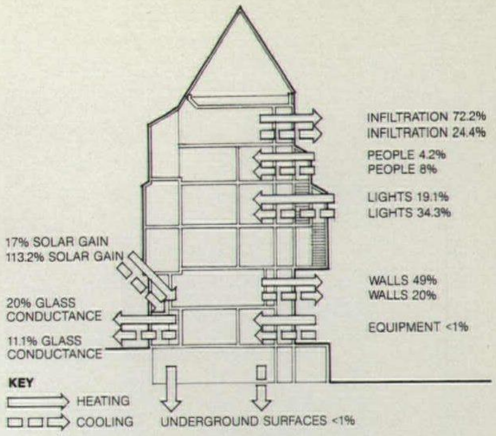
The building, as designed, is poorly insulated. The addition of R19 insulation in walls would reduce the heating load by almost 17 percent. Party wall construction is valuable—freestanding parts ("houses"), if built in a staged construction, would increase the heating load by 18 percent. Greenhouses are beneficial but less than expected: they save only 3.5 percent of the total energy needed.

The cold climate makes quadruple glazing extremely valuable. Quadruple glazing with low conductivity (approximately equal to R5) and high transmissivity (.625) reduces conductive losses very effectively, while it reduces solar gain comparatively very little.

The building is divided for the purpose of this analysis into its component "houses." Each house is potentially an independent group of dwelling units. Three houses (C, D, and E) are so similar in size, unit mix, and architectural characteristics that only the performance of house C was actually simulated. The results were then extrapolated to include houses D and E. House A is the largest; it has the largest floor area and contains mostly studios and single-bedroom units. Thus, it has the greatest load demand. In fact, its electrical loads are so much bigger that, when thermal shutters are employed, they almost exceed heating loads. Houses B and C have a more favorable solar exposure.

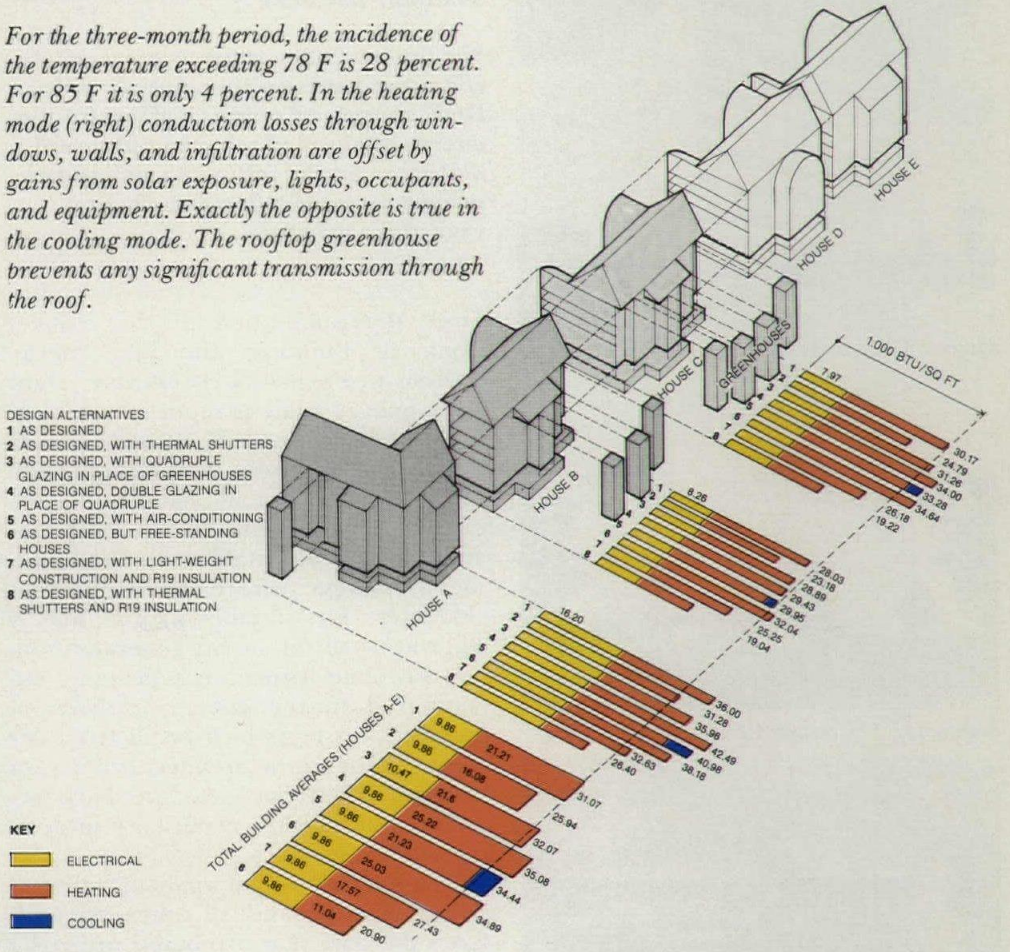



TEMPERATURE FLUCTUATION IN A THIRD FLOOR APARTMENT IN HOUSE B DURING THE SUMMER MONTHS




COMPONENTS OF LOADS

*For the three-month period, the incidence of the temperature exceeding 78 F is 28 percent. For 85 F it is only 4 percent. In the heating mode (right) conduction losses through windows, walls, and infiltration are offset by gains from solar exposure, lights, occupants, and equipment. Exactly the opposite is true in the cooling mode. The rooftop greenhouse prevents any significant transmission through the roof.*




COMPARISON OF ANNUAL ENERGY PERFORMANCE

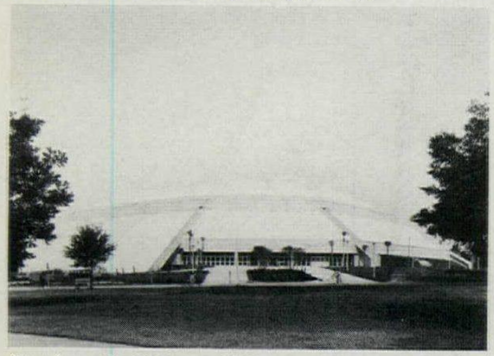
House B also has the smallest floor-to-exterior-wall ratio, which is beneficial in that climate.

The entire building features roof greenhouses. Their purpose is to collect heat and supply some of it to the apartments, and to function as an indoor rooftop garden. The garden function nullifies the benefits from the thermal mass of the concrete floor. The earth cover of the slab acts as insulation. The garden is also well shaded at all times. Behind the south-facing sloped glass is an "air" collector, which amounts to a freestanding flat-plate absorber and a heat pump. Warm air, collected between the absorber and the glass, rises by convection to the heat pump, which extracts heat and sends it to the apartments. The modeling of this system with DOE-2 was possible only as a gross approximation. Simulation results are inconclusive.

*The analysis of the energy performance of this building does not include the performance of the mechanical systems in the building. It is based on annual simulations with DOE-2.1, using custom weighting factors, and the actual 1962 weather tape for Berlin. Its accuracy is limited to the accuracy of DOE-2.1 in representing the building's thermal behavior and does not necessarily conform to all of the details of the actual performance of the existing building (P/A, April 1980, p. 100). A detailed report will be available upon request.*

# Energy analysis: one year later

*Hooker Chemical (April, p. 105).*



*Stephen C. O'Connell Center (June, p. 121).*

*Flat Rock Brook Nature Center (July, p. 63).*

Dr. Vladimir Bazjanac is teaching in the Department of Architecture at the University of California in Berkeley. He is project director in the Center for Planning and Development Research and is also guest scientist at the Lawrence Berkeley Lab. The author wishes to acknowledge the help of graduate research assistant Peter Brock in the preparation of this article. He and graduate research assistants Dale Brentrup, Joe Johnson, Ed Pineda, Gerhard Schmidt, and Harvey Bryan (now assistant professor at MIT) have carried out a major portion of the simulations of energy performance during the past year.

**Vladimir Bazjanac**

**For the past 12 months, *Progressive Architecture* has been cooperating with a DOE-sponsored research effort for the energy analysis of selected published buildings. In the following article, the project director reflects on the first year of the program.**

Since the publication of the Hooker Chemical Building, the first energy analysis in *Progressive Architecture,* eight more energy analysis reports have been published. It would be ideal to report some clear trends developing from those analyses, but no significant common patterns in the energy performance have been established. All buildings are unique. All are of very different character. The number of buildings is still too small for broad generalization, yet the same issues are repeatedly encountered in the energy analyses of buildings—issues which result from decisions made in the architectural design process. After one year we have acquired considerable experience in dealing with these issues.

One strength of our analyses is that all energy reports and all other research from the past year are based primarily on the results of computer simulation with DOE-2. This provides for consistency in analysis from one building to another, permits the study of the building's annual performance, and uses the best available data and resources for simulation. This method of analysis also has weaknesses: the inherent inability to precisely predict the actual performance, the difficulty in modeling building characteristics that deviate from the standard, and the fact that the fallacies inherent in the simulation model are carried into the results of simulation (see P/A, April 1980, pp. 98–101).

However, when the performances of different design alternatives are compared (alternatives which differ in a limited number of design parameters), the results indicate trends *in change* of energy performance which are valid. In other words, simulation of energy performance shows trends rather accurately and is usually of considerable help in the study of the effect of architectural design decisions.

**Building shape**

The exterior building shape affects energy performance in two important ways: it determines the total area of the building skin and how much of the floor area can be naturally lit. These in turn determine the amount of conductive heating gain and loss, the degree of solar exposure, and the amount of needed artificial lighting in the building.

The larger skin area results in a greater conduction loss or gain. Depending on the particular climate and the type of use of the building, this can be either beneficial or detrimental. If the building is used for offices, a larger skin area is beneficial in all climates. Because of internal loads (heat gain from lighting fixtures, occupant-operated equipment, and the occupants themselves), the cooling load in such buildings is much larger than the heating load, and a large lightweight skin area is useful as a means of heat rejection. In such buildings, a larger skin area also provides opportunities to use daylighting over more of the floor area, which in turn reduces the electrical consumption in the building and the resulting heat gain in the space.

Rectangular shapes have typically higher heating loads than square shapes. In cold climates, the increase in heating load from larger skin area frequently negates the reduction in the cooling load. The heating load in warm climates is so small, however, that its increase is negligible when compared to the reduction of cooling load possible in rectangular buildings.

A large skin area is most useful in climates which offer cold outdoors when the building needs to be cooled, and yet seldom gets excessively warm. The climate in Medford, Or, is a good example; it results in a greater *difference* in load between, for example, square and rectangular shapes of office buildings than from any other climate we encountered in our work. In contrast, there is little difference in total loads between square and rectangular floor plan office buildings in cold climates. Therefore, the square floor plan of the Hooker Chemical Building, for example, does not deter its energy performance.

Because a larger perimeter area reduces the cooling load (it allows for more natural lighting), it is especially helpful in buildings dominated by internal loads. This effect is more advantageous in warm climates. The reduction in electrical load because of reliance on natural lighting is the same for all climates only if it is assumed that differences in climates do not affect availability of natural light.

The trends discussed above are reversed if buildings are used as apartments. For apartments, the larger skin area is detrimental to the energy performance because heat exchange throughout the skin is the major component of the building's load. This is true regardless of whether the building is dominated by cooling or heating and regardless of the climate.

**Type of use**

The type of use of the building determines the magnitude of internal heating load and its effect on the overall building load, the timing of the thermal conditioning of the various spaces in the building, and the timing of the use of thermal shutters. All things being equal, there is usually a large difference in the demand for energy between office use and apartment use, for example. It is always smaller for apartment use. This difference is also consistently larger in square than in rectangular buildings. Electrical consumption is the main culprit for the excessive demand for energy generated for office use. This is especially true when artificial lighting is used excessively and when the user-controlled equipment load is large.

Combined cooling and electrical loads by far exceed heating loads in office buildings in all climates. In contrast, heating loads are much higher in apartments, regardless of climate. This is caused by the higher need for thermal conditioning of apartments at night. The higher heating loads in apartment buildings can be substantially reduced through the nighttime use of thermal shutters.

**Orientation**

Building orientation affects solar exposure: the timing and the magnitude of solar gain. The effect of orientation is most pronounced in totally unshaded buildings. South-facing façades inherently offer the most desirable orientation for solar gain. They get most of it in winter when it is most needed and least in summer when it is undesirable. East- and west-facing facades have exactly the opposite effect.

The difference in demand for energy between square and rectangular building shapes oriented north and south is negligible in all climates. The rectangular shape facing east and west performs much worse regardless of climate. Heating and cooling loads are higher both because buildings do not benefit enough from south exposure when such exposure is beneficial, and because they suffer too much from the west exposure when such exposure is detrimental. The relative disadvantage of east and west orientation is smaller in warm climates. Heating loads are minimal and more of the cooling load is caused by conductive heat gain than by solar gain.

Apartments suffer most from east-west orientation. Cooling dominates apartment loads so much that it almost offsets the much higher electrical loads present in offices. This is so because the overheating period with east-west orientation coincides with the time of the most intense apartment use.

**Shading**

Shading of windows and other glass surfaces, as well as of walls and roofs, controls solar gain by controlling the time at which surfaces on the building exterior are exposed to sun. The reduction in solar gain directly reduces the cooling load in the building, though it may also increase the heating load. Typically, the reduction in the cooling load is much greater than the increase in the heating load.

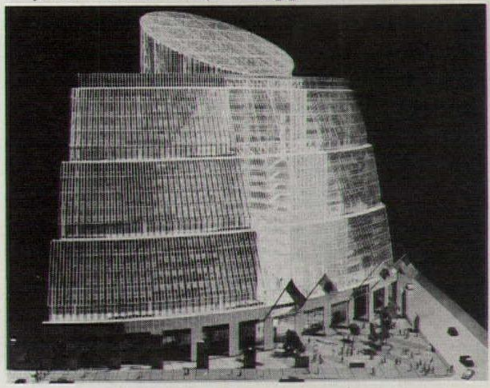
Only exterior shading is truly effective; substitute strategies, including special glazings, are never as effective. Perfect shading for all orientations is practically impossible to achieve without operable shades and louvers. As can be expected, shading is more critical in warmer climates. In such climates, heating load is small and opportunities to offset that load by solar gain are limited; solar gain then adds to already substantial cooling loads from conduction through the skin. East-west oriented rectangular buildings benefit most from shading in all climates. Yet effective fixed exterior shading (often by far the most cost-effective energy-saving device), is most difficult to achieve for such orientation. Square buildings are relatively insensitive to shading in all climates. This is especially true of office buildings where internal loads are so high. The absence of shading in cold climates can shift the predominant load in apartments from heating to cooling.

External shading is most effective in moderate climates. When outside temperatures are predominantly low enough to keep heat gain through con-

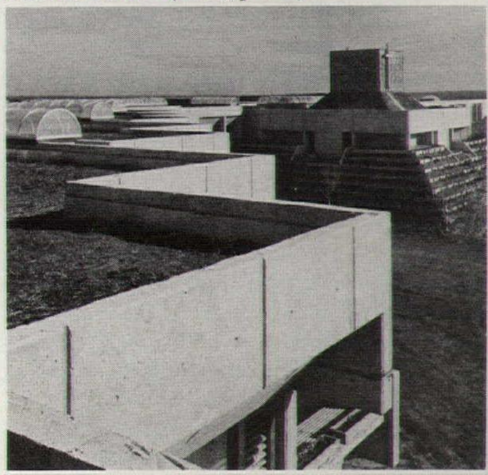
*Chapel Hill House (Oct., p. 75).*

*Arcade Square (Nov., p. 111).*

*Crystal Cathedral (Dec., pp. 84–85).*



*Illinois Center (Feb., p. 99).*



*Benedictine Mission House (March, p. 109).*

duction at a minimum, most of the cooling load is caused by internal gains or by solar gain. This provides the greatest opportunity to reduce the cooling load through effective shading.

### Thermal shutters

Shutters limit the heat loss through conduction. Their employment is more valuable in apartments than in offices in all climates. The reason for this is simple: apartments are tempered at night (when the shutters are employed), while offices are not. In colder climates, for example in the case of the International Meeting Center, shutters can reduce the demand for energy in apartments by as much as 18 percent. Thermal shutters are useful in offices only in colder climates. The heat loss that can be offset by shutters is too small in warmer climates. If shutters are employed in such conditions, they actually reduce the natural cooling of the building, which results in higher demand for energy.

In reality, thermal shutters are not used when the building needs to be cooled. In general, shutters are most effective in buildings that are most sensitive to heat loss through building skin. Because of this, thermal shutters reduce the demand for energy more for rectangular than for square buildings.

### Unconditioned spaces

The less the building is conditioned, the less energy it demands. Unfortunately, if left completely unconditioned, most buildings would not be habitable (this, of course, depends on the climate and the type of use in the building). Leaving certain types of spaces unconditioned can sometimes reduce energy consumption in the building very significantly, without seriously jeopardizing comfort.

Unconditioned spaces can function in several beneficial ways. As thermal buffer zones, they reduce loads in adjacent tempered areas. As collection spaces, they absorb excess heat, which can then be disposed of through natural ventilation, as is the case of the double skin in the Hooker Chemical Building. As delay devices, they delay the change from heating to cooling, and vice versa, to a time more suitable for use. The unconditioned nave in the Crystal Cathedral in Garden Grove has such a function.

Unconditioned spaces in heating-dominated buildings are more useful when they are less exposed to the outdoors. For example, the unconditioned Arcade and Rotunda of Arcade Square in Dayton are more effective than the atrium in the State of Illinois Center in Chicago if it were left unconditioned. The time delay of an unconditioned space is more effective when the space has substantial thermal mass.

If unoccupied, unconditioned spaces reduce the building efficiency ratio and represent a construction cost penalty. Setting the thermostats to a wide range can still reduce the demand for energy very substantially, and yet make the spaces quite comfortable for circulation. Both the Arcade Square and the State of Illinois Center are excellent examples of this.

### A word of caution

The energy analyses we prepared during the past year employed some of the most sophisticated thermal simulation models. Yet serious problems have surfaced in modeling buildings' energy performances. Almost every building has a feature that significantly influences its energy performance and that does not "fit" into what can be simulated with a quantitative model. This results in approximation and compromises which, in some instances, can be of such magnitude that the possible error renders the accuracy of the analysis questionable.

**Daylighting:** A simulation model that adequately combines daylighting and thermal analyses is not yet available. At best, the link between daylighting and thermal analyses is accomplished by studying the daylighting performance separately and then adjusting the use of artificial lighting in the thermal analysis. This is a cumbersome process, and the results are not very refined. There is a limit to the detail in which artificial lighting schedules are defined. It is virtually impossible to model accurately the use of artificial lights as a result of sunrise and sunset, or the change in illumination from changing weather.

Models of artificial lighting controls and of the logic of their use are not very sophisticated in thermal simulation models. Of necessity, one must assume "reasonable" use of daylighting in order to give the building an opportunity for daylighting credit. In turn, the effect of daylighting on the energy consumption of a building is nearly always optimistic.

**Natural ventilation:** Natural ventilation can lower the inside temperature (though never below ambient temperature) and can substantially reduce the cooling load. DOE-2 does not simulate natural ventilation. When buildings have operable windows and explicitly rely on natural ventilation, spatial provisions must be made in the analysis. In simple cases, such as in the Crystal Cathedral, the effect of natural ventilation can be approximated by increasing the rate of infiltration and scheduling it at the time of ventilation. A more appropriate solution is to write special natural ventilation simulation routines and add them to DOE-2. (This was done in the analysis of the Hooker Chemical Building.)

**Air stratification:** The difference in temperature between the bottom and the top of a large, high space can exceed 10–15 F. It is caused by the upward surge of warmer air, and it is the driving force behind natural ventilation. No thermal simulation model simulates air stratification directly. A plausible DOE-2 strategy seems to be one of compromise: divide the high space horizontally into zones separated by imaginary floors/ceilings with the conductivity of air. While no air movement is simulated in this way, the change in temperature through conduction may result in different temperatures at the bottom and the top of the space. This strategy was employed in the analyses of the Stephen C. O'Connell Center in Gainesville, Fl, and the Crystal Cathedral.

**Underground surfaces:** Berming can reduce heating loads in winter and cooling loads in summer, as demonstrated in the analysis of the Chapel Hill house. In warm climates, berming can at times become a cooling liability (as was the case with the Stephen C. O'Connell Center). In cold climates, it can become a heating liability to the extent that underground surfaces have to be insulated (see the analysis of the Benedictine Mission House.

The understanding of the actual heat exchange between the ground and the structure is incomplete. Ground temperatures and conductivity change with the moisture content of soil, conductivity sometimes by a factor of 4 or 5. Methods by which the behavior of underground surfaces is modeled at present are approximations at best. Heat loss or gain through those surfaces accounts for a substantial portion of buildings' loads. Possible errors there can distort the assessment of the overall energy performance.

### Conclusion

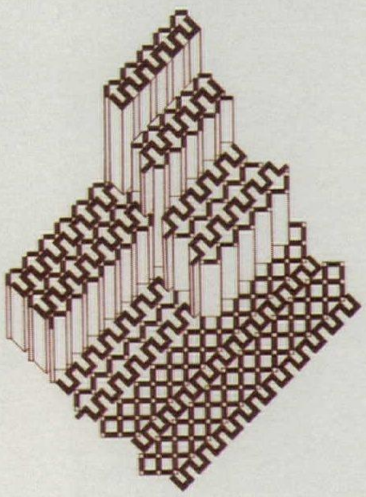
Our energy analyses clearly show that there are no recipes for the design of energy-efficient buildings. Such buildings typically employ several energy-conserving features. The selection of features depends on the climate, orientation, planned use, and a variety of other architectural considerations. It is important to understand how employed features act individually and as a group, how they act as seasons and weather change. Blind use of greenhouses, berming, reflective glazing, etc., may actually hamper the energy performance of the building, as in the case of the Chapel Hill house and the International Meeting Center.

It is as important to understand that design decisions, which have an effect on energy performance, are made very early in the design process. Therefore, it is imperative to consider energy performance from the very beginning of the design. □

**Conclusion**

# The assimilation of energy

**Here are a few reflections on the state-of-the-art of energy-conscious design, April 1981. A place has been made for the land of energy in the world of architecture.**



The fever has subsided, the patient will live. The road to recovery is there to use. Whether you hacked your way through the energy malady with the first road or now, years later, use the four-lane highway, the reason for the road is still there: we are, as a country, still energy dependent.

The pioneers in energy-conscious design have probably learned the most, but many have worn themselves out in the process. New thought begins where theirs ends. Every energy-conscious design begins with a little switch in the mind, which is flipped from neutral to on. It stays on, and of primary importance, until the designer is comfortable with the technology. Comfort is the assimilation of the tool until it disappears into use.

Energy is not an expression of life; it is a fact of life, like gravity or friction. Architecture is an expression of life. Energy is instructed and controlled by the arrangement of built form, like wind through a flute. A building should not begin with energy-conscious design, nor should it end there. Energy consciousness is simply a bridge crossed while designing. The departure point of a building is shelter, the destination is an inspirational place to be. It is the use of the building in concert with the search for form that yields original form.

Energy conservation is part of the function and affects the form. Those designers who rejected energy consciousness as a design element because they feared they would be shackled by it have now, in fact, been shackled. Those designers who saw the more intimate understanding of natural principles as a source of freedom have been freed by it.

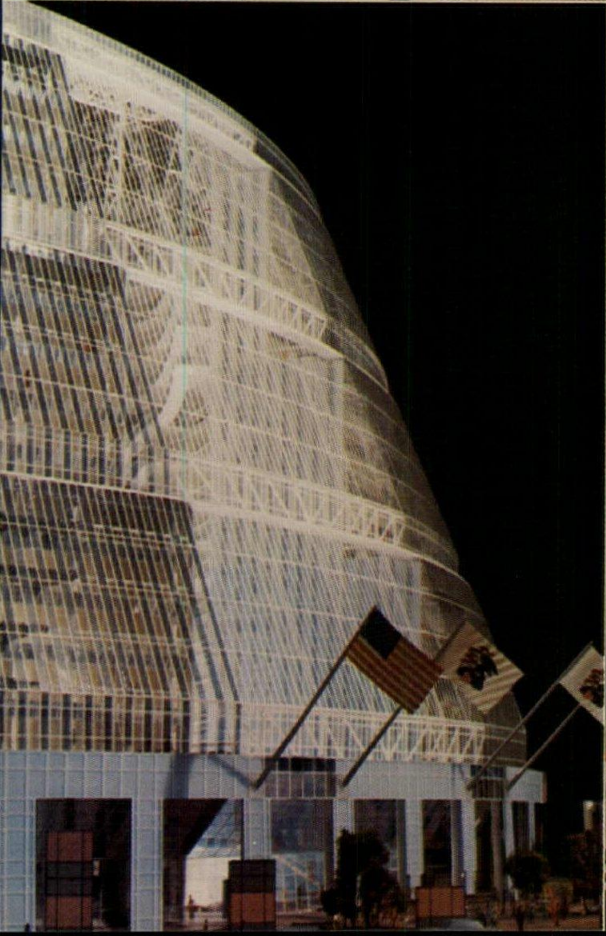
Make no mistake. Energy technology did not set out to find a place in architecture; architecture reached out to grab it. The formal building vocabulary has not so much been diminished as extended. The sawtooth roofs, earth berms, thermal mass, new insulation systems, daylighting strategies, and solar collectors of all sorts have new importance. Yet vocabulary does not a sentence make. Work is not complete on a sentence until it has expressed an idea concisely. Energy independence is simply not in itself a big enough idea. The difference now is that energy should be part of all of the other environmental ideas. Being energy independent does add much needed discipline to the larger ideas. It has awakened our roots in the natural world and increased our dependence on nature's simple strengths.

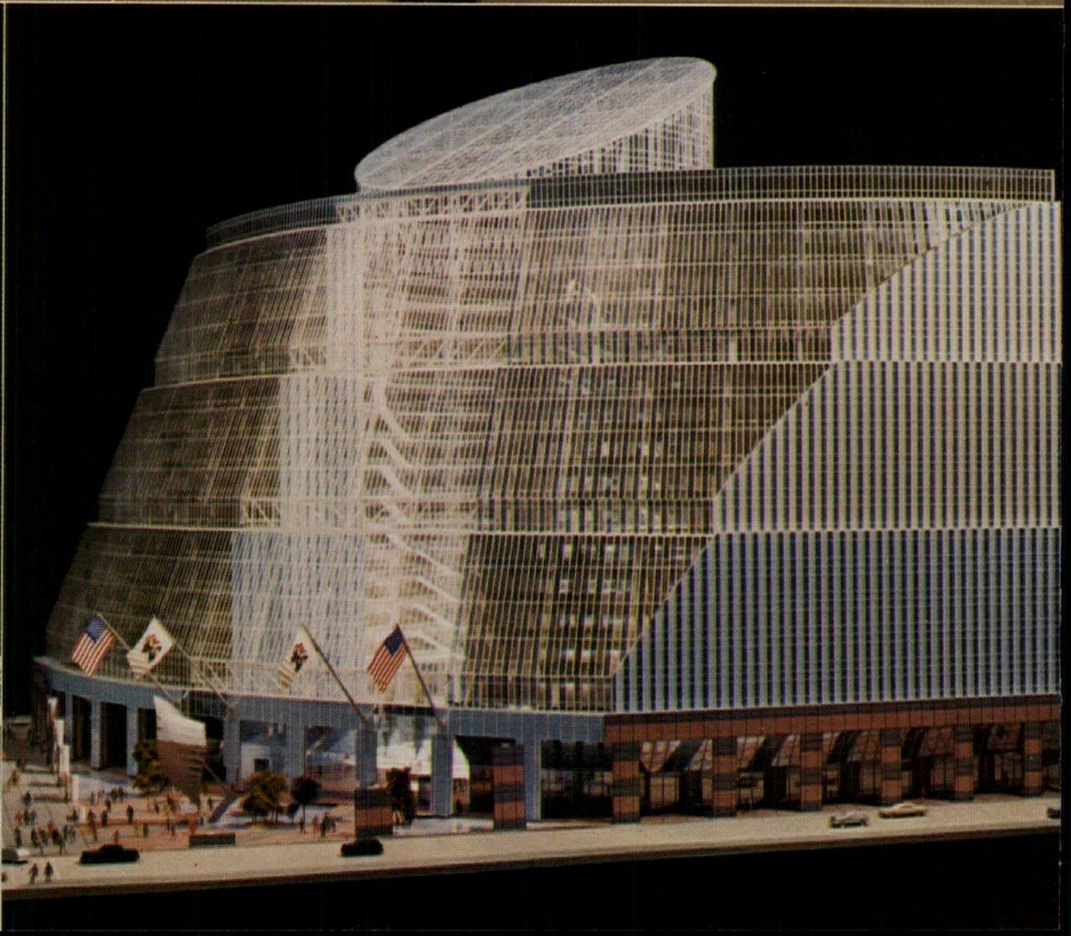
Part of the energy question is the relationship we have to nature; the other part is our relationship to mankind. The independence seems necessary both because the nonrenewable fossil fuel supplies are diminishing and because these remaining supplies are for the moment controlled by others (or more accurately, out of control).

While the dependence upon nature is a positive force in architecture, the search for independence from other people is not. Families, communities, businesses, nations, and cultures are built upon the interdependence of people, the addition of strengths rather than the nullification of them. It would be sad indeed for the world if, for example, energy independence meant the destruction of the economy in the Persian Gulf or if only the wealthy could afford solar energy. The goal of the energy movement should not be independence; it should be abundance.

With the right goals, the right means, and the right attitudes, the energy future of this country is very bright. As the Technics section that follows demonstrates, the technological frontiers we now face are just as daring as the frontiers we were forced to advance in the early 1970s.

Lest we finish in a state of false euphoria, we must emphasize that the assimilation of energy by a segment of the architectural profession does not imply the instant flipflop from waste to abundance. There are thousands of existing buildings still wasting fossil fuels. There are thousands of architects who have all but ignored the presence of energy-conscious design as merely a passing trend. For them the new world is still flat, and they most certainly still fear that they will someday fall off its edge. [Richard Rush]





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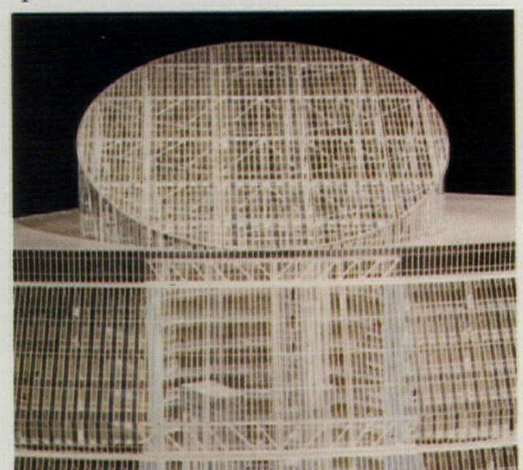

massive skylight. These features will take advantage of enough passive solar heating and natural light to reduce energy usage to nearly one-half the level consumed by most conventional office buildings. Since artificial lighting generally consumes 40% of a building's energy load, any heat lost through the glass walls will be more than offset by the cost reduction achieved through natural lighting. These factors, the architects and owners say, are the keys to the building's energy efficiency.

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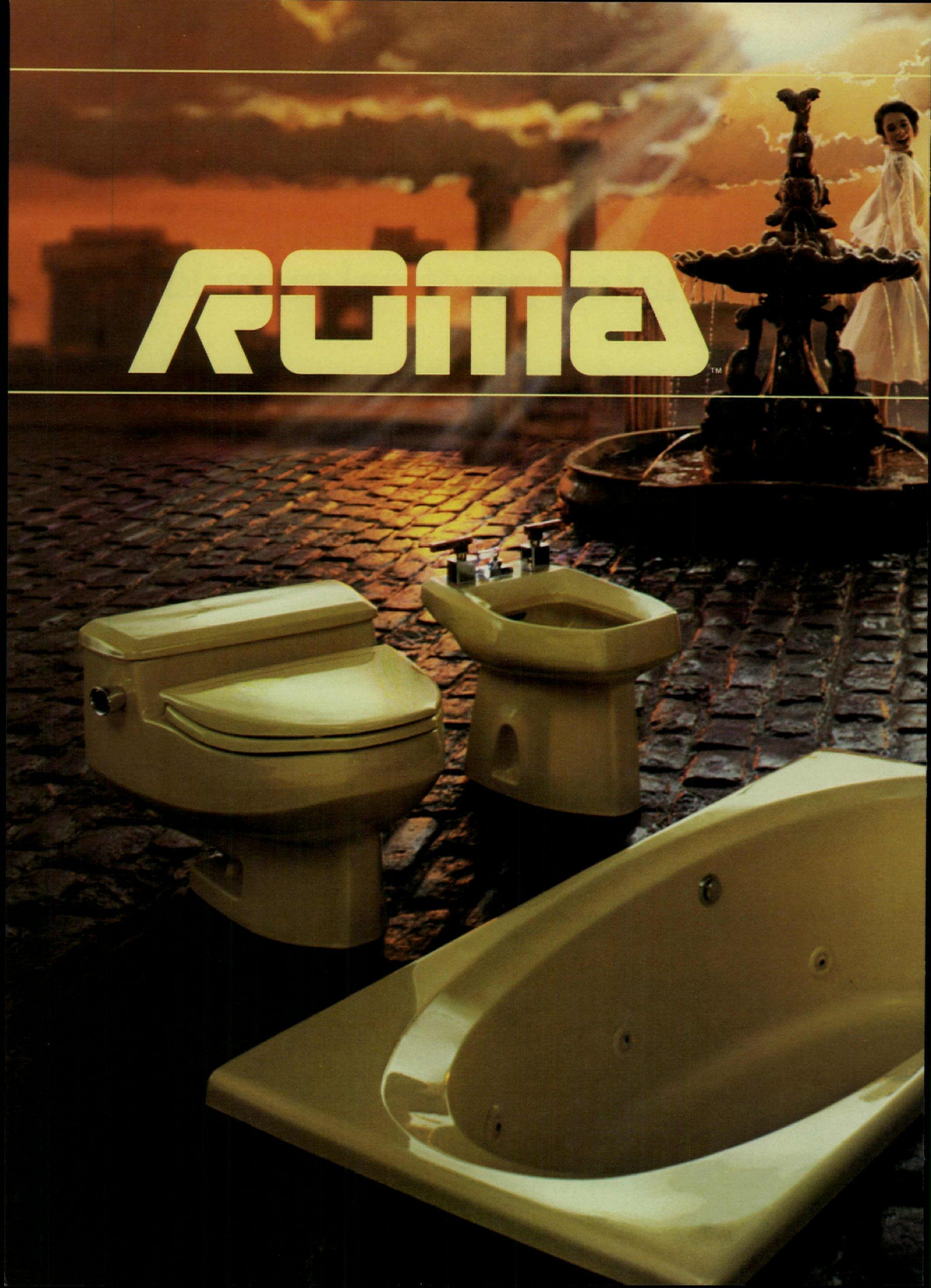
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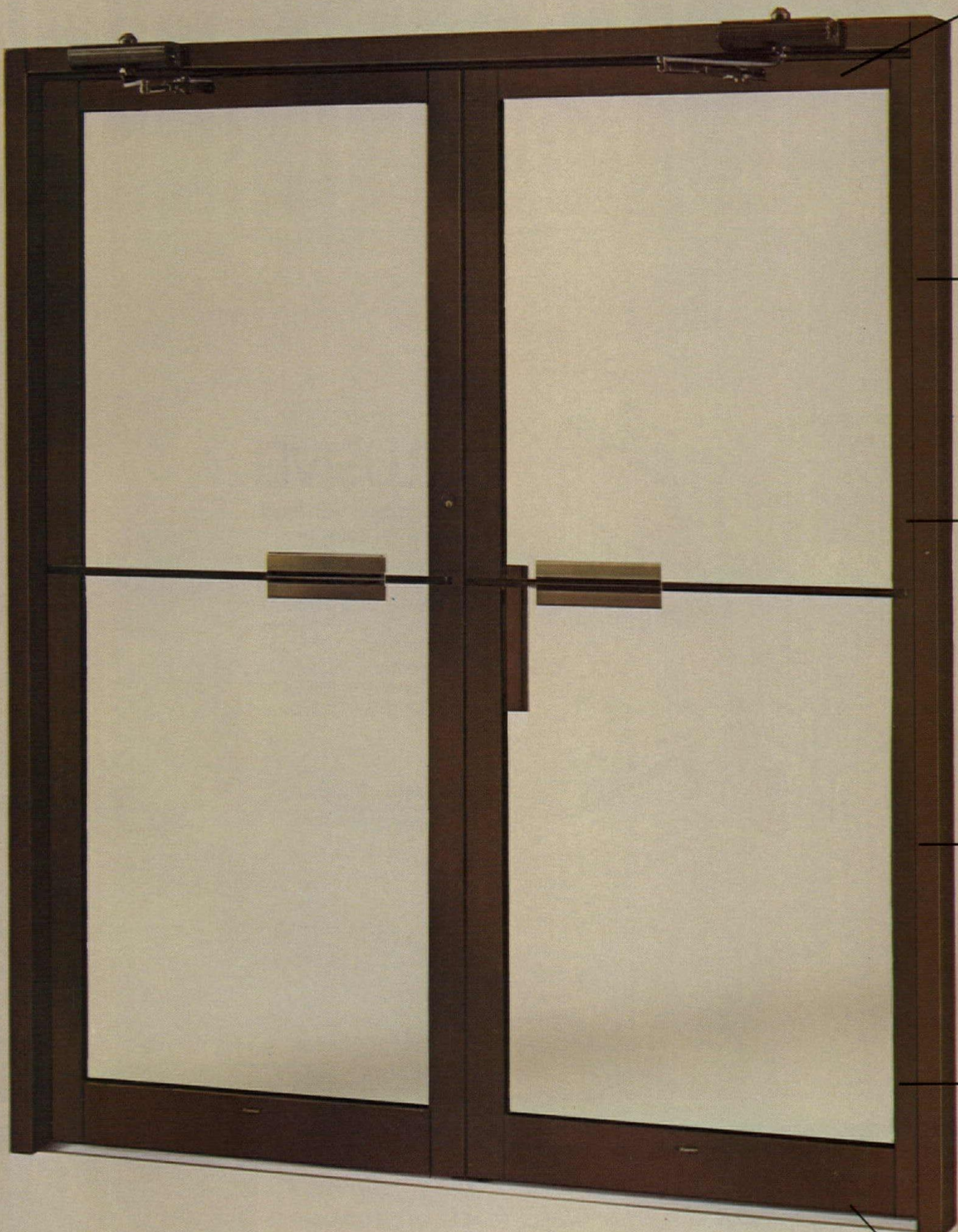

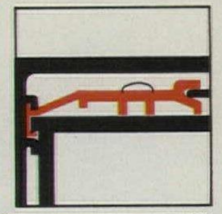

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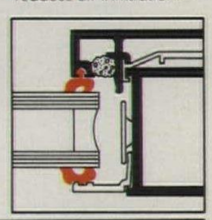

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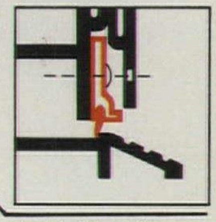

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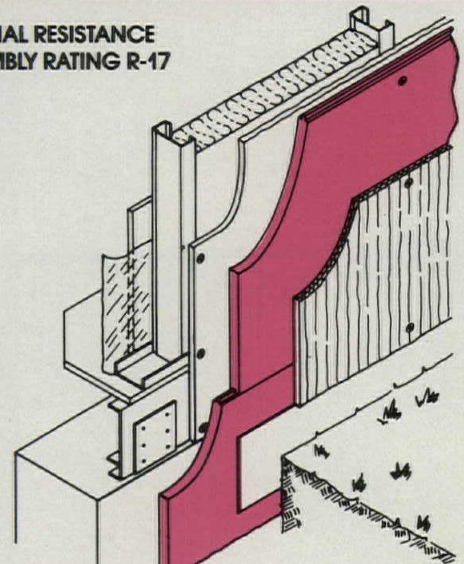

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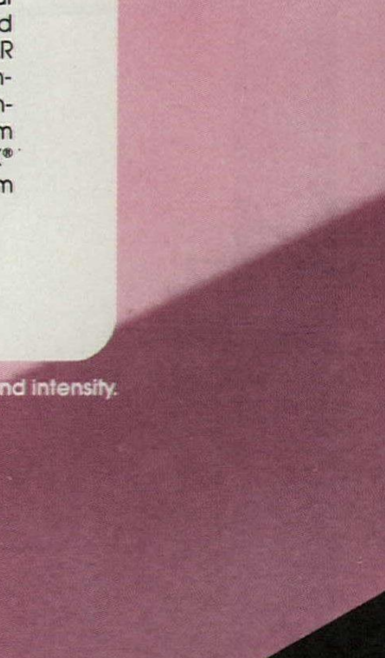

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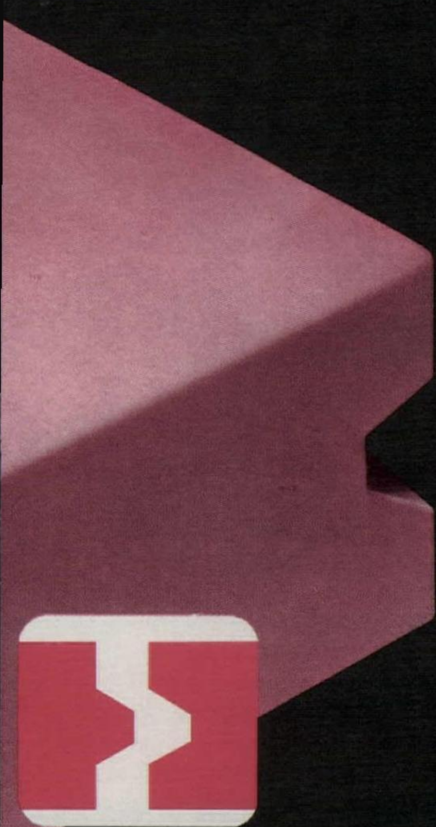

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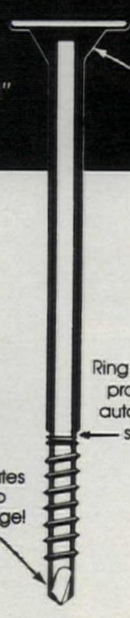


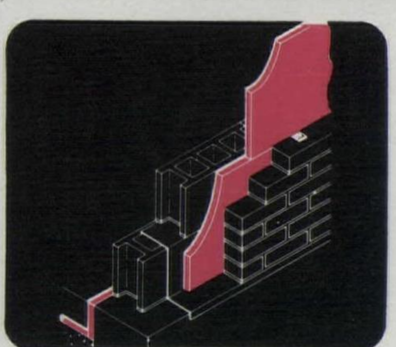

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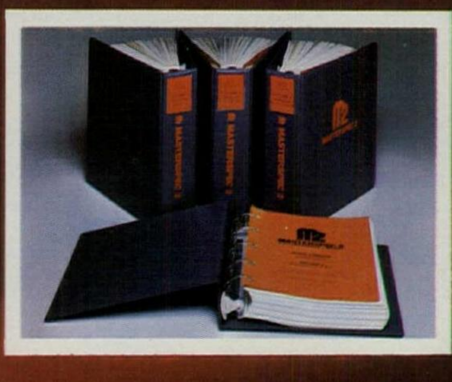

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# Evaluating new energy products

**Walter Rosenfeld**

**Manufacturers have sprinkled the marketplace with a variety of new products in response to energy conservation needs. Cautious optimism about durability and effectiveness of these products comes to the specifier only after he is solidly convinced by either laboratory data, product data, or field data. Ideally he has a combination of all three.**

Walter Rosenfeld CSI is Managing Director for Professional and Technical Services at The Architects Collaborative in Cambridge, Ma.

The relatively new field of energy-related products and equipment, particularly for active solar heating systems, has once again brought into focus the architect's role in evaluating new materials for buildings. Traditional procedures of examining the product itself, the manufacturer's data, the theory under which the product was designed, and the recommended installation procedure are all essential steps and valuable in predicting the product's potential for success. But while building is to some extent a science, it is a very practical science and depends on experience to validate its practices. Thus the ultimate test of a new product is its durability and usefulness in the field over a period of time, and it is precisely these characteristics that are so difficult to determine in advance.

The product itself gives clues to its future when examined under the specifier's experienced eye. Early solar collectors often used multi-metal connections (steel casings with copper connectors, for example), which invited galvanic activity in exposed locations and which could be safely predicted to have substantial corrosion problems within a short time. In later models, plastic fittings separated the metals. The specifier who examined the early model carefully didn't buy it as offered; but the right questions had to be asked. Eventually, the National Bureau of Standards (and others) began developing performance and testing criteria for solar collectors to aid in system evaluations.

Manufacturers subject their materials to accelerated use and weather tests (as well as other tests) to convince specifiers and themselves that the product will perform well and will endure. But laboratory conditions (even outdoors) are only simulated use situations, and the way in which the product is actually handled and installed may be quite different. Yes, we need these tests, but we also need to know how to interpret and understand them.

The result of actual use in a variety of applications and conditions is the ultimate evidence we seek, but it can't be had easily on new products. Who is willing to try a new product outside the laboratory so that we can get the information needed to specify with confidence?

If we divide building into arbitrary categories, one answer suggests itself. Surely the architect and the owner are hesitant to experiment on an institutional building where long life and low maintenance are important. Only tried and proven materials would seem to be appropriate for this use. But there is a sector of the industry that is willing to take risks in return for financial rewards, and if the new product can save money, it will find a receptive audience there. Even small unit savings when multiplied by large quantities are attractive, and as long as the risks are clearly delineated and accepted by the owner, this might well be one entry point into the system for a new product, energy-saving or otherwise. How long the product needs to be in use before it can be confidently specified depends, therefore, at least partly on the acceptable risk factor for the segment of the building industry in which the architect is working.

Of the three types of documentation—laboratory data (on which the manufacturer relies), product data (on which the architect relies), and field feedback (on which architect, manufacturer, and owner rely)—the latter is the most difficult to obtain quickly, and often the most difficult to obtain at all. Thus the specifier, who must examine all three plus the product itself, needs a degree of cautious optimism (or pessimism, depending on his experience) in approaching new products until a substantial amount of evidence is in hand and the product can finally be accepted or rejected for a particular use.

This is not the total process by which products succeed or fail in the architectural marketplace, but it is a part of it. New products developed to meet energy conservation needs, particularly those that form part of the exterior fabric of the building (rather than those components of mechanical systems that are close developments of existing similar equipment), also need to pass the time-in-use test before they can be routinely specified on a variety of major building types. Not such exhilarating news for manufacturers perhaps, but consistent with the cautious Victorian admonition that litigation-shy specifiers might well consider adopting: "Be not the first by whom the new is tried nor yet the last to cast the old aside." Some old-fashioned advice to modern specifiers from Alfred Lord Tennyson. □

# New energy frontiers

*About the authors: Several portions of the article that follows have been contributed by authors not on the P/A staff. In order of appearance they are:*

***Hal Levin*** *is a researcher in the College of Environmental Design, University of California, Berkeley, a lecturer in Environmental Studies, University of California, Santa Cruz, and a member of the California State Board of Architectural Examiners. He is currently writing a book,* Building Ecology, *the same subject about which he has written for this article.*

***Chris Johnson*** *is an assistant professor at the UCLA School of Architecture and Urban Planning and coordinator of the Los Angeles office of the Minneapolis-based architectural firm Architectural Alliance. Johnson was intimately involved in the architectural design process that conceived the ice storage system employed for the Cray Research, Inc., office building.*

***Richard Schoen*** *is an associate professor at the UCLA School of Architecture and Urban Planning and a principal in the Los Angeles architectural firm RSA Architects. Among his current projects is an 88,000-sq-ft space frame, which incorporates solar photovoltaic arrays, for the new Jeddah King Abiz Abdullah International Airport in Saudi Arabia.*

***Julie Flicker*** *recently received her Bachelor of Arts degree from Brown University in Comparative Literature. In addition to her interest in research and writing in the field of energy-conscious design, Ms. Flicker is fluent in several languages and is a recipient of the German Book Award from Generalkonsulat der Bundesrepublik Deutschland in Boston. She resides in New York City.*

## Introduction

In less than ten years, there has been a cloudburst of energy technology, new products, new ideas. A vibrant new industry has emerged. The products have evolved, the ideas have spread. What an education!

During the same period, the mechanical engineering world has witnessed a renaissance. The terms "heat pump," "economizer cycle," "variable volume," "task lighting," and "electronic control system" have become drafting-room buzz words and mechanical product boom words.

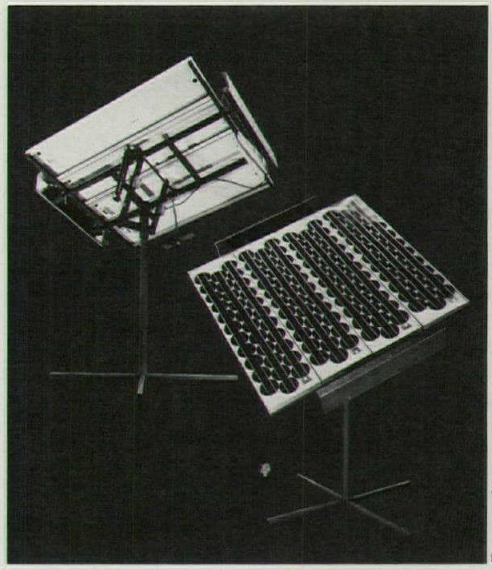
Solar collectors, the quintessential symbol of the early energy years, have blossomed more slowly than their manufacturers had hoped. Some successful collector companies have swallowed less economically successful ones. Several of those who began by making primarily collectors have been forced into the engineering and design of their systems on buildings to protect their own product reputations. Massive testing facilities are establishing common performance standards. Government tax incentives attempt to entice buyers.

Passive solar techniques have also flourished in the early years. An evolution has occurred, for example, from the primitive "drumwall" solutions to translucent plastic tube containers of water to phase change salts. There are hundreds of reflective coatings, insulation systems, daylight control devices, and thermal shutters that have come (and gone) from the market. Experience has fostered formal knowledge. The knowledge is being refined.

In the context of the commercial world, we might sometimes be lulled into believing that all the good ideas have been had, the discoveries made. Nothing could be more remote from the truth. The frontal idea wave that surfaced in the early 1970s is still moving aggressively forward. Many of those participating are the same people who rode the first wave to the beach.

In the articles that follow, we have assembled a current sampling of efforts that we are speculating will be regarded five years from now as the energy-related technology frontiers of the early 1980s. We have certainly not included all of the frontiers (and some we have included are old frontiers). We have talked about photovoltaics, but not about the rest of the electronic boom, which promises to reform our reality. We mention thermal envelope buildings, but leave out promising new double-glazed window systems that draw return room air through the panes. We discuss ice storage and phase change salts, but not solar ponds or advanced geothermal systems.

We have tried to choose those forces on the frontier that will most strongly begin to affect energy-conserving architecture. We start, therefore, with the discussion of the interrelation of energy and health. It may complete the other half of the duet, "comfort and health" in buildings which, in our preoccupation with energy, we have occasionally thoroughly misjudged. [Richard Rush]



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*The highest solar technology with the simplest means is displayed in this tracking photovoltaic array. With the freon-activated device, inventor Steve Baer continues his pioneering efforts that began years ago using a passive solar storage system known as "drumwall."*

# Building ecology

**Hal Levin**

**The life process has a way of reminding us that no single emphasis of design can exist to the exclusion of others. The world oil situation reminds us that energy conservation is vital. Building health problems remind us that energy conservation alone may make a building unhealthful.**

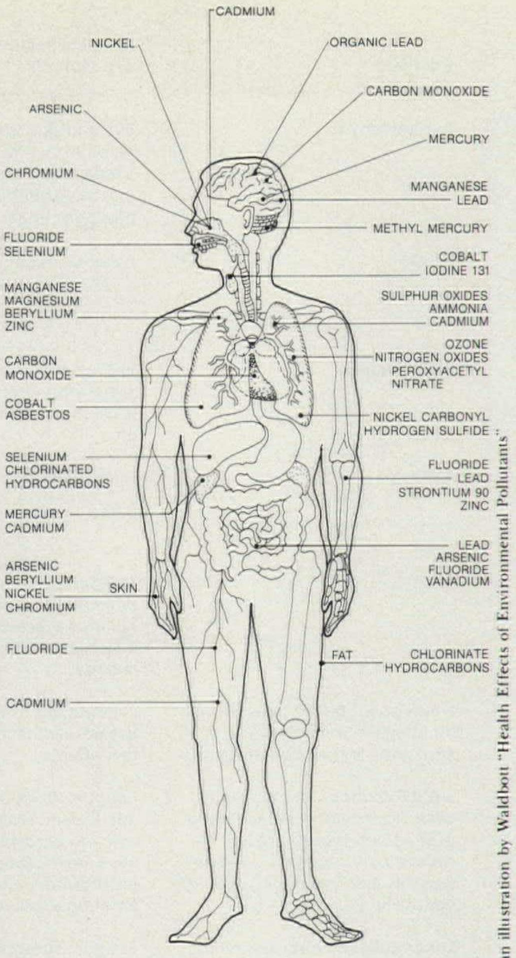
Modern buildings pose a number of new energy and health problems. These problems relate to changes in building practices begun mainly since World War II. They include the widespread shift from natural to synthetic materials generated by the chemical and materials industries after the war's end. Environmental controls including lighting, heating, cooling, and ventilating have necessitated a shift from largely architectural passive methods and systems to increasingly energy-intensive active mechanical systems in sealed (closed) buildings of great height and bulk.

Maintenance compounds, fire retardants, stain repellants, and other chemicals abound—most of the new products with considerable release to the environment. Building materials, furnishings, and equipment also consist primarily of modern chemical products often suspected or confirmed as toxic or carcinogenic.

Brightly illuminated (fluorescent-lighted) interiors have replaced incandescent- and day-lighted spaces. Increasing use of electric equipment has significantly changed the electromagnetic and electrostatic environments indoors. Many office and factory workers and students spend their days at computer or microfilm screens. Considerable concern has emerged about the impacts of these systems on their users' health and functioning.

Building occupancy patterns have also changed considerably. Occupations have shifted most workers from outdoors to indoor jobs. Modern building technology has increased settlement in hostile climates where people spend more time indoors. The result is that most Americans now spend from 70 to 90 percent of their time indoors.

The rapid decrease in cheap, readily available energy supplies has resulted in a rush to save money/energy by tightening building envelopes and reducing ventilation rates. Pre-Arab oil embargo rates of 3 to 10 air changes per hour have been revised downward to 1.5 air changes per hour or less, and many serious health hazards result from increased concentrations of air pollutants. Many contaminants are generated by the buildings themselves; some are produced by the occupants; and some, like the bacteria linked to Legionnaires Disease, originate outside. Many of these contaminants are concentrated, bred, or intensified by the building itself.




MAIN TARGETS OF MAJOR POLLUTANTS

After an illustration by Waldbott "Health Effects of Environmental Pollutants"

From the energy crisis (and the drought in California) we have learned that we can get by on far less, that we had acquired careless habits of design and consumption during years of abundant, cheap supplies of these and other resources. Now we are facing a squeeze on resources of all types, and we do not yet know the implications of adapting our buildings to new constraints.

Research conducted recently suggests that simple modification of existing approaches and technologies will often result in serious health hazards. Many of these hazards are related to substances or problems with which we have frightfully little experience. What experience we do have suggests that the interactive effects of diverse hazards and components of the built environment may have impacts several orders of magnitude greater than the individual or even additive effects of combined hazards.

Currently we are confronted with problems in newly constructed or remodeled structures. The examples given below only suggest the range and complexity of these problems.

### Oakland High School

In September 1980, some of the faculty and students who were moving into the new $9.5 million *Oakland High School in Oakland, Ca,* reported eye irritation and difficulty in breathing. The woman responsible for the textbook room complained of severe headaches, skin irritation, and nausea. In a survey, one-half of the student and faculty respondents said their health had deteriorated since coming to the new campus.

Particle board shelving in the new storage units was suspected of giving off formaldehyde. Cal-OSHA investigators found that the school's air contained 1.2 to 1.6 ppm (parts per million) of formaldehyde. While the state has no indoor air quality standards, its occupational exposure ceiling for formaldehyde is 2 ppm. A majority of people, however, suffer eye, skin, nose, or throat irritations at formaldehyde concentrations above 1 ppm.

The school's air-handling system was not functioning according to the design specifications when school sessions began. So it is difficult to know which factor—the releasing of fumes from new building materials or the inadequate ventilation system—contributed most to the formaldehyde levels detected.

In contrast to the old building (constructed in the late 1920s and abandoned because of its reportedly inadequate resistance to withstand earthquakes), the new structure is totally sealed. A mechanical system ventilates, heats, and cools the building. The few windows cannot be opened when occupants want fresher air. Most spaces are illuminated by fluorescent lights.

Some of the original environmental problems of new buildings like Oakland High School do diminish with time. The presence of formaldehyde actually results in the numbing of the sense of smell, lessening detection of other noxious chemicals occupying the building. Gradually some of the worst odors recede, and some of the most offensive chemicals are released. People gradually adapt to many other aspects of the building, developing a tolerance for artificial lighting, sealed windows, higher noise levels, etc. But this adaptation does not come without a price—in annoyance, frustration, and physiological and psychological change.

### DOT in Augusta

When it opened in the summer of 1976, the three-story state *Department of Transportation (DOT) building in Augusta, Me,* was hailed as a model for energy-efficient structures. Heat is generated entirely from solar gain, workers' bodies, lighting, and equipment. Completely sealed and slightly pressurized, the building does not have operable windows. A Delta 2000 computer monitors the artificial environment, regulating temperature, humidity, and air flow. Eighty percent of the air is recycled throughout the building; the rest is pumped in by a roof-top fan, mixed with the recycled air, and distributed via ducts. Electric heating coils near the fan heat the air pulled in from the outside. Recovered air is cooled by seven air conditioners and maintained at 78 F.

After the first few days in the building, workers complained that it was stuffy and dry. Temperature and humidity levels were reset, but workers contracted colds and continuous coughs. A new, more powerful fan, installed to increase fresh-air capacity, caused the fiberglass ducts to fray.

A so-called "comfort" problem affected two-thirds of the 600 DOT workers. Symptoms included rashes, watery eyes, hoarseness, coughing, dizziness, lethargy, sores that would not heal, breathing problems, stiff shoulders and necks, and coughing up blood. One worker developed what her doctors called a "restrictive and obstructive lung disease," which may have been caused by cotton fibers and small shards of fiberglass in the building's air. In March of 1980, state investigators indeed found that the air supply contained minute particles of fibrous glass.

The president of the Salter Corporation, the building contractors, blamed the health problems on the workers' general frustrations and their "aggressive union." The employees' association has requested removal of all fiberglass air ducts. But there is general agreement that the fiberglass is just one of a combination of problems with the DOT building.

| Pollutant | Possible health effects of pollutants | Some building uses where pollutants may be found |
|---|---|---|
| **Formaldehyde** | Eye and skin irritation; Upper respiratory problems; Headaches, dizziness, nausea, fainting; Suspected of causing nasal passage cancer. | Adhesive in particle board, plywood, insulation, furniture, and panelling. Cigarette smoke, gas combustion products, many consumer products. |
| **Radon** | Causes cancer. | Masonry materials (especially granite, concrete, brick). Soil under buildings. Water supply. Some wallboard. |
| **Particulates** | Various effects including upper respiratory problems, stomach and lung cancers, headaches, etc. | Combustion appliances; cigarette smoke; paper processes such as data handling, duplicating, copying. |
| **Asbestos** | Lung diseases including cancer. | Insulation sprayed on building components for fire-proofing and sound control, air duct linings, acoustical tiles. |
| **Lead** | Abdominal pain, headache, muscular aches, weakness, central nervous system damage, kidney damage, anemia, affects bone marrow. | Paints (no longer permitted, but still on older walls, in air during renovation). Pipe joint compounds. |
| **Noise pollution:** Human activity, building equipment, office machines, traffic, construction. | Hearing impairment or loss; cardiovascular and nervous system effects. | |
| **Light Pollution:** Intense brightness; poor color rendition; lack of shadows; flicker effects (fluorescent); luminaire "noise" (audible and inaudible); spectral deprivation. | Fatigue, epileptic seizures, Vitamin D deficiency, inadequate calcium absorption, bone disease, developmental deficiencies in laboratory animals; headache, emotional stress. | |
| **Other EMR (Electro-magnetic radiation):** Computer terminals; microfilm screens; business machines; copying machines; etc. radar (air traffic) equipment. | Fatigue, stress, headache, dizziness, nausea, nervous system disorders; operator errors. | |

BUILDING SOURCES OF TYPICAL HEALTH HAZARDS AND THEIR EFFECTS

**Social Services Building**

The design-award-winning new headquarters for the *Social Services Building in San Francisco* was completed in the fall of 1978. Shortly after moving in, many employees complained of eye and skin irritation, and headaches and respiratory problems. Absentee rates were higher than in the older, previous quarters, and the Occupational Health Clinic at San Francisco General Hospital saw many of the workers who were suffering effects apparently caused by the new building.

In the spring of 1979, the University of California, Berkeley's School of Public Health faculty and Lawrence Berkeley Laboratory Ventilation Program scientists were called in to determine the source of the problem. Air sampling indicated elevated levels of many organic chemicals including common industrial solvents known to be highly toxic. While precise sources of the air pollution were not identified, the ventilation system was implicated by the evidence gathered. Supply air diffusers were incorporated into the ceiling system and the space above was serving as a plenum. The diffusers were not getting air down to the workers, but were functioning to exchange air in the upper two feet of the space.

The organic compounds discovered in the building are not atypical of those found in similar offices currently constructed in the United States. They include constituents of cleaning products, waxes and polishes, office equipment including typewriters and copying machines, adhesives used in the manufacture of building materials and furnishings, and a host of other compounds. While the health effects of most of these substances at their commonly found concentrations are not yet fully understood, many of them are known to be highly toxic, and some are suspected carcinogens. The accompanying chart shows a comparison between the concentrations of these substances in outdoor air and in the Social Services building as measured by LBL.

The problem at the Social Services building represents the tip of the chemical pollution iceberg. Over one ton of chemicals is manufactured every year for each inhabitant of North America. More than 66,000 separate compounds are among these products. Most of them are intended to resist decomposition in the environment and a significant portion of them are intended to attack living organisms. A large portion of them ultimately find their way into the water above or below the ground or in the seas. The construction industry, building maintenance, and many of the activities conducted within buildings, are dependent upon these substances.

For example, formaldehyde, a suspected cancer-causing substance, is currently manufactured at the rate of about 6 billion pounds per year—about half of which is used in building products. It decomposes while in the building and is released into building air where it is inhaled or absorbed through the skin of building occupants. It is a widely used construction adhesive and is also used in the manufacture of modern office and home furnishings. Studies indicate that workers in furniture manufacturing develop nasal cancer at rates four times higher than the general population. Current use of formaldehyde continues unabated, although the U.S. Consumer Products Safety Commission is attempting to ban one building product, urea-formaldehyde foam insulation.

**St. Elizabeth's Hospital**

In August 1965, pneumonia broke out among 81 patients at *St. Elizabeth's Hospital,* a chronic-care facility in Washington, DC. The epidemic killed 14 people. The disease agent remained a mystery until 1977, with the discovery of a pathogenic bacterium in the lung tissues of those who became ill at the Legionnaire convention in Philadelphia. The bacterium was tied to several previous respiratory illness epidemics, including the 1968 incident in a Pontiac, Mi, health department building, when 95 out of 100 people developed high fever, headache, and muscle ache, but no pneumonia.

The bacterium responsible for the outbreak at St. Elizabeth's was traced to the soil. During that summer several sites on the hospital grounds had been excavated for installation of a sprinkler system, and it was theorized that contaminated dust raised in the process entered the building's air-conditioning cooling towers, and spread throughout the building.

"Legionella pneumophila" has been isolated from water found in cooling devices in at least three cases of the epidemic. Any airborne bacteria can now gain access into a building's cooling system, and from there into the fresh-air system. This argues for some form of bacterial air filtering, or perhaps the removal of air-conditioning systems altogether and the substitution of fresh-air circulation, which would at least prevent the possibility of bacterial infection brewing up in the cooling tower and emerging into the fresh-air system.

**A new field of study**

We have presented only a cursory overview of some building-related health problems (or health-related building problems) in order to acquaint the reader with the range of problems and their occurrence in buildings. It is useful to study the accompanying table, which lists some major problems, their sources or use in buildings, and some of the well-known health effects associated with them. The interested reader will wish to pursue individual research in connection with design and specifications by asking material manufacturers and suppliers for their product safety data sheets and chemical data sheets prepared for each product. In order better to understand and cope with problems like those described above, it is necessary to gather information from a variety of disciplines including public health, air quality management, environmental health, toxicology, and a host of others. As a researcher in the College of Environmental Design, University of California, Berkeley, I have been attempting to assemble the information into a coherent and useful body of knowledge for those who design our built environment: architects, engineers, interior designers, etc.

My inquiries and investigations to date have led to the term "building ecology" to describe the interrelationships between people, the built environment, and the natural environment. Building ecology draws heavily from the ecologists who have developed techniques for studying complex interrelationship in the natural environment—the "eco-systems approach." I have attempted to incorporate the major features of this approach, which derive from the systems approach, ecology, and bio-energetics—the study of energy flows through living systems.

**Conclusion**

The new building problems described above do not occur only in energy-conserving buildings; even pre-1973 buildings where air sampling has been done commonly show pollutant levels higher than in outdoor air—in some cases worse than levels found during severe air pollution episodes. The effort to conserve energy in buildings has accelerated our recognition and understanding of indoor pollution. But we must recognize the importance of reducing or eliminating toxic substances and other forms of pollution and learn to control pollution levels through ventilation, natural light, acoustical control, and other design strategies. A preliminary set of guidelines will help while we learn to understand and deal with these new problems.

**1** Maximize the use of natural ventilation, cooling, heating, and sun control with user control wherever feasible; passive solar approaches are desirable.

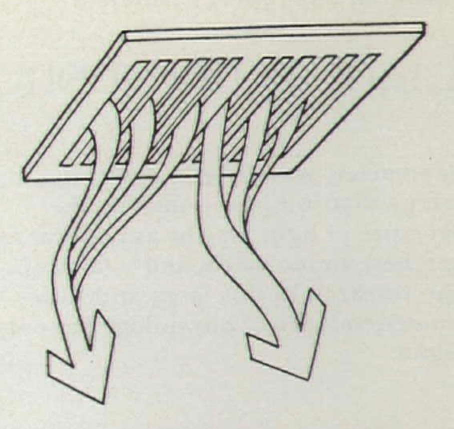
**2** Diversify and carefully locate sources of air intake and distribution.

**3** Utilize state-of-the-art air filtration and cleaning as well as heat exchangers where air supply is mechanical.

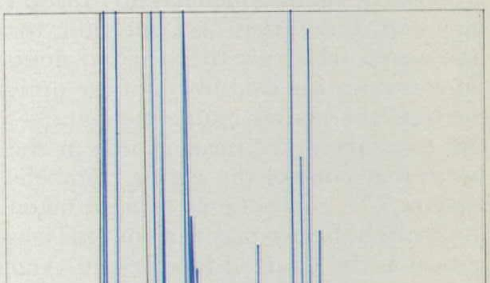
**4** Select durable, stable materials for exposed finishes, especially those subject to heavy use or possible surface damage. Avoid materials which require frequent painting or other chemical treatment.

**5** Request manufacturers' product chemical data sheets when considering materials for specification; seek out non-toxic products wherever possible.

Awareness of the health problems in buildings has emerged rather rapidly. While we cannot adequately respond overnight, aware designers can evolve strategies such as those suggested above to modify current practice. By understanding the "building" in *building ecology* as both noun and verb, architects and others can move toward the design of healthful environments. □



**Concern for the problems mentioned herein is spreading throughout the architectural and related professions. The Board of Directors of ASHRAE recently accepted a draft report, for example, calling for further broad-based research on Legionnaires Disease. The Board also approved a revised standard designed to avert indoor air pollution. ASHRAE Standard 62-1981 calls for the measurement of the various pollutants and provides specific steps to deal with them. At a seminar on indoor air quality at the recent ASHRAE Convention in Chicago, Dr. Jan A.J. Stolwijk of the Yale University School of Medicine cited an incidence of death from heart attack that was related to insufficient ventilation. Said Dr. Stolwijk: "Cases like this teach us that we cannot sacrifice indoor air quality to the demand of energy conservation. We must reconcile the two. The revised ASHRAE Standard attempts to do just this."**



COMPARISON OF INDOOR AND OUTDOOR ORGANIC SUBSTANCE CONCENTRATIONS — OUTDOOR — INDOOR

EACH PEAK REPRESENTS A SEPARATE SUBSTANCE. PEAK HEIGHT INDICATES STRENGTH. VENTILATION PROGRAM TAKEN AT THE DEPARTMENT OF SOCIAL SERVICES BUILDING.

BASED ON MEASUREMENTS BY THE LAWRENCE BERKELEY LABORATORY.

Technics: New energy frontiers

# Light as nutrition

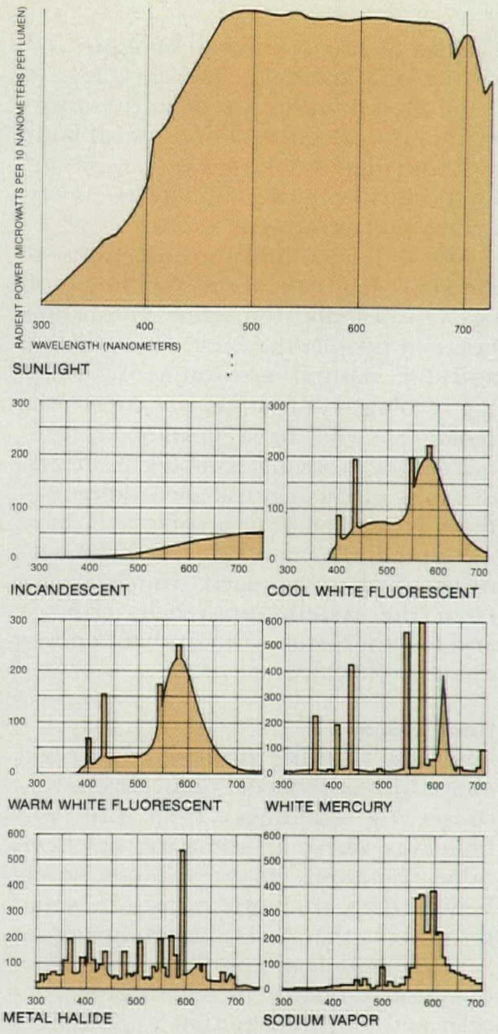
**Nanometer, wavelength, spectral energy distribution—someday the structure of light may be as familiar as starches, amino acids, and vitamin C. The research in this large and little-understood area of physiology has only begun.**

If it is light enough to read or walk down the corridor without bumping into anything, most people don't give light another thought. Since 1973, energy-conscious and just plain cost-conscious architects and owners have added lumens per watt and greenhouse effect to their concerns, with resulting shifts in lamp and glazing specifications. But if a fascinating new area of scientific research is correct, at the same time that we are saving energy, we are aggravating a problem we should have been paying attention to all along. And the penalty may be as serious as cancer.

This line of research has been indicating a role for light in human physiology besides vision. The more prevalent notion is basically that light is for seeing and the only light that affects people other than that is ultraviolet, which is harmful. Normal glass cuts out most ultraviolet light, plastics manufacturers put special UV inhibitors into the product, and artificial lights use various segments of the spectrum but rarely UV.

What some researchers are now suggesting is that there seems to be a layer of the retina which has no function in vision, but serves as a receptor for lightwaves, which are then carried along non-vision-connected fibers of the optic nerve to the master endocrine glands—the pituitary and pineal glands in the brain that control the entire metabolic system. The components of light taken in through the eye may turn out to be as critical as the kinds of foods eaten. And light that is significantly different in structure from sunlight may cause the metabolic equivalence of malnutrition. (For an introductory discussion, see P/A, September 1973, p. 79.)

In the U.S., some of the most provocative and influential investigations have been conducted by a hobbyist, John Nash Ott. Now 72 and largely retired in Sarasota, Fl, Ott has been trying to interest people in the "other" function of light for several decades. Not only not a scientist, Ott never attended college, but became involved in this through unexpected discoveries while pursuing his hobby, time-lapse photography. Beginning in high school with a 16-mm camera and the works from the kitchen clock, Ott has invented much of



SPECTRAL ENERGY DISTRIBUTION CURVES

the equipment used in time-lapse photography, as well as doing dozens of the flowers-bloom-before-your-very-eyes educational films for Disney Studios. Meanwhile, his career was banking—20 years with First National Bank in Chicago, from which he retired in 1948 because "it was interfering with the photography." Along with the films, Ott began a 10-year television career of a show on gardening, devoting that salary, lecture fees, and everything he could raise from foundations and individuals to his research.

### The early surprises

Ott's first experiences with the significance of different areas of the spectrum came from his growing plants for the Disney films. With pumpkin plants, he discovered that under the redder fluorescents all the female flowers died, and under the bluer fluorescents all the male flowers died. Tomato plants were subject to viruses in his glass greenhouse, but stayed healthy under special UV-transmitting plastic.

The significance of light for plants, however, was well established even if the influence of different parts of the spectrum was less so. At this point, Ott collected information and began his own research on animals. He heard from one correspondent that she had produced more female chinchillas per litter under blue fluorescent lights than under incandescent. Various scientists reported of fish that didn't get pop-eye (a viral infection) under daylight or ultraviolet-emitting fluorescent lights but did under regular fluorescent; of snakes that accepted food in daylight but not in fluorescent light; of hamsters whose dental cavities seemed to increase under fluorescent light; and of shrimp that stopped cannibalizing their young when ultraviolet was added to their light.

Using a microscope with color filters, Ott discovered in cells from both chick embryos and rabbit eyes that blue sent the cells into contortions and red made the cell walls weaken and rupture. Several virologists told him that the chick embryo cells under blue filter closely resembled cells being attacked by viruses. Ott's experiments with $CH_3$ strain of mice, used by researchers because they are very susceptible to tumors, also seemed to show dramatic responses to different light sources. Under pink fluorescent, their tails became spotted and covered with severe lesions and eventually dropped off. Under purple light (red and blue grow lights) they lost most of their fur and the tails became scaly. The heart tissue (not exposed directly to light) of the animals under pink fluorescent light had large dark areas (calcific myocardities). None of these symptoms appears in the animals kept in daylight.

### The human animal

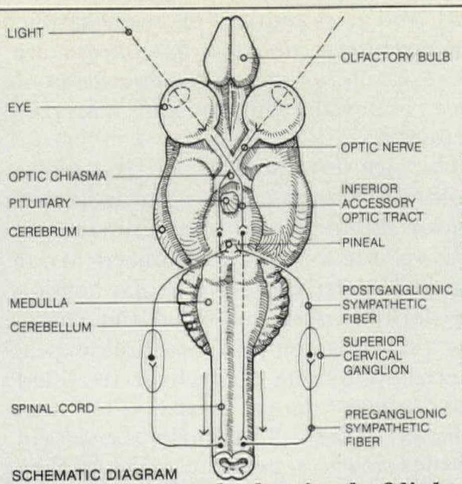
Convinced of the implications of these findings, Ott began collecting dribs and drabs of evidence on people. He linked a leukemia cluster (a peak of unusually high incidence) in children to classrooms where warm-white fluorescent bulbs were used in conjunction with closed curtains. Workers in a contact lens factory and a restaurant, both provided with a full spectrum of light (including UV), were found to escape flu epidemics. A radio station reported bad tempers with pink fluorescent; back to normal with white. A nurse reported cancer remissions with added time outdoors. And Ott's own arthritis improved dramatically as he removed the barriers to full spectrum light from his life.

His speculation is that alterations to the light spectrum taken in make equivalent alterations to human metabolism. If light is one of the factors in regulating the metabolism, then it could be a factor in metabolic disorders, including arthritis, diabetes, infertility, heart disease, and more. Some diseases—from influenza to cancer—are not sufficiently understood to be clearly categorizable. Most scientists consider a virus an or-

**In fact, there have been scientists all over the world wrestling with the effects of light on health for decades. Recently the scientific publisher Springer-Verlag commissioned a German professor of ophthalmology to write a compendium of research on the subject. The volume, entitled *The Influence of Ocular Light Perception on Metabolism in Man and in Animal,* is by Fritz Hollwich whose own research in this field dates from 1947.**

**The experiments discussed detail a pathway between nonvisual photo-receptive cells in the retina, along the optic nerve, to the hypothalamus (part of the brain) and pituitary gland, and from there through nerve networks to the pineal gland. (Curiously the pineal gland is evolutionarily descended from photo-receptive organelles—a third eye—in amphibians, fish and reptiles).**

**In experiments not only with mammals, but with blind people and people blinded by cataracts both before and after corrective surgery, many connections have been drawn between light and metabolism (including growth, sugar balance, blood count, and sexual function). If light entry to the eye is blocked, the evidence suggests, metabolic and hormonal processes occur, but at a lower than normal level and with abnormal adaptation to increased stresses. Abnormalities are far**



SCHEMATIC DIAGRAM

*Courtesy of Hallwich, Ocular Light Perception*

**stronger in people deprived of light as children than as adults.**

**The research into the impact of specific wavelengths—or any pathological effects of non-natural spectral distributions—is as yet sketchy. Initial work with animals suggests wavelength distinctions may be germane. Also adaptation to intensity of light may be governed by specific wavelengths, as high levels of artificial light—but not sunlight or full spectrum lighting—have been found to trigger stress reactions in people.**

**Though it is clearly too early for conclusions, the author interestingly goes on to say: "It is now time to direct attention to the medical aspects [of artificial light]. . . . Above all in the case of children who attend schools without windows, we must be prepared for the eventual appearance of pathological consequences."**

ganism without all the characteristics normally associated, such as reproduction. But a few think it might be the byproduct of a misfiring metabolism. There is also a minority opinion that cancer may be viral.

### American industry

As soon as these pieces began to come together, Ott began talking to companies who manufactured the products that provide or screen light. He managed to convince two eyeglass, two contact lens, and two window manufacturing companies to offer products of UV-transmitting plastic.

Another company was convinced to produce a fluorescent fixture with an extra small tube emitting black UV light. (An earlier version with a different company inserted a black light phosphor into ordinary tubes. This proved insufficient as that phosphor burned out before the others, but without a visible sign.) In addition to the UV tube, these tubes have lead shields around the cathodes at each end (which Ott claims emit harmful radiation) and a grounded wire grid inside the plastic cover to further drown the radiation.

Among the places he has tested these fixtures was the first grade of a Sarasota school. The school had been having problems with several hyperactive children. Two classrooms were equipped with Ott's fixtures, two with regular fixtures. Ott reports that in the classrooms with his lights, not only did the hyperactive children calm down but the achievement of all the children rose.

### A question of credibility

Ott has spent almost as much time publicizing these findings as in a laboratory. He has written three books: *My Ivory Cellar, Health and Light* and *The Dynamics of Color and Light* (to be released this month from Devin Adair), as well as making countless lectures.

The reception from scientific, medical, and related industrial communities to Ott's efforts has ranged from occasionally excited to outright ridicule.

As more of an explorer than a research scientist, Ott is left open to many of the technical charges. Few of the experiments (and there are many more than reported here) or collected evidence can be said to rely on statistically significant samples. Often there is no control group. Even when there is a control group, there is rarely thorough control for each possible variable.

Ott further opens himself to skepticism with his enthusiasm for hypothesis. If chick embryo cells rupture under red filtered light, he says, perhaps human heart disease is related to the prevalence of incandescent lighting. If prisoners respond well to horticultural therapy, he wonders, might it be the sunshine that is making the greatest difference.

On the other hand, though he clearly loves the romance of it, Ott makes no claims of being a scientist himself. He is an enthusiast, an inquisitive man with a lively mind, whose curiosity has led him into a life—fortunately supported by a modest inheritance—of churning up possibilities and flinging out questions to be pursued more rigorously and doggedly by the scientific estate.

In recognition, he has been awarded an honorary Ph.D. from Loyola University and a medal from the National Eye Research Foundation. He has conducted seminars at both Notre Dame and Johns Hopkins and has lectured at countless universities.

### And now . . .

In recent years, Ott's interests have led him to broader investigations of the electromagnetic aspects of physiology. How this might fit in with what we don't know about the electomagnetic aspects of the human nervous system, why some people are worried about low intensity radiation, and how all this might relate to the previous work on the effect of partial spectral distribution of light is the subject of Ott's current book, recent lectures, and a good bit of contemporary scientific research in this and other countries. [Nory Miller]

### Yellow pages

Here is a list of the products which are offered as a result of Ott's collaboration with specific manufacturers. (These do not necessarily represent the complete range of products aimed at providing full-spectrum light indoors.)

*Fluorescent fixtures and tubes:* Acme Dunbar Industries.

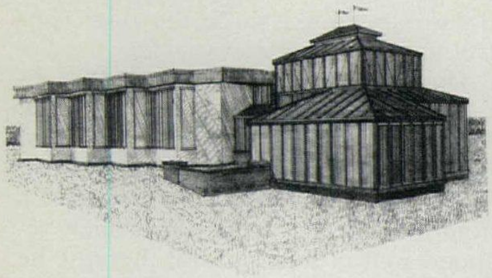
*UV-transmitting plastic for windows and skylights:* Rohm and Haas "UVT Plexiglas"; American Cyanamid "Acrylite UVT."

*UV-transmitting eye glasses:* Eye Kraft "Sunlite Lenses"; Armorlite "Full Spectrum." Both clear and neutral gray sunglasses.

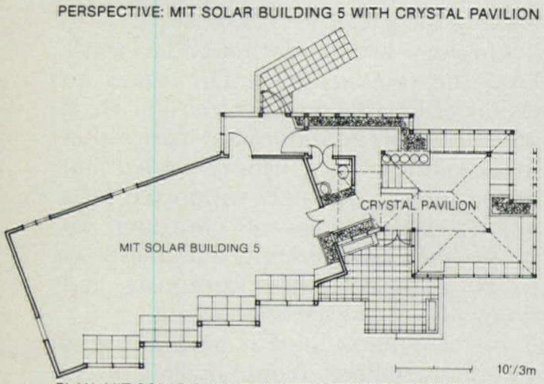
*UV-transmitting contact lenses:* Bausch & Lomb soft lenses; Wesley/Jesson hard lenses.

Technics: New energy frontiers

# MIT Solar 5



PERSPECTIVE: MIT SOLAR BUILDING 5 WITH CRYSTAL PAVILION




PLAN: MIT SOLAR BUILDING 5 WITH CRYSTAL PAVILION

**Energy research at MIT forges new directions for building materials. The research results of the MIT Solar Building 5 and the potential of its new addition show great promise for phase change salts as well as new transparent heat-reflecting glazing products.**

Solar energy research is not new at the Massachusetts Institute of Technology. In the late 1930s and 1940s, such solar pioneers as Dr. Maria Telkes and Dr. George Löf explored the practical implications of solar energy at MIT. The Godfrey L. Cabot Fund for Solar Research was given to MIT and Harvard University during those years to help finance basic research in the direct use of sunlight. A symposium on solar house heating was held in 1950 at MIT and was one of the first such congregations. A series of five solar buildings was begun in the early years, and 40 years later an addition to MIT Solar Building 5 is nearly complete. The original 866-sq-ft Solar Building 5, like its predecessors, has been sponsored by the Cabot Fund. The new addition is being paid for by DOE.

Now in its third year of operation, the Solar Building 5 was designed by Timothy E. Johnson, Charles C. Benton, and Stephen Hale. One goal of the research is the utilization of solar heat in multifamily housing or even office space. It accepts the requirement that such spaces have traditionally employed large areas of glass, window blinds, and ceiling panels. Trombe walls often limit daylight and view. Direct solar gain onto carpeted floors and walls is interrupted by furniture and presents fading problems and a potential for overheating. The architects decided to concentrate the research not on the configuration of these materials, but on the materials themselves.

The window section of the Solar Building 5 employs an encapsulated window blind which is covered on its concave side with an aluminized Mylar skin and inverted to reflect solar heat on the dark-colored ceiling of the space. The ceiling is composed of hollow polymerized concrete tiles which are filled with "phase change" salts. The heat reflected to the ceiling causes the salts in the tiles slowly to begin to melt. As they change their state, they absorb great amounts of heat while remaining the same temperature. At night or in periods of no additional solar heat, the crystals then reject their heat to the space below.

Also integral to the window section of the south-facing double-glazed windows was a third layer of polyester film called Heat Mirror™. The product was developed in the early 1970s at MIT and later at Lawrence Berkeley Laboratory by Day Charoudi, John Brooks (now of Suntek, the R&D affiliate of the Southwall Corporation), and others. It consists of the sheet-plastic substrate coated on both sides with a vacuum-deposited metal surface, which is transparent to the eye. The molecular distribution on the film is such that shortwave infrared light will pass into the building, but the long-wave infrared light generated by the warmed surfaces on the interior of the space will be reflected by the film back into the space; hence the name "Heat Mirror." The result is that the double-glazed assembly for the building has a thermal resistance of 3.5 times that of conventional double glazing. The film becomes "transparent insulation."

In recent months the window section has been altered and the internal plastic layer eliminated. In its place, double glazing has been used except that the inside face of the interior light has itself received a metallized coating, which allows the glass to function as a "mirror" to the interior heat source.

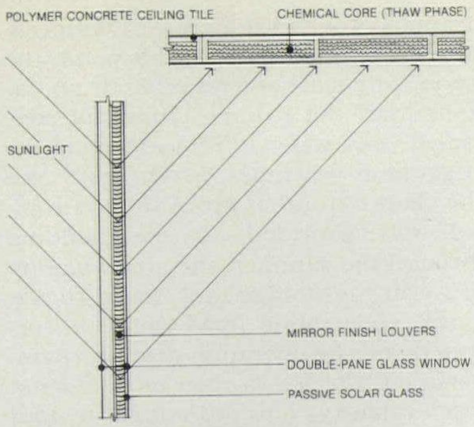
**The new addition:** The Solar Building 5 has been monitored by the Department of Energy. So impressed was DOE by the building's performance, that it has financed the new addition to the building designed by Brian Hubbell, an MIT graduate student. The purpose of the added space is to further demonstrate the capability of the coated glass assembly and the potential of obtaining solar heat gain from diffused daylight from north-facing glazing.

The intertwining of the various new techniques in the Solar Building 5 causes the results of the research to be of somewhat limited use. By linking the "Heat Mirror" to the inverted blinds and ceiling tiles, the "conventional" replacement of a double-pane window by the new assembly alone is not evaluated. How well will it work with conventional window-shading devices? Similarly, the ceiling tiles will certainly work with no film or coating on the glass, but how successfully? In fact, the greatest value of the research is in the understanding that it has provided towards the potential of either phase change salts or the metallized coating on film or glass.

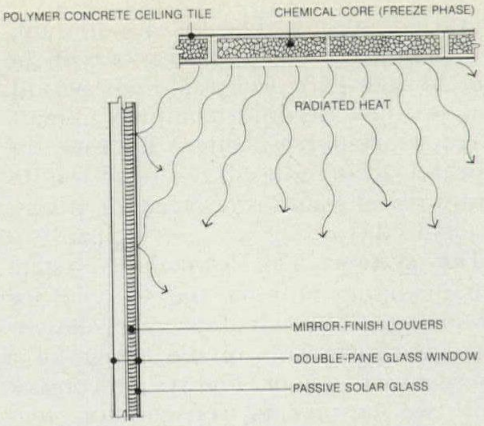
### Phase change salts

When ice changes state from crystalline to liquid form, it absorbs a great deal of heat. Much more heat is needed to raise the temperature from 32 F to 33 F than from 33 F to 34 F. Phase change salts are chemical compounds that can take advantage of the same principle but at higher temperatures. Sodium sulfate crystals, for example, have a melting temperature of 74 F. Calcium chloride melts at 81 F. Other similar salts melt at still higher temperatures. Until all of the salts in a particular container are melted, the temperature of the salts cannot rise above the melting temperature. They can, however, continue to absorb heat. Once the salt quantity has melted, if the heat source is withdrawn, the salts will yield their heat to the cooler space around them, essentially becoming a heat source of constant temperature until they recrystallize. MIT's research team leader Timothy Johnson refers to this fixed temperature situation as a "chemical clamp."

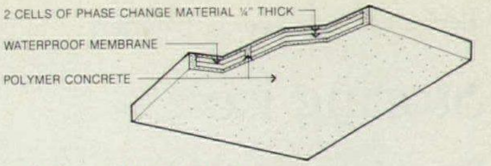
**Sodium sulfate:** For MIT Solar 5, Johnson used Glauber's Salts or sodium sulfate decahydrate crystals as the phase change material encapsulated in the ceiling tiles. Such salts have been in common use for maintaining drug temperatures in the medical industry and in military gloves. The problem with the material in bulk form is its limited lifespan. After a series of cycles, its thermal clamping properties break down. In the ceiling tiles, Johnson is confident that he has avoided such problems by creating layers of the salts, separated by polyethylene sheets, and water and chemical additives that hold the salts in suspension and allow crystal growth to occur without destructive aging. The tiles developed at MIT are called Sol-Ar-Tile® and are currently manufactured by Architectural Research Corporation of Livonia, Mi. The salts are available in bag form from C.M.I., Colloidal Materials Inc., of Andover, Ma. The cost of the salts is small;



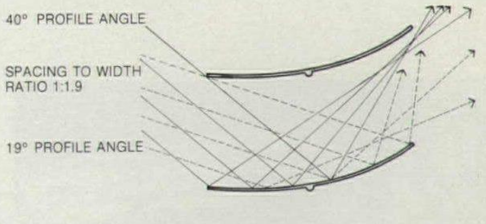
DAYTIME SOLAR HEAT GAIN TO CEILING TILES



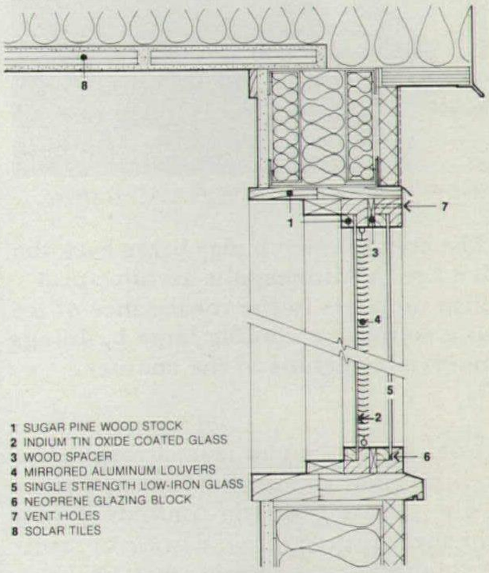
NIGHTTIME HEAT FLOW TO ROOM FROM CEILING TILES



SOLAR CEILING TILE CONSTRUCTION



LOUVER SECTION



SOUTH WINDOW SECTION: MIT SOLAR BUILDING 5

*In the passive solar heating system employed in the MIT Solar Building 5, the sun's heat and light are reflected from inverted window blinds onto the ceiling tiles filled with phase change salts. At night the heat released by the tiles is reflected back into the space by heat-reflecting glass.*

the packaging is expensive. A disadvantage of the tiles at present is that they must be used horizontally, a flaw that Johnson feels he can eventually control.

**Calcium chloride:** There are also a number of products available commercially that use calcium chloride crystals. These more expensive crystals absorb heat more slowly than sodium sulfate and expand 10 percent when they change state. They melt at 81 F, and there are no restrictions in orientation of the use. The key to the successful manufacture of containers full of such materials is the elimination of moisture. If moisture is able to enter the container with the salts, the balance that allows the recurrent crystallization process will eventually self-destruct, and render the product useless.

Such calcium chloride crystals are available in long slender tubes, large juice-size cans, and plastic pods (see products and literature, p. 231). The dimensions of the products are governed by the desire to have the heat penetrate to the innermost portions of the container during the course of a normal day's usage. The dimensions are also governed to some degree by the intention of using them within the dimensions of walls and ceilings.

Such salts can be used in direct line of heat gain or indirectly as a storage vehicle. As a direct-gain product the salts are considerably lighter and consume less space than rocks or water. In bulk storage there is a tremendous opportunity for combination with heat pumps.

### Reflecting heat

Your stove probably has a small pane of heat-reflecting glass in its oven door. Freezer compartments also typically employ small windows of heat-reflecting glass. What the original research crew accomplished was the high-volume low-cost manufacture of a roll of plastic film coated with a molecular scale metallic coating. In so doing, the team (later sponsored by the National Science Foundation) was able to manufacture sheet materials large enough to apply to building uses. Incorporating the material into a double-pane window assembly results in the thermodynamic equivalent to triple glazing at less expense. The manufacturers claim it adds about $3 per sq ft to the cost of double glazing. Heat Mirror™ is manufactured today by The Southwall Corporation of Palo Alto, Ca.

**Heat reflecting glass:** The manufacture of glass coated with the metallic coating represented another problem of scale. Airco Temescal, an industrial gas manufacturer, was able to solve the problem with a machine that coats glass sections up to ten feet wide in a continuous production line. This allows construction size panes of any type of glass to be coated. The single manufacturer currently producing the material in the U.S. is Guardian Industries. They call their product Passive Solar Glass. Pilkington Glass in England and Canada is developing its own versions using the Airco machinery as is S.I.V. (Societa Italiana Vetro) in Italy. Europeans are especially interested in the new type of glass. Some Scandinavian countries require triple glazing in buildings by law.

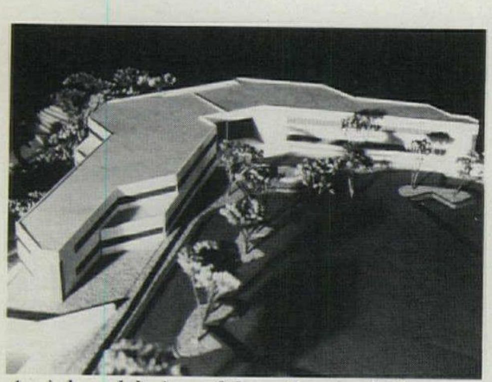
Timothy Johnson calls the product "a revolution in glass." Coated heat-reflecting glass of this type is significantly different from all other commercially available reflecting glass. It is clear and therefore permits daylight to enter the building. While the daylight and solar radiation entry is roughly equivalent to conventional window glass, it differs markedly from other glass in its ability to contain heat in the space by reflecting 85 percent of the long-wave infrared heat energy that strikes it. All other transparent glass reflects 0 percent of this heat. It is this quality which has such great promise for energy conservation. By using the coated glass as the interior pane of a double-glazed assembly (with the coated side encapsulated in the air space), the room-facing glass surface heats up to the point where the surface temperature of the glass is only a few degrees different from that of the interior air space. Normal glass can have a temperature difference of ten to fifteen degrees. Says Johnson, "The bottom line with the material is that it insulates twice as effectively as Thermopane and can increase comfort by measurable amounts because of the warmer surfaces."

**Looking ahead:** The present version of this glass is meant to contain heat within a space. A future version (office heat mirror) will do the same to keep heat out of the space in the summer but still permit valuable daylight to enter.

How does all this affect the building? In a moderate climate such as the Pacific Northwest, where the temperature drops are not extreme and there is a great probability of diffuse light, the glass will be able to trap solar heat. It can be installed on the north side of the building in such climates without heat loss. Eventually, as the technology develops, researchers foresee the capability of using future generations of the heat-reflecting double glazing on the north side of buildings even in very cold climates with a positive effect. You guessed it. Within a few short years it may be possible to again build total glass boxes, but this time have them be passively solar heated! [Richard Rush]

# Storing ice

**Chris Johnson**



*Aerial model view of Cray Research, Inc.*

**The energy crunch may bring back the ice age. A Minneapolis architectural firm pioneers in the renaissance of ice as a source for cooling large buildings in certain regions of the country.**

A dead man dangles from a rope as the central plot for Agatha Christie's story "The Cracked Mirror" unfolds. When the investigation into the cause of death is completed, it is determined that a man committed suicide by standing, with a rope around his neck, on a block of slowly melting ice. In a sense, society is slowly committing suicide by the lack of understanding of the dimensions, interactions, and solutions to the world energy crisis. But the use of ice, rather than providing a method for self-destruction, actually offers some intriguing methods for energy-conserving design.

A Minneapolis architectural firm, Architectural Alliance, recently completed a building for Cray Research Incorporated which uses ice to augment the building's air-conditioning system. A 15,000-cu-ft concrete storage tank holding an ice and water mixture is located in the lower level of the building. The ice, made at night when electrical rates are lowest, is used during the day to cool the building, its occupants, and equipment. The ice storage tank not only permits lower energy costs but allows for the installation of considerably smaller sized cooling equipment. A detailed description of the architectural and energy features of the Cray Building is in last year's April issue of *Progressive Architecture* (page 30).

The ice-making system in the Cray Research office building, although probably not offering such monumental changes in design concepts, could, if applied to a substantial number of commercial and industrial buildings, result in a less centralized, more energy-efficient society. The ice storage tank, which distributes the energy use of the building evenly over a 24-hour period, allows the local utility company to manage its resources better. Because the peak load is reduced, the need for future power plants is reduced, or at least stabilized.

**The system:** The ice-making system and storage tank in the Cray office building is the result of several evolutionary improvements in the design of a mechanical system. The system consists of two ice-making refrigeration machines suspended over a large concrete storage tank. In effect, the ice machines and storage tank replace a standard building's chiller or heat pump. The ice-making refrigeration units, originally developed to provide ice for food preservation, were used here with very little modification for cooling the building.

Manufactured by Turbo Refrigerating Company, the units pull water from the storage tank and distribute small streams of water over many ice-cold evaporator plates. The result, depending on the temperature of the water, is an (approximately) 4′ x 6′ thin piece of ice on each side of the evaporator plates. When the evaporator plates are warmed, the ice produced drops into the storage tank.

The Cray storage tank was constructed on-site in concrete. Burying the tank sides in earth allows the top to be the floor of the mechanical equipment room. The tank is insulated below the water line with 2 in. of polystyrene between the concrete and the earth. To reduce costs, no waterproofing or waterproof membrane was used, so there were several traumatic days when the tank was originally filled with water. During the first year of operation, the tank has lost approximately 8 in. of water, probably because of small cracks and evaporation. The water loss represents only about 1 percent of the total 115,000 gallons of water. In order to detect any sizable water loss, however, drain tile has been placed around the bottom of the tank and is connected to a sump pump. The tank is divided into two parts, with a concrete wall as separation. In the event of a leak, this allows half of the tank to be emptied and repaired. The other half can still be utilized by the building's mechanical system.

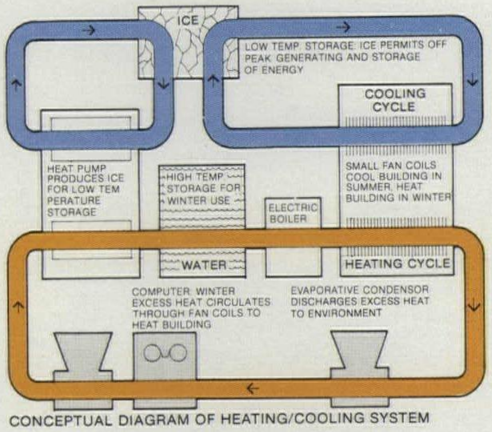
**Early performance:** Cray's ice-making system has been in operation since early summer of 1980 and has provided the building with all of its needed air conditioning. As can be expected with most innovative systems, however, there have been start-up problems. Last year Minneapolis experienced a record temperature of 94 F in April. At this point, the ice-making machinery was barely operational and the storage tanks still contained only water. The ice-making refrigeration machines never really got the chance to catch up. Although cooling was provided to the building through the summer, the accumulation of ice in the storage tank was difficult. Until refrigeration leaks could be corrected and the operation procedure understood, the ice storage tank did not reach capacity. This did not occur until the end of the summer. This year, as another cooling season approaches, all systems are again operational.

In the future, as operating characteristics are understood, ice systems can be designed more effectively. Based on the limited experience with Cray's system, the use of an unlined concrete storage tank appears to be the cheapest solution to containing the large quantity of required water. The size of the tank can probably be further optimized. The Cray system was designed at approximately 3 gallons of water per gross sq ft. In the future, 2.5 gallons appears reasonable for office buildings. Finally, to prevent clogging of ice around the cold-water supply line, a 14-in. perforated PVC tube placed over the water intake line is recommended. The water should also be treated to prevent corrosion of the piping system.

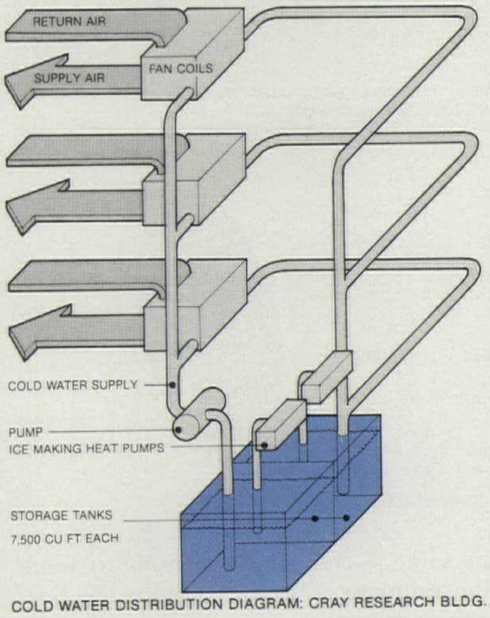
The reason for using ice rather than cold-water storage is quite simple. Ice can absorb large quantities of heat before melting. Due to unique thermal properties in changing from solid to liquid, ice has excellent heat storage capacity. As an example, it takes the same quantity of energy to raise the temperature of 1 cu ft of ice one degree as it does to raise 135 cu ft of liquid water one degree. For the Cray system, if cold water were used instead of the ice and water mixture, the tank would need to be over ten times as large to provide the same potential for cooling.

**The future of ice:** As the current methods of using ice for cooling buildings become more refined, the applications should rapidly expand. At the time of construction, Cray was the largest—and only commercial—application of a handful of ice storage systems in the United States. Since then, however, larger and more complicated systems are being proposed. The 1.2-million-sq-ft State of Illinois Center in Chicago (P/A, Feb. 1981, pp. 96–99) is now "out to bid" with an ice storage capacity of over 200,000 gallons. The system is expected to reduce the electric cost by half and save the owner approximately $150,000 per year. The building is to be completed in 1983. Future applications, although not well defined, will probably depend on the building type, utility rates, and the mechanical distribution.

*A main entrance to the building.*




CONCEPTUAL DIAGRAM OF HEATING/COOLING SYSTEM




COLD WATER DISTRIBUTION DIAGRAM: CRAY RESEARCH BLDG.

*The diagrams above explain the concept of ice storage as it is applied to the Cray Research, Inc., building. Being able to make ice at off-peak hours reduced electrical costs significantly. The ice itself reduced both the cooling machinery and the area needed for it in the building and ultimately resulted in energy savings over conventional systems.*

The designer contemplating the use of an ice storage system must understand all of these influences.

The building type should ideally be one with large variations of electrical consumption from day to night, primarily due to the need for air conditioning. Office buildings are a good example. Most large office buildings ordinarily operate only during the day, when the building is occupied, the air-conditioning equipment is operating, and the lights are on. The larger the difference between the day and night energy use the better the potential is for ice storage. Other obvious building types for ice storage systems include schools, auditoriums, and shopping centers. Hospitals, single-family and multifamily housing and certain industrial buildings are marginal candidates.

An ideal building type is one that is infrequently but intensively used, such as a church. In fact, during the 1940s and 1950s, several mechanical engineers experimented with ice-making equipment in churches. Ice would be produced throughout the week by a small-tonnage ice-making machine. During Sunday services, all of the ice would be used during a relatively brief period of time to cool the structure.

Local electric utility rates are of particular interest when considering an ice storage system. The typical method used by utilities to charge for electricity is through both the amount used (consumption) and the maximum used (peak demand). Electrical rates vary throughout the country and are constantly increasing. At the time of construction, the electrical rates for the Cray building were approximately $1.56 per Kw-hr for energy consumption and the peak demand charges ranged between $3.55 per Kw during the eight winter months and $4.55 per Kw during the four summer months. (The higher summer rates indicate that the utility is a summer-peaking utility.) The result is high electrical costs.

Besides the usage and peak rates, many utilities are also contemplating "time of day" rates where electricity used during the day, when there is heavier demand, is more costly than at night. As these higher rates are applied, ice storage systems become even more attractive.

**Where to look:** At present, the best areas of the country for using ice storage systems appear to be in the Northeast, where electric rates are particularly high. The least profitable area is the Northwest, where hydroelectric utilities provide less expensive power.

In the future, utilities may be a source of funding for architects who are considering an ice storage system. Because the widespread application of ice storage systems could reduce the need to build more power plants, utilities could be convinced to invest the money saved in ice storage systems. Several utilities, such as the Southern California Edison Company, have already begun to offer money for installation of energy-saving equipment in residential buildings.

Another important consideration is the type of mechanical distribution system being considered for the building. Larger distribution systems appear to offer some advantages. In the Cray Research Building, the distribution system consists of 26 fan-coil units placed throughout the ceiling plenums of the building. Each fan coil is connected to hot and cold water lines to provide for heating or cooling. The result is a very long distribution system. A simpler and more cost-effective distribution system would have been a variable air volume system with several large air handlers. The result would have been a substantial reduction in the required piping. The potential of an ice storage system should be considered very early in the design process to allow for changes in the mechanical distribution system and associated changes in the design of the building.

In making the decision to use an ice-making system, several other criteria need to be considered. The scale of the project should be larger than 20,000 square feet, until the systems have been more thoroughly tested. Several of the first ice storage systems were used in residential structures. At that time, the complexity and cost of an ice storage system made it unattractive. The building should also be made as energy conserving as possible. Every reduction in energy use will directly reduce the size of the expensive ice storage tank.

**Ice as opportunity:** Ice storage systems for cooling represent one of many new energy-conserving technologies waiting to be discovered. The potential of these systems is here, similar to the potential of active solar systems in the early 1970s and passive solar design in the late 1970s. In large part, it is the architect who makes the difference between systems that work and those that don't. Until the risks have been well defined, the architect must be the facilitator between the various disciplines that are involved in applying a new technology. Because most architects now focus on the multitude of other issues associated with building design, this may be difficult. But failure to understand this and other innovative, energy-conserving technologies, may result in the melting away of an opportunity to reduce the drain on our precious energy resources. □

Technics: New energy frontiers

# Solar photovoltaics

**Richard Schoen**

**Obtaining site-manufactured electricity from photovoltaic cells is today an expensive reality. The PV array of tomorrow shows great promise to be a competitively priced alternative to the electrical grid.**

Photovoltaics create electricity directly from the sun's energy. The currently most common solar PV cells consist of two layers of silicon crystal. One layer has a faint trace of the element boron, which gives it extra positive charges (+). The other layer has an equally faint trace of the element arsenic, which gives it extra negative charges or electrons (−). The two layers are joined together to make a PV cell, and separate grids or metallic electrodes are attached to the top and bottom surfaces. When the cell is exposed to the sun's rays, the units of energy or photons they create excite the silicon layers' atomic structure, freeing those positive and negative charges. The charges accumulate at the electrodes as electrical potential or voltage. Solar PV cells produce Direct Current (DC).

Initial photovoltaic markets have been similar to their use in outer space. They are in remote places on earth where small amounts of electricity are required that cannot justify the running of a powerline or the constant fueling of a diesel electric generator. Small solar arrays, of two or three panels at most, have been powering ocean buoys and other navigational and aviation aids, scientific experiment in remote desert and mountainous regions, and microwave repeaters in communications links. As the cost of PV continues to drop, viable new applications, even connected to the utility grid, are being created. One can purchase at least components for those systems from no less than seven competing companies, some bearing parent names of the largest corporations in the country.

**Government programs:** As is the case of solar thermal development before it, initial cost reductions in photovoltaic development are primarily due to federally financed programs that have been carefully developed in response to a stated national policy of replacing fully One quad (or quadrillion Btu) of (primarily fossil-fueled) energy annually in the U.S. by the year 2000.

The two basic collection and array modes are: **1** flat-plate solar arrays having a power capacity of 70–130 watts per sq meter (6.5–12 watts per sq ft), and **2** concentrator-enhanced solar arrays with possible capacities of 150 watts per sq meter (14 watts per sq ft). Each type finds application at the following levels of use:

**1** Remote Standalone: primarily international and remote U.S. use.

**2** Dispersed/On-site: individual buildings, primarily residential and in U.S., more than likely connected to the grid.

**3** Intermediate Load Stations: substation-sized power systems for shopping centers, mixed-use complexes, and possibly light industry.

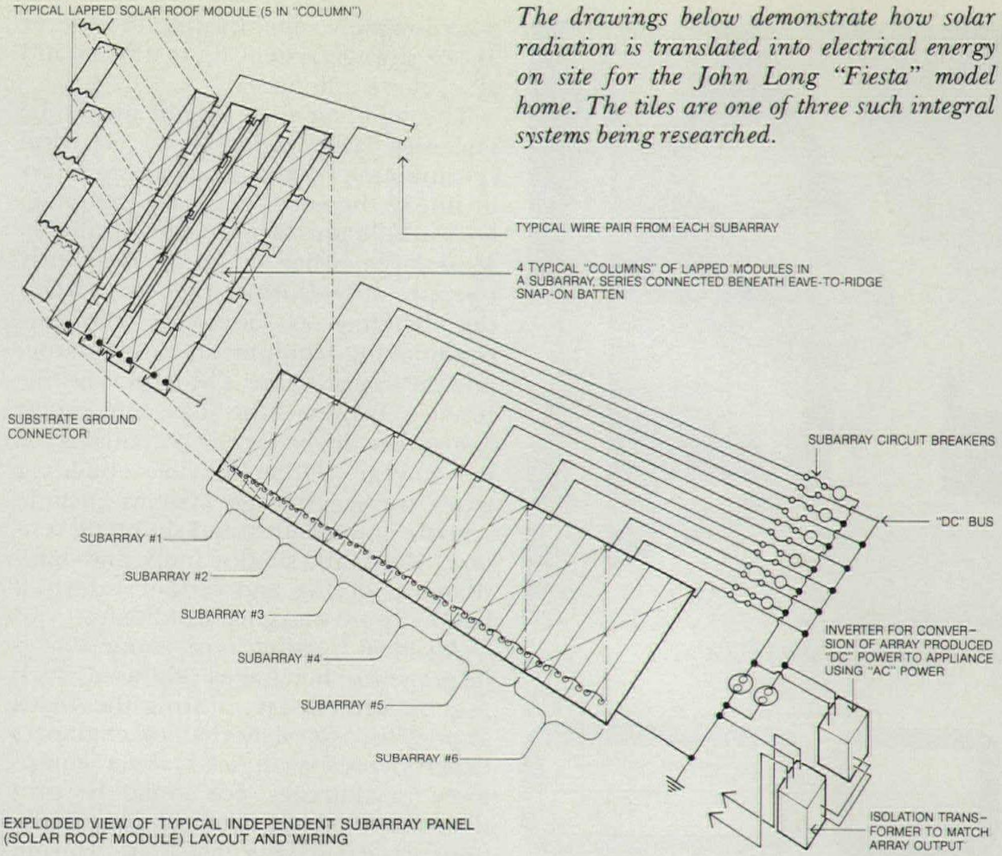
**4** Central Station Power: similar, for example, to well-known solar thermal counterpart, the high temperature-creating "Solar One" generating plant now under development in the desert near Barstow, Ca.

The most recent activity has been specifically directed at the development of two types of modules: intermediate and residential loads. The project is part of the on-going "Low-Cost Solar Array Program" at the Jet Propulsion Laboratory (a NASA facility run by the California Institute of Technology).

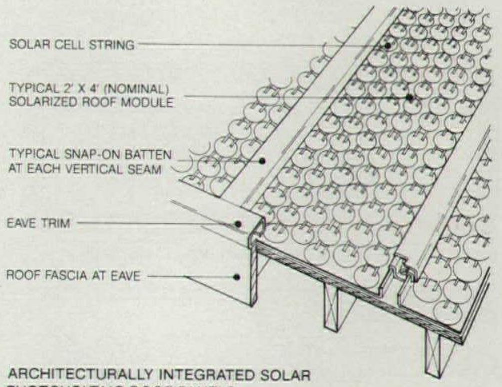
There are three residential module manufacturers' approaches. The first two, the ARCO Solar "Batten and Seam" Photovoltaic Roof and the General Electric "Solar Shingle" are known as "direct mounts." That is, they are mounted directly onto roof sheathing materials. They are the roofing material. Each must depend upon the quality of the underlying substrate of the roof itself, having little structural rigidity of their own. In this way, they are much the same as the traditional roof systems they emulate. The third system, by Solarex, is an "integral" mounting. That is, the modules replace the roofing *and* substrate and provide a watertight seal, usually to intervening structural roof elements such as rafters or joists.

Two other types of mountings are also common. The best known is that closest to its solar thermal predecessors, the rack mount. In this case, individual modules usually have a structurally stable surround. They are laid up on racks to form subarrays. As such they are of course most applicable to flat roofs, and

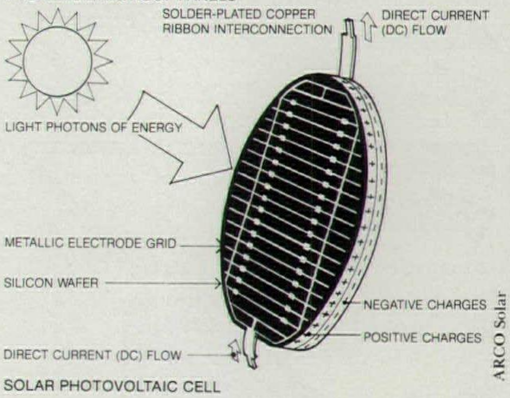
*The drawings below demonstrate how solar radiation is translated into electrical energy on site for the John Long "Fiesta" model home. The tiles are one of three such integral systems being researched.*



EXPLODED VIEW OF TYPICAL INDEPENDENT SUBARRAY PANEL (SOLAR ROOF MODULE) LAYOUT AND WIRING



ARCHITECTURALLY INTEGRATED SOLAR PHOTOVOLTAIC ROOF PANELS



SOLAR PHOTOVOLTAIC CELL

ARCO Solar

most of the intermediate load center modules are so configured. Similar modules may also be used for the fourth generic mounting type, the "stand-off." These are module panels that are supported slightly above finished roofing material (e.g., on "sleepers") and are usually parallel to the roof plane upon which they are mounted. Most panels tend to be rectangular in shape, ranging in size from 12 to 24 in. wide and from 24 to 72 in. long.

"Residential experiment stations" have been established in the Northeast, Southwest, and shortly will be in the Southeast. The direction of the centers is by MIT-Lincoln Laboratories, for DOE. Each station has been or will be running competitive solicitations for "Solar Photovoltaic Residential Projects."

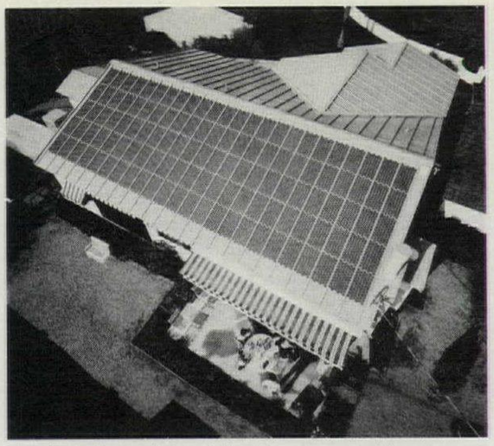
**Residential projects**

In the earliest residential PV studies, combined photovoltaic thermal collectors were assumed. Photovoltaic arrays run most effectively within narrow temperature bands. Waste heat rejected by them would be taken off their collector backplates and used to partially heat the house and its hot water.

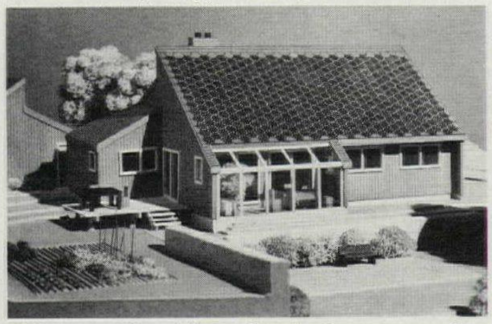
**Westinghouse:** One 1975 study, "Conceptual Design and Systems Analysis of Photovoltaic Power Systems," by Westinghouse with Burt Hill Associates for ERDA, assumed combined PV thermal roof-integrated collectors with backup from electric and thermal energy supplied by local utilities, but no sell-back to them. A typical design for Santa Maria is shown here. Favorable cost/benefit ratios were shown to be achieved in most areas of the country by 1990.

**General Electric:** General Electric conducted a parallel study in which two basic house configurations were assumed: a two-story northern house and a more spread out one-story southern house. This study concluded that all-electric, PV-only collectors, without storage (e.g., grid-connected), promised as good economic viability as any other solar options and combinations studied, or better, in all regions of the country. This required, however, that utilities accept excess PV output at sell-back rates in the range of 40 to 50 percent of the electricity buy rate. Gordon Tully of MASSDESIGN executed a "conceptual design for residential photovoltaic systems in four regions" working for GE Space Division.

**ARCO Solar:** In parallel with those programs yet somewhat outside (although still under the supervision of MIT-Lincoln Labs), two grid-connected installations have recently been completed. The first, and the first installation of the ARCO Solar batten-and-seam solar photovoltaic roof, is on the John Long "Fiesta" model home in Phoenix, Az. This installation was made on an *existing house.*

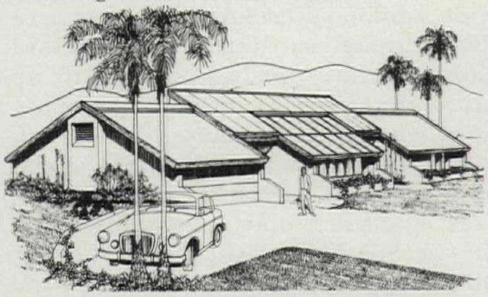


*Aerial view of the John Long model home.*

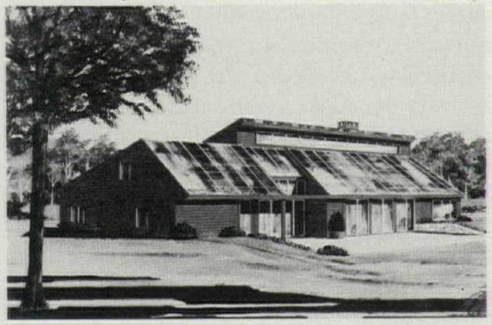


Sam Sweezy

*PV-powered residence for the Boston area by Cambridge architects* MASSDESIGN.



*PV-powered residence for the Santa Maria area proposed by Burt Hill Kosar Rittelman Associates of Butler, Pa.*



*The rendering above represents a house in Carlisle, Ma, which is PV powered and now nearly complete. It is designed by Solar Design Associates of Lincoln, Ma.*

The Long house, while not lived in full-time, has a continuous stream of visitors since it is one of a collection of houses which serve as the single model home complex for the many concurrent developments in the Valley of the Sun by John Long, Arizona's largest home-builder. Thus, the system serves much of both the diversified load due to lighting and power and the dominant load in that area of the country (full central air conditioning) on a 24-hour per day basis.

**MIT:** Another house of equal significance is the "Carlisle House" in Carlisle, Ma. Designed by Steve Strong of Solar Design Associates, Lincoln, Ma, for MIT-Lincoln Labs. This house is designed to be lived in and will be speculatively sold on the open market. It incorporates an integral 7.5 kW peak solar array, double-wall construction, triple glazing, high-mass internal elements, and other integrated passive and energy-conserving design techniques. Its integral array also includes glazed panels for solar access to south-facing sunspaces below. Solar Design's integrated roof system collector array is designed for south-facing surfaces only, with those to the north, east, and west being of any other conventional roofing material. The house incorporates a solar-thermal domestic hot water system and a dual-compressor, high efficiency air-to-air heat pump. Just as the John Long house provided instant information on the first direct-applied solar PV array to go into service, the Carlisle House should provide equally useful experience with the first roof-integral solar PV array.

**A viable alternative:** With the advent of building primarily residential applications, the limited amount of south-facing roof plane available in turn presents very real issues of size-limited capability. Issues of cell packing density and concentration or other forms of enhancement came into play, in order to maximize array output. Ever more efficient houses would also seem to be in order, to drive down the load placed *upon* that array. Even assuming that 100 percent buyback ratios from the local utility mean a maximum amount of roof coverage is in order, the larger the excess being fed back into the grid, the quicker the payback.

To the extent that single-family development remains possible in this country, photovoltaics in combination with solar thermal and alternative water supply and solid/liquid waste disposal systems begin to make the long sought-after but largely chimeric "autonomous house" a real entity. Stand-alone housing can have a most significant impact in remote areas of the world's developing nations as an alternative to the phenomenal investment required to create, or even extend, a comprehensive utility grid. It has equally exciting potential for emergency housing in the world's disaster belt, especially if combined with self-help participation to ensure that indigenous forms rather than prefabricated trailer modules will result. Finally, stand-alone housing of the type described just might become viable here in the U.S., even within the grid. □

# Thermal envelope

Julie Flicker

**While initially mired in controversy, the thermal envelope concept of building has emerged as a viable, economic, and comfortable solution to energy conservation.**

In recent decades, designers have been developing a thermal envelope system with superior capabilities. The earliest completely integrated thermal envelope system seems to be that invented by Frazer W. Gay of Metuchen, NJ. The patent he received in 1951 (number 2,559,869) describes a building "so constructed that its habitable interior is surrounded by spaced inner and outer insulating walls which define an envelope space through which air may be circulated, said envelope space including portions contiguous to the earth so that heat may be transmitted to and stored in adjacent earth for return to the circulating air in extremely cold weather." The earth's steady mean temperature below the frost line of 50 F is supplemented by extensive glazing on the south exterior wall through which "solar energy may . . . be transferred to the air circulating in said envelope, and thus transferred to the earth for storage therein." Gay's system incorporates fans for circulating the envelope air and an overhang to reduce summer insolation.

Gay's concept appears to have received little attention during the pre-oil-embargo years, until it was reinvented around 1974. At that time, Malcolm Lillywhite of Solstice Designs, Inc., in Evergreen, Co, and Lee Porter Butler of Ekose'a in San Francisco, Ca, developed thermal envelope systems independently that had solar greenhouses as the south plenums and that relied on natural gravity convection for air circulation. By 1976, Lillywhite had completed a thermal envelope house in Falcon Park, Co (to which he later added a fan for supplementary envelope air movement), and Butler had built one in Jackson, Tn. The envelope house that sparked the greatest explosion of interest as the subject of inordinate publicity and imitation, and often mistakenly considered the first one built, was the Tom Smith House, completed in 1977 in Lake Tahoe, Ca.

**Performance, true or false:** In the past few years, several hundred envelope buildings have been designed or constructed. Excessive criticism and praise have characterized the controversial system's reception by designers, builders, researchers, and the media.

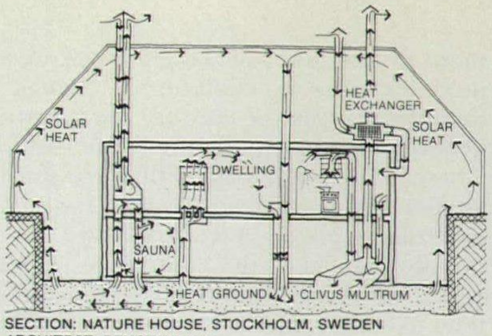
The early envelope houses were to a great extent empirically built, and monitoring has shown evidence that their performances differ from what their designers had anticipated. Natural convective movement of envelope air, upon which many of the buildings have relied for space heating and cooling, has been found to be disappointingly small. During heating seasons, research demonstrates overheating often occurs in the attic and in the top of the solarium, and minimal heat moves into storage beneath the house.

During cooling seasons, hot air was expected to rise in the solarium and in the north plenum, and be allowed to escape through an opened vent at the top of the building. The vent created a siphoning or chimney effect that would suck air in from an exterior air intake and through the crawl space, where it would be cooled by the earth and any thermal mass present. The exterior air intake has been placed often at a distance from the building in order to provide additional cooling to the air as it flows through earth tubes into the crawl space, before the air is drawn up through the north and south plenums.

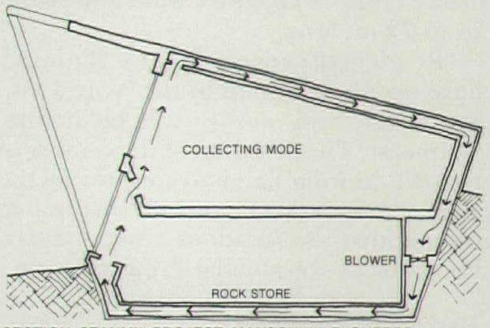
When the performance of the earth cooling tube installation of the Ekose'a-designed Stokes House in Canton, Ga, was monitored under the sponsorship of the Southern Solar Energy Center, the report concluded that "the greenhouse is incapable of inducing adequate flow, or in some cases any flow, through the cooling tubes." Despite their preference for a completely natural system, the Stokeses have been obliged to accelerate air movement with a fan because "temperatures in the upper greenhouse have risen above 100 F when the fan is not used."

Designers had also hoped to have reversal of envelope air flow at night, as air cooling in the solarium sank and heat acquired during the day rose from the crawl space into the north plenum. This nighttime flow reversal, however, has mostly failed to take place. Whether or not the failure can be corrected—which appears unlikely—a preferable solution seems to be to seal the south glazing with insulating shades and to allow the air to stratify, rather than to throw Btu's out the windows of the solarium just for the sake of natural nighttime convection.

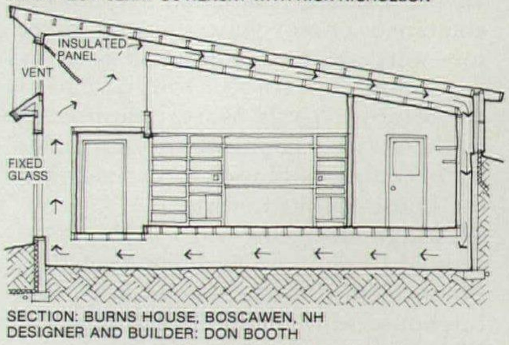
Purists still hope to create effective natural convective loops through more careful attention to such details as the amount and placement of south glazing. Don Booth of Community Builders in Canterbury, NH, remains optimistic that decreased glazing in the upper part of the south plenum and emphasis on the lower glazing will enhance gravity convective flow because, says Booth,



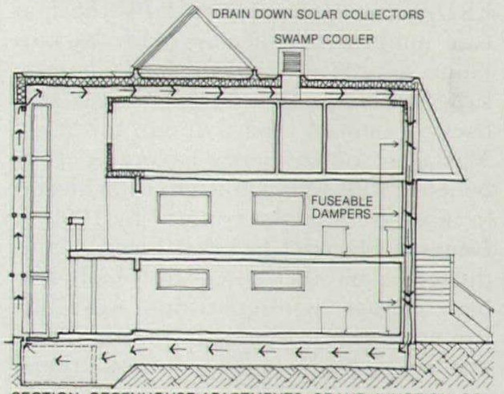
SECTION: NATURE HOUSE, STOCKHOLM, SWEDEN
ARCHITECT: BENGT WARNE



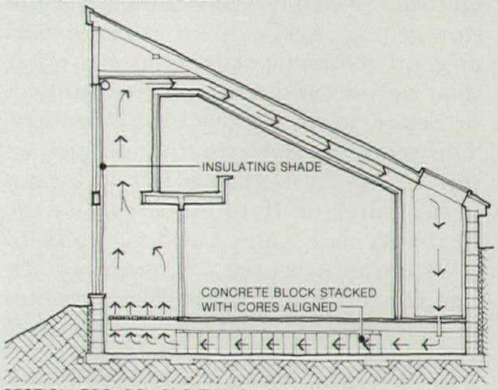
SECTION: STANMIL PROJECT, MANSONVILLE, QUEBEC
ARCHITECT: JERRY COVIENSKY WITH NICK NICHOLSON



SECTION: BURNS HOUSE, BOSCAWEN, NH
DESIGNER AND BUILDER: DON BOOTH



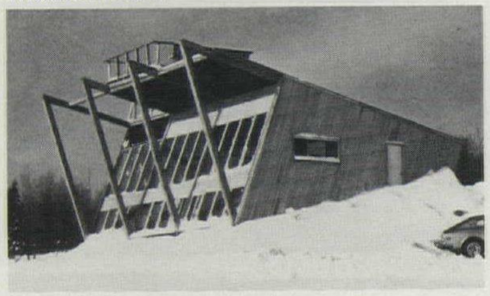
SECTION: GREENHOUSE APARTMENTS, GRAND JUNCTION, CO.
ARCHITECT: MALCOLM LILLYWHITE



SECTION: ECOLOGY SHELTER, SIMSBURY, CT.
ARCHITECT: RICHARD A. SHOPE

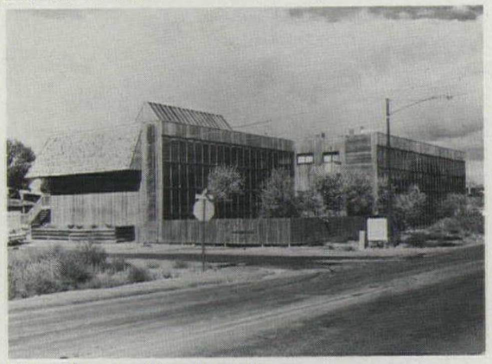
*The built examples of the thermal envelope concept shown here show both an international acceptance and varied use of the idea.*

*Nature House.*

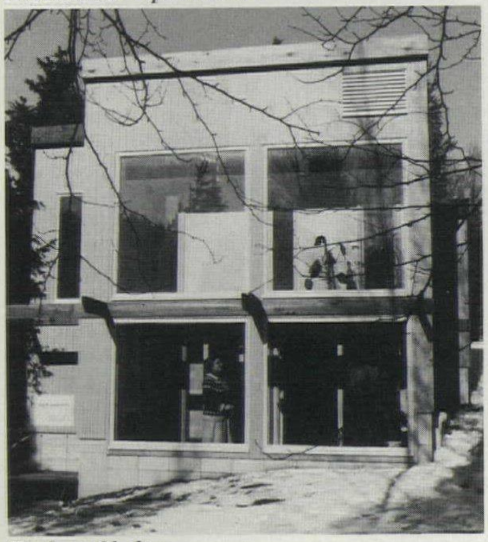


*Stanmil Project.*

*Burns House.*



*Greenhouse Apartments.*



*Ecology Shelter.*

"solar heat applied low in a greenhouse or sunspace will give more lift to air than will the same heat applied high."

Hank Huber, whose own thermal envelope house in New Ipswich, NH, was the first built in New England, says he has equipped his house for forced envelope air circulation this year. He reasons, "My approach is that there is a problem to be solved, and to me a simple fan and thermostat is appropriate for a home." The cheapness and effectiveness of fans and blowers have earned them almost universal approval.

**Answers to questions:** A great deal of responsible research intended to answer the questions that still remain about the thermal envelope system is currently underway at such institutions as Brookhaven National Laboratory in Upton, NY, Solar Energy Research Institute in Golden, Co, and Southern Solar Energy Center in Atlanta, Ga. Various universities and individuals are also experimenting with the system and monitoring existing envelope structures. For example, an envelope building in Simsbury, Ct, designed by Richard Shope and Allan Shope is functioning not only as Shope Architects' office annex, but also as a testing laboratory equipped to measure air-flow rates, relative humidity, and temperatures throughout the structure. The building is designed to accommodate investigation of such variables as types and placements of thermal storage materials and the relative efficiency of natural convection, vs. fan-forced air movement, vs. the two operating ensemble.

Innovative techniques for improving envelope designs are constantly being sought. The Stanmil Project in Mansonville, Québec, designed by Nick Nicholson and Jerry Coviensky, utilizes large, built-up trusses as the main supporting structure and as a design element throughout the house. Among other functions, Nicholson explains, this makes it possible for a house with extensive glazing on the south side but little north-facing glass to enjoy the benefits of windows in all the living areas, "as spaces are allowed to flow from one another, being delineated only by structural supports."

**Advantages and disadvantages:** One suspected disadvantage of the thermal envelope system is the construction cost for building a "house within a house." However, this expression misrepresents the system; the north and south walls are the only essential additions, since the attic and crawl space constitute the remainder of the envelope. Many designers defray the surplus cost by incorporating closets, stairwells, entries, etc. into the north and south plenums.

Certain advantages of the thermal envelope system are unquantifiable. Envelope structures offer greater comfort than conventional buildings because of the reduction of drafts and cold surfaces. The natural humidity levels found in envelope buildings provide a more healthful environment than the dried air created by conventional heating systems. Hank Huber explains: "Access to ground moisture in combination with active plant growth helps maintain relative humidity at adequate levels year round. In our house we have typically 40–50 percent relative humidity through the winter." The envelope system also allows for greater amounts of glazing than most energy-efficient designs.

The thermal envelope system has already proven itself to be cost-effective in supplying over 80 percent of the building's heating and cooling needs. Some of its proponents anticipate that future refinements will bring not only 100 percent efficiency, but even the production of surplus energy. Modifications to the system are enhancing its applicability as well. With the greater air-flow velocities made possible by utilization of fans, the wide south plenum has become dispensable, and the solarium can be eliminated if it is not desired. Multistory envelope buildings for commercial use are becoming increasingly practical, and some are already in the planning stages.

The elegance of the thermal envelope concept stems from its simplicity. The system requires no technologically sophisticated devices that baffle builders and break down. It involves conventional building materials and techniques, and the design is forgiving. The building is naturally superinsulated. Solar inventor and engineer Norman B. Saunders has helped to instrument many of the monitored houses. He explains, "The double envelope house works after a fashion almost no matter what you do with the principle."

The temperatures found in the technology employed in envelope structures are more consistent and moderate than those inherent in most conventional systems. So long as envelope air flows (which fans insure), there should be no drastic daytime highs or nighttime lows. Solar heat is transferred to and from a large area of geothermal mass. As thermal storage systems improve and materials with greater heat capacities are developed, the time lag will grow. Solar energy may eventually become storable not only for a period of a few days, but even from summer to winter. The principle will then grow more and more relevant to buildings of all types and sizes. Thermal envelope systems with maximum efficiency, acceptability, and applicability are evolving rapidly, and they appear to be bound to play a significant role in our energy future. □

# THE 7TH INTERNATIONAL MISAWA HOMES PREFABRICATED HOUSING DESIGN COMPETITION '82

## "HOUSE FOR LONGER LIFE"

**Sponsored by: Misawa Homes Institute of Research & Development**
**With the cooperation of The Building Centre of Japan**

"To live sound and long," has not only been a hope that people have sought unceasingly, but it is also a common goal in our everyday life styles and behavior. How should we grasp this idea and realize this goal toward which our ancestors have also devoted themselves since many years ago?

Ways and means of improving health and realizing a longer life have been vigorously developed through the scientific innovations of medical and engineering technologies, as well as through increased social awareness concerning mental health and activities related to leisure time and household work. All generations have benefited by such advancement, however, the environments in and around our residential space and not sufficiently reflecting the results of technological development. There still remains a lot of room concerning our daily life for further improvement and the development of technical devices.

In search of housing and living patterns necessary to realize "a sound and longer life," suggestions related to (1) household components, equipment, tools, machinery, furniture, and other elements to be included in the housing environment for the purpose of improving the value of the living space or house; (2) how these elements are combined and used in the dwelling space in order to obtain the utmost results; and (3) how the above housing plans (or parts thereof) and housing environments may be devised in order to improve the capacities and functions of the houses, are now being solicited worldwide according to the following requirements.

**I. REQUIREMENTS**

Settings for suggested plans may concern indoors or outdoors or both, while resident(s) may be an individual or a group (including families). However, the purpose, method, and anticipated effects from the use of any settings and residents must be clarified within the suggested plan. The applicant must explain and clarify his/her suggested settings and elements. In addition, the applicant is required to clarify the interactive relationship between man and his dwelling space by creating narratives or diagrammatical descriptions which will explain how these settings and elements influence human life, behavior, and health.

**SUBJECT**

1) Means and household components, equipment, tools, machinery, furniture, or other elements (called elements hereinafter). Furthermore, "household components" mentioned here include the living space as well as those housing parts which are sold (as finished products) to be utilized for improving children's development, health conditions, or physical constitution and capacity, and the living space or a housing structure equipped with such elements.
2) Means and elements to be utilized for a couple's mental and/or physical invigoration, maintenance and/or improvement of health conditions and physical constitution/capacity, and living space or a housing structure equipped with such elements.
3) Means and elements to be used for the prevention of adult diseases and creation of healthy and desirable environments for the middle- and old-aged, and living space or a housing structure equipped with such elements.
4) Combination of two or more of the above items (1 through 3), assuming a model family will use them, and clarifying related age brackets and life patterns.
5) Connection with the living environments designed for further improvements of the above items.

All of these materials should be on three sheets of JIS A2 (595mm x 420mm) or JIS A1 (840mm x 595mm) paper on one side.

**II. SUBMITTED TO:**

Misawa Homes Institute of Research & Development, "Design Competition for Prefabricated Houses '82", 2-4-5, Takaido Higashi, Suginami-ku, Tokyo 168 Tel.: (03) 332-5111

**III. ENTRY DEADLINE**

January 10, 1982.

**IV. ANNOUNCEMENT**

February 1982.

**AWARDS**

| | | |
|---|---|---|
| First Prize | ¥1.5 million | 1 person |
| Second Prize | ¥700 thousand | 2 persons |
| Third Prize | ¥300 thousand | 2 persons |
| Honorable Mentions | ¥150 thousand | 4 persons |
| Best Idea Award | A total of ¥400 thousand will be divided among a number of persons according to the results. | |

**JURY OF COMPETITION**

Chief Judge:

- Kiyoshi Seike (Professor of Tokyo National University of Fine Arts and Music, The Japanese Representative of Japan Center for Environmental Planning)

Judges: (in alphabetical order)

- Gregory Clark (Professor of Sophia University, International Commentator, M.A. Oxford)
- Kazuo Hayakawa (Professor of Kobe University, Guest Professor at University of London)
- Akira Koizumi (Professor of University of Tokyo)
- Yoshiyuki Mizukoshi (Director of the Building Centre of Japan, Professional Member of International Conference of Building Officials)
- Eizaburo Nishibori (Director of Misawa Homes Institute of Research and Development, Member of The Professors World Peace Academy)
- Tsunemasa Terazaki (Professor of Nihon University and the University of Hawaii)
- Sumio Yoshida (Professor of Osaka Medical College, Executive Director of Japan WHO Association)

In cooperation with the Building Centre of Japan.

The detailed announcement of competition will be sent to applicants upon request provided you send us a printed or typewritten piece of paper or seal with your name and address on it to paste on the return envelope.

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# Solar access rights

Norman Coplan

**As the use of sunlight as a source of energy grows, ways must be found to prevent denial of solar access by one property owner to another.**

The development of solar energy as an alternative source of energy may be dependent in part upon the resolution of legal problems which relate to solar access. Common law legal doctrine as applied in the United States relating to implied easements of light and air, while generally guaranteeing the right to solar access in connection with light that enters onto one's property vertically, provides little protection for solar access in connection with light that enters through another's property. If solar access can freely be denied to one property owner through the manner in which another owner utilizes his property, the impediment to the development of solar energy as an alternative source of energy is apparent.

In an article entitled "Right to Light" (David Morton) appearing in the April 1979 issue of *Progressive Architecture,* questions were raised whether buildings could be designed so that each property owner "respects the accessibility of others to solar light" and whether future design could insure that "no property owner be victim or victimizer" in this respect. The author pointed out that great benefit can be derived from an understanding of the principles of location and form, which are the keys to solar design methodology. Although the orientation of future design to assure solar access will be a significant contribution to development of the use of solar energy as an alternative source, the problem will nevertheless remain of how solar access may be promoted or guaranteed, under our prevailing legal framework, in connection with existing structures as well as in respect to future development.

There are three general legal areas which might be utilized to protect solar access. They are: **1** private easements which may run with the land or which can be created through private agreement; **2** public nuisance laws; and **3** zoning laws. Each approach to the legal problem relating to solar access has its advantages and inadequacies.

A solar easement is negative in character in that it would prohibit certain use of the property of others so as to deny sun or light to the property owner holding the easement. Such an easement can be established by the owner of a large tract of land who thereafter sells or subdivides the same as such easement runs with the land. Although in general the common law does not recognize implied easements, courts in the United States will uphold express easements of light and air created by an express grant or reservation.

Several states have enacted statutes which relate to solar easements. These statutes authorize the creation of such an easement, provide for the recording of the same, and set forth indicia as to what must be contained in such an easement. Some of the statutes expressly require that a solar easement restrict the use of structures and objects that would impair or obstruct the passage of sunlight through the easement.

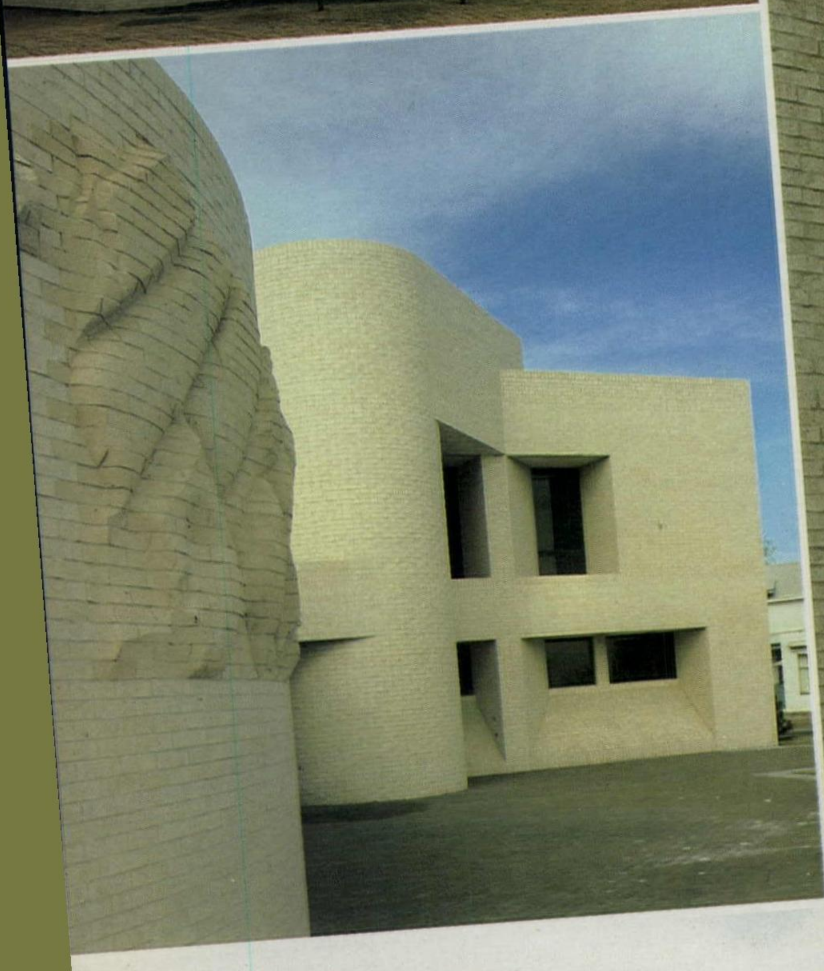
Easements as an answer to the legal problem of solar access are not by far the complete solution to the problem. Most states do not as yet have solar easement statutes; in some of the states which have adopted solar easement laws, such statutes have provided either too much or too little in respect to the contents to be contained in solar easements; an easement may not be adequately drawn so as to insure solar access or protection against shadow; and most significantly of all, property which does not carry an express easement of light or sun cannot avail itself of this approach.

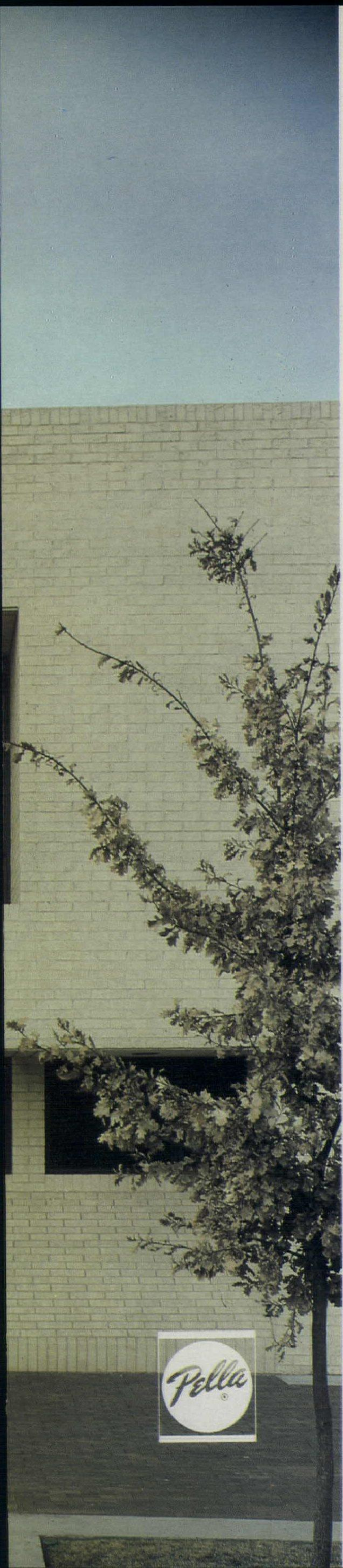
Another possibility to aid in the resolution of the problem of solar access is utilization of public nuisance laws to prevent one property owner from blocking sunlight to another. Existing public nuisance laws that have been adopted under the "police powers" of the state are directed at various public evils without any particular consideration of the problem of solar access. It is certainly questionable whether the concept of "public nuisance" can be adopted to prevent the casting of shadows caused by a structure that is erected in compliance with a building permit. On the other hand, it is possible that courts could construe certain acts of one property owner, which intentionally or otherwise prevented solar access to another, as constituting a public nuisance.

Some states have adopted a specific statute under the public nuisance doctrine directed to solar access. For example, California has adopted a law making it a public nuisance for a property owner to allow a tree or shrub to be placed, after the installation of a solar collector on adjacent property, in such a manner as to cast a shadow that would substantially interfere with the collector absorption area. This statute, however, may be inadequate in that it does not permit the adjacent property owner to bring a private suit to protect his system from shadows.

The most popular method suggested of assuring solar access is through zoning regulation. Zoning provides a flexible approach to planning and is of general application, as distinguished from easements, which are more costly, relate to individual parcels, and are consentual in nature. In developing appropriate zoning, the effect of proposed construction on solar access can be considered in the context of local use and density requirements as well as local topography and climate. Zoning is traditionally concerned with height and setback requirements, and it is in this context that the problems of solar access must be considered. The zoning process, because of its broad application and less costly consequence, contains significant advantages over other approaches to legally protect solar access. On the other hand, however, zoning cannot provide a solution in respect to those situations where a property owner, through pre-existing use, has acquired a vested interest, in essence, to block solar access to other property. ☐





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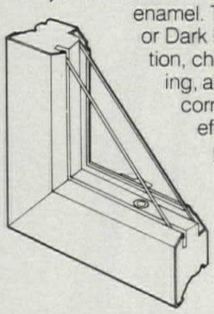
Operable Pella Clad Windows relieve the occupants of the "sealed box" feeling and are integral to the efficient operation of the building's absorption air conditioning system as well. And the Pella Clad System keeps the exterior as maintenance free as possible while still providing the warmth and beauty of real wood in the inside.

**The Pella Clad System.** Completely covering the exterior surface of doors and windows is a sturdy aluminum jacket that's finished with high-temperature baked enamel. This tough coat, in either White or Dark Brown, resists color degeneration, chipping, flaking, peeling, cracking, and a host of other plagues. The corners are carefully lap-jointed for effective weather protection and give a neat, mitered appearance. Underneath, the solid wood construction has been vacuum treated with a water and insect repellent preservative — after forming and *before* the units are assembled. Perhaps the best part of the Pella Clad System is that custom sized and shaped fixed windows are available with the same low-maintenance Cladding to match doors and operable windows.



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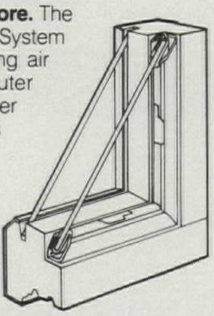

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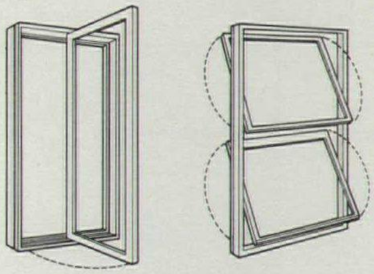

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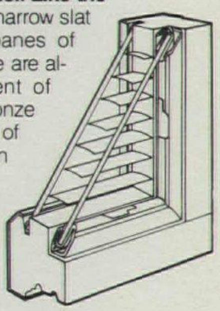

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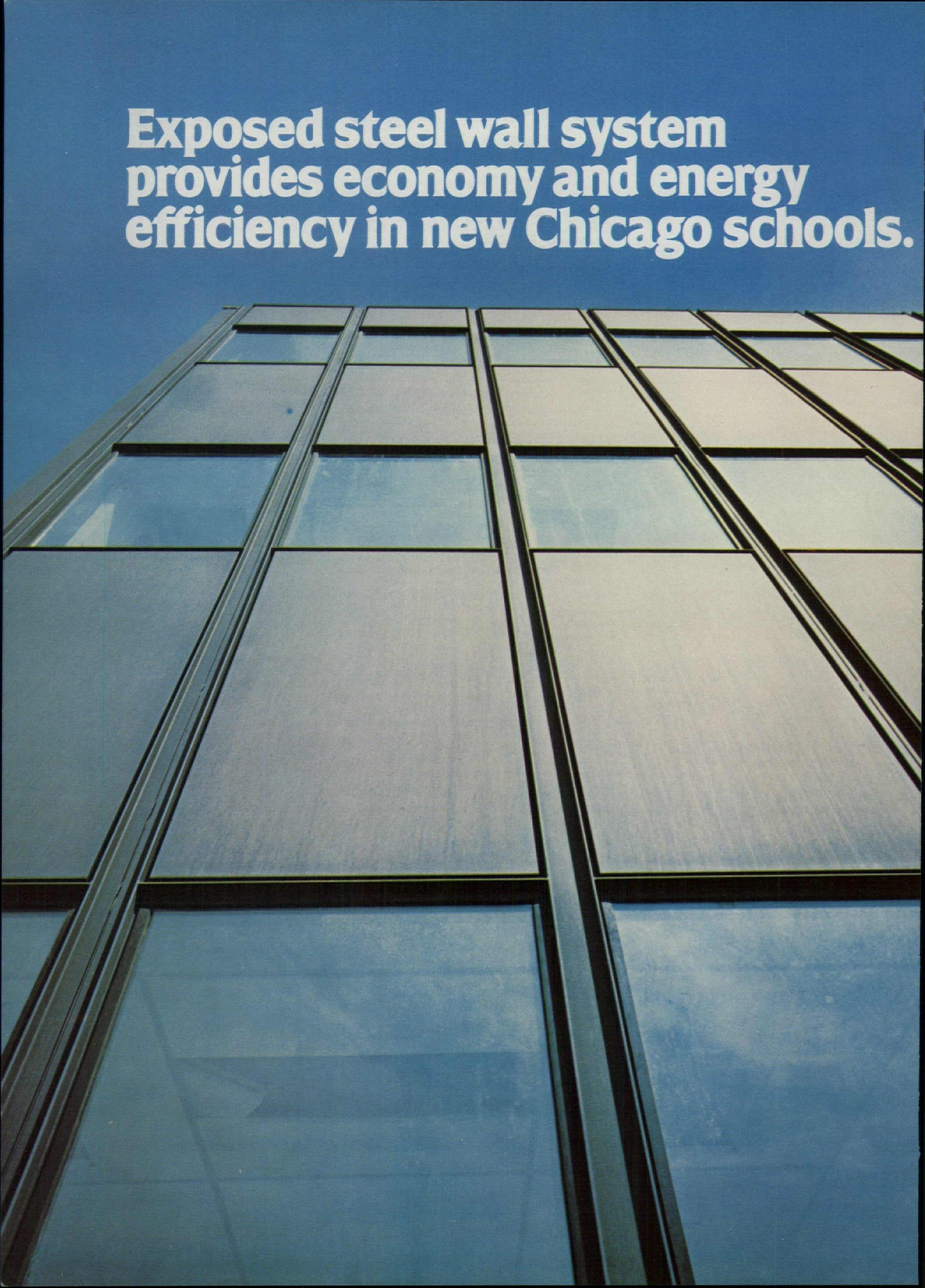
Exposed steel wall system provides economy and energy efficiency in new Chicago schools.

The new 357,000 sq. ft. Olive-Harvey College in southeast Chicago was designed to provide 8,500 full-time students with programs covering the arts, sciences and technical areas of learning.

The building's 30-foot by 30-foot bay steel framed structural system provides good quality spaces for students and faculty functions.

The building's enclosure of insulated painted ¼ in. thick carbon steel plate with 1″ thick insulated glass on a 5-foot module, was designed in 10-foot wide full height 46-foot 6-inch sections for rapid erection and early close-in of the building.

This enclosure is not only an effective barrier to the high noise levels caused by the heavy auto and truck traffic from the adjoining streets and expressway but also complies with energy conservation design requirements. Of the 59,150 square feet of exterior wall surfaces only 35% is glass.

The new Olive-Harvey College is a successful example of the design flexibility and practical economy of using structural steel on the inside and a painted, easily maintained, exposed light-weight steel skin on the outside. The Richard J. Daley College building in southwest Chicago duplicates this structure and exposed steel wall system.

To find out more about these buildings, and for information regarding the many applications for structural steel, contact a USS Construction Representative through your nearest U.S. Steel Sales Office. Or write for a copy of the USS Exposed Steel Design Data Sheet C.5/5a to United States Steel, P.O. Box 86, (C1496), Pittsburgh, PA 15230.

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TRADEMARK

*Owner*: Public Building Commission of Chicago, Chicago, Illinois

*Operator*: Board of Community College District No. 508, Chicago, Illinois

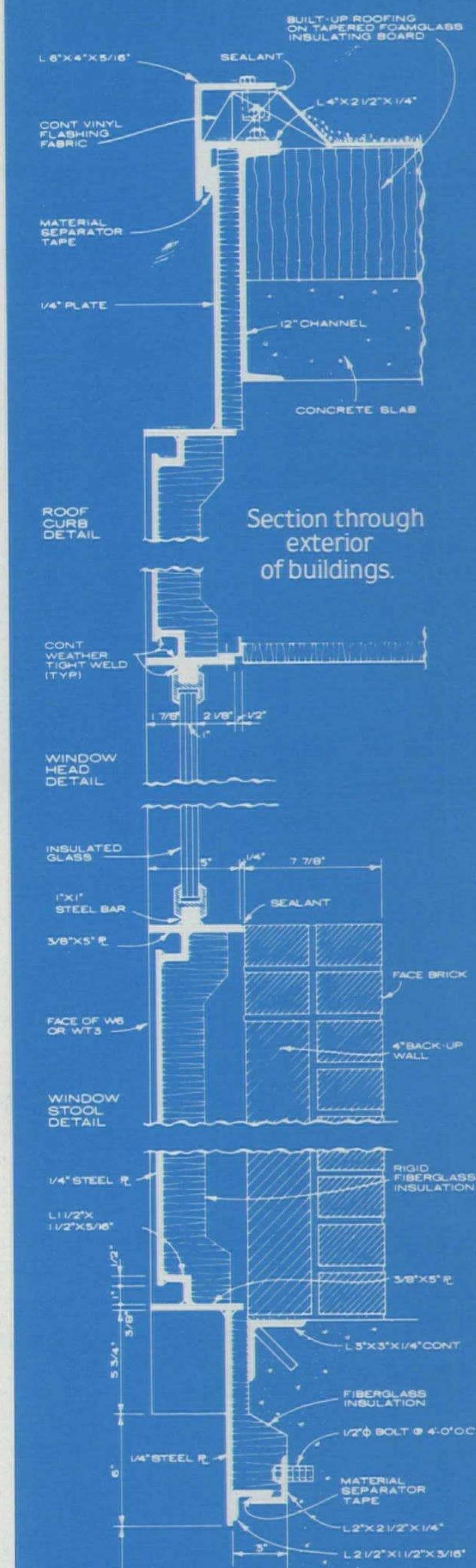
*Architect/Engineer*: Dubin, Dubin, Black & Moutoussamy, C.F. Murphy Associates—A Joint Venture—Chicago, Illinois

*Construction Manager*: DDBM Inc., Chicago, Illinois

*Curtain Wall Fabricator/Erector*: Chicago Ornamental Iron Co., Melrose Park, Illinois

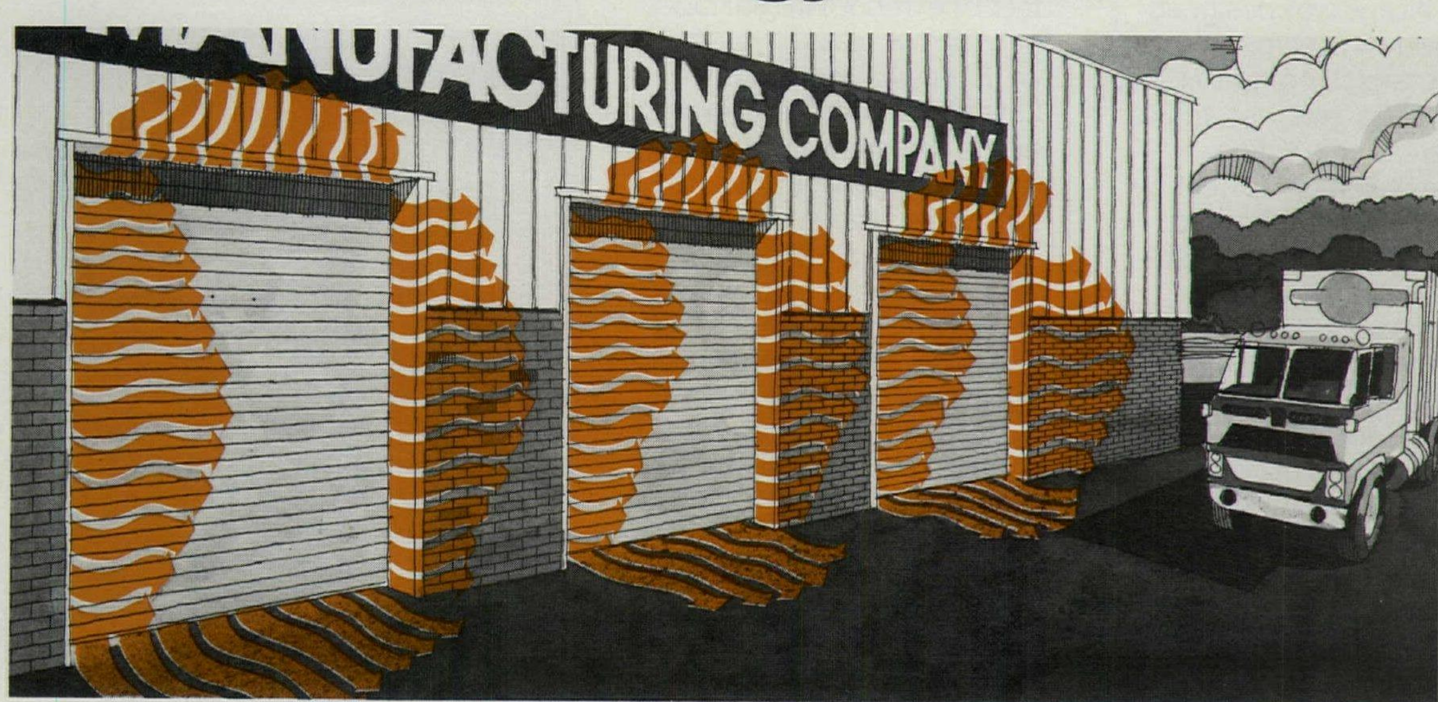
*Structural Steel Fabricator/Erector*: Wendnagel and Company, Inc., Chicago, Illinois

Circle **No. 438** on Reader Service Card

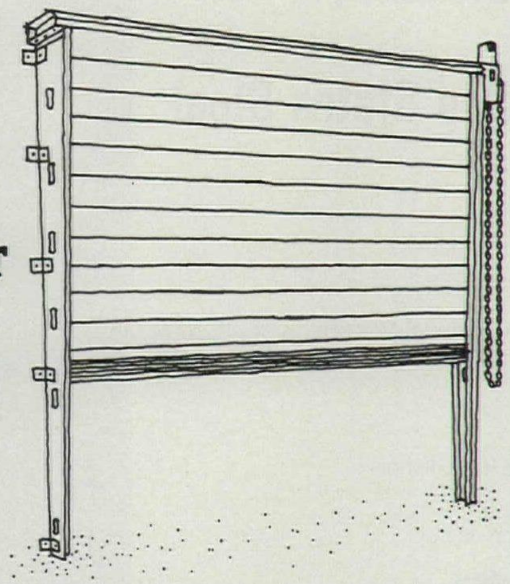


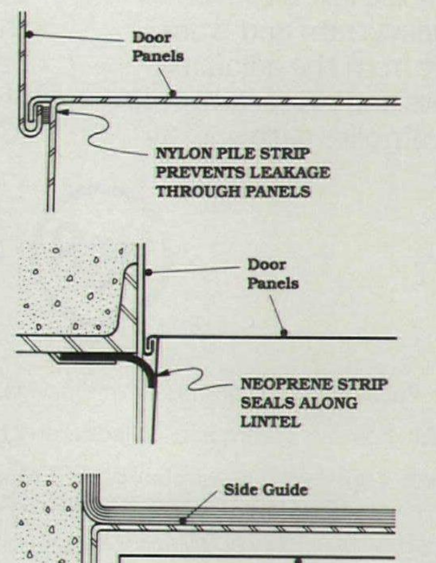

Section through exterior of buildings.

# Don't let drafty doors waste energy dollars




## The Inryco® Telescoping Door reduces air leakage for long range savings!






Air infiltration through vehicle door perimeters wastes energy—can add hundreds of dollars per door per year to a building's operating costs.

The Inryco Telescoping Door reduces such waste dramatically. Tested at 1.56psf air pressure (25mph wind) it achieved an infiltration rate of only 0.93cfm per foot of perimeter. Calculated rates for most other doors are at least three to six times higher. That translates into substantial life cycle savings.

Check the Inryco Telescoping Door before you specify. In addition to energy conservation, its unique design provides high cycle usage, offers long term maintenance savings, reduces down time and curtails noise.

For full details, see our Catalog 36-1 in Sweet's, section 8.8/In, or write for a copy: Special Products Group – Milcor Division; INRYCO, Inc.; Dept. D-4069; P.O. Box 393; Milwaukee, WI 53201.

**Inryco**
an Inland Steel company
General Offices: Melrose Park, Illinois

AO-36-2

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# Total Performance

## Sunglas® Reflective.
## Less heat. More daylight. Low cost.

Sunglas® Reflective by Ford blocks up to 65% of the sun's heat, while letting in over 40% more natural daylight than the closest competitor, at a cost that's surprisingly low.

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For more information call:
1-800-521-6346.

Ford GLASS DIVISION

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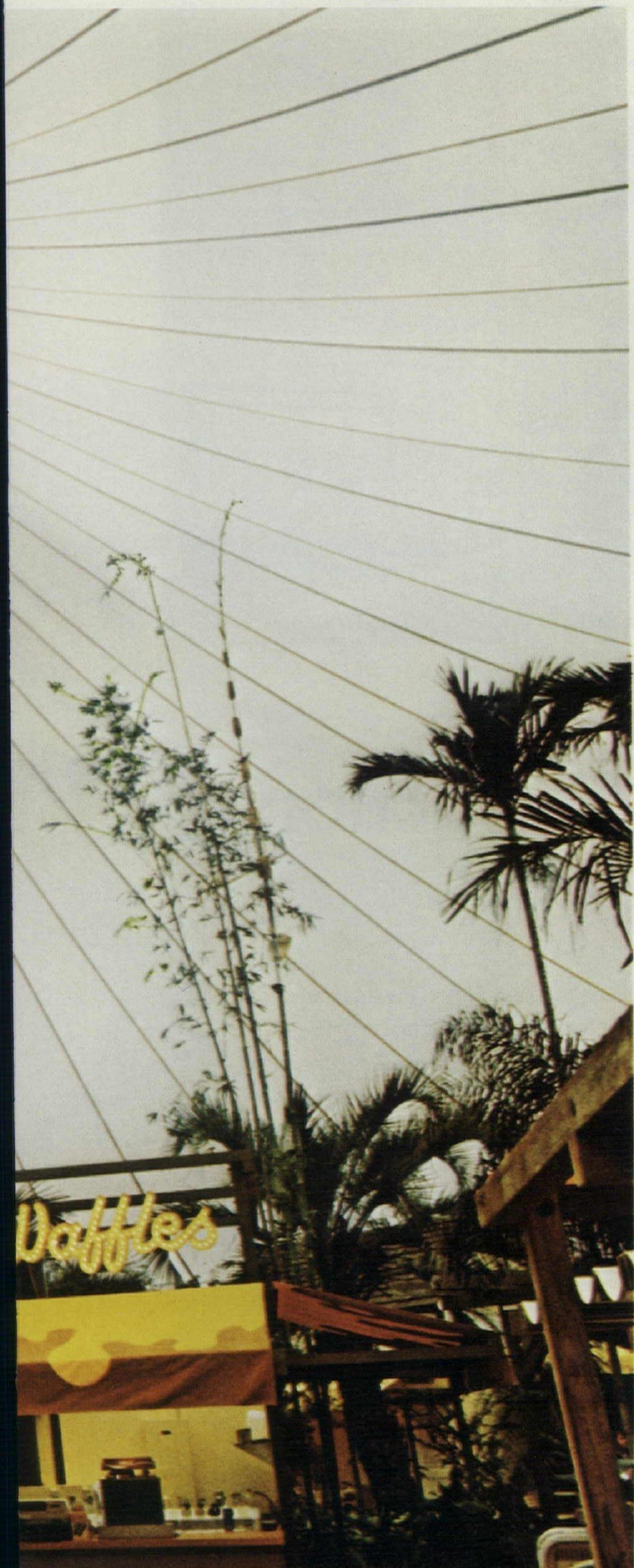
# 60,000 sq. ft.

# of daylight.




## Translucent fabric coated with TEFLON® brings the outdoors in.

"Florida Festival" in Orlando, Fla., has the highest light transmission (18%) yet developed for a roofing fabric. The permanent structure is a free-form tension canopy made of Fiberglas* fabric coated with Du Pont TEFLON fluorocarbon resin. The 60,000 sq. ft. complex is designed to provide recreation, entertainment and a bustling marketplace attraction for the millions who visit Sea World Park each year.

**Planning Indoor Ambiance** The architects and planners in charge of design and construction made innovative use of sweeping arches, wide interior spaces and the high translucency fabric to create a lush environment in which tropical plants flourish.

Visitors to "Florida Festival" are treated to a unique indoor ambiance. They experience the light of the sun, the movement of the clouds, the sound of rainfall.

**Strong and Durable** The coating of TEFLON provides outstanding long-term resistance to UV deterioration, moisture and temperature extremes. Thus TEFLON protects the glass fabric, enabling it to retain its inherent strength over time. And the non-stick properties of TEFLON help the fabric's brilliant white appearance stay that way as each rainfall washes it clean.

**Economical and Energy-Efficient** In addition to design flexibility, fabric structures offer today's building planner substantial economic advantages. They often require less time to construct than conventional buildings. And the lower roof loads permit smaller foundations and the use of less structural steel. Operating costs can be reduced, too, through lower energy consumption needed for artificial lighting. The high solar reflectivity of these fabrics minimizes heat gain, reducing air-conditioning requirements.

**Send for a Free Brochure** A 28-page brochure will tell you more about the distinct advantages of architectural fabrics coated with TEFLON. For your copy, write Du Pont Company, Room 38320-X, Wilmington, DE 19898.

*Registered trademark of Owens-Corning Fiberglas Corporation

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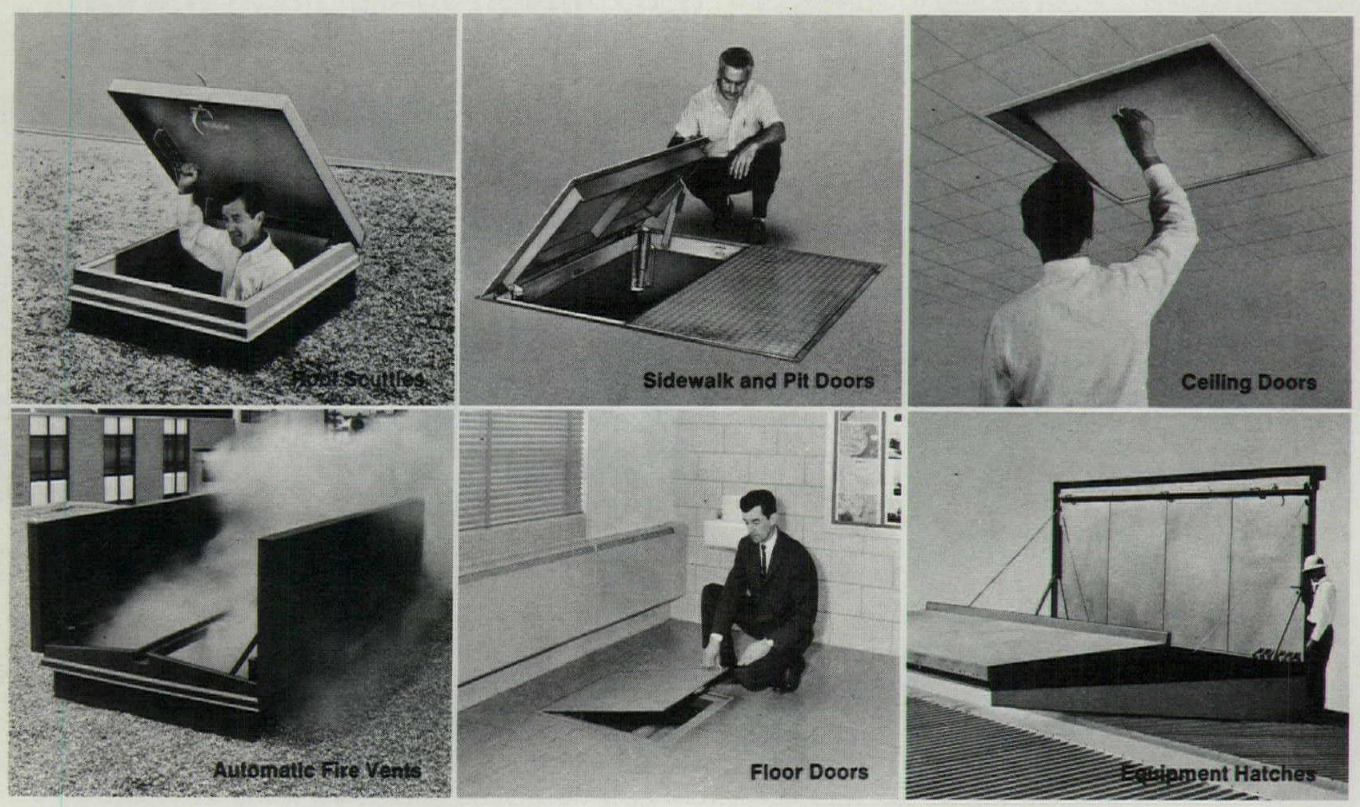
# Bilco horizontal doors.




# Your assurance of value and satisfaction for your clients.

When you specify Bilco horizontal doors or automatic fire vents you're specifying the quality that is uniquely Bilco. You're calling for the design, materials and workmanship that add up to long, trouble-free service. And you're calling for products that will operate properly. Proper operation is the most important requirement of a horizontal door or vent.

Bilco. Your assurance of value and satisfaction for your clients. Roof scuttles, automatic fire vents, sidewalk, floor and pit doors, ceiling access doors. Performance proven products by the leader in design and quality.

See our catalog in Sweet's General Building, Industrial Construction and Engineering Files, or write for a copy.

Bilco® DOORS FOR SPECIAL SERVICES

The Bilco Company, Dept. PA 41, New Haven, CT 06505

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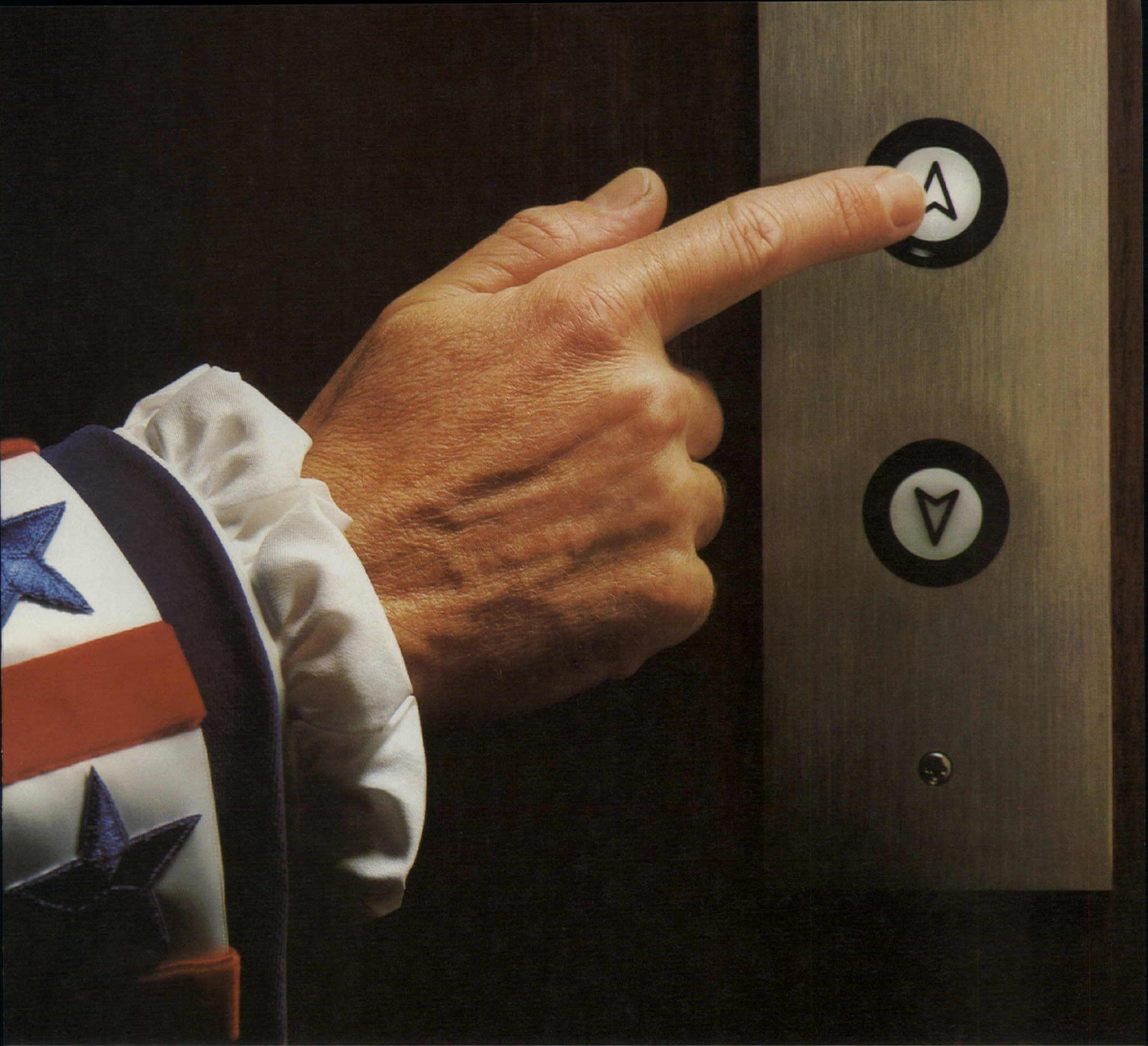

# A new reason for America to love Otis.

America has another new reason to fall in love with Otis...a mid-rise geared elevator designed to deliver top performance and top value in six money-saving ways.

We call it the MRV. The key to its remarkable performance is a new motion controller. When this solid-state A.C. direct-drive servo unit goes to work, it refers to an "ideal" motion profile and matches the elevator's acceleration and deceleration to the curve. For passengers it means less waiting time and a discernably smoother, more efficient ride.

But the control system really starts saving you money when it stops working. Because *it really stops working*. With no motor-generator set to run constantly while the elevator is not in use, the system saves energy. And that makes it perfect for apartments, hotels and offices of up to 15 floors.

That's only part of the savings. The new Otis mid-rise system shrinks machine room space by 23% and requires less installation time. It also has CABLE-SAVE™ to extend hoisting rope life, and it's designed to cost less money for maintenance.

Best of all is the affordable price your Otis representative can offer when you buy the MRV.

Call your Otis representative for all the details about America's new love affair with Otis.

**UNITED TECHNOLOGIES**
**OTIS ELEVATOR**

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**. . . For High-Rise Buildings Using Gail Brickplate Panels in Steel Stud Framing!**

This new prefab system offers "Mercedes-Benz quality at VW prices."

Basic elements are shown in the cutaway drawing. Significant advantages are obvious: • Tons of expensive design deadload and structural mass are eliminated since panels weigh 80% less than precast concrete • Significantly less expensive than glass or aluminum curtainwalls • Eliminates costly scaffolding • Provides a chase for pipes and wiring in exterior walls for faster, more economical installation • Virtually maintenance-free—no painting, sandblasting, acid-cleaning • Work proceeds regardless of bad weather since panels are assembled in an enclosed structure • Excellent insulation values, energy efficient.

For the ultimate in architecturally beautiful exterior walls . . . on a tight budget . . . the prefab Gail Brickplate system warrants your interest. Write or call for our new Technical Brochure "Prefab Brickplate Panels."

Gail

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Sales offices / warehouses in Redwood City, CA; Norcross, GA; Cedar Grove, NJ; Houston, TX. Distributors nationwide.

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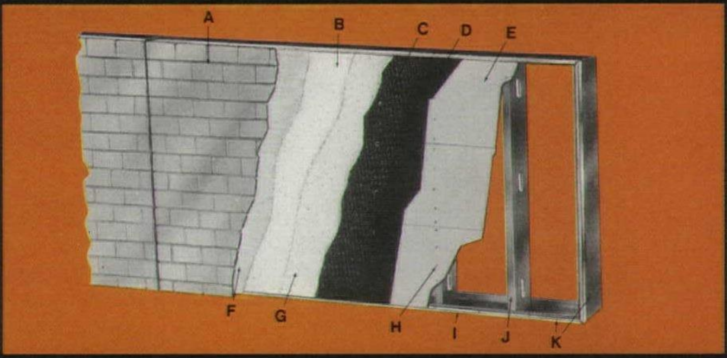
**A.** Gail Brickplate Tile (Keyback Design) **B.** ⅜" leveling coat of cement plaster with latex and chopped fiberglass strands **C.** 3.4 lb. self-furred Diamond Mesh Metal Lath (galvanized or painted where rust-resistance is required); secured to studs with self-tapping screws (washers optional) **D.** 15 pound tarred felt stapled to gypsum board **E.** Tongue and groove asphalt impregnated ½" thick gypsum plaster board (Installed horizontally, tongue up) **F.** ¼" latex modified portland cement; scored, toothed, troweled **G.** ⅜" scratch cement plaster **H.** Gypsum board screwed to steel channels **I.** 1¼ inch plaster stop, tack screwed to frame 12" on center **J.** 16 gauge steel channels, 16" to 24" on center **K.** 18 gauge welded 2" x 6" steel channel frame




# CERAMIC TILE EXTERIOR - PRE-FAB ECONOMY

**Frostproof Gail Brickplate is permanently locked into panels with keyback ridge design**

**The spectacular new Lincoln Court Building, Denver, Colorado. Architect: McOG Associates (Denver); General Contractor: Turner Construction; Tile Contractor: Ace Tile & Terrazzo (Denver).**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3. Dependability
Gas is America's reliable energy. Our vast underground supplies and potential new sources will mean gas for generations to come.
AGA American Gas Association
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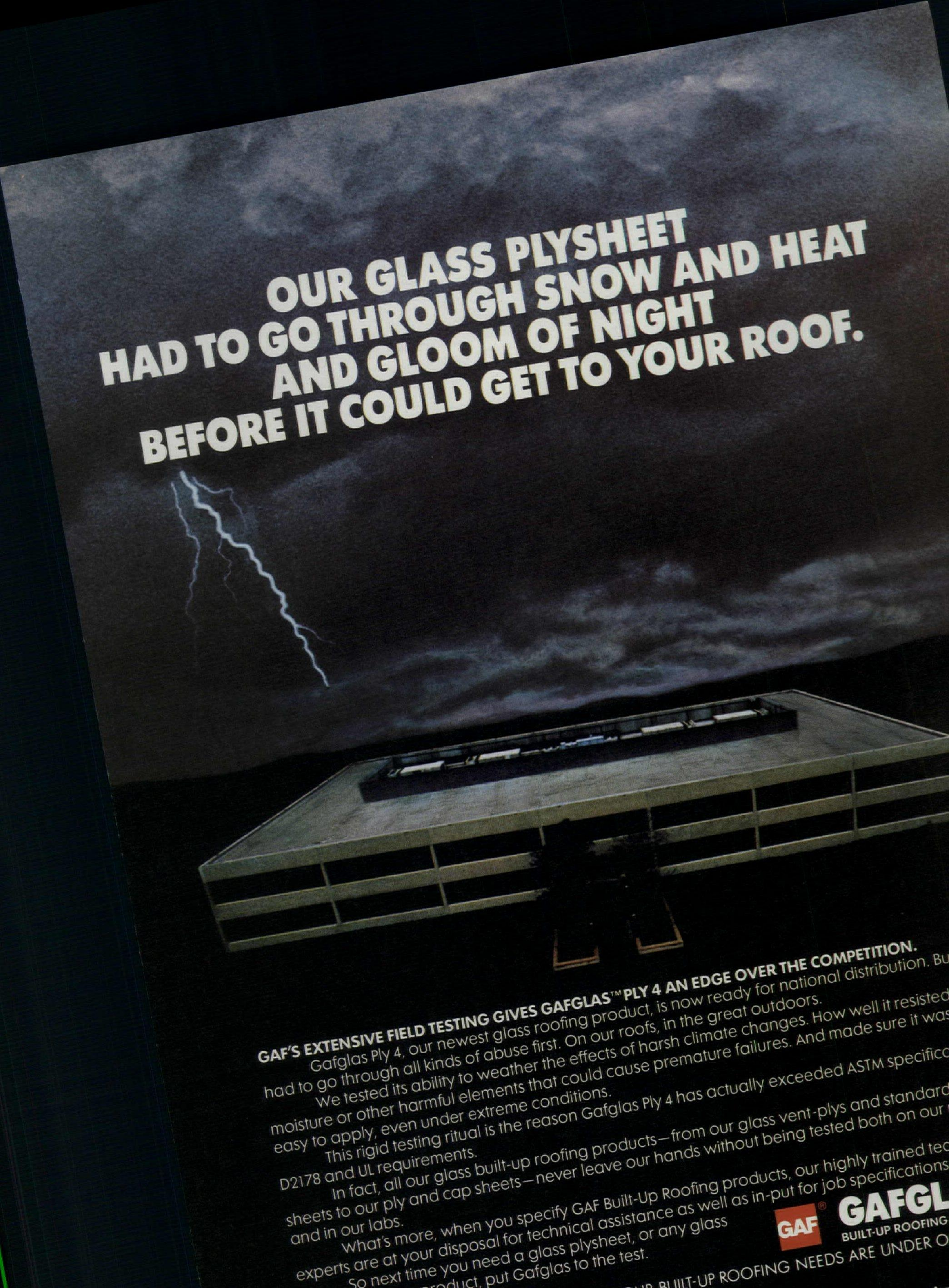
Gas: The future belongs to the efficient.



OUR GLASS PLYSHEET
HAD TO GO THROUGH SNOW AND HEAT
AND GLOOM OF NIGHT
BEFORE IT COULD GET TO YOUR ROOF.
GAF'S EXTENSIVE FIELD TESTING GIVES GAFGLAS™ PLY 4 AN EDGE OVER THE COMPETITION.
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had to go through all kinds of abuse first. On our roofs, in the great outdoors.
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D2178 and UL requirements.
In fact, all our glass built-up roofing products—from our glass vent-plys and standard
sheets to our ply and cap sheets—never leave our hands without being tested both on our
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What's more, when you specify GAF Built-Up Roofing products, our highly trained tec
experts are at your disposal for technical assistance as well as in-put for job specifications
So next time you need a glass plysheet, or any glass
product, put Gafglas to the test.
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# Saddlebrook is a great new idea for your next FLORIDA VACATION

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For a personal condominium resort vacation that offers you a whole lot more and costs you a whole lot less, contact your travel agent. Or call toll free 800/237-7519.
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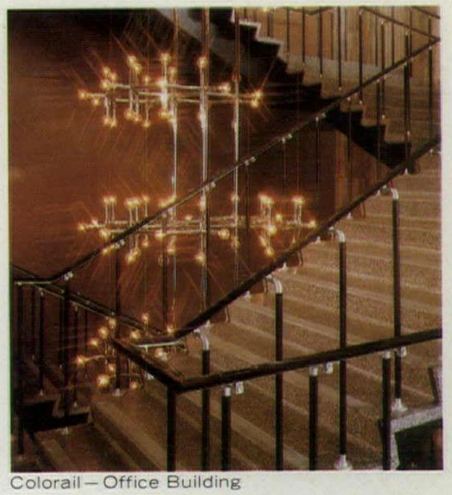
f and Tennis Resort

A Penton/IPC Subsidiary

Design flexibility and good engineering have been major objectives in the development of Blum railing systems. Components of the several systems are interchangeable to offer the designer the widest possible selection of metal, acrylic/wood and plastic components. Examples shown here illustrate the variety achieved by designers and executed through the ability of metal fabricators.

Blum's comprehensive catalogs supply data and methods for engineering design as well as clear and complete details of stock components. Thus the designer can specify Blum railings for style and appearance, for economy and structural soundness, and design railings to meet applicable codes or safety requirements.

All components are carried in warehouse stock in quantity and are available through architectural metal fabricators in all parts of the United States. Refer to Sweet's catalogs or request Catalog 13.


Colorail—Office Building

# RAILING SYSTEMS

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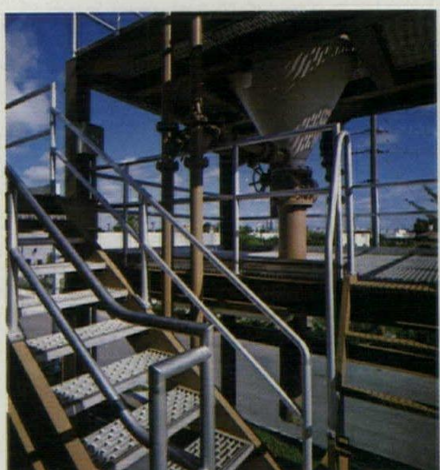
Arch: Jack R. Kinkel & Son;
Fabr: Tuttle Aluminum and Bronze Inc.


Connectorail—Wastewater Plant


Acrylic/Wood—Oneonta S & L


Ornamental—Brooks Brothers


Carlsrail—Studio


Carlstadt—Umbach & Vowells Building

Circle **No. 324** on Reader Service Card

# WHICH SOLAR GLAZING MATERIAL IS BEST?

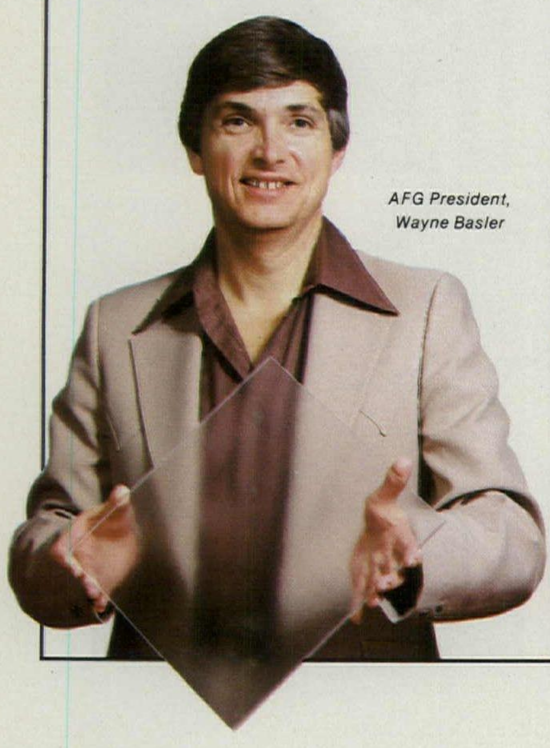
## AFG Glass. We'll tell you why.

**Why is glass better than plastic or film for solar glazing?**

Glass is produced from natural materials and is perfect for utilizing a natural source of energy. The dimensional stability and high-temperature operating performance of glass is unrivalled. Glass is the most durable, maintenance-free product for solar glazing. It resists abrasion and ultra-violet deterioration, and is nonflammable. Plastic materials are not as durable, are prone to solarization, and are likely to increase drastically in price due to their petrochemical bases. When you consider life-cycle costs, glass is your best buy.

**If glass is best, isn't it more expensive?**

No. Glass has the highest cost/benefit ratio of any glazing material. It transmits a high amount of energy for the longest period of time, minimizes heat loss from the collector, and offers the best protection from the elements.



*AFG President, Wayne Basler*

**OK. Why should I buy solar glass from AFG?**

Experience. Other companies have followed our lead in manufacturing solar glazing materials, but none of them have surpassed AFG's quality and knowledge in the field. We were the first. We're committed to remaining the best. When you buy AFG solar glass, you know you're getting a high-quality, performance-tested product. Our experience is backed by research and testing, so that we can continue to give you the most innovative quality materials for your solar needs.

At AFG, we listen to your requests and complaints. If there is a demand for a new product or a change in an old one, we will do our best to give you what you need. For example, our old Solatex glass performed well, but many of you thought that it did not offer enough obscurity to present a good appearance. Our new Solatex pattern is now on the market, offering the same benefits **and** collector concealment.

**Can you give me a choice of products for different applications?**

We are the **only** company that offers different types of glass specifically designed for solar applications. We have three solar products with different cost/efficiency levels—Sunadex, Solatex, and Clearlite—and each is designed to produce the maximum benefit.

**What about capacity—can you keep up with my needs? And how long will I have to wait?**

We're glad you asked. One of the most important criteria in the selection of a supplier is his ability to meet customer needs in a rapidly expanding market. While other companies have poured money into other fields, we've been preparing for a busy future in the solar business. As you grow, we'll grow to meet your needs. Ask our competitor about his capacity and plans for expansion, then compare it with the figures you get from your AFG representative.

You can get your AFG solar glass in four to six weeks. Our capacity assures us that we have enough for everybody.

*More questions? Circle our reader response number on the card in the back of this publication, or call AFG at 800-251-0441. We'll send you more information.*

AFG

**AFG INDUSTRIES INC.**
PO BOX 929
KINGSPORT, TN 37662

MEMBER SEIA SOLAR ENERGY INDUSTRIES ASSOCIATION

Circle **No. 306** on Reader Service Card

# ISES: Solar Rising

May 26-30
The Civic Center
Philadelphia, PA
Solar
Rising

The American Section of the International Solar Energy Society (AS/ISES) is the successor, on American soil, of an organization that began in quieter times when petroleum energy was plentiful and inexpensive. The American Section's members now number 6000 and include such organizations as industrial firms producing solar technology, educational and research institutions, agricultural and governmental agencies, and individuals ranging from scientists and engineers to interested lay persons. All share the conviction that nonrenewable fuels cannot provide satisfactory answers to world-wide energy demand. They believe that, ultimately, man must look to the original source of power, the sun, to bear an increasing share of the energy burden, and it is the mission of ISES and AS/ISES to advance the development and the public acceptance of solar power.

The American Section now has 28 regional chapters, which sponsor seminars and conferences for both consumers and technical professionals and make information available to those desiring it. The organization is divided into nine topical sections, reflecting the wide range of specialists and potential solar energy users now involved in what was once a narrow field of interest. Members can join sections on agriculture, architecture, biology and chemistry, passive systems, windpower, radiation, and socioeconomics, among others.

The American Section of the International Solar Energy Society (AS/ISES) is planning to launch America's solar age May 26–30 at Philadelphia's Civic Center with a full-scale national conference, annual meeting, and product exposition called "Solar Rising."

AS/ISES intends for this year's meeting to be a significant departure from the usual annual meeting. "It's a kickoff for the eighties," as conference chairman Fred S. Dubin says. "We're attempting to show a wide range of professionals, business people, and others, through technical and outreach programs, that solar has arrived. It's cost-effective *today*. There's no need to wait for some new breakthrough before considering solar."

The technical sessions and workshops, the traditional heart of the conference, will contain some new features: There will be much greater emphasis on hard data for making efficiency and cost comparisons of different kinds of solar power systems. Two additional symposiums on "Solar in Cities" and "The Commercialization of Solar," which will take place during technical session hours Friday and Saturday, will deal with the critical new directions solar must take to become a significant part of America's energy future. Technical sessions will take place between midmorning and 5:30 p.m. Wednesday, May 27, through Friday, May 29, and from 8:30 a.m. to 12:30 p.m. Saturday, May 30.

Some other features of the conference of special interest to design professionals will be:

"Hands-on" workshops on the design of internal-load-dominated buildings, passive solar building calculation methods, and passive and hybrid cooling systems.

A three-day "Energy Design Charrette," in which five teams will develop designs for two sites in Downtown Philadelphia with special attention to the solar heating and cooling possibilities of the sites—as well as the thermal energy potential of a nearby subway tunnel.

For those whose personal or professional interests lie in the "hardware," Solar Rising has set aside over 50,000 sq ft in the Philadelphia Convention Center. Wednesday through Friday, attendees will be able to view hundreds of displays of solar and other energy-related products and services from all over the U.S. and many foreign countries. On Saturday, exhibits will be open to the public as well. Those interested in exhibiting should contact Elliott Boardman or Barbara Zeiller, Solar Rising Show Managers, Government Institutes, Inc., P.O. Box 1096, Rockville, Md 20850. Telephone: (301) 251-9250.

"We think 'Solar Rising' will become a major milestone in solar energy use," says AS/ISES Executive Director G. Lee Salmon, "and our hope is that many people who have never attended a solar conference will rise to the occasion."

For more information, including hotel, banquet, and conference registration forms, contact Rick Ross, Solar Rising, Rm. B-2, Bennett Hall, University of Pennsylvania, Philadelphia, Pa 19104.

May 26-30
The Civic Center
Philadelphia, PA

Solar Rising

# Conference Program

## Wednesday, May 27, 1981

**Energy and the New Architecture**
**11:00–12:10**
Architectural evolution in the Twentieth Century: Past/present/future?
Energy as catalyst for a new architecture.
The organization of complexity.

**Photochemical and Thermochemical Conversion**
**11:00–12:10**
Thermal and electrochemical biomass conversion program at SERI.
Electrochemical studies with isolated reaction center of rhodopseudomonas sphaeroides.
Photochemical solar energy conversion in heterogeneous systems.

**Low Temperature Collectors 1**
**11:00–12:10**
Black selective fluids: A new way to collect solar energy.
Advanced solar collector concepts using carbon.
A comparison of performance of flat plate and parabolic trough solar collectors in several cities.
Air collector leakage characteristic effects upon thermal performance.

**Passive Design Aids 1**
**11:00–12:10**
Mass is not insulation.
CONSOL: A microcomputer based interactive design aid leading to balanced conservation-solar strategies.
More (rigorous) PEGFIX tricks.
Graphic passive design tools for annual performance: New developments.
An effective integration of design process, design tools, and passive solar systems with architecture in commercial building application.

**Performance results of Active Systems 1**
**11:00–12:10**
Solar domestic water heating test program.
Experimental evaluation of an active residential solar heating system.
Performance comparison of air and liquid solar heating systems for CSU Solar Houses II and III.
The performance of the USAF Academy retrofit solar test house—a summary report.

**Solar Education 1**
**11:00–12:10**
Solar commercialization on a community level: The AS of ISES/CRR Solar Action Program.
Energy-efficient housing rehabilitation training program.
The International Training Center: Training in alternative technology.
Educating the design professional: Energy-conscious design for commercial buildings.

**Design Planning 1**
**1:40–3:20**
Analysis of weather data for determining appropriate climate control strategies in architectural design.
Use of computerized graphics to optimize building energy use in predesign and programming.
Solar 6: A conceptual computer tool in energy-conserving design.
Energy impact analysis and building design.
Planning a solar new town.

**Biomass Around the World**
**1:40–3:20**
Biomass energy in Canada.
The Brazilian biomass program.
Biomass in Europe.
Preliminary U.S. objectives for the UN Conference of New and Renewable Sources of Energy.

**Low Temperature Collectors 2**
**1:40–3:20**
High performance open flow concrete FPC for "metal poor" Middle East.
Performance prediction of site-built building integrated solar air heaters.
Effect of heat capacity on flat plate solar energy collector performance.
An improved method for flat plate solar collector evaluation.
Flat plate solar collector with a cantilevered mirror.

**Performance Results of Active Systems 2**
**1:40–3:20**
Florida SDHW performance monitoring: Correlation with site specific parameters.
Estimation of solar space heating performance using only building utility and temperature measurements.
Large active solar demonstrations.
The total solar house description and performance.
Determining comparative performance of solar and conventional electric water heating systems: A fifty-residence, two-year monitoring project.

**Passive Cooling Techniques**
**1:40–3:20**
The testing of full-scale ventilator types to determine their effect on natural ventilation.
Forced ventilation cooling of residential buildings.
Overheating control in passive solar heated buildings.
Development of a solar regenerated desiccant dehumidifier for use in passively cooled buildings.
Using vegetation to cool small structures.

**Photovoltaic System Design**
**1:40–3:20**
Photovoltaic system development status.
A 100 kW photovoltaic power system for the Beverly High School.
Commercial application of a photovoltaic concentrator system (CAPVC).
Solar one-type hybrid conversion system.
The FSEC experimental photovoltaic residence: Operation and simulation.

**Solar Economics**
**1:40–3:20**
Cost reduction projections for active solar systems.
The effect of offpeak electrical storage on the cost of conventional and solar water heating and space heating/cooling at three U.S. locations.
Impact of residential photovoltaics on utilities.
Solar and nuclear jobs: A qualitative assessment.
Emerging technologies and utility load growth.

**Alcohol: Sources and Uses**
**3:30–5:30**
Sugar stalk crops for ethanol production in the United States: An integrated approach.
The potential for fuel ethanol production from cellulosic biomass in the United States.
Critical policy issues for methanol from wood.
Design, construction and testing of a small-scale fuel alcohol plant.
Demonstration of dissociated methanol as an automotive fuel: System performance.

**Design Planning 2**
**3:30–5:30**
Updating the "Bio Sphere": Bringing the concept to fruition.
Daylighting and thermal effects of skylights on annual building energy use.
The Passive Solar Handbook for California as a design tool.
Health impact of indoor air pollution in solar structures.
Passive solar and energy conservation: The need for coordination with the building industry.

**Evacuated Tube Collectors**
**3:30–5:30**
Design considerations in reducing optical losses due to gaps between absorbers and their reflectors.
A stationary evacuated collector tube with integrated concentration for 100 to 300C.
A parametric study of the performance of a CPC collector comparison with a flat plate collector.
Incident angle modifiers for evacuated tube collectors.
Bonding solar selective absorber foils to glass receiver tubes for use in evacuated tubular collectors: Preliminary studies.

**Active Cooling Systems**
**3:30–5:30**
Optimizing the performance of desiccant beds for solar regenerated cooling.
Improvements in absorption systems for solar air conditioning.
Testing of a solar powered cooling system using cross-cooled desiccant dehumidifiers.
Thermal and economic assessment of solar cooling systems for small commercial buildings.
Solar applications of a variable effect absorption process.

**Other Passive Topics**
**3:30–5:30**
A summary of what is known about controls for passive and hybrid residential buildings.
St. Bartolph's effect: Solar reflection from building surfaces.
Up and Down, energy and cost comparison.
Test method for the thermodynamic characterization of window treatments used as passive solar devices.
Analysis of a solar atrium for a high-rise office building.

**Utility Solar Programs**
**3:30–5:30**
A critique of solar electric utility interface models.
Electric utility value analysis of solar electric plants.
Portland General Electric Company water heater incentive program.
Bonneville Power Administration's solar domestic hot water pilot program.
Resale Housing and Energy Efficiency.

**Builders' Experience**
**10:00–1:00**
Special sessions organized by Ralph Johnson.

## Thursday, May 28, 1981

**D.O.E. Solar Overview**
**10:30–12:10**

**Thermal Energy Storage**
**10:30–12:10**
Thermal and economic comparison of sensible and latent storage for residential systems.
Ground coupling and packed bed thermal storage in a double envelope house.
A unique, low energy air-conditioning system using naturally frozen ice.
Summer cooling by means of passively grown ice.
Technical and economic evaluation of a Brayton-Rankine combined cycle solar thermal power plant.

**Industrial Process Heat**
**10:30–12:10**
Parabolic trough collector systems for thermal enhanced oil recovery.
Solar applications for process heat in New York State.
Solar thermal process heat market analysis: Size, temperature and type distributions.
The Georgia solar industrial process heat project.
Solar cogeneration for copper smelting.

**Line Focus Components and Systems**
**10:30–12:10**
A model for optimization of receiver tube design for linear parabolic troughs.
State-of-the-art solar trough collectors.
Design evolution of a large-scale parabolic trough.
Operational evaluation of a 150-kW solar thermal power plant.
Computer-aided design of a receiver using the heat energy analysis program.

**Passive Modeling 1**
**10:30–12:10**
A daily radiation model for use in the simulation of passive solar buildings.
Experimentally verified simulation of a passive modular solar house.
The design, modeling and performance of four breadbox passive solar water heaters.
A storage wall model development in the DOE-2 computer program.
Incremental cooling load determination for passive direct gain systems.

**Photovoltaic Tests and Applications**
**10:30–12:10**
Photovoltaic stand-alone systems projects.
Photovoltaic concentrator power system for solar villages in Saudi Arabia.
Experience from DOE photovoltaic grant projects.
The southwest residential experiment station: The first year.
The San Bernardino photovoltaic project.

**Solar in the City**
**10:30–12:10**
Municipal solar utilities in California: A status report.
A solar water heater program for the City of Atlanta, Georgia.
Solar design guidelines for an inner city neighborhood.
The utilization of daylighting as an urban design strategy.
A critical review of small-scale solar thermal energy systems for community use.

**Solar Heat Pumps**
**1:40–3:20**
Solar-assisted templifier heat pump system for Mercy Hospital.
Experimental evaluation of a series solar augmented heat pump system.
Experimentally verified simulation of a series augmented heat pump.
A reversible solar assisting heat pump.
Investigation of heat pump augmentation of air systems with a validated model of CSU Solar House I.

**Instrumentation and Controls**
**1:40-3:20**
Microprocessor control and data acquisition system for the commercial application of a photovoltaic concentrator system.
An example of how to build a mini-computer-based monitor system.
An inexpensive non-invasive flow meter for solar application.
Cost-effective instrumentation and control of alternative energy systems.
Passive solar instrumentation and energy display.

**Point Focus Components and Systems**
**1:40-3:20**
An overview and status of the parabolic dish program.
Point focus solar concentrator technology.
Development of the EE-1 small community solar thermal power system.
The Shenandoah solar total energy project.
Low-cost thermal transport piping networks for point-focusing parabolic dish solar thermal systems.

**Passive Modeling 2**
**1:40-3:20**
Ground coupling techniques for cooling in desert regions.
Validation of two TI-59 programs by using monitored performance.
At last, a cheap easy method for energy analysis of earth-sheltered buildings.
Passive cooling retrofit applications for residential concrete block structures in warm, humid climates.
Performance summary of Balcomb solar home.

**Residential Photovoltaic Systems**
**1:40-3:20**
Design description of a photovoltaic system for a Northeast residence.
A prototype solar photovoltaic energy system for residential applications in the Northeast.
Solar photovoltaic residence in Carlisle, Ma.
The solar electric home.
Photovoltaic residential retrofits.

**State and Local Policy, Law and Legislation**
**1:40-3:20**
Local solar legislation: A nationwide survey.
A blueprint to achieve energy-efficient housing.
Local financing options for energy conservation and solar retrofit programs.
A comprehensive consumer assurance program for California.
Code related considerations for flat plate photovoltaic arrays.

## Friday, May 29, 1981

**Design Methods for Active Systems 1**
**10:30-12:10**
Optimized design of distributed solar thermal transport systems for process heat.
Active charge/passive discharge solar systems: thermal analysis and performance comparisons.
A comparison of actual versus predicted performance of an active solar heating system using FChart 4.0.
Design processes for photovoltaic tract houses.
Accuracy of monthly average design methods for various solar climatological types.

**Central Receivers**
**10:30-12:10**
Solar repowering central molten salt receiver system and interface requirements.
Heliostat for volume production.
Advanced solar receivers high temperature steam loop experiments.
Modeling requirements for determinations of convective losses from solar receivers.
A cavity radiation model for solar central receivers.

**Solar Fuels and Chemicals**
**10:30-12:10**
Metal oxide decomposition in horizontal beam furnace.
Testing of a sodium liquid metal heat pipe receiver module at the advanced components test facility.
Development and testing of a fluidized bed solar thermal receiver.
Evaluation of candidate catalyst for an ammonia-based solar thermochemical receiver.
Radiant flash pyrolysis as a source of liquid syrups from biomass.

**Passive Heating Techniques**
**10:30-12:20**
On the controlled integration of Trombe wall and direct gain in passive solar residences.
The design and construction of three passive solar homes: A field test.
A self-insulating, passive solar heating system using heat pipes and phase change material.
Passive solar heating systems for manufactured housing.
Test cell results of various passive solar water wall configurations.

**Solar Power System Comparison (Panel Discussion)**
**1:40-3:20**

**Design Methods for Active Systems 2**
**1:40-3:20**
Optimal flow configuration in solar collector arrays.
Preparation of a radiation data base for performance prediction using a tilted flat plate collector/reflector system.
The solar threshold energy method.
Solar heating design with a performance requirement.

**Passive Design Aids 2**
**1:40-3:20**
Utilizability for south-facing vertical surfaces shaded by an overhang.
Design tools for optimizing collector-area-to-storage ratio.
The un-utilizability design procedure for collector storage walls.
Finite width overhang shading of south windows.
A simplified design method of cylinder water walls for passive solar heating.

**National Solar Mobilization**
**1:40-3:20**
The role of financing in the marketability of capital intensive solar technologies for industry.
The national solar water heater workshop.
Interstate Solar Coordination Council.
Home energy inspection as employee benefit.
Preparing for a mobilization of renewable energy resources.

**Radiation Modeling and Analysis**
**1:40-3:20**
Estimation of the monthly average diffuse radiation fraction.
A technique for determining solar insolation deficits.
Comparison of Theoretical Diffuse Shadow Band Corrections with Minute by Minute Data.
Solar Climatology Classification for Space Heating Applications.
Preliminary Validation of Models Predicting Insolation on Tilted Surfaces.

**Passive Design Aids 3**
**3:30-5:30**
Solar load ratio correlations for sun-tempered buildings.
A simple graphic method for design of fixed shades.
The thermal capacitance of passive building structures.
Response surfaces: A new design tool for passive and hybrid buildings.
Solution scheme for estimating the performance of attached sunspaces.

**Solar Ponds**
**3:50-5:30**
The 400 m² solar pond: One year of operation.
A one-dimensional model of the dynamic layer behavior in a salt gradient solar pond.
What happens when a solar pond boils?
Application of solar ponds to district heating and cooling.
An economic comparison and design report of nonconvecting solar pond for the Tennessee Valley region.

**Simulation of Active Systems**
**3:50-5:30**
The trade-off between collector area, storage volume, and building conservation in annual storage solar heating systems.
Accuracy of predicted electric backup consumption of solar hot water systems by TRNSYS.
The use of an open cycle absorption system for heating and cooling.
Various strategies concerning solar heating for a baseboard hot water heating system.
A computer simulation study of multifamily DHW recirculation systems.

**Solar Thermal Tests and Facilities**
**3:50-5:30**
Solar Thermal Test Facilities and Users Association.
Operating experience at the Central Receiver Test Facilities.
Advanced component research in the Solar Thermal Program.
Correlation of test results with a nonlinear dynamic model of a solar-powered once through boiler.
First results of steam receiver testing at JPL's Parabolic Test Site.

**Radiation Topics**
**3:50-5:30**
Design, construction, and testing of a new pyrheliometer.
A computer drive solar tracking mount.
Use of satellites: An emerging technology.
Why standard pyranometer calibrations are inappropriate for solar collector testing.
Scanning solar spectroradiometer: Facilities design, calibration, and significant data.

## Saturday, May 30, 1981

**Greenhouses**
**8:30-10:10**
A dynamic mathematical model for predicting thermal performance of a greenhouse heat storage system.
A modified degree-day procedure for estimating greenhouse heating energy requirements.
Design curves for a sub-floor soil heated solar greenhouse system.
Los-cost solar energy heating system using aquifer energy storage for greenhouses.
Performance data on multi-layer thermal curtains for greenhouses.

**Domestic Hot Water Systems 1**
**8:30-10:10**
Generalized method for solar hot water heating systems.
Performance evaluation of refrigerant-charged thermosyphon solar DHW systems.
Domestic hot water systems testing utilizing draft ASHRAE Standard 95-P, April 1980.
Variability of domestic hot water (DHW) consumption and its effect on solar water heating system design and operation.
Performance of solar water heating systems in Ithaca, NY.

**Passive Case Studies 1**
**8:30-10:10**
Detailed simulation of a large passive solar building.
The Kirkwood: Actual versus predicted energy use in super-insulated house.
Superinsulated/passive homes for a mild climate/low mass construction.
Performance of a selective surface Trombe wall in a small commercial building.
The design of a phototypical office facility for the Los Alamos Scientific Laboratory.

**Solar Marketing**
**8:30-10:10**
HUD Consumer Market Profile for the States of Florida, Maryland and Delaware.
A study of market potentials for four passive solar technologies in the residential new construction single-family market segment.
A market suitability analysis for solar IPH systems.
Impacts of the residential conservation service program on residential solar development.
Energy spots on television: an empirical evaluation.

**Other Agricultural Applications**
**10:30-12:20**
Solar drying of crops in Illinois.
Sugar stalk crops for ethanol production in the United States: An integrated approach.
Farmstead production of fuel alcohol.
A commercial scale solar food dryer.
Wind energy use for solar drying of fruits and vegetables.

**Domestic Hot Water Systems 2**
**10:40-12:20**
Photovoltaic-powered circular pump.
Cost effectiveness of solar DHW systems: Results of side-by-side tests of active and passive systems.
One year of monitoring results for eight residential solar water heaters in the TVA Memphis Project.
Assessment of commercial readiness of solar water heating.
Florida SDHW site inspection experience.

**Passive Case Studies 2**
**10:40-12:20**
Earth-sheltered housing: A summary report.
An effective integration of design process, design tools, and passive solar systems with architecture in commercial building application.
A marketable passive solar house.
Residential design: Maximizing the use of Colorado's tax credits.
Energy-efficient active/passive college chemistry laboratory.

**Solar Education 2**
**10:40-12:20**
Solar energy education: Where do we stand?
Solar energy technician curriculum: Report on Phase II activities.
A university course for the solar transition.
Alternative energy activities for young children.
Solar in the secondary school curriculum.

**Wind Energy Conversion Systems**
**10:40-12:20**
WECS commercialization within the Department of Defense.
The Wisconsin anemometer loan program.
Consumer evaluation of small wind energy systems.
A short-term parallel anemometric approach to wind mill siting.
Designing for safety in wind systems for homes.

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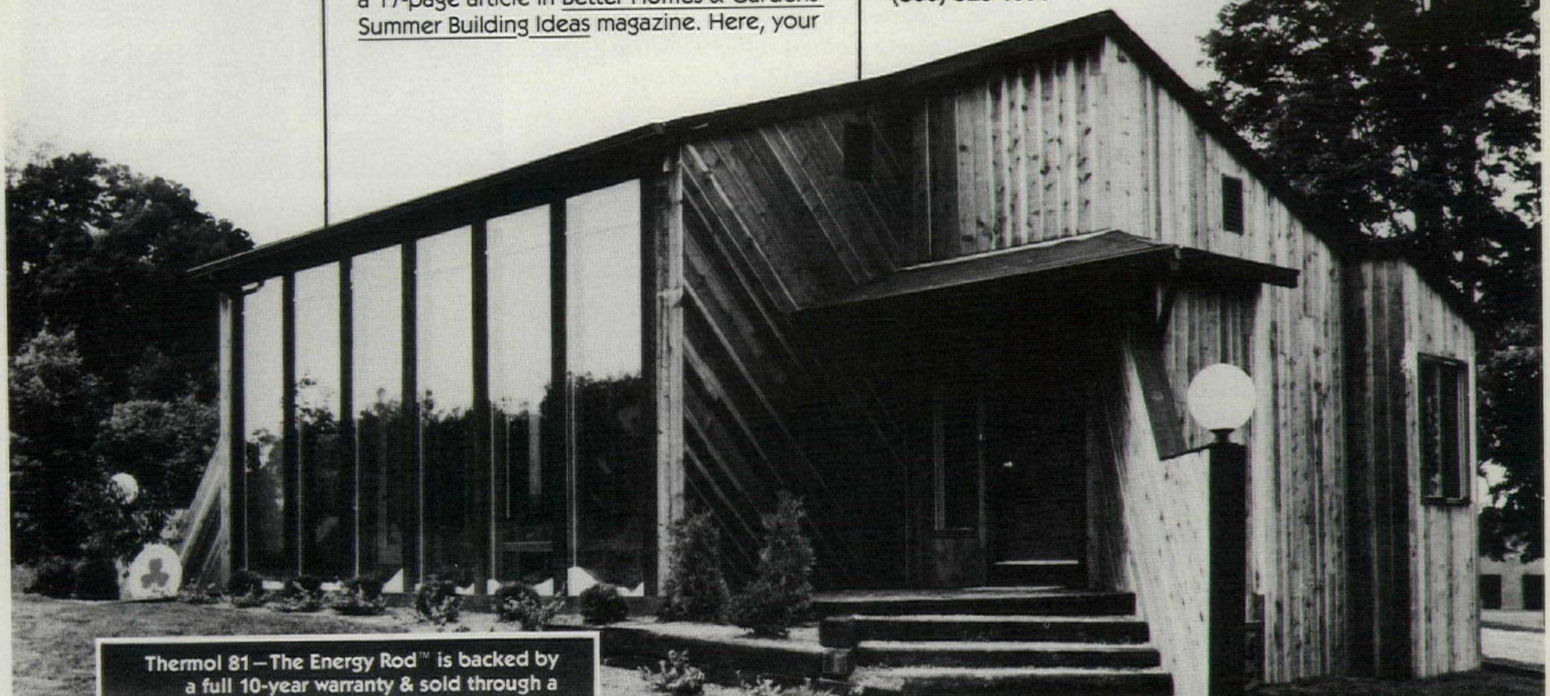

May 26-30
The Civic Center
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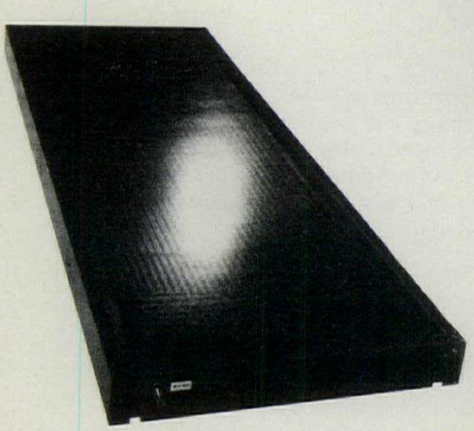
# Solar Rising



**Ametek:** *SunJammer high efficiency flat plate solar collector designed for commercial, industrial, and residential use.*
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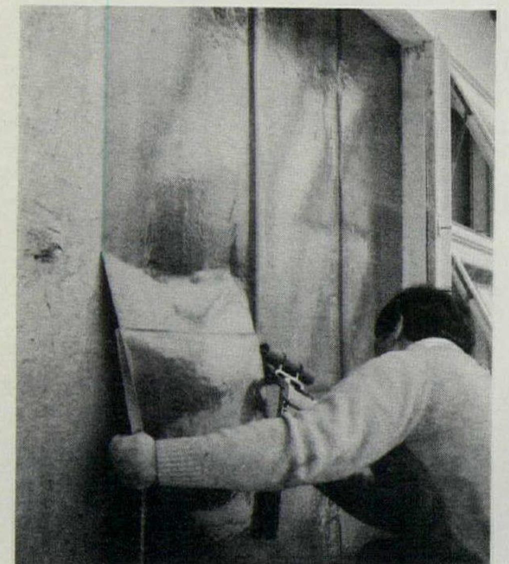

**Berry Solar Products:** *Sunsponge™ selective black chrome on copper foil surface with corrosion inhibitor, which absorbs solar heat.*
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**Con-Serv International Corp.:** *The heart of the Con-Serv™ solar system is the single-walled heat exchanger. [Right]*
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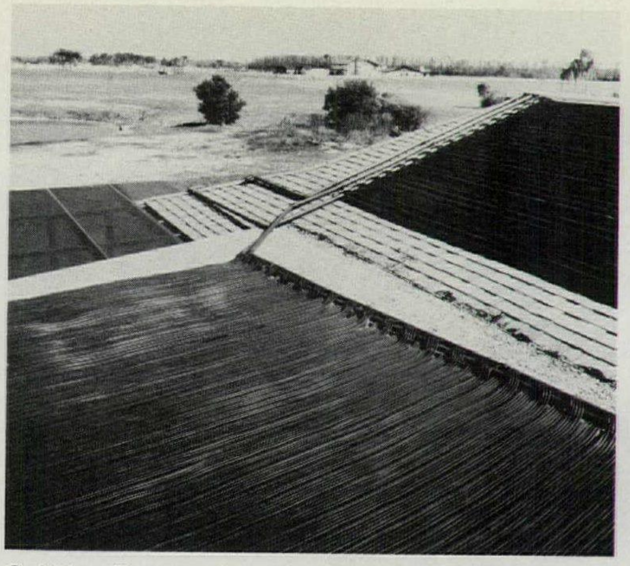

**Cal Mac Corporation:** *Sunmat Solar Absorber, a versatile, efficient, low-cost approach to making a solar collector for both low and medium temperature applications.*
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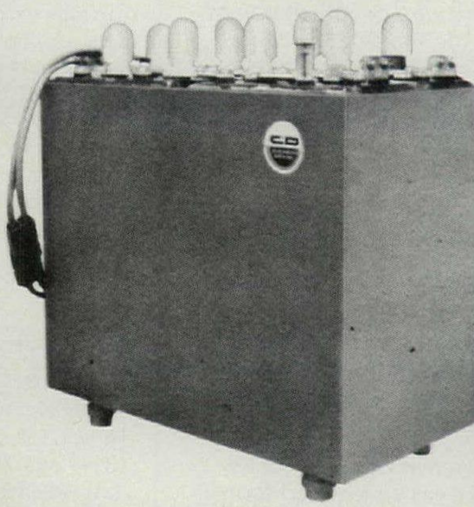

**C & D Batteries Division:** *Photovoltaic energy storage batteries offer increased capacity, lower freezing point, and reduced maintenance.*
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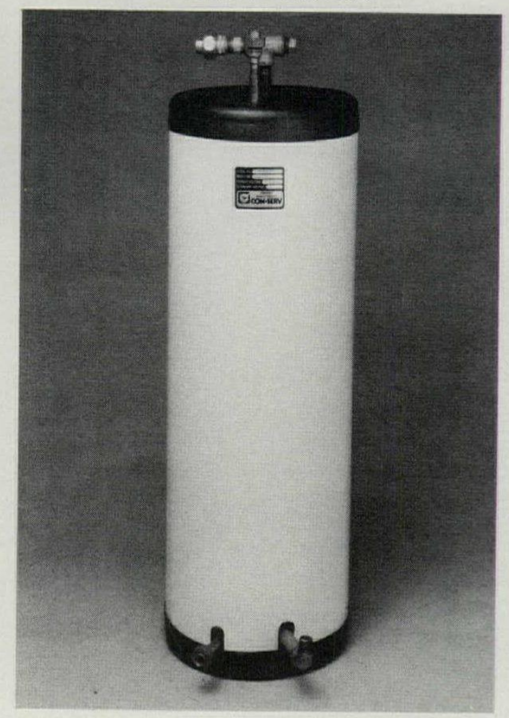

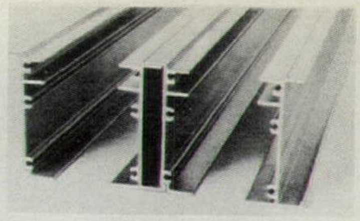

**Easco Aluminum Co.:** *Aluminum solar frames in three different standard sizes complete with cap and in stock.*
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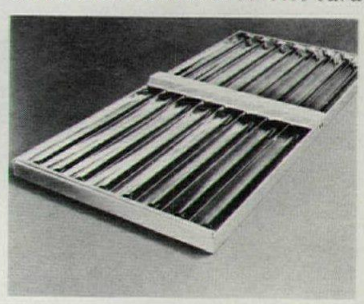

**General Electric:** *TC-120 is the newest GE vacuum tube liquid-type solar collector.*
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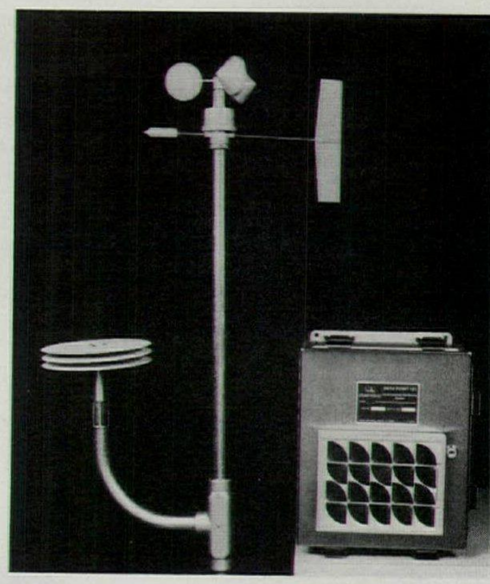

**Hollis Observatory:** *Data Point 121-10 photovoltaic and battery-powered wind survey system for remote stand-alone sites.*
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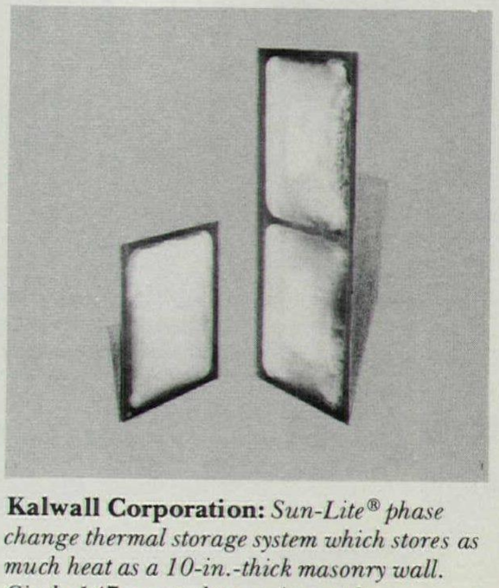

**Kalwall Corporation:** *Sun-Lite® phase change thermal storage system which stores as much heat as a 10-in.-thick masonry wall.*
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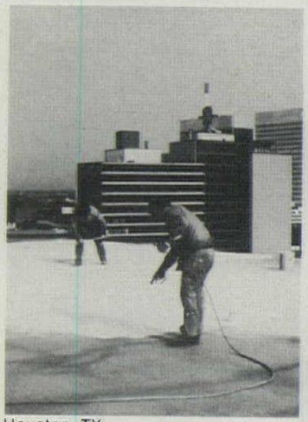
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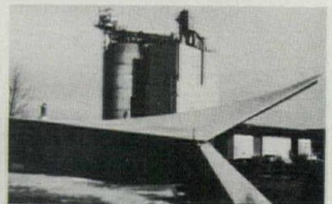
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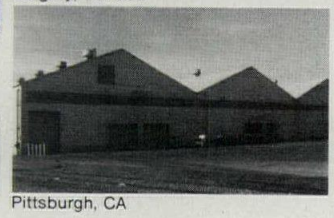
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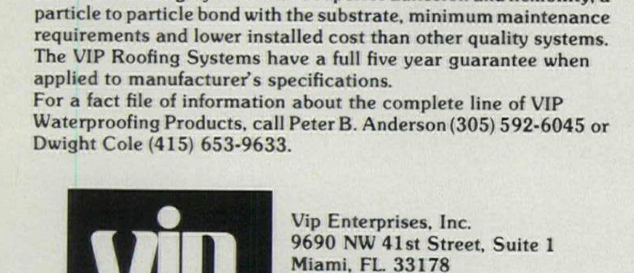


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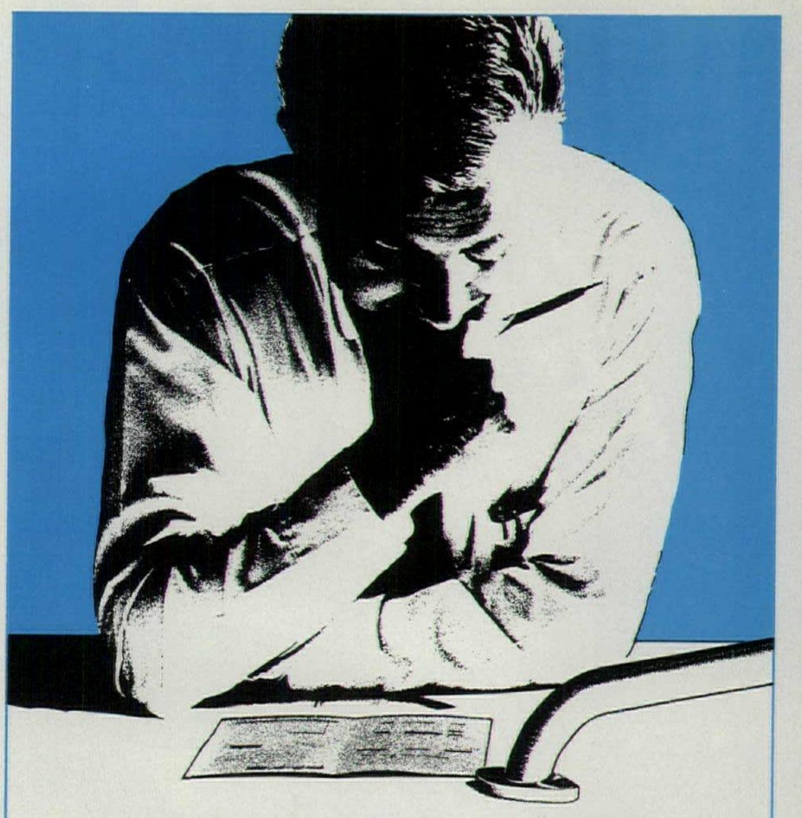

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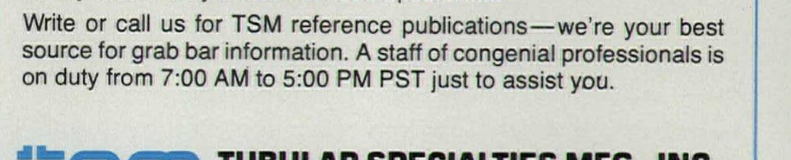

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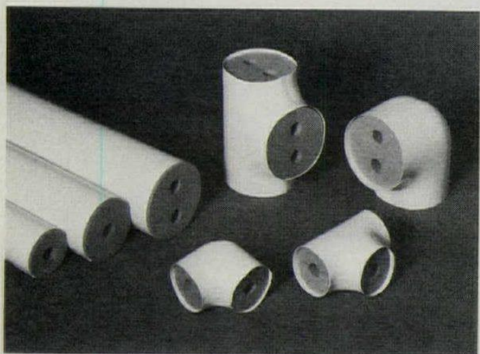
Solar Rising



**Northeast Specialty Insulations:** *Solar-7® pipe insulation especially effective for solar energy pipe insulations.*
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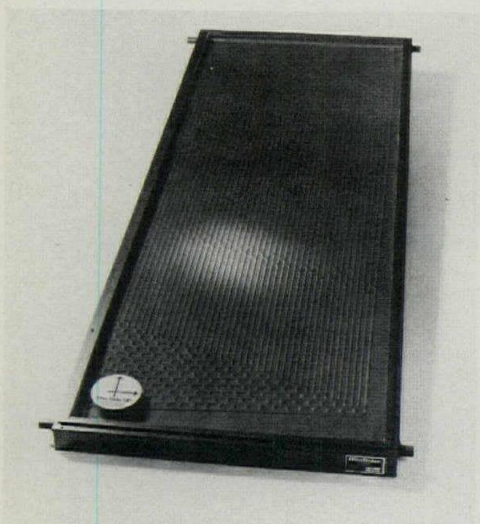

**Olin Corp.:** *OlinSolar® all-copper light-weight solar collector for open or closed loop installations. For use in both water heating and space heating installations.*
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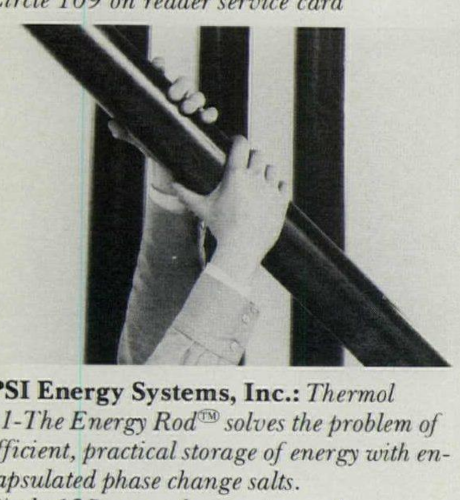
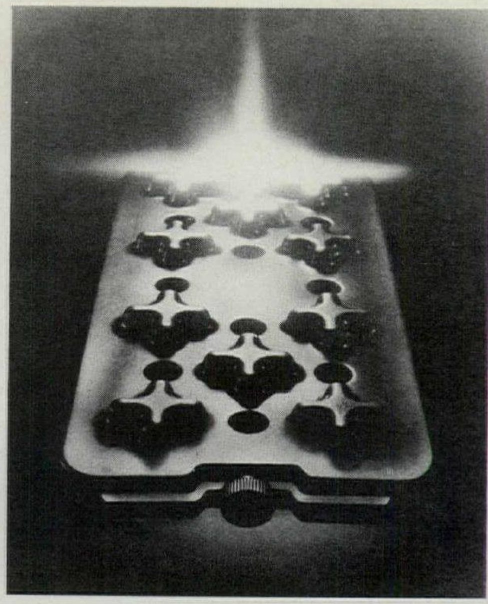
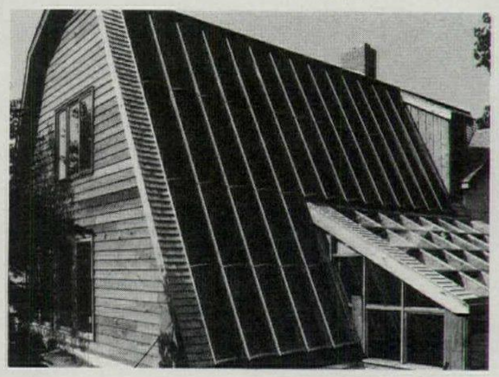


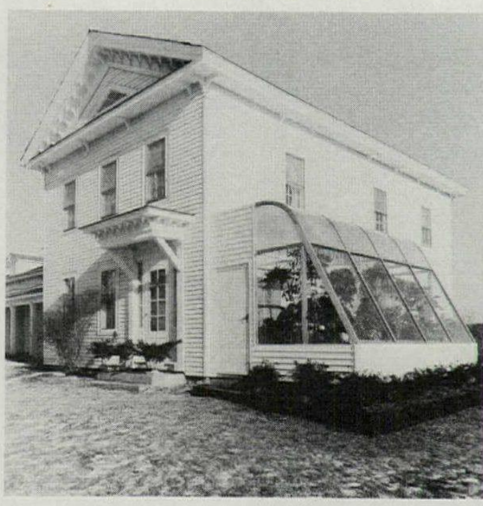
**PSI Energy Systems, Inc.:** *Thermol 81-The Energy Rod™ solves the problem of efficient, practical storage of energy with encapsulated phase change salts.*
*Circle 125 on reader service card*



**Solar Research Associates:** *Heat tray is a sealed high-density polyethylene tray filled with a mixture of Glauber's salt and other additives for heat storage.*
*Circle 110 on reader service card*



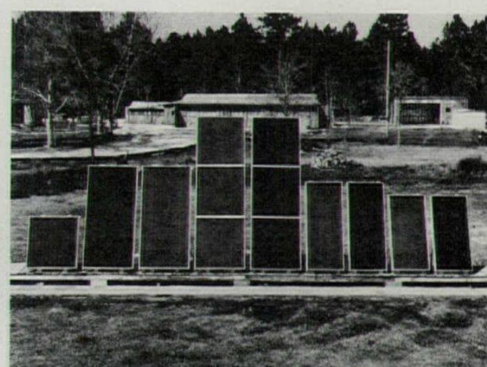
**Solartech Limited:** *Solair flat plate air type solar collector for use on any existing or new structure of any type.*
*Circle 111 on reader service card*



**Sunplace Corporation:** *Sunplace® solar greenhouse claims the best possible mixture of solar components in a high-quality modular system.*
*Circle 112 on reader service card*

**Thermal Technology Corporation:** *Insulating Curtain Wall® is an electrically activated insulating curtain designed to limit heat loss through glazed surfaces.*
*Circle 113 on reader service card*


**The Dampney Co.:** *Thurmalox 250® selective black solar collector coating collects heat more efficiently than ordinary non-selective black paints.*
*Circle 114 on reader service card*



**U.S. Solar Corporation:** *Eagle Sun™ liquid type solar collectors for use in hot water, space heating, and pool heating.*
*Circle 115 on reader service card*


# Fewer footings.

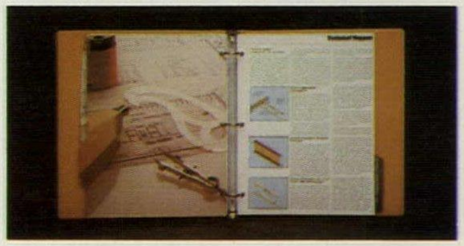
Trus Joist systems require fewer load-bearing walls and footings. This leaves precious commercial floor-space free for displaying and selling goods.

That's why Kinney shoe stores use Trus Joist Corporation's lightweight TJL open web truss in their structural systems. Depending on load and spacing, Trus Joist systems can span up to 60' in floor and 120' in roof systems.

There are other reasons why Kinney selected Trus Joist, and they all add up to the same bottom line: it's the most economical in-place structural system available. Try walking in their shoes—and see if you don't save money.

Wood Technology Leader for 20 years.
**TRUS JOIST CORPORATION**
P.O. Box 60-A • Boise, Idaho 83707 • (208) 375-4450

COMPLIMENTARY COPY of our 94-page technical support manual will be delivered by a Trus Joist representative on request. Please write on your company letterhead to the address below.



Circle **No. 415** on Reader Service Card


# You're invited!

The American Section of the International Solar Energy Society (AS/ISES) will hold its 1981 Annual Meeting and Product Exposition in Philadelphia, May 26-30, and you're invited.

If you're seriously interested in solar energy, you should be part of Solar Rising. It's the largest event of its kind ever planned in the U. S. — and the most diverse, with "state-of-the-art" workshops, demonstrations, technical sessions and exhibits covering every aspect of solar energy utilization.

**Solar Rising. Rise to the occasion.**

*For information, send coupon to:*
Solar Rising
Rm. B-2 Bennett Hall
3340 Walnut Street
Philadelphia, PA 19104

Name:__________

Address:__________

Business/profession:__________

AS/ISES Member_____ Non-Member_____ Student_____

*Conference fees:*

**Before April 10:** AS/ISES Member ($80); Non-member ($110); Student Member ($45); Student Non-member ($60). **After April 10:** AS/ISES Member ($120); Non-member ($150); Student Member ($55); Student Non-member ($70).

***Pre-register before April 10 and save!***

## Partial list of exhibitors

Ametek Corporation
AnaChem Corporation
ASTM

Berry Solar Products
Bio-Energy Systems

Cal Mac
C&D Batteries
Combustion Engineering/Glass Division
Con-Serv International Corp.

Dampney Company
Du Pont Company

Easco Aluminum Co.
Environment/One Corporation

General Electric Co.
Gulf Thermal Corp.

Heliotrope General
Hollis Observatory

Independent Energies

Kalwall Corporation

Meenan Solar
MIT/Lincoln Laboratory

New Resource Group
Northeast Solar Energy Center
Northeast Specialty Insulations, Inc.
Novan Energy, Inc.

Olin Corp.

Pennsylvania Sun Brokers
Philadelphia Electric
Princeton Energy Group
PSI Energy Systems, Inc.

SES, Inc.
Solar Energy Products
Solar Energy Research Institute
Solar Engineering Magazine
Solar Industries, Inc.
Solar Research Associates
Solartech, Ltd.
Solarware, Inc.
Sun Earth Solar Products
Sunplace Corporation
Sunway Consultants, Inc.
Sunway Solar Systems, Inc.

Thermal Technology Corp.

U.S. Solar Corp.
U.S. DOE Solar Data Network

Van Nostrand-Reinhold
Ventarama Skylight Corporation

Western Sun

ROSE•JOHNSON

# DETAILS OF A TRUE GRID

Rose Manufacturing Company and Johnson Furniture Company have combined 135 years of manufacturing experience to offer an open plan furniture system that pays attention to details.

Proven acoustical panels complemented with a full line of furniture components enables Rose•Johnson to effectively furnish todays office interior environment.

For more information on how this system can work for you, contact Rose•Johnson

ROSE•JOHNSON

**ROSE•JOHNSON**
Eleven-Eleven Godfrey Ave., S.W.
Grand Rapids, MI 49503
Phone (616) 245-2103

Circle **No. 402**


**Job Site:** Detroit Medical Center

**Alcan Planar® Ceiling Systems:** combines dramatic visual effect with functional, highly flexible installation.

**Finish:** Silicon polyester over aluminum panel. Weather resistance and structural strength for interior or exterior applications.

**Colors:** A spectrum of five tasteful low-gloss shades of blue.

**Ventilation/Lighting:** Easily accomplished through incremental slots between panels, without cutting or modification of the ceiling.

**Architect:** William Kessler and Associates, Incorporated, Detroit, Michigan; Zeidler Partnership, Incorporated, Toronto, Ontario; Giffels Associates, Incorporated, Southfield, Michigan. Associated architects, engineers and planners.

**Availability:** Exclusively through Alcan Building Products.

**Information:** Write "Planar," Alcan Building Products, P.O. Box 511, Warren, Ohio 44482.

**Alcan Building Products**
Division of Alcan Aluminum Corporation

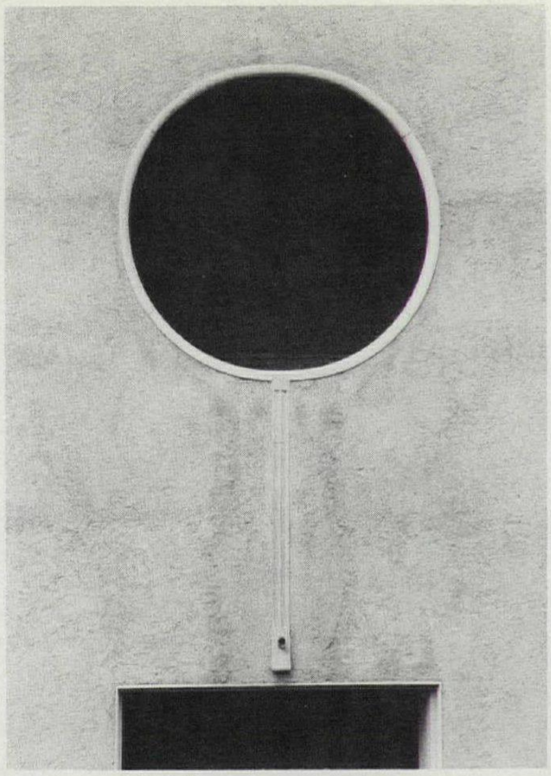
ALCAN ®

Circle **No. 307** on Reader Service Card

**Coming next month**

# P/A in May: Scarpa, S.O.M., and more

**Carlo Scarpa** was the most renowned and original architect of his generation in Italy. Over a period of decades up to the time of his death in 1978, Scarpa produced remarkable works of architecture—too little known in the U.S.—that explore areas of particular concern to us today. He was a master at integrating new construction and spaces into the historic fabric; he developed a contemporary design vocabulary that reflects a knowledge of history and includes all the levels of scale recognized in the past, from that of ornament to that of the city. A major retrospective feature will be introduced with an essay by Emilio Ambasz and will conclude with reflections by Scarpa's teaching assistant and one of his associates in architecture, Guido Pietropoli. The major works to be featured include:
Castelvecchio Museum in Verona: the most splendid of his renovations, built within and of the Medieval Scaligeri castle.
Cemetery of Brion-Vega: Scarpa's masterpiece—and his own resting place.
Banca Popolare di Verona: a sensitive urban infill structure well underway before Scarpa's death and completed in January of this year.



*Exterior detail of the Banca Popolare di Verona.*

**Skidmore, Owings & Merrill** has been in many ways the quintessential architectural firm in America after World War II, the latter-day equivalent of Burnham & Company. At a time when many of the internationally known design figures of this huge firm have retired, P/A will shed some light on how the firm is organized for the highly diversified and active practice it carries on today. An incisive profile, examining the inner workings of S.O.M. in 1981—based on visits with partners and staff members in their offices in several major cities—will be accompanied by an extensive portfolio of illustrative current projects of all scales in many parts of the world.

**Indoor gardens** will be the topic of an informative and timely article in P/A's Interior Technics series. Now that interior landscaping has escaped from the prototypical clay pot, the architectural professional should know a few basics about lighting, drainage, moisture—not to mention plants—even before approaching a consultant. It is all laid out here, in a densely packed update on the subject.

**The International Conceptual Furniture Competition** sponsored by P/A, results of which will be honored and exhibited at NEOCON 13, Chicago, in June, will be the subject of a feature report, illustrated by the projects that ranked highest with the jury.

**P/A in June** will focus on regional vernacular characteristics in the design of a number of houses and other small-scaled buildings in several parts of the country, from Florida to the state of Washington.

THE BOLD LOOK OF KOHLER

At the edge of your imagination lies a new frontier of comfort. The SuperSpa. Installed indoors or out, with optional fixed or floating teakwood table. Serves as both hot tub and whirlpool. Shown in Sequoia, one of a variety of exciting colors. For those who prefer their comfort with a different slant, Kohler's Spa Ville D'eau features a chaise longue and modified triangular form with gently contoured sides. For more information about Kohler products, write: Kohler Company, Dept. SPA RK4, Kohler, Wisconsin 53044.

Circle **No. 367** on Reader Service Card

# This earth-sheltered school offers a lesson in energy savings.

One of today's most modern schools echoes ancient South American tier-type design in a remarkably energy-efficient earth-sheltered structure. A substantial portion of the 146,000 square foot building is totally underground: The entire gym, industrial arts area, amphitheatre and some classrooms are 25 to 35 feet below grade.

This building will set new standards for energy efficiency. STYROFOAM* brand insulation is one of the reasons. There are 4 inches of STYROFOAM on roofs and decks and 3 inches in exposed walls. In below-grade areas, 3 inches are used from grade line to frost line, 2 inches in the intermediate zone, and finally, 1 inch near the footings.

Only STYROFOAM brand insulation has proved it has the compressive strength, moisture resistance and lasting high R-value to work in demanding below-grade applications. These very same characteristics make it your best choice for walls and roofs as well.

To offer your clients maximum energy efficiency, specify STYROFOAM brand insulation from frostline to skyline. And accept no substitutes—make sure STYROFOAM is what's actually installed.

For complete information, call your Dow representative, or write: The Dow Chemical Company, Dept. D58, STYROFOAM Brand Insulation, Midland, MI 48640.

DOW

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Styrofoam®

North Central High School, Spokane, Washington;
Stingle, Ronald, Heylman and Cloninger, Architects, Engineers
Steve Ronald, Partner in charge
Peter Suden, Structural Engineer.

WARNING: STYROFOAM brand insulation is combustible and should be properly installed. A thermal barrier equivalent to a gypsum board interior finish should be used in buildings used for residential or commercial purposes. For specific instructions, see Dow literature available from your supplier or from Dow.

1-102 © 1981 The Dow Chemical Company

# Energy Conscious Design and Cost Efficiency. The Cado Advantage.


If you specify for new buildings or are re-modeling older ones consider this: a room panelled in SYSTEM CADO with insulation can cut heat loss by about 50%. That means reduced fuel bills. Forever.

And whether installed in home or office, an insulated CADO wall system has immediate cost advantages. It meets government standards for energy conservation so owners are eligible for income tax credit the first year; and if significant room alterations will be made, owners may qualify for re-mortgage financing, making SYSTEM CADO an affordable as well as intelligent investment.

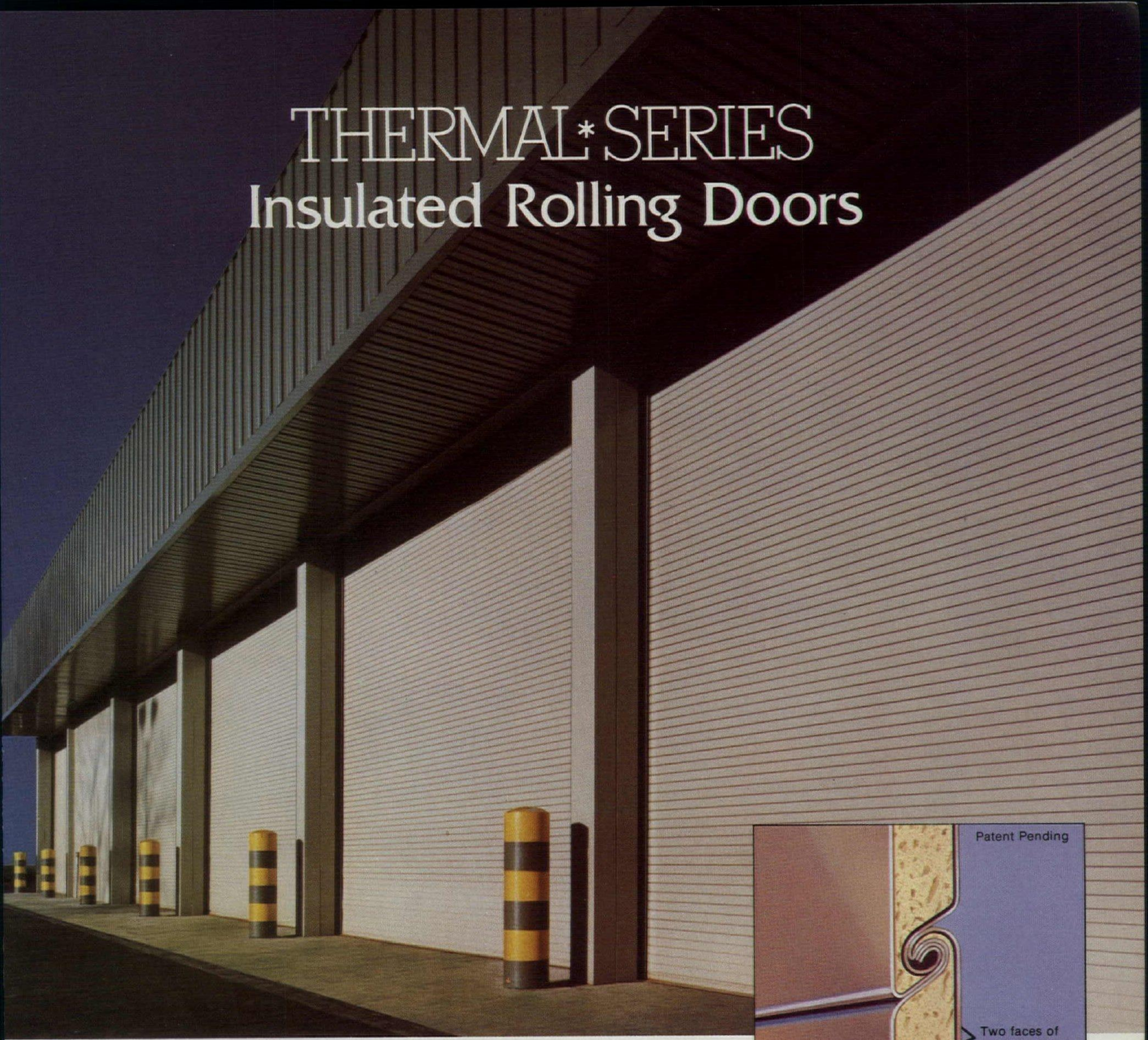
Simple to install in any room, CADO can be tailored to fit around doors and windows as well as accommodate walls and ceilings of varying dimensions.

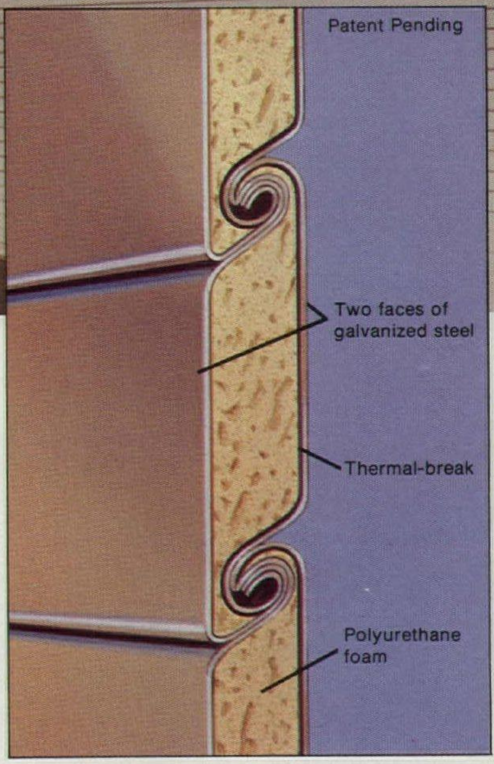
Get all the facts on the advantages of an insulated CADO wall system. Call or write us today.

CADO/ROYAL SYSTEM, INC., Dept. C-203
155 Helen St., South Plainfield, NJ 07080.
Showrooms: D&D Building, 979 Third Avenue, NYC/Merchandise Mart, Chicago/Oak Lawn Plaza, Dallas/PDC, Los Angeles/Atlanta/Cincinnati/Denver/Houston/Miami/Philadelphia/San Francisco/Seattle.

CADO

Circle **No. 326** on Reader Service Card




# The Creative Challenge of Today

To design a building that's energy efficient you've got to use every means to conserve energy. That's why Atlas has developed a series of insulated rolling doors that cuts wasted energy due to heat flow through and around the door curtain.

The door slat is uniquely constructed so that polyurethane foam is sandwiched between two faces of 22-gauge galvanized steel. The door frames are weather-stripped on all sides, to make them the logical solution for the temperature-weather control problems that occur at large door locations. Whether used at exterior or interior openings, whether motor or chain operation, our Thermal-Series is the best bet-when you have to meet the challenge of today.

If you'd like more information on our Thermal-Series call or write Atlas Door Corporation (201) 572-5700. Because we're committed.

atlas

Atlas Door Corp.
110 Truman Drive
Edison, N. J. 08817
201-572-5700

## Meeting the challenge of today...

Circle **No. 317** on Reader Service Card

# 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.

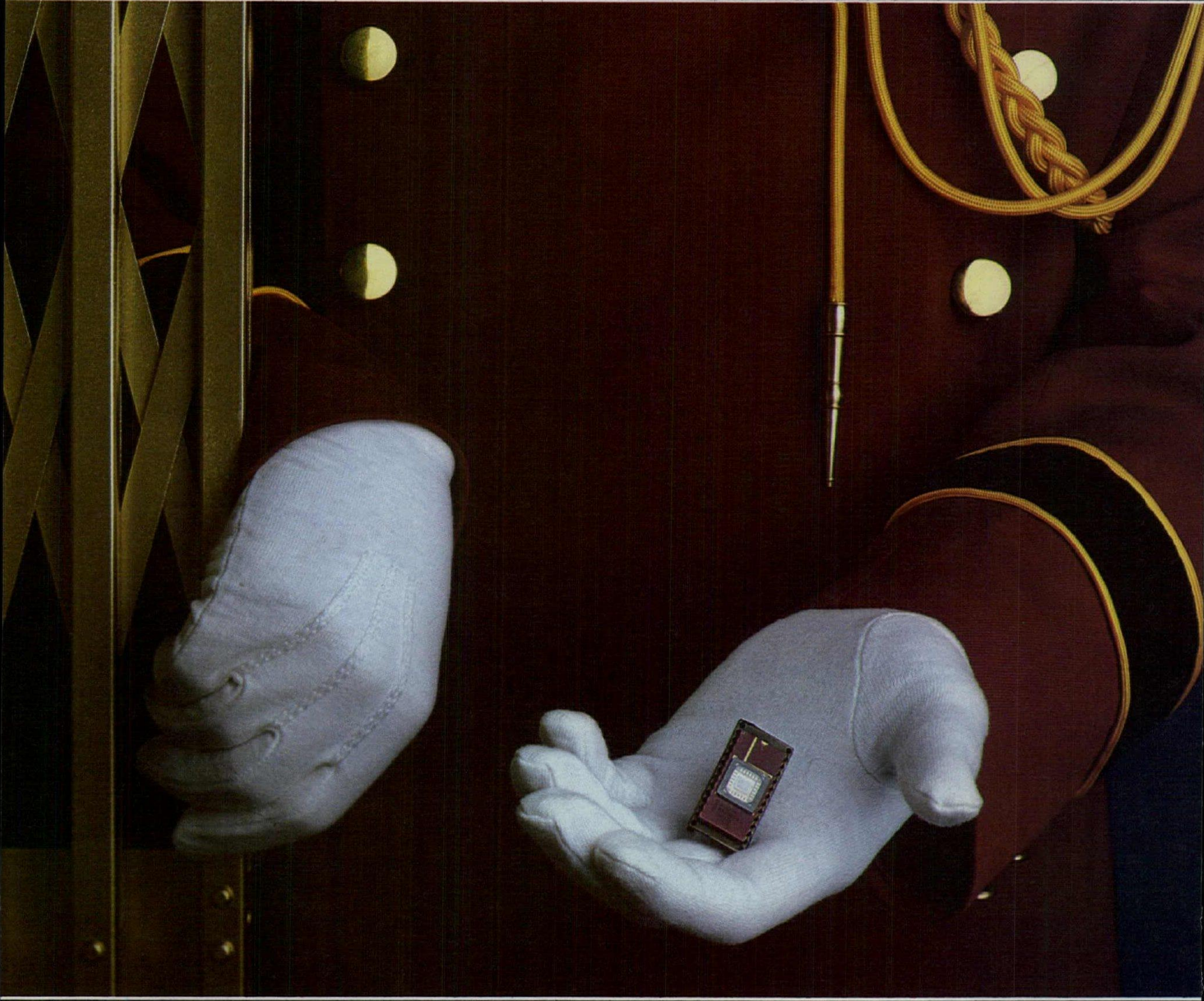
Twelve years ago, Schindler Haughton replaced mechanical programmers with integrated circuits. The equipment was so advanced that this electronic chip could analyze more than 27,000 possible service combinations (and select the best one) in 10 milliseconds. It took our competitors a decade to catch up. Now we have even more advanced microprocessing equipment. It's the best of its kind.

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.**

Circle No. 404 on Reader Service Card

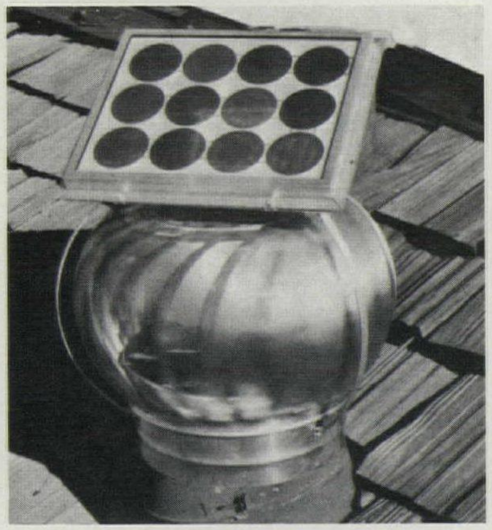


**Schindler Haughton**
ELEVATOR CORPORATION
Toledo, Ohio 43609

# Products and literature

**The following items are related to the theme of this issue, energy-conscious design. They are separated by category for the reader's convenience.**

## Photovoltaic products



**The Solar Turbine** is powered by silicon solar cells that directly convert sunlight into electricity. For use as an attic ventilator, it can use both wind energy and solar energy to move up to 1400 cu ft of air per minute, depending upon available sunlight or wind. A thermal switch will shut the fan off when the temperature drops below 65 F. The turbine helps to cool in summer and control condensation in the winter. Photowatt International, Inc.
*Circle 119 on reader service card*

**Solar cell module AS1-16-2300,** designed for mass production, contains 35 photovoltaic cells connected in series. Each single-crystal silicon wafer cell is approximately 4 in. in diameter and will generate approximately 1 watt. Tempered glass, which is resistant to weather and blowing sand, transmits a higher percentage of light energy than conventional glass does. Polymer-coated metal foil back is impervious to air and moisture. Modules are approximately 4′ x 1′ x 1.5″ deep and weigh 11 lb. ARCO Solar, Inc.
*Circle 120 on reader service card*

**The 129SL Solar Panel,** although designed for marine use, is adaptable for many other applications. In remote locations where conventional electric power is impractical, it can be used to charge batteries. The panel has 35 silicon solar cells encapsulated in silicone rubber and encased in plexiglass for resistance to corrosion and impact. Free Energy Systems.
*Circle 121 on reader service card*

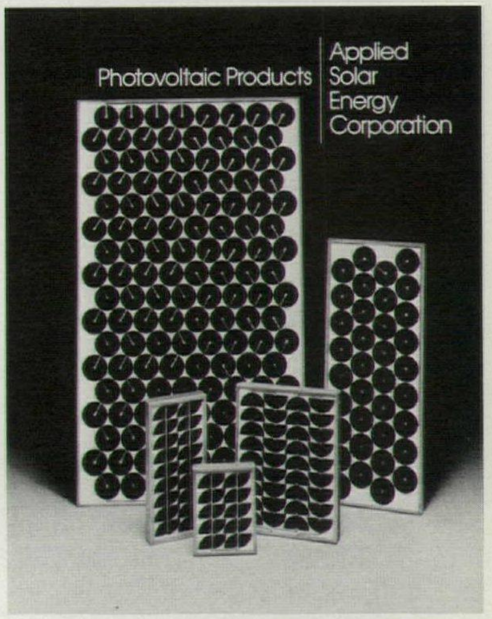
## Photovoltaic literature

**Photovoltaic energy storage batteries** are discussed in a four-page brochure that also shows a typical circuit. It includes tables of details and specifications for deep daily discharge and shallow discharge applications, and data for applications having an average annual temperature less than 90 F. C&D Batteries.
*Circle 200 on reader service card*

**Metal Roofing Systems** brochure describes and illustrates eight types of roofs including batten, standing seam, metal panel, tile, and shingle systems. Also discussed are two integrated solar roofs, one a domestic hot water collector system and the other using photovoltaic cells for direct conversion of sunlight to electricity, which are being tested but are not yet available. The 20-page brochure includes specifications and detail drawings of the roofs that are available. Architectural Engineering Products Co.
*Circle 201 on reader service card*

**The Photon Power™ Module** combines eight thin-film coated-glass panels, 24″ x 24″, each panel having 60 cells. Each eight-panel module is expected to produce from 80 to 120 watts. A six-page, four-color brochure describes the panels and provides technical data. Photon Power, Inc.
*Circle 202 on reader service card*

**MSP43A40 40-watt photovoltaic modules** consist of 33 cells per module, each cell 4″ x 4″ square. The module produces 40 watts peak power. A data sheet lists features and provides electrical, mechanical, and construction information, along with a list of typical applications. Motorola Semiconductor Products, Inc.
*Circle 203 on reader service card*



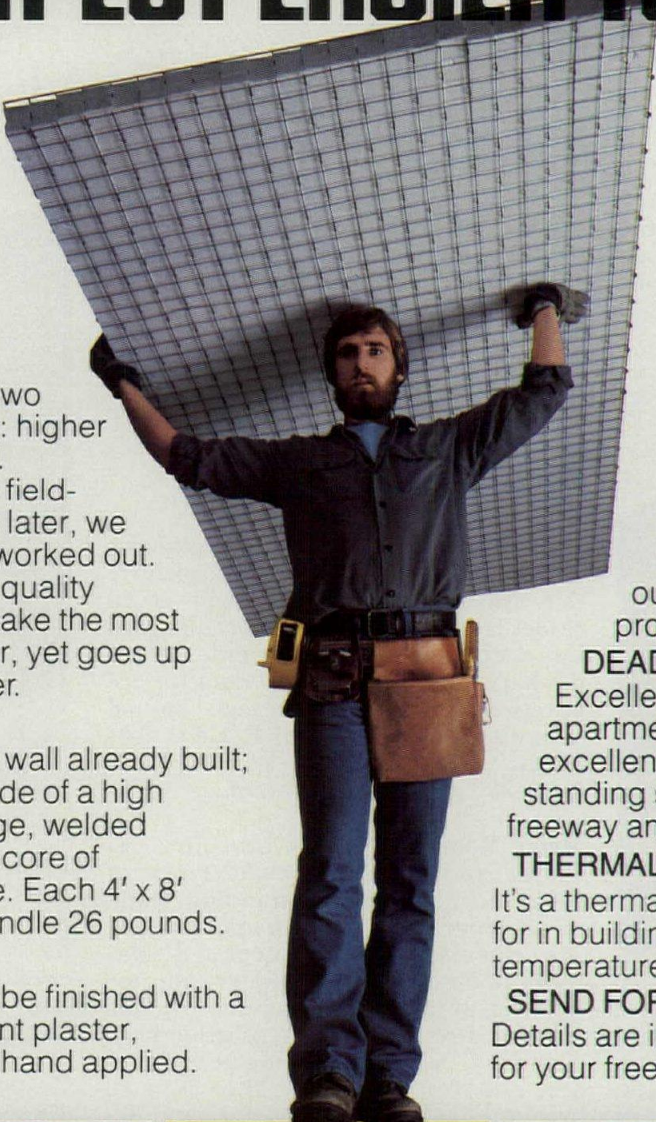

**Photovoltaic products** brochure suggests factors to be considered about solar electric power and provides information about them. It discusses cell efficiency, module panel construction, and support services available. Cell shapes, panels, and typical installations are illustrated. Applied Solar Energy Corporation.
*Circle 204 on reader service card*

## Phase change salts

**The heat tray,** made from high-density polyethylene, is filled with phase change salts that melt at 89 F, at which point heat energy is stored. When the tray cools below 89 F, the stored energy is released. Solar collector requirement is 1 sq ft for each tray, and one tray is capable of storing up to 500 Btu of heat energy. According to the manufacturer, a 3′ x 3′ x 7′ high stack of trays could provide 50 to 70 percent of the annual heating requirements of a 1200-sq-ft home having R-20 walls and ceiling. Saskatchewan Minerals.
*Circle 122 on reader service card*

**Energy PODS** are made of phase-change material, factory-sealed into translucent, fiberglass-reinforced polymer containers. Hung behind solar glazing, they will store as much heat as a 10-in.-thick masonry wall, says the manufacturer, but with 80 percent less [*Products continued on page 234*]

# A GREAT WALL IS NOW A LOT EASIER TO BUILD.



Our new building system gives you the two things that count most: higher quality and lower cost.

It's been thoroughly field-tested. 1500 buildings later, we have all of the details worked out. The result is a simple, quality system that lets you make the most of quickly trained labor, yet goes up fast and ends up better.

**THE BASIC PANEL.**
You start with half the wall already built; the inside half. It is made of a high strength steel wire cage, welded through and around a core of expanded polystyrene. Each 4′ x 8′ panel is an easy-to-handle 26 pounds.

**IT'S STRONGER.**
The basic panel can be finished with a coat of portland cement plaster, inside and out, gun or hand applied.

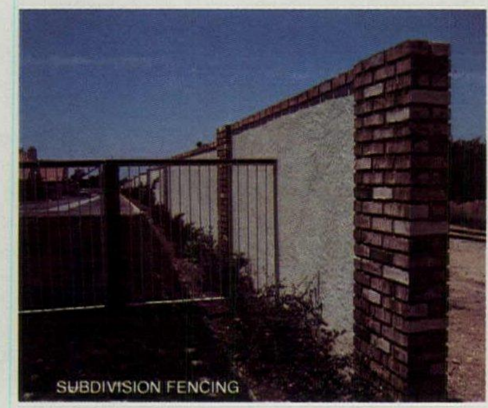
The finished wall has excellent structural load bearing qualities.

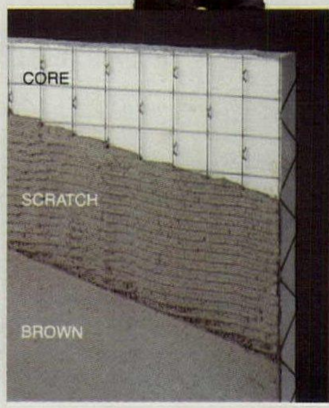
**IT LASTS LONGER.**
No rot, fungus or termites. Also, the walls are fire resistant and have outstanding seismic properties.

**DEADENS SOUND.**
Excellent in offices, homes, apartments and condos. Also excellent as a low cost, free standing sound barrier wall against freeway and other noises.

**THERMAL EFFICIENCY.**
It's a thermal mass—just what's called for in buildings designed for passive temperature control.

**SEND FOR THE FULL STORY.**
Details are in our latest brochure. Send for your free copy.


SUBDIVISION FENCING





RESIDENTIAL CONSTRUCTION

COVINGTON'S
**THERML-IMPAC™ PANEL** *THE NEW BUILDING SYSTEM*

Covington Technologies/17811 Mitchell Avenue/Irvine, CA 92714

Circle **No. 334** on Reader Service Card

C O N W E D

# Aurora ceilings. Above all, dramatic.

Above all, Aurora ceilings from Conwed. Dramatic styling echoed in a deeply eroded pattern, rendered in warm, inviting ivory tones. Drama from a pattern carefully proportioned to accommodate the scale of any room of any height or size. Drama from a designer ceiling which complements any commercial interior. Conwed® Aurora ceilings. Above all, dramatic.

Aurora ceilings offer drama with performance. Performance that comes from solid dimensional stability, good acoustical control and U.L. Time-Design Fire-Ratings. Choose from either concealed or reveal edge tiles.

Find out more about the drama and performance of Aurora ceilings by Conwed. See Sweets File 9.1/Co or contact Conwed Corporation, Ceiling Products Division, 444 Cedar St., P.O. Box 43237, St. Paul, Minnesota 55164. Phone 612-221-1184.

**CONWED**

innovative products for better interior environments

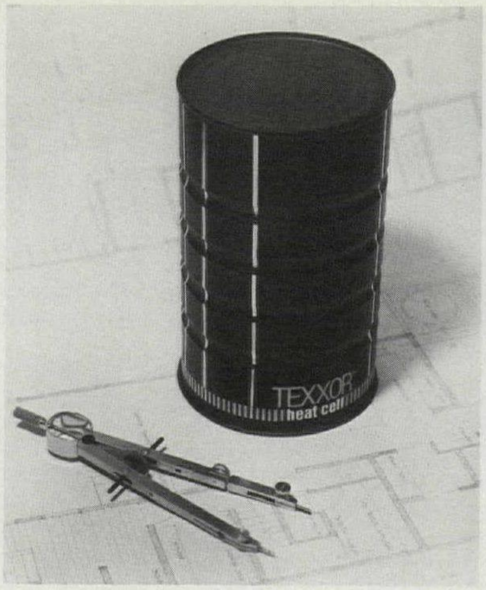
**Circle No. 332 on Reader Service Card**

**Products** continued from page 231

thickness and 95 percent less weight. They can be used in either active or passive solar heating systems and are recommended for greenhouses, remote storage installations, and waste-heat recovery systems. They can be hung or suspended on racks or clips. Solar Components Div., Kalwall Corp.
*Circle 123 on reader service card*

**The C.E.S. Energy Rod** is designed to absorb excess heat from the sun, a fireplace, or any other source, then slowly release it as it is needed. Six 6-ft rods will absorb and store 15,000–20,000 Btu, enough energy to keep an average room warm through the night, according to the manufacturer. Stands are available that hold three to five smaller rods, which can be charged in one area, then moved to another where heat is needed. Certified Energy Systems, Inc.
*Circle 124 on reader service card*

**Thermol 81—The Energy Rod™** works on the phase-change principle, absorbing heat as the compound melts. Each 3½-in. diameter, 6-ft rod absorbs 2460 Btu of latent heat at 81 F. The rods have been used in passive and active solar systems, heat reclamation, heat-pump systems and solid-fuel heat systems. They can be assembled in different combinations to meet specific needs. PSI Energy Systems, Inc.
*Circle 125 on reader service card*




**The Heat Cell** for thermal storage is based on a melting phase-change material that begins to absorb heat at 81 F. When the heat is lowered below 81 F, a fully charged Heat Cell will release heat at 81 F for hours. The cylinder has a large surface-to-volume ratio for excellent heat transfer. Sources of heat can be the sun, industrial and commercial processes, and off-peak electricity for later use. Texxor Corp.
*Circle 126 on reader service card*

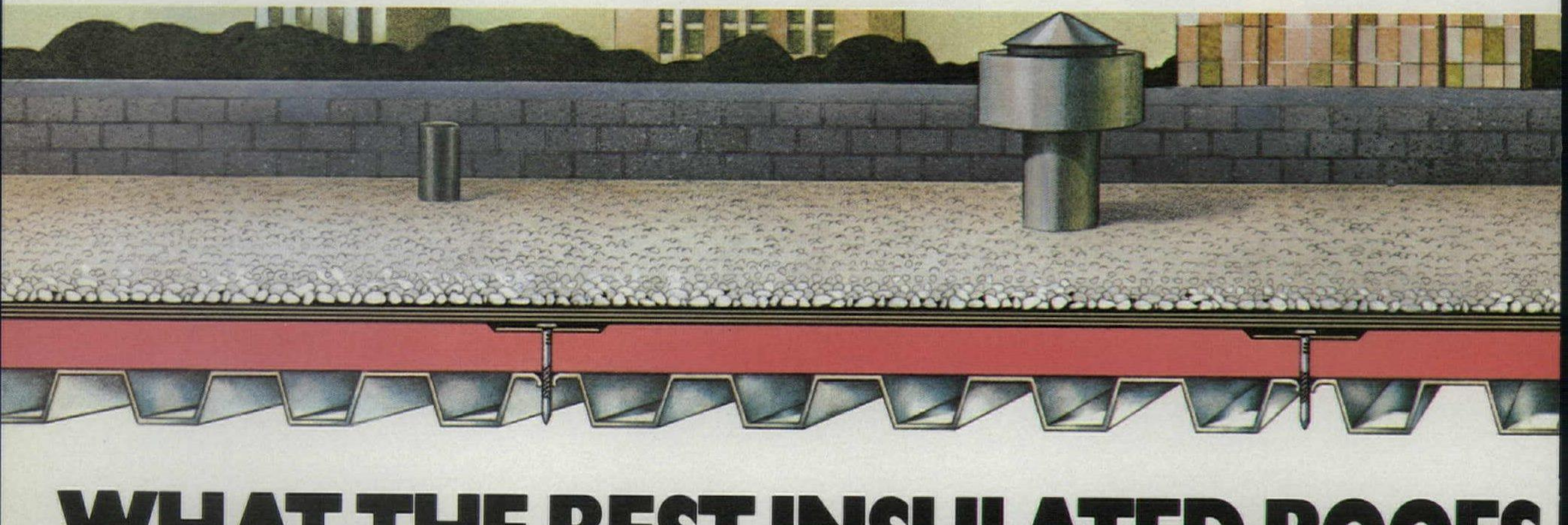
**Thermalrod-27™ phase change salt system** uses calcium chloride hexahydrate within a high density polyethylene storage rod to store heat. Heat is stored at 82 Btu per lb at 81 F as the salts melt; the salt gives off heat below that temperature as it returns to crystal form. It can be used in passive or active solar heating, hybrid solar systems, waste-heat reclamation, and water-source heat-pump systems. Energy Materials, Inc.
*Circle 127 on reader service card*

**HeatPac™ energy storage system** stores heat in a medium consisting of Glauber salt and filler, which is enclosed in a dark green pouch. The HeatPac modules, placed between the ceiling insulation and finished ceiling, absorb heat bounced from the sun, from wood-burning stoves, or from off-peak electricity. When the temperature drops, the heat packs radiate the heat back into the room. Colloidal Materials, Inc.
*Circle 128 on reader service card*

## Exterior insulation

**Therm-System exterior wall insulation** and finish brochure describes Pleko Therm insulating building material. There are cutaway illustrations of the components, and step-by-step methods of application are also shown. A table of technical data on tests and their results is included. Kern-Tac, Inc.
*Circle 205 on reader service card*

**STO exterior wall insulation and finish** can be applied to any sound substrate, such as precast concrete, masonry,



# WHAT THE BEST INSULATED ROOFS

THE PINK STUFF: Thermax.® It is simply the most efficient roof insulation on the market with a Factory Mutual Class I Fire Rating over steel decks. Thermax provides more insulating efficiency per inch than fibrous glass, composite, perlite or fiberboard roof insulations. Since mechanical fastening is the preferred system of attachment to steel decks, use Insulfast rapid fastening nail/disc system – a pneumatic gun and oxide-coated nails for fast, easy, permanent installation of Thermax to steel decks.

brick, block, and sheathing. It consists of expanded polystyrene insulation board, fiberglass mat or mesh embedded in a ground coat, and a decorative, seamless, acrylic-based wall coating that is ready mixed, scrubbable, and impact resistant. An eight-page brochure describes and illustrates the system and its components and discusses its advantages. STO Energy Conservation, Inc.
*Circle 206 on reader service card*

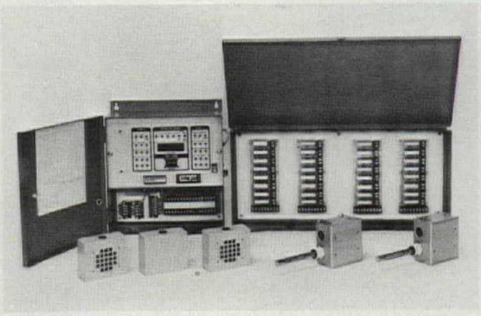
**Outsulation™ brochure** provides energy-saving features of the exterior wall insulation and finish system. It compares the expanded polystyrene panel with conventional alternatives. It describes physical properties, design and aesthetic possibilities, application methods, and thermal shock reduction capabilities. Dryvit Systems.
*Circle 207 on reader service card*

## Heat mirrors

**Heat Mirror™** is a thin, invisible coating applied to polyester film that is sealed between two pieces of conventional glass. Acting as a selective filter, the film allows sunlight to pass through the window, but reflects heat rays back into the room. It is said to reduce heat loss through windows by as much as 66 percent. It is also effective in reducing heat gain during the summer. Cost is expected to be about that of triple-pane glass. The Southwall Corp.
*Circle 129 on reader service card*

**Passive Solar glass,** available as a double-pane insulated unit, transmits short-wave radiation from the sun to the inside, but reflects long-wave heat radiation back into the interior space. Primarily for use in cool climates, the glass has a thin metal coating applied directly to the inner surface. The metal gives a warm blue cast to the outside of the window but appears clear from the inside. Guardian Industries.
*Circle 130 on reader service card*

## Controls products

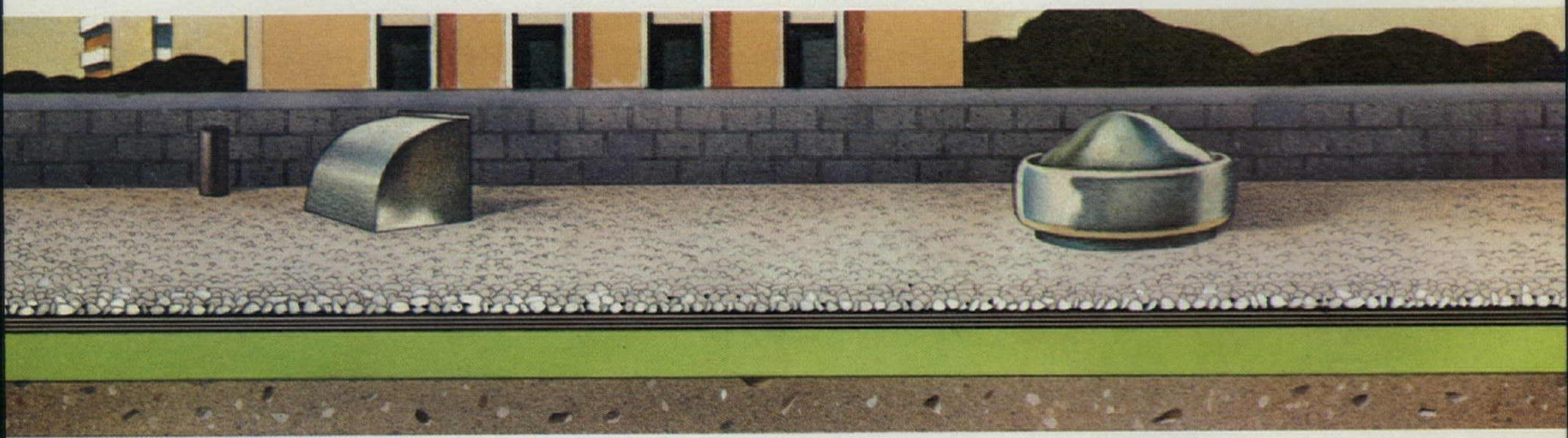


**Dual zone environmental control system** Model 2-336 controls up to six air-conditioning stages, six heat-reclaim stages, and twelve auxiliary heat stages to manage the environment in supermarkets, warehouses, and other large building complexes. Electronic sensors measure indoor and outdoor temperatures and dewpoint. The control system computes and maintains desired environment through seasonal and day/night changes, says the manufacturer. Com-Trol, Inc.
*Circle 131 on reader service card*

**Solid-state dimming systems** conserve power and cut maintenance for incandescent, fluorescent, and high intensity discharge lighting systems. They offer low-voltage, single- or multi-point control with preset timed fades of 0–60 seconds. Systems are available to control lighting in offices, restaurants, churches, department stores, hotels, and auditoriums. They are self-contained and include all circuit breakers, transformers, etc., in a wall-mounted cabinet. Hub Electric Co., Subs. of Westinghouse Electric Corp.
*Circle 132 on reader service card*

**Automatic Lighting Controllers** turn lights on and off sequentially, rather than dimming them. Sensors determine when daylighting levels are insufficient and turn on lights where they are needed. Variations provide flexibility for handling special incandescent, fluorescent, or HID lighting requirements. Substantial savings are said to be possible, not only in reduced power for lighting, but in reduced air-conditioning loads. International Technology Corp.
*Circle 133 on reader service card*

**The Pneumatic Integrated Control system** for air-handling units is a modular temperature and humidity control sys-
[*Products continued on page 238*]



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**THE GREEN STUFF:** Tempchek.® It gives you the same high R-values as Thermax, and is used on all types of decks, except directly over steel decks. Tempchek is the only urethane foam roof insulation reinforced with glass fibers. It has greater dimensional stability than the others, so it resists "growth" and ridging. All of which makes Tempchek first choice for any application other than directly over steel. Talk to your Celotex representative about the stuff the best insulated roofs are wearing these days, or call Ed Levin at Celotex, Roofing Products Division: (813) 871-4545.

Celotex
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Circle **No. 327** on Reader Service Card

# Stark Structural Facing Tile

Summit Junior High School, Ashland, KY / Architects: James E. Moore & Associates / General Contractor: W. B. Fossons & Sons

## The face that won't show its age

When you specify Stark Structural Glazed Facing Tile, you design for the future. Because even after 25 years of use - and abuse - walls like these at the Summit Junior High School will still look like new.

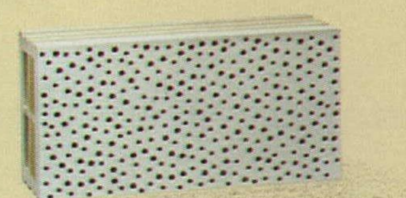
With SGFT, the ceramic glazed face is baked on the clay body. It's not painted on. And it's not plastic. So the face won't peel, crack, fade or discolor with age. That's why it's ideal for applications like schools, food processing, water and power plants, and hospitals.

Because it *never* needs painting, SGFT reduces maintenance significantly over the life of the building. And it resists stains, marks and chemicals better than any other wall material.

### Impervious, fire resistant, thermal efficient

During manufacture, Stark SGFT is kiln-fired at over 2000° F. So it won't burn, spread flames or emit toxic fumes.

SGFT is available in a wide range of colors. For lower price and quick delivery, select a Stark Quick Start Color and specify standard stretchers from floor to ceiling. Eliminate all unnecessary shapes and fittings.



In areas such as gymnasiums and swimming pools where noise control is important, choose Stark acoustical tile. Face perforations with fiberglass pads let the wall, rather than the ceiling, absorb the sound.

For new literature, write: Stark Ceramics, Inc., P.O. Box 8880, Canton, OH 44711. Or call toll free: 1-800-321-0662. In Ohio, call collect: 216-488-1211.

stark

Circle **No. 409** on Reader Service Card

# A PEN HAS TO BREATHE TO DRAW.

A technical pen does not live on ink alone. It needs air to keep the ink flowing, and that's the problem ordinary pens have failed to overcome.

You see, inside an ordinary technical pen there's a tiny breathing passage which has an infuriating tendency to clog, choking off the vital air supply. The ink stops and you have to start shaking the pen every few seconds to keep the ink trickling out.

**The Castell TG Pen has no breathing problems.**

TG's patented drawing cone has tremendous breathing capacity. As our diagram shows, air enters the pen through a wide opening where the drawing cone meets the collar. It flows through a unique channel which spirals five times around the cone, then passes into the reservoir to displace ink as it's needed.

**It won't clog.**

TG's spiral channel has wide, deep grooves which won't get blocked with dried ink deposits like the narrow breathing passages of ordinary technical pens. What's more, TG stays clog-free even if it's not used for weeks. Inside the cap, there's a special Hygro humidifying element which, when activated by a drop of water, keeps the point moist and ready to draw.

**The not-too-technical technical pen.**

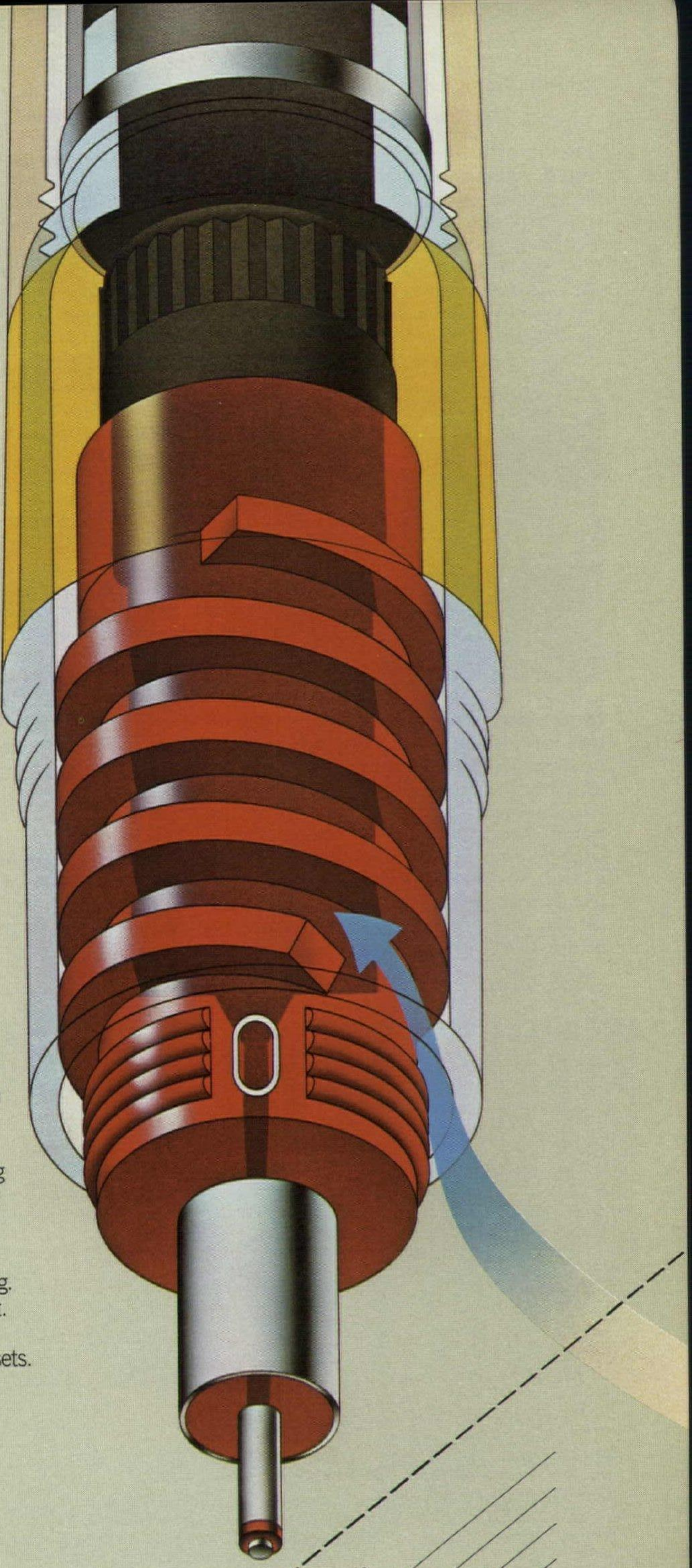
With all its sophisticated design, the TG is amazingly easy to use. You can take it apart, clean it, fill it and put it back together in seconds. Time studies show that compared to ordinary pens, using the TG System saves a lot of time which saves a lot of money.

In fact, the only thing that's hard to do with a TG is get the line widths confused. Each pen has bold markings on three sides identifying both American standard and metric sizes against a color background conforming to ISO line width color codes.

**Stainless, tungsten, and now, jewel points!**

In the TG System, there's a point that's perfect for the work you're doing. For drawing on paper or vellum, there's the TG with stainless steel point. And for drafting film you can use the tungsten carbide TGH or our new sapphire jewel TGJ. All three are available individually and in working sets.

Try the TG System. The things that make it breathe easy will make you breathe easy too.




**The Castell® TG® Technical Pen System. It Won't Clog.**

**FaberCastell**

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Phone: (201) 484-4141

**Products** continued from page 235

tem that is designed, ordered, and tested with computer assistance. Five function modules satisfy logic and control requirements for economizer switching, damper control, heating, cooling, and humidity, auxiliary, and fan status. A variety of modules allow the system to be adapted to almost any air-handling unit. Johnson Controls.
*Circle 134 on reader service card*

**Delta 5600 building management system** uses the Delta 1000 independent microprocessor-based central control and monitoring system. Each Delta 1000 has its own sensors, data gathering panels, and peripherals for functions such as energy management, fire protection, serurity, and monitoring of electrical and mechanical systems. The master control includes a minicomputer, interactive cathode ray tube, operator console, and a number of printers to provide management reports. Applications are in very large building complexes, such as universities, industrial facilities, and military bases. Honeywell, Inc., Commercial Div.
*Circle 135 on reader service card*

**'Smart' digital thermostats** now have space for a 9-volt backup battery for operation when electrical power is interrupted. The thermostats are available in two models, one for heating/cooling and one for heating only. Both accommodate all 24-volt systems except heat pumps, and there is an adapter kit that allows the thermostat to be used with electric, hydronic, and oil-fired units. Jade Controls, Inc.
*Circle 136 on reader service card*

**Energy management system EMS-100** is a microprocessor-based system that programs deferrable energy loads and controls electric demand peaks. Functions can be entered by means of four function buttons with a numeric keyboard, with LED indicators that show what loads are on. Manual override switches can be used to meet specific requirements. Eagle Signal Energy Management Systems.
*Circle 137 on reader service card*

**The DMC 2000 digital monitoring control** combines with the company's two-speed heat pump to limit the use of resistance heat in the recovery cycle. The computer controls automatically change temperature settings up to twice a day, to provide both heating and cooling. A stand-by setting keeps the temperature in an unoccupied house from reaching damaging extremes. Tiny sensors located throughout the house relay temperature readings to the monitoring control to improve comfort. General Electric, Air Conditioning Business Div.
*Circle 138 on reader service card*

**A Programmable Lighting Control** that is a microprocessor-based system can be used in both new and existing buildings. It enables automatic time scheduling of lighting, HVAC, and other electrical loads, with manual override capabilities. The controller can schedule up to 8000 loads and be programmed to make up to 1000 schedule changes. There is a battery backup in the event of power outages. General Electric Co., Wiring Devices Dept.
*Circle 139 on reader service card*
[*Products continued on page 243*]


# NEW PRODUCT GUIDE ON Life/Safety Door Controls


**Yours FREE! From Reading-Dorma. 20-page illustrated product guide on the failsafe Dorma F Series and the Reading 101 Series. Covers both electro-mechanical and electro-pneumatic door closers. Includes a Typical Application Chart to simplify correct product selection for specific applications. Contains a Cross Reference Guide to competitive products; also a Function and Size Selector Chart. Get your copy now.**

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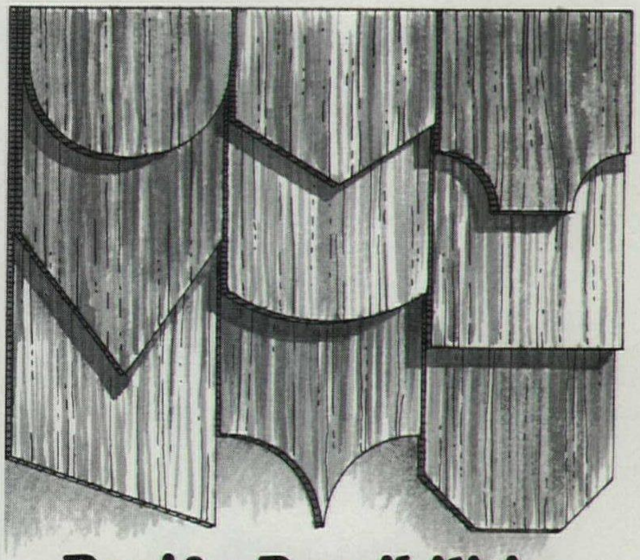

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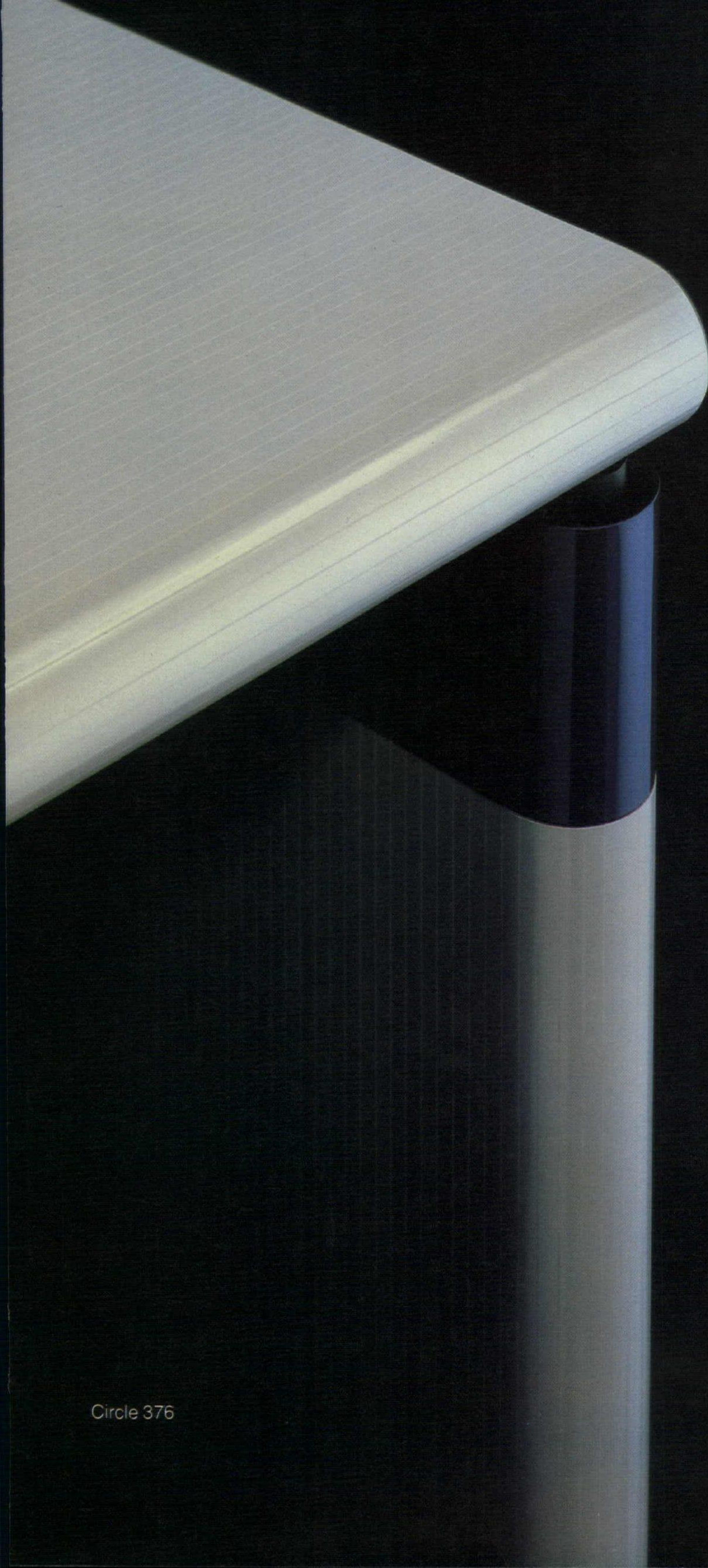

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Circle 376

# E SCHOOL BOARD
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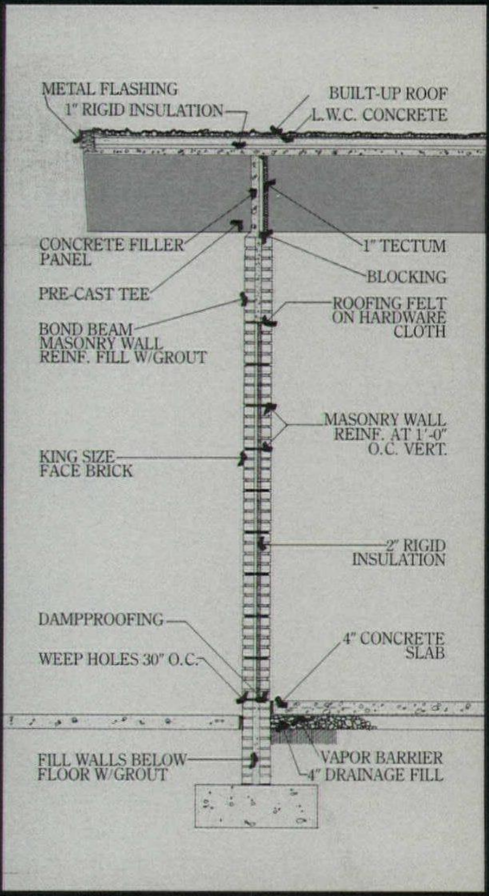
# ME BRICK GAVE
# EM MORE THAN THEY
# RGAINED FOR.

Loadbearing Acme Brick were ed for the Barling Elementary School rt Smith, Arkansas. Its curved walls ry corner were accomplished by a imple factory modification to stan- ing-size brick. The double wythe rovides its own finish surface, both and out. A wall, that for the life of hool has been, and will continue to tally maintenance-free. Maintenance ergy costs have been further ed by limiting the number of exterior ws. Glass breakage has been ed to an absolute minimum.

Miles Shopfner, Director of Mainte- and Purchasing, Fort Smith Public s: *"Glass breakage savings alone stify the selection of brick."* He further *"Our average school interior needs ompletely repainted every ten years, or ore often. This is eliminated at Bar- nd besides, the building is less costly uction-wise."*

Fire safety is another factor all par- nd school officials are concerned Walls of Acme Brick are totally fire- nt. Principal Rex Cochran: *"The fire an exercise we really don't need— alls that just can't burn."*

n this school's seven-year life, the 0 Acme Brick have paid for them- several times over by savings to hool District and the people of mith, Arkansas.




For more information on Acme Brick's Loadbearing Design, and for cost data on Barling Elementary School, call collect (817) 332-4101, ext. 365. Or write Acme Brick Technical Services, P.O. Box 425, Fort Worth, Texas 76107.

**ACME BRICK. THE BEST ALL-AROUND BUILDING MATERIAL.**

Barling Elementary School
*Owner:* Special School District of Fort Smith, Fort Smith, Arkansas
*Architect:* Saxton Wanslow Smith Associates, Fort Smith, Arkansas
*Structural:* Burrough-Uerling-Brasuell, Engineers, Fort Smith, Arkansas
*General Contractor:* Gary Crawford Construction Co., Fort Smith, Arkansas
*Masonry Contractor:* Ronald Ray Masonry Contractor, Fort Smith, Arkansas

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St. Procopius Abbey is an impressive example of contemporary architecture, and like many other recently erected buildings of comparable distinction, it is roofed with TCS (terne-coated stainless steel). There is an inherent logic here, for TCS is unmatched in its resistance to corrosion, never needs maintenance if properly installed, and weathers to a uniform and attractive warm gray. Thus excellence of product complements excellence of design.

# TCS: THE LOGICAL CHOICE

ST. PROCOPIUS ABBEY, LISLE, ILLINOIS ARCHITECTS: LOEBL, SCHLOSSMAN & HACKL, CHICAGO, ILLINOIS ROOFING CONTRACTOR: SYTSMA SHEET METAL, INC. BRIDGEVIEW, ILLINOIS

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C423.2 Commerce Wing, Southern Furniture Center, High Point, N.C. 27261

**Products** continued from page 238

**Distributed Digital Control** computer-based building automation system integrates primary environmental control and energy management supervisory control functions into one system. It is fully compatible with the company's System 600, allowing the use of components to suit building requirements. A simple, on-line exchange of boards allows users to upgrade systems as building needs change. MCC Powers, Mark Controls Corp.
*Circle 140 on reader service card*

**Inn-Command™, a wireless guest room control system,** uses existing building wiring to permit front-desk personnel to place individual room conditioners in occupied or unoccupied status. The control point is a front-desk console. When in the occupied mode, a conditioner will respond to the setting on the thermostat by the room's guest. In the unoccupied mode, it will respond to the setback sensor in the conditioner. Optional features are a message and a wake-up system and a copy printer for room status or listing reports. The Singer Co., Climate Control Div.
*Circle 141 on reader service card*

## Controls literature

**Accustat energy-saving** thermostats include single, multistage, heat-pump, line-voltage, limiter, and setback models. Snap-in setpoint mercury sensors are accurate to ±0.5 F and are free of drift and fatigue. Accustats, which are designed for residential, commercial, and industrial applications, are described and illustrated in an eight-page catalog. PSG Industries, Inc.
*Circle 208 on reader service card*

**'ECON VI Facilities Management'** is a 16-page brochure that describes a computer-based system for central control of building energy consumed and environment. Sensing devices feed information to data acquisition panels that transmit it to the central console. Both hardware and software components are discussed. Barber-Colman Co., Environmental Systems Div.
*Circle 209 on reader service card*

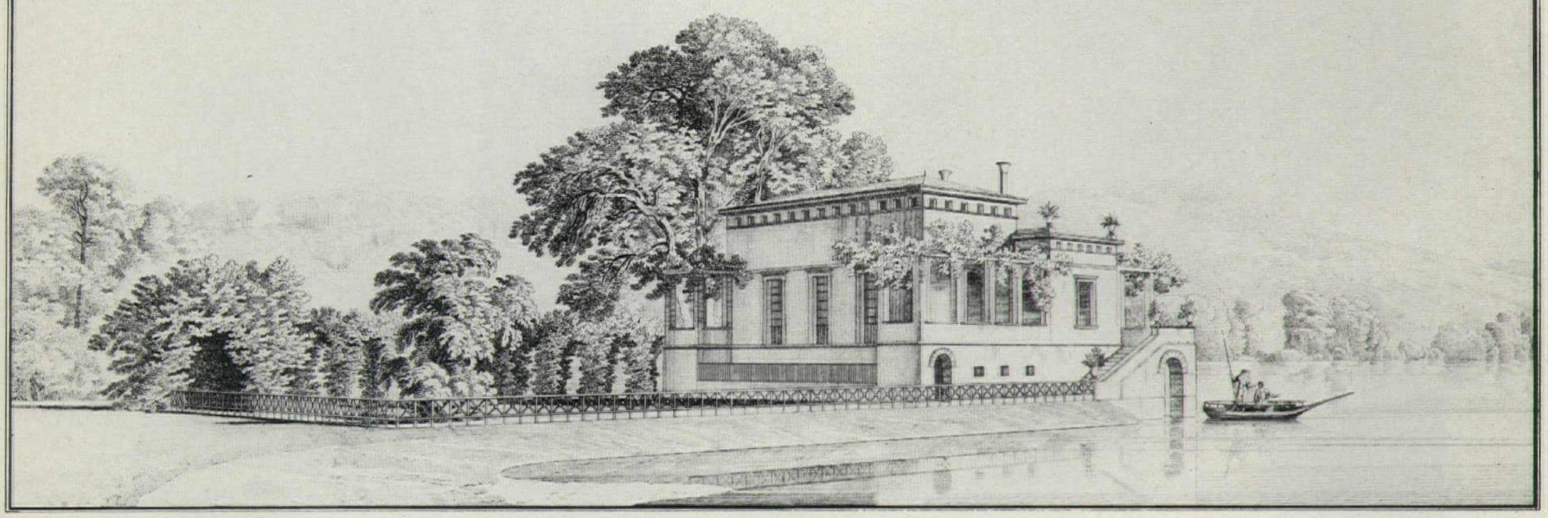
**The Watchdog™ Class 8865 energy management system** is microprocessor-based and designed for use in commercial and industrial applications having monthly electric bills exceeding $1000. Priority, shed and restore times, and weekday and weekend time-of-day scheduling can be entered. The system is described in an eight-page brochure. Square D Co.
*Circle 210 on reader service card*

## Solar products

**The SAV cylindrical solar collector** presents its curved surface at the optimum angle to the sun's radiation during daylight hours. Bounced radiation from the reflective surface over which the cylinder is mounted puts the entire cylindrical surface to use. Model HD-20 uses normal water-line pressure and requires no pumps, storage tanks, wiring, or control devices. Collectors can be arranged in both series and parallel groups for industrial, residential, and recreational uses. SAV Solar Systems.
*Circle 142 on reader service card*

**Trident solar-based energy system** is said to provide complete space heating, space cooling, and domestic hot water. It consists of collector panels, fully insulated storage tanks—one for space heating, one for hot water—tubing that circulates warm water through the con-
[*Products continued on page 246*]


# KARL FRIEDRICH SCHINKEL



A LIMITED FACSIMILE EDITION of Karl Friedrich Schinkel's *Sammlung Architektonischer Entwurfe,* "Collection of Architectural Designs" is now available for immediate delivery from Exedra Books Incorporated. Fully respecting the delicate lithography of the 1866 edition, this new volume maintains the eighteen by twenty-four inch format and includes all 174 original plates plus the first complete English translation of Schinkel's own descriptive commentary. A preface by Mr. Philip Johnson and scholarly essays by Dr. Hermann G. Pundt, author of *Schinkel's Berlin,* and Professor Rand Carter provide contemporary criticism. This new edition of Schinkel's timeless work is limited to one thousand volumes, each in its own boxed folio. Price: US $450.00

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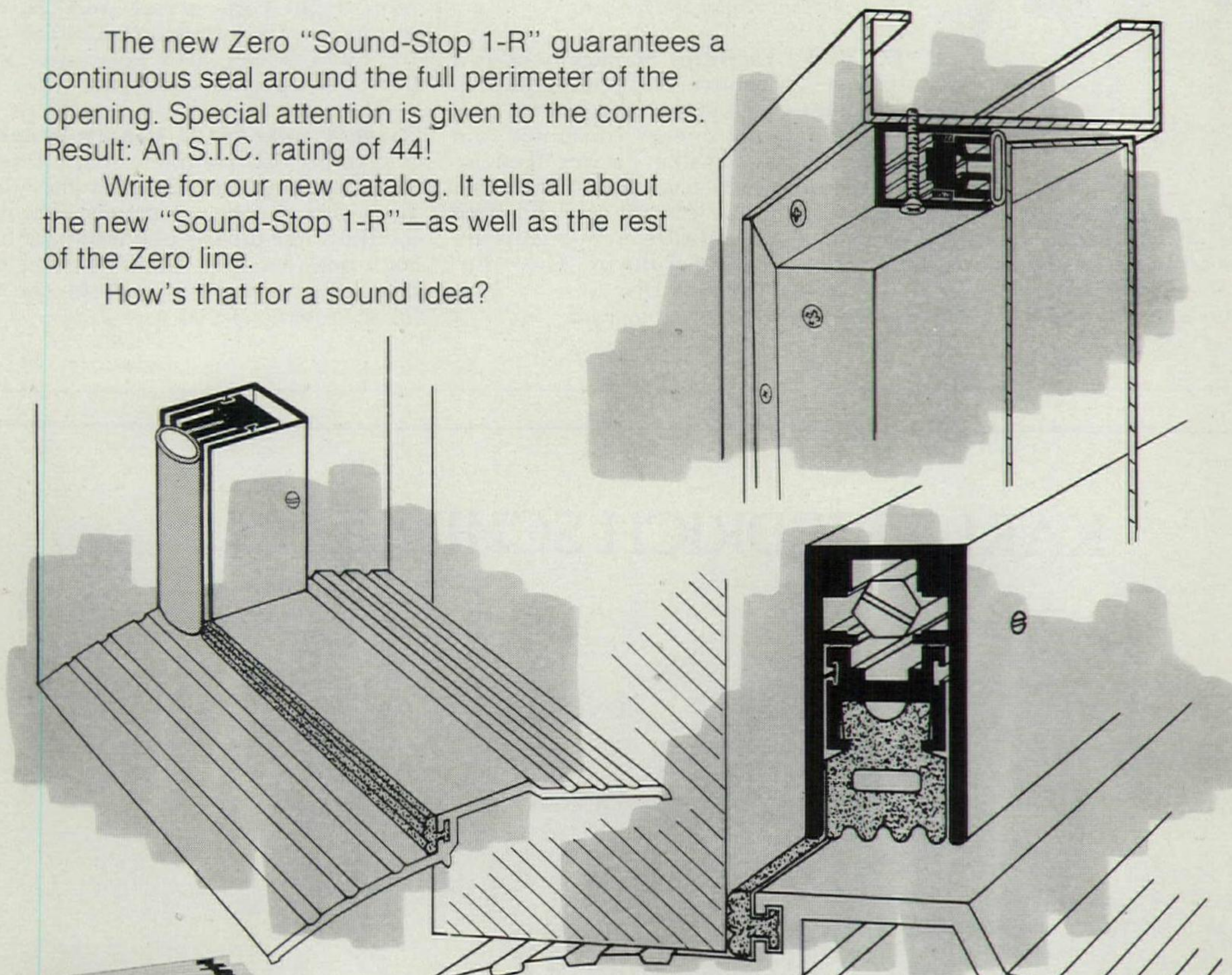
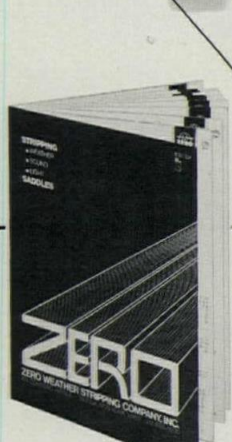
# Zero's new "sound-stop 1-R" door system

The new Zero "Sound-Stop 1-R" guarantees a continuous seal around the full perimeter of the opening. Special attention is given to the corners. Result: An S.T.C. rating of 44!

Write for our new catalog. It tells all about the new "Sound-Stop 1-R"—as well as the rest of the Zero line.

How's that for a sound idea?



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# HOW JUST 1½ CORDS OF WOOD, THE SUN, AND EXOLITE™ SHEET, CARRIED A CONNECTICUT FAMILY THROUGH A FRIGID WINTER.

When Frank and Ruth Cooley built their 1,500 square foot home in a wooded area outside Washington, Connecticut, they decided to eliminate the furnace.

Instead, they chose to rely on EXOLITE double skinned acrylic glazing and a unique passive solar energy system for comfort.

The home not only saved the Cooleys a lot of money in heating bills, but also proved to be an excellent example of a passive solar house that required very little effort by the occupants.

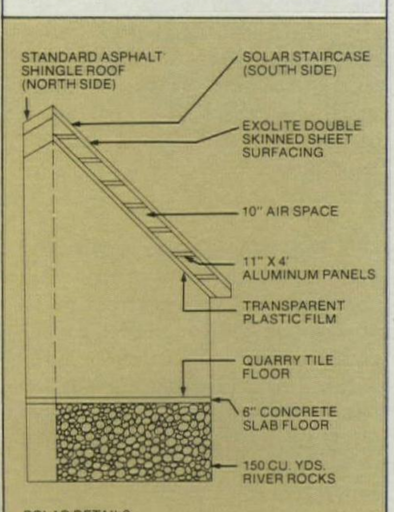
There are no shading devices or night curtains to be opened or closed to prevent heat loss or diffuse the summer sun.

**A solar staircase lets the sun shine in.**

A solar staircase made up of 11″ x 4′ strips of aluminum sheeting, coated with a thin covering of resin and toluene to prevent corrosion and help retain their reflective surface, is positioned between the rafters under the EXOLITE acrylic sheet.

Under the solar staircase is a transparent plastic film attached to the wood rafters.

The solar staircase reflects 75% of the summer sun's rays but allows penetration of 100% of winter sun's rays. The transparent plastic film assures maximum insulation. And EXOLITE acrylic sheet on the roof transmits the sunlight.




Architect: Solsearch Architects, Prince Edward Island, Canada

**How the Cooley house solar collection system works.**

During the winter, the solar staircase allows sunlight to enter the house providing direct gain heating of the south side. A 6″ thick concrete floor acts as a solar energy collector and provides storage.

In addition, a 5′-deep bed of 3″ and up rocks under the slab floor stores excess daytime heat for use at night.

This excess heat is collected by 3¼ hp fans, which pull heat through two ducts from the top of the living area. The outer surface of the ducts is glazed to help prevent heat loss. The interior surface is painted black to absorb more heat.

At night, the slab floor allows re-entry of heat directly to the room. Glazed transoms admit light to the bedrooms on the north side of the house. And the forced air circulation system draws warm air from the top of the rock bed and distributes it to the house, as required.

The only component of the system that requires manual operation is a roof ridge vent that exhausts summer heat.

**EXOLITE acrylic sheet makes it happen.**

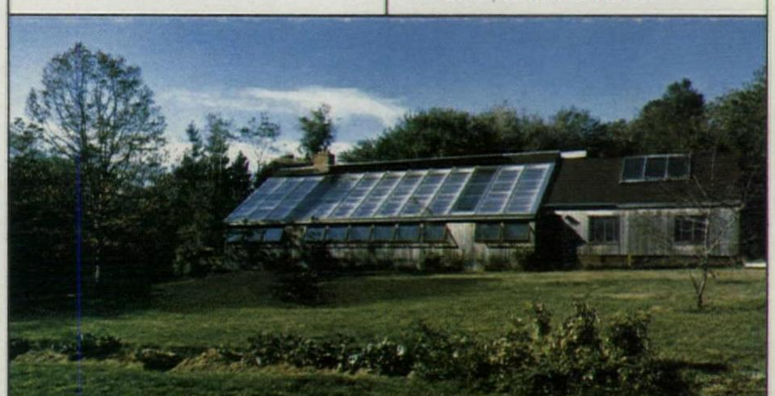
The key to the solar collection system is the south-facing roof glazing, composed of eleven 4′ x 14′ panels of EXOLITE acrylic sheet. The double skinned sheet provides an insulation value equal to 5/8″ insulating glass at a considerably lower in-place cost.

The large glazing area requires a product that offers rigidity, light weight and high light transmittance. The ribbed structure of EXOLITE sheet provides both good stiffness and low weight. It has a light transmittance of 83% and a heat transfer coefficient (U value) of 0.55 BTU/hr./sq. ft./°F. in the summer and 0.58 BTU/hr./sq. ft./°F. in the winter.

And, EXOLITE sheet offers the additional advantage of light diffusion to provide pleasant, not harsh, daylighting.

How well did this passive solar system collect the sun's energy? The Cooleys burned just one and one-half cords of wood in their woodburning stove — the home's only back-up heating system. Ninety percent of their heating requirements came from the sun.

Want to know more? Please contact us at 697 Rt. 46, Clifton, NJ 07015, (201) 560-0485. In Canada: Chemacryl Plastics Limited, 73 Richmond St. W., Toronto, Ont. M5H 2A2.



Caution: EXOLITE double skinned sheets are combustible thermoplastics. Precautions used to protect other common combustibles should be observed. Building Codes should be followed carefully. Further data are available from CY/RO Industries.

CYRO

CY/RO Industries
A Partnership of Cyanamid Plastics, Inc. and Rohacryl, Inc.

Circle **No. 333** on Reader Service Card

**Products** continued from page 243

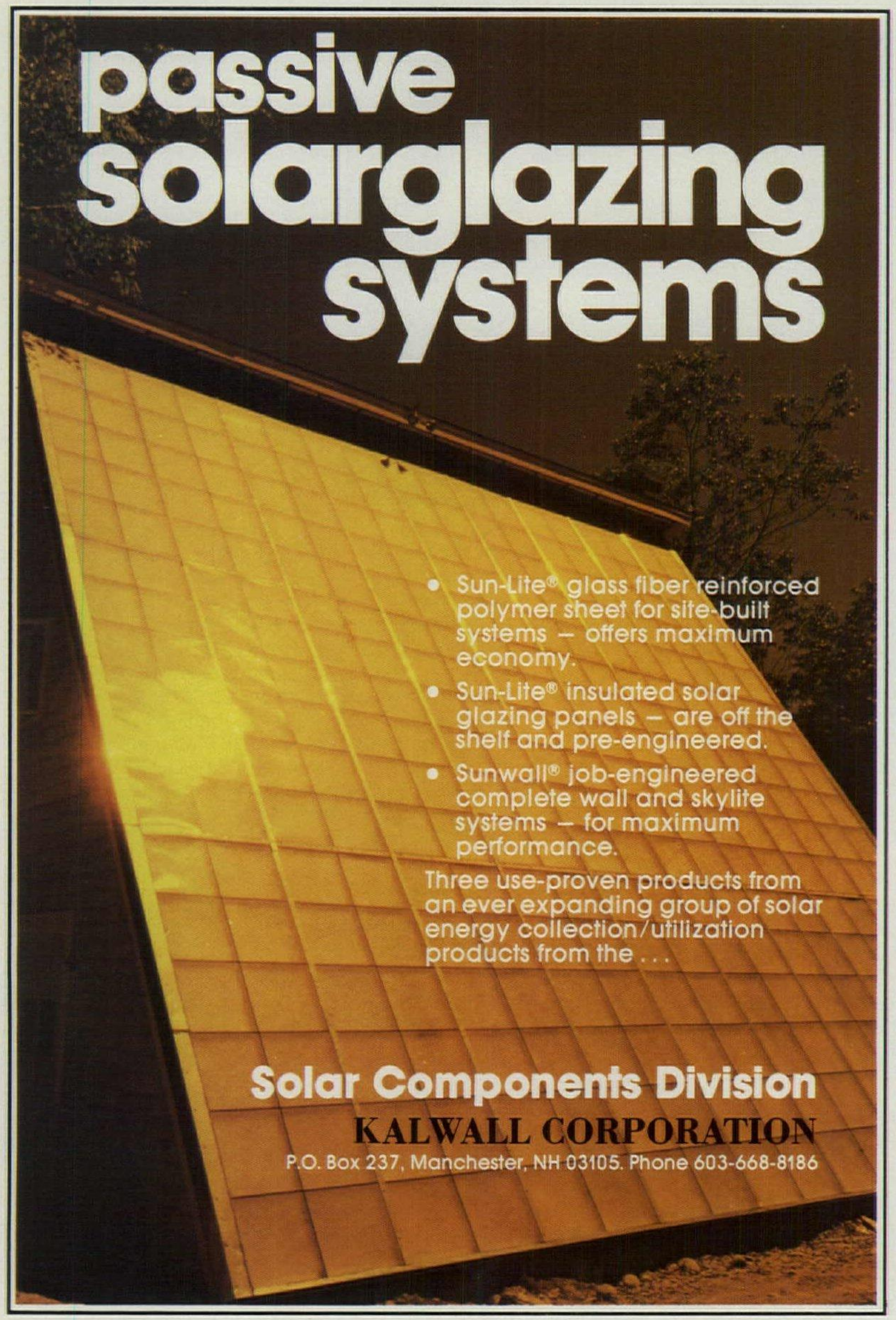
ventional slab for radiant heating, and a computerized controller that monitors air and water temperatures. An integral backup gas-fired unit is automatically activated when solar energy is insufficient. Trident Energy Systems.
*Circle 143 on reader service card*

**Helio-Flo 1 for drain-down solar water heaters** has been redesigned to include an electronic device to eliminate problems of cycling, when fitted with a daily drain-down controller, generally preferred for fail-safe freeze protection. A new regulating valve allows fine tuning of the flow rate for optimum performance. Compact styling makes it easy to install on most standard solar storage tanks. Heliodyne, Inc.
*Circle 144 on reader service card*

**A solar domestic hot water system** combines a conventional domestic hot water tank and a solar fluid storage tank in one compact unit. Heated water is pumped from the draindown tank, through the heat exchanger in the hot water tank, and back to the collectors. A 3-in. layer of insulation gives the tank a rating of R-21. The system uses Sunpak™ evacuated tube solar collectors, with parabolic cusp reflectors to direct sunlight onto the collectors all day. Sunmaster Corp.
*Circle 145 on reader service card*

**A solar collector, Series 4000,** offers features that include tube/fin design and black chrome-plated panels. Two lightweight models are a double-glazed acrylic/Teflon collector weighing 65 lb and a low-iron-glass/Teflon model weighing 95 lb. A "free float" design allows the plate to expand and contract within the frame, and an EPDM gasket maintains a water-tight seal. The all-aluminum frame withstands corrosion, weather, and climate extremes. Sunearth Solar Products Corp.
*Circle 146 on reader service card*

**Sun-Lite® Premium II cylindrical tanks,** made of fiberglass-reinforced polymer sheet, are available for solar energy storage in both active and passive solar heating systems. Because of their strength and wet heat resistance, they can be used to hold most liquids and other materials. Approximately 50 percent of the sun's energy striking water-filled tubes is absorbed for heat storage, and 50 percent is transmitted as natural light. Normal service range is between 34 F and 170 F. They are 18 in. in diameter, 120 in. high, and weigh 20 lb when empty. Solar Components Div., Kalwall Corp.
*Circle 147 on reader service card*




Circle **No. 364** on Reader Service Card

**Solar differential control C-30-1S-2F** offers primary and secondary freeze protection for domestic hot water systems. Control features include an adjustable storage high temperature limit, LED power and pump indicators, LED valve status indicator, and pump-mount fit kits to simplify installation. Independent Energy, Inc.
*Circle 148 on reader service card*

**A solar pool heater,** available with 23- and 29-sq-ft absorber plates, is lightweight and provides uniform thermal efficiency. Integral manifolds, 1½ in. round, accommodate the flow of solar-heated water through the system and the absorber plate, which is constructed entirely of copper. Accessories include mounting bolts, relief valves, hose connections, and clamps. Terra-Light, Inc.
*Circle 211 on reader service card*

**Kopper King CR-4000 solar panel** has a copper absorber plate that provides maximum thermal energy transfer and decreased maintenance. The panel has an iron-free tempered glass that increases light absorption. It has been tested according to ASHRAE 93-97 and meets or exceeds HUD requirements, says the manufacturer. The unit is 30″ x 90″ x 2″ high and weighs 86 lb. Thermex Solar Products Corp.
*Circle 212 on reader service card*

**The HP-150 flat plate solar collector** has internal reflectors around the perimeter of the absorber plate to produce a mild concentration effect by directing extra radiation onto the absorber plate. The reflectors help to capture radiation that might otherwise be lost, extending the hours of collection during the day and over the year. Energy Design Corp.
*Circle 213 on reader service card*

**Two domestic water heating systems,** Solector Pak 2100 and 3000, are prewired and preplumbed systems. Model 2100 is for residential use in relatively
[*Products continued on page 248*]

# Ceco puts out fire doors to meet every label requirement.

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Ceco has the fire door you're looking for. In fact, we can draw from thousands of attractive door and frame combinations to meet all your Underwriters' and Factory Mutual label requirements.

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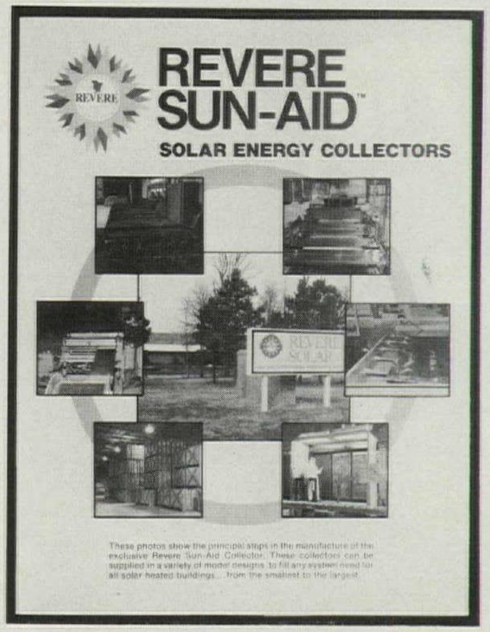
mild climates and consists of internally manifolded solar energy collectors, temperature controls, pumps, shutoff valves for drainage, and electrical connections. Model 3000, intended for use in colder climates, features drainback capacity. Sunworks, Div. of Sun Solector Corp.
*Circle 214 on reader service card*

## Solar literature

**The Collect-A-Ray solar water heater** system is described in a four-page brochure that lists its components and features, and the capacity required, depending on family size. The percentage of hot water needs that can be met range from 55 percent in northern U.S. zones to 80 percent in the south. SJC Corp.
*Circle 215 on reader service card*

**Solcan concentrating solar collectors** track the sun in a 180-degree rotation to provide efficient, all-day collection. They can be used with domestic hot water or space-heating systems. A four-page brochure describes the collectors and provides specifications. Solar Resources International.
*Circle 216 on reader service card*

**Solar air systems** for space and water heating are described in a four-page brochure. It discusses the advantages of the four modes: collector to house, collector to storage, storage to house, and collector to water. Solar Farm Industries.
*Circle 217 on reader service card*

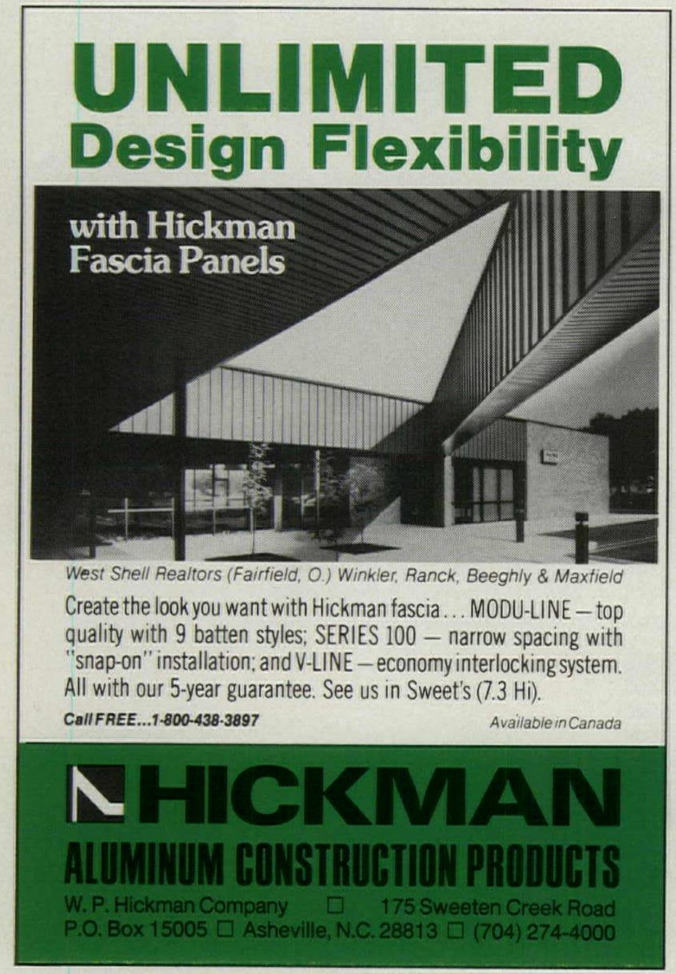



**Sun-Aid™ solar energy collectors** brochure includes dimensions, product features, material specifications, sample engineering specifications, and collector efficiency rating charts. A reply card enables the reader to request information on systems. Revere Solar and Architectural Products, Inc.
*Circle 218 on reader service card*

**Sunpak™ evacuated tube solar collector** is described in a 16-page, full-color brochure. Information provided includes performance data, engineering data, and product specifications for three types of collectors. Photos show typical installations. Sunpak, Owens-Illinois, Inc.
*Circle 219 on reader service card*

**'Materials—Key to Solar Success'** is a 12-page brochure that discusses the properties and use of silicone material in solar energy systems. Drawings show where the materials are used: energy conservation in buildings, flat plate collectors, concentrating collectors, solar electric units, passive systems, and valves and controls. Dow Corning Corp.
*Circle 220 on reader service card*

**Concentrating Solar Collector Model 3001-03** for high-temperature applications is described in a data sheet. It is designed to heat fluids to temperatures from 140 F to 600 F with typical applications including industrial process hot water and steam, space heating and cooling, and Rankine cycle power generation systems. Acurex Solar Corp.
*Circle 221 on reader service card*
[*Literature continued on page 252*]



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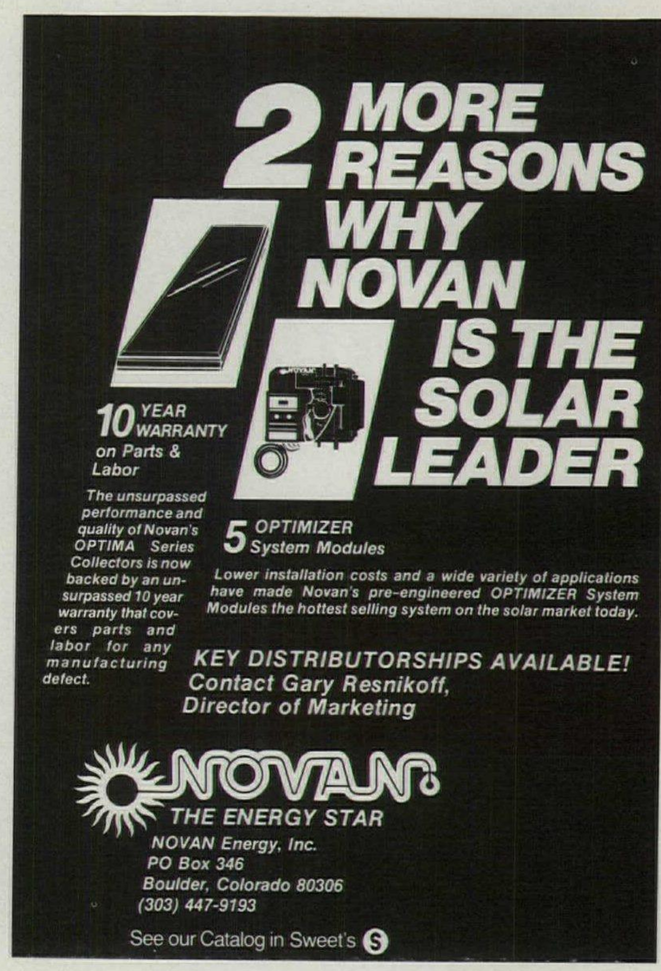

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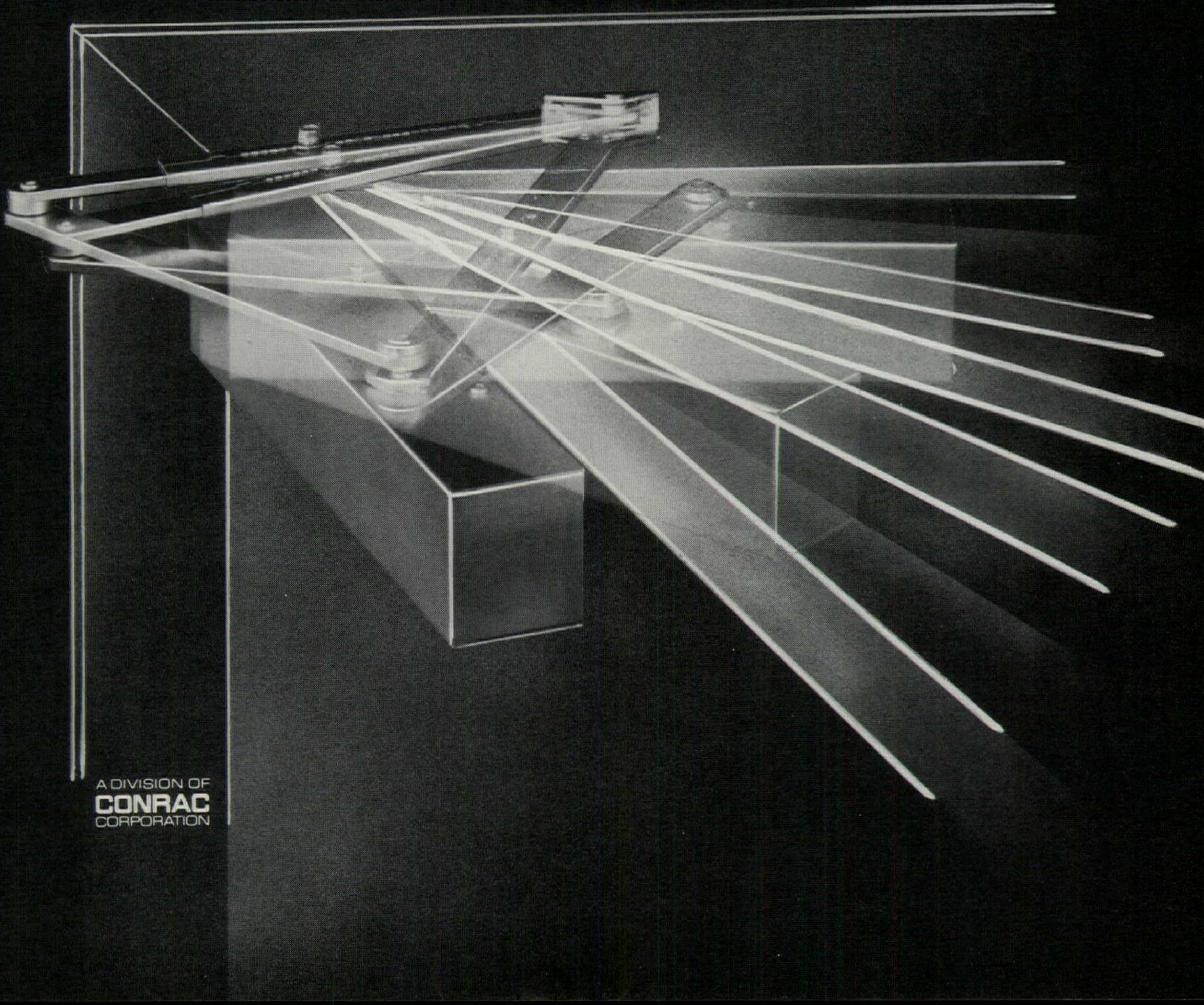

**Here, for the first time in this century,** is an opportunity to re-examine the philosophy of the Beaux-Arts school of architecture.

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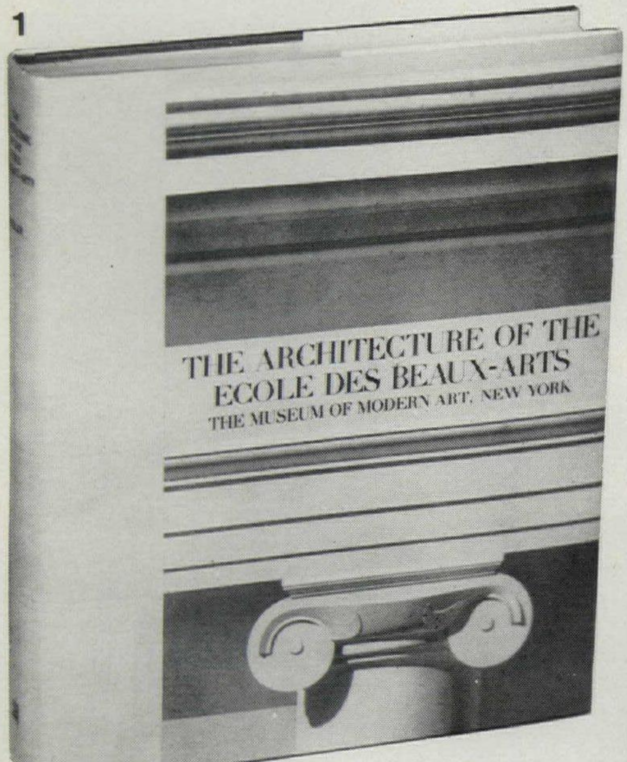


2 3 4★ 5 ★8 7 10 6 9


# P/A Book Store

Each book has been selected for its usefulness to you in your professional practice. **Prices slightly higher in Canada. Foreign orders must be accompanied by payment.** It is not necessary to send payment with the order. Circle appropriate numbers on the Reader Service Cards in the back of this issue, add your name and address and mail. Local sales tax **must** be included with payment. Prices subject to change.

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## P/A Back issues

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February ...... Two by HHPA/Moisture control
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November ..... Remodeling and reuse/Product design
October ....... Italian Rationalists/Fire protection

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### 1 The Architecture of the Ecole des Beaux-Arts

Edited by Arthur Drexler with essays by Richard Chafee, David Van Zanten, Neil Levine and Arthur Drexler
423 pp., illus. . . . $55.00

The most comprehensive analysis and documentation of Beaux-Arts architecture ever published. Includes large-scale drawings of elevations and plans and photographs of major French and American Beaux-Arts buildings (including Pennsylvania Station and Grand Central Terminal).
**Circle B601 under Books.**

### 2 Energy Conservation Through Building Design

Edited by Donald Watson,
305 pp., illus. . . . $24.25

This precedent-setting book provides the bridge between architect and engineer, practitioner and researcher, so necessary to the development of a rational approach to energy conservation. Not limited to new building designs, it also includes methods of analyzing existing structures and specific ways to reduce their energy consumption.
**Circle B602 under Books.**

### 3 Architectural Rendering: The Techniques of Contemporary Presentation

By Albert O. Halse, 326 pp., illus., 2nd edition, 1972 . . . $39.95

This completely up-dated revision of the most widely used guide to architectural rendering covers all working phases from pencil strokes to finished product — and shows how to obtain the desired mood, perspective, light and color effects, select proper equipment and work in different media.
**Circle B603 under Books.**

**NEW★**

### 4 Architecture: Form, Space and Order

By Francis D.K. Ching,
294 pp., illus. . . . $22.50

Written to foster understanding of design concepts, this rich source of architectural prototype demonstrates how to extract the fundamental principles of form and space from the environment, whether in the architectural one views or inhabits, in architectural visualization, in drawing, or in actual design.
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### 5 Affordable Houses Designed by Architects

Edited by Jeremy Robinson,
168 pp., illus. . . . $19.95

This lavishly illustrated volume shatters the myth that architect-designed houses are more costly than developer-built houses. The superb photographs, floor plans, drawings, and details of interiors and exteriors present a wealth of ideas on how to construct beautiful and unique houses within limited budgets.
**Circle B605 under Books.**

### 6 Design Competitions

By Paul D. Spreiregen,
310 pp., illus. . . . $27.50

The first comprehensive guide to design competitions based on American practices, it examines in detail all important aspects of this timely subject, including how competitions work and the ground rules that govern most competitions.
**Circle B606 under Books.**

### 7 Design and Planning of Swimming Pools

By John Dawes,
276 pp., illus. . . . $49.95

A comprehensive manual that describes the essential characteristics and consequent design requirements of every type of pool imaginable. Also deals in great detail with more technical matters, such as structural problems and how to solve them, finishes, filtration, circulation and water treatment, heating and ventilating.
**Circle B607 under Books.**

**NEW★**

### 8 Landscape Design with Plants

Edited by Brian Clouston
456 pp., illus. . . . $39.95

A comprehensive manual, which compliments "Landscape Techniques", combines (for the first time in a single volume) the theoretical and practical aspects of landscape design with plants. The text is divided into three parts, each with a different focus.
**Circle B608 under Books.**

### 9 A Golden Thread 2500 Years of Solar Architecture and Technology

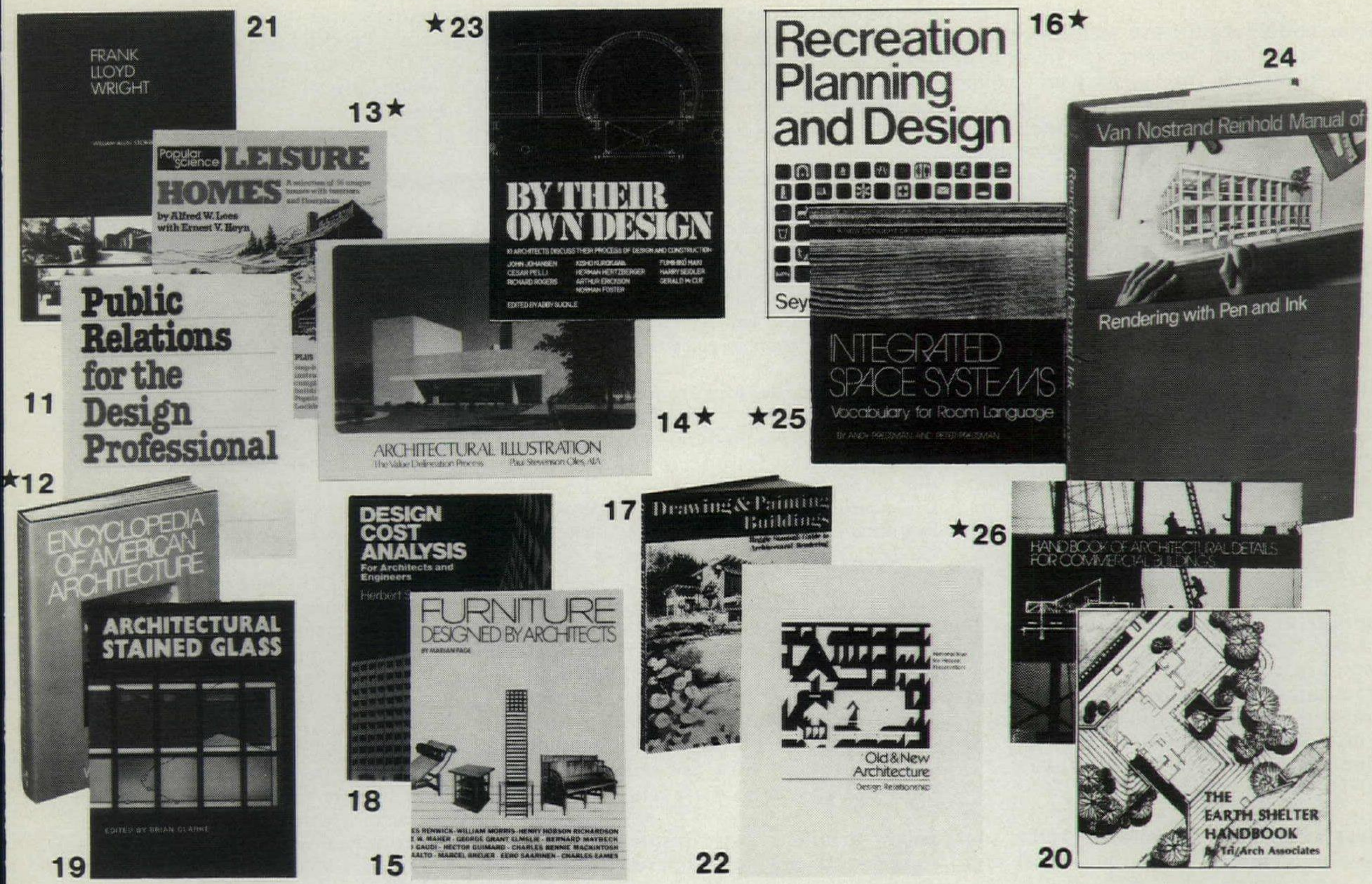
By Ken Butti & John Perlin,
304 pp., illus. . . . $15.95

This carefully researched narrative not only presents a history of solar energy use, but also demonstrates that successful solar energy applications of the past pave the way toward a society that depends on the sun for a large part of its heat, light and motive power.
**Circle B609 under Books.**

### 10 Water in Landscape Architecture

By Craig S. Campbell
128 pp., illus. . . . $15.95

This profusely illustrated book is the first published work that deals in substantial detail with the technical as well as the aesthetic principles of fountain design. Covers basic hydraulic principles, practical limitations, environment and available equipment.
**Circle B610 under Books.**




**11** **Public Relations for the Design Professional**

By Gerre Jones,
278 pp., illus. . . . $21.50

An authoritative book on public relations written in easily understood language for architects, engineers and other design professionals. Explains how to plan, set up and carry out a PR program that meets special requirements, as well as how to take advantage of some often overlooked opportunities for free publicity from the media.
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**NEW★**
**12** **Encyclopedia of American Architecture**

By William Dudley Hunt, Jr.
612 pp., illus. . . . $39.95

Presents in words and illustrations the full, rich fabric of American architecture. The volume narrates the full, fascinating scope and splendor of American architectural tradition. It contains biographical profiles of 50 American innovators.
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**NEW★**
**13** **Leisure Homes**

By A. W. Lees with E. V. Hyen,
320 pp., illus. . . . $18.95

The homes collected in this informative guide represent a broad spectrum of imaginative architectural design. Floor plans and interior views of 56 stunning leisure homes are shown in striking color, plus step-by-step instructions and complete plans for building the *Popular Science* Lockbox House.
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**NEW★**
**14** **Architectural Illustration The Value Delineation Process**

by Paul Stevenson Oles,
288 pp., illus. . . . $34.50

In this copiously illustrated, clearly organized explanation of his value delineation system, the author presents a detailed description of the process which has resulted in these award-winning delineations that show realistically how a designed structure will appear when built.
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**15** **Furniture Designed by Architects**

By Marian Page,
224 pp., illus. . . . $25.00

This well-illustrated volume features 26 prominent architects whose work, spanning two centuries, encompasses a broad spectrum of styles. The author explores the architects' reasons for their designs, as well as how they related to their time, place and contemporaries.
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**NEW★**
**16** **Recreation Planning and Design**

By Seymour M. Gold
322 pp., illus. . . . $27.50

This book integrates systems and site planning with state-of-the-art examples highlighting recreational potentials of cities in the 1980's. Successful plans and projects are described showing innovative approaches to recreation planning.
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**17** **Drawing & Painting Buildings**

By Reggie Stanton,
144 pp., illus. . . . $17.95

A one-volume library on architectural rendering shows how to render the many components, props and elements in terms of setting, mood and composition for both residential and commercial projects.
**Circle B617 under Books**

**18** **Design Cost Analysis for Architects & Engineers**

By Herbert Swinburne,
317 pp., illus. . . . $21.50

This first-of-its-kind book shows architects and engineers how to analyze and estimate the costs of building construction during the design stage when the potential for controlling costs is greatest.
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**19** **Architectural Stained Glass**

Edited by Brian Clarke
234 pp., illus. . . . $32.95.

The contributors to this book (through their stunning designs) emphasize stained glass as a constructivist art form, taking it out of its medieval ecclesiastical context and putting it into a contemporary framework, both secular and architectonic.
**Circle B619 under Books.**

**20** **The Earth Shelter Handbook**

By Tri-Arch Associates,
244 pp., illus. . . . $12.95

This paper-back handbook presents to architects, builders, private homeowners and commercial clients an easy-to-follow, step-by-step evaluation plan for site selection, soil evaluation and criteria for placement in relation to wind and sun.
**Circle B620 under Books.**

**21** **The Architecture of Frank Lloyd Wright A Complete Catalog Second Edition**

By William Allin Storrer,
456 pp., illus. . . . $15.00

This second edition, which documents all of the buildings designed by Wright, replaced a number of photographs with new ones that show the buildings to better effect, changed some copy in the text, and incorporated factual information that has come to light since the original publication in 1974.
**Circle B621 under Books.**

**22** **Old and New Architecture: Design Relationship**

280 pp., illus. . . . $25.00

How to make new architecture compatible with its current setting, whether in the midst of a large historic urban area or as an addition to an old building, is analyzed in this first comprehensive book on the subject by 18 design experts.
**Circle B622 under Books**

**NEW★**
**23** **By Their Own Design**

Edited by Abby Suckle,
160 pp., illus . . . . $19.95

Ten internationally known architects describe their concerns, both artistic and pragmatic, as they related to the process of designing and constructing one or more of their major buildings.
**Circle B623 under Books**

**24** **Rendering With Pen and Ink**

By Robert W. Gill,
368 pp., illus. . . . $12.95

This paper-back edition is a copiously illustrated guide to the techniques and methods of rendering, including sections on perspective, projection, shadow, reflections, and how to draw cars, ships, aircraft, trees, and human figures. The author also describes the very wide range of instruments and equipment currently in use.
**Circle B624 under Books.**

**NEW★**
**25** **Integrated Space Systems Vocabulary for Room Language**

By A. Pressman & P. Pressman,
116 pp., illus. . . . $16.95

This unique volume describes the theory and practices of integrated space systems, a novel approach to home renovation that promotes the economical and humanistic use of space, without damage to the existing structure.
**Circle B625 under Books.**

**NEW★**
**26** **Handbook of Architectural Details for Commercial Buildings**

By Joseph DeChiara
506 pp., illus. . . . $32.50

This Handbook illustrates and examines the full range of architectural details currently used for commercial buildings. Part I features plans, elevations, and sections for office buildings, banks, retail stores, theaters, and more. Part II concentrates on architectural details. Practicality and realism are stressed.
**Circle B626 under Books**

**Literature** continued from page 248

**Solar collectors** for use with hot water, pool, and space heating are described and illustrated in a six-page color brochure. Features of the deluxe, standard, and economy models are listed, and diagrams show cross-sections of each type. All have aluminum frames, all-copper absorber plates, and tempered glass coverplates. AcroSun Industries.
*Circle 222 on reader service card*

**NOVA™ solar collectors** are described and illustrated in a four-page brochure that discusses the use of solar heat and shows the collector components, with detail drawings of its construction. Efficiency tests of the NOVA collector, conducted under standards of ASHRAE 93-77, are also provided. Applications are in residential, commercial, and industrial water heating. American Home Solar Energy Systems, Inc.
*Circle 223 on reader service card*

**SunCeiver® solar collectors** are described in a data sheet that provides technical information about dimensions, materials, and performance. A detail drawing shows the collector construction and components. Halstead & Mitchell, Div. of Halstead Industries.
*Circle 224 on reader service card*

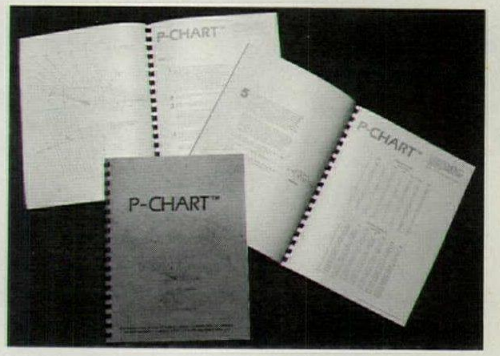
**Heat Exchanger Module CF 100A,** for new or retrofit domestic hot water systems, is compatible with any conventional gas, electric, or oil hot water system when used in a two-tank or preheat configuration. A data sheet describes the heat exchanger, illustrates its installation, and includes schematic drawings. Grumman Energy Systems, Inc.
*Circle 225 on reader service card*

**Flat plate air solar collector A-24,** for use primarily in new construction, is described in a data sheet. Characteristics of the collector system are listed, and drawings show how the collectors are installed. General Solar Systems, Div. General Extrusions, Inc.
*Circle 226 on reader service card*

**Three solar collectors** are described in a four-page folder. Specifications are provided for two air-type collectors and one with liquid for use in supplementing home heating or hot water heating for home or business. Bethany Solar Systems.
*Circle 227 on reader service card*

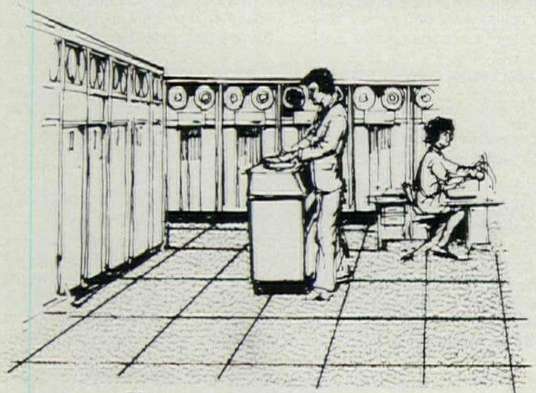
**Solar energy chambers** for both liquid and air storage systems are assembled of panels insulated with 4 in. of foamed-in-place urethane with an R-value of 34. A data sheet describes and illustrates each type of chamber, provides specifications for each, and discusses accessory items. Bally Case & Cooler, Inc.
*Circle 228 on reader service card*

**Solar products** for residential and commercial use are described in an eight-page catalog. Included are space and hot water heating systems, pool and spa heaters and accessories, and solar collectors. Product drawings and system installation drawings illustrate products and their application. Futuristic Solar Systems Corp.
*Circle 229 on reader service card*




**P-Chart tables** can be used to determine the most cost-effective passive design by comparing different types of systems, materials used, whether to use night insulation, quantity and quality of night insulation, alternative building designs using different heating loads, back-up fuels, fuel inflation estimates, and mortgage rates. Determinations can be made with a simple, nonprogrammable calculator. The tables can be used for direct gain, thermal storage wall/ masonry storage wall, and water storage wall passive systems. Solar Energy Design Corporation of America.
*Circle 230 on reader service card*

**Now, all the benefits of carpeting... with better static protection than tile.**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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.

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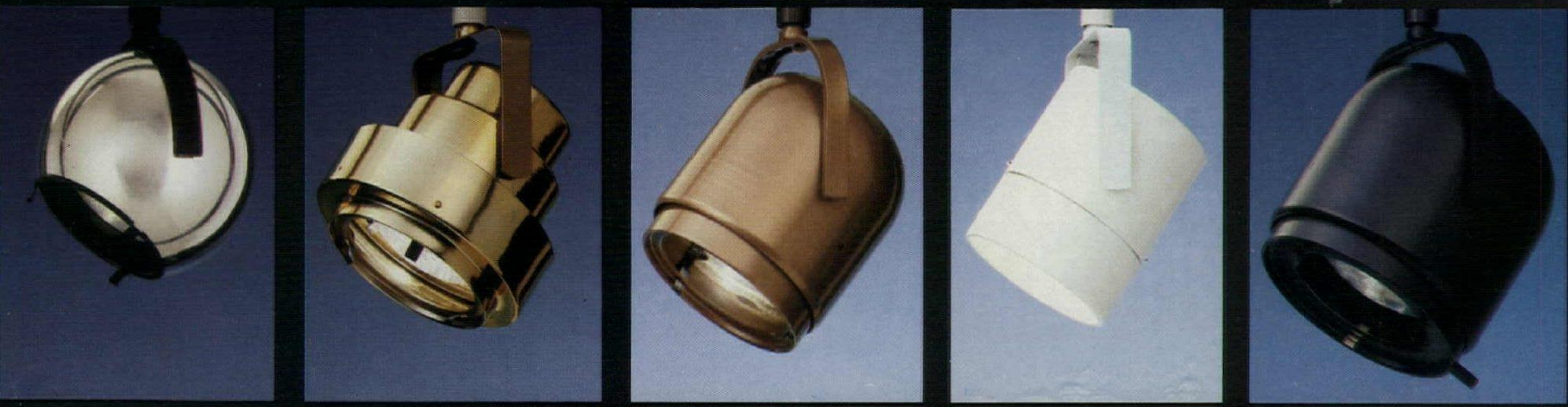
# LESS IS MORE.



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Progress Low Voltage Track Lighting does it for the Hillman Hall of Minerals and Gems in Pittsburgh's Carnegie Museum of Natural History.

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So rest assured next time you specify a contract carpet of either solution dyed Zeftron 500™ nylon or stock dyed Zeftron nylon, you'll get the same outstanding benefits that made the Zeflon nylons market leaders.

- multiple soil hiding and soil resistant properties
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For more details on Zeftron nylon, write for our brochures. Badische Corporation, Williamsburg, VA 23185. You'll find the only change in our story is the name.

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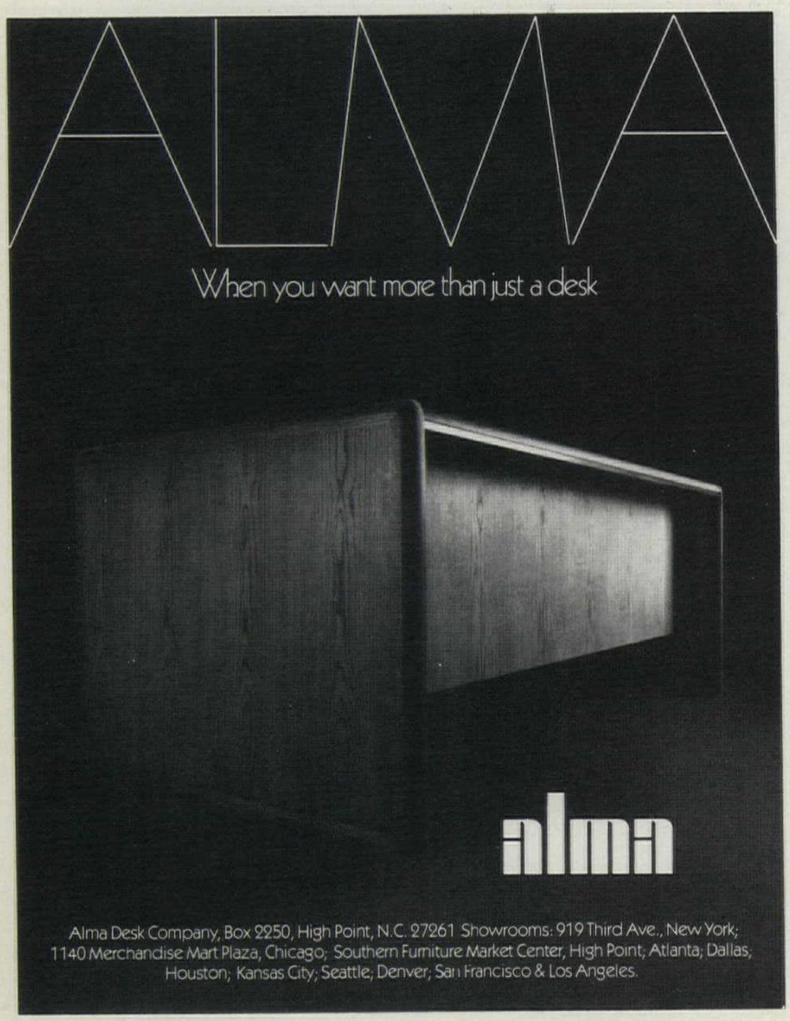
## Building materials

**Major materials suppliers for buildings that are featured this month, as they were furnished to P/A by the architects.**

**Museum of Science and Industry, Tampa, Fl (p. 108).** *Architects: Rowe Holmes Associates, Tampa, Fl.* Continuous strip footings reinforcement: Florida Steel Corp. Space frame roof: Unistrut Corp. Concrete floors: Prestressed Systems. Roof: Roll Form Products. Skylights: Pam-Hillsdale Industries, Inc. Doors: Steelcraft. Overhead metal doors: Jim Walter Corp. Carpet: "Ironclad" by Patcraft Mills, made of Zeftron 500™ by Badische Corp. Roofing: GAF. Waterproofing: Mameco International. Insulation: Dow Chemical Co., Johns-Manville. Accent paint: Glidden Paint. Stain and waterproofing: Chemprobe Prime-A-Pell. Hardware: Corbin, Rixson-Firemark. Intercom: Bogen. Public address: Southdolier. Fire detection, lighting, sprinklers: Automatic Sprinkler. Lighting protection: Heary Brothers. Elevators: Montgomery Elevator Co. Lighting: Hydrell Corp., Westinghouse Airport Systems, Moldcast Lighting, Lightolier, Benjamin Electric Mfg., Federal Pacific Electric. Waterclosets: Crane, Beneke Corp. Plumbing fixtures: Tyler Pipe/Wade, Sloan Valve Co., Bobrick Washroom Equip., Elkay. Air compressor: Ingersoll-Rand. Water heaters: Jackson Mfg. Co. Air conditioning: Carrier Corp., Technical Systems, Inc. Environmental controls: Honeywell, Airflow Co. Casework: J.E.L. Millwork.

**The Hotsy Corporation, Englewood, Co. (p. 114).** *Architect: Richard L. Crowther, Denver, Co.* Concrete foundation: Mobile Premix. Prestressed concrete structure: Stanley Structures. Exterior metal studs: Metal Stud Forming, Inc. Exterior wall surfacing: Compo Industries. Interior wall surfacing: U.S. Gypsum. Thermal windows: Kawneer. Skylights: Donn Products. Hollow metal insulated doors: Gate Way Metal Products. Solid core wood doors: Scottsbluff Sash & Door. Flush steel door: Overhead Door. Exterior paving: Brannon Sand & Gravel. Wood parquet interior floors: Harris Manufacturing. Suspended ceiling: Conwed Corp. Roofing: Carlisle Tire & Rubber. Sealants: Carlisle Tire & Rubber. Polystyrene: Advance Foam Plastic. Roof drain: Smith Manufacturing Co. Interior metal studs: Amtco. Interior paint: KWAL Paints, Inc. Hardware: Schlage. Ice maker: Sub Zero. Refrigerator & dishwasher: General Electric. Cook top: Thermador. Background sound: Mood Music. Security: Denver Burglar Alarm. Exterior signage: Advance Neon Sign Co. White board: Claridge Products. Steel stairs: General Welding. Custom handrails: Shaw Construction. Exterior lighting: Kim Lighting. Interior pendant lighting: Columbia Lighting. Downlighting: Kurt Van Sen. Metal conduit: Staff. Lavatories, water closets, and plumbing: Eljer. Toilet stalls: Amtco. Washroom accessories: Bobrick. Water fountains: Cordley. Water heater: State. Solar heated air radiant panels: Solaron Co. Variable air volume system: Trane. Pneumatic environmental control system: Barber-Colman Controls. Carpets: Bigelow. Executive desk: Interiors International. Seating: Thonet. Tables: Intrex. Conference tables: Vecta. Chairs: Knoll International. Vertical blinds: Solas International. Screen & projector: Colorado Visual Aid.

**Milford Reservation Environmental Center, Milford, Pa (p. 118).** *Architects: Kelbaugh & Lee, Princeton, NJ.* Concrete spread footings: Widener Concrete. Rubber floor covering: Novament. Windows: Caradco, and custom made. Skylights: CY/RO. Overhead doors: Raynor Mfg. Co. Asphalt shingle and corrugated asphalt sheet roofing: Onduline. Waterproofing panels: Volclay. Insulation: Homasote. Concrete block partitions: Soundblock. Glass block partitions: Pittsburgh Corning. Hardware: Stanley, Schlage, LCN, Von Duprin. Lighting: Moldcast, Lightolier. Plumbing: American-Standard, Eljer, Bobrick, Western. Composting toilets: Main Tank, Clivus Multrum. Wood/oil-fired furnace: Riteway. Wood-burning stove: Bow and Arrow. Fireplace: Heatilator.
[*Building materials cont. on page 256*]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**Building materials** cont. from page 255

Carpeting: Wellco. Roll-up thermoshades: Solar Energy Construction.

**Main Post Office, Aspen, Co (p. 122).** *Architect: Copland Hagman Yaw, Ltd., Aspen, Co.* Waterproof membrane: Okon. Paint: PPG. Metal laminate: The October Co. Windows: Consolidated Aluminum. Interior wood doors: Weyerhaeuser. Interior metal doors: Fenestra. Overhead door: Overhead Door Co. Exterior paving: Elam Construction Co. Resilient tile: GAF. Damp proofing: Contech, Inc. Silicone sealant: General Electric. Loose insulation: Permalite. Roof and deck drainage: Zurn. Hinges: Henry Soss & Co. Locksets: Yale. Door closure: Norton. Wall stops: Ives. Weatherstripping: Pemco. Fire alarms: Fire Light Alarms. Steel stair: Steel Fabricators. Lighting: Universal Ballast, Lightolier. Emergency lighting: Devine Lights. Electrical distribution: Westinghouse. Lavatories: Universal-Rundle. Plumbing fittings: Chicago. Flush valves: Sloan. Toilet stalls: Knickerbocker Partition Corp. Washroom accessories: American Dispenser. Water fountains: Haws. Sprinklers: Reliable Auto-Sprinkler. Water heater: Industries, Inc. Solar collectors: Solar. Boiler: Weil McFain. Baseboard radiation: Trane. Supply fans: Pace. Heat exchangers: Taco. Humidifier: Armstrong. Evaporative cooler: Pace. Temperature control: Honeywell. Exhaust fans: Pace. Carpet: GFI. Service counter: Colonial Cabinet & Door.

**Federal correctional institution, Bastrop, Tx (p. 126).** *Architects: CRS, Inc., Houston, Tx.* Tubular steel columns encased in concrete: Capitol Cement and American Steel & Aluminum Co. Precast concrete deck: Houdaille Industries; reinforcing, Ceco Corp. Wood trusses: Wood Structures, Inc. Steel joists: Vulcraft. Sealant: G.E. Silicone. Insulation: Owens-Corning Fiberglas. Fire alarm system: ZECO/Annandale. T.V. monitoring system: Motorola Communications & Electronics. Sound system: Dukane Corp. Steel stairs and rails: American Steel & Aluminum Co. Site lighting: Crouse-Hinds Co. Fluorescent interior lighting: Columbia Lighting Co. Wall-hung plumbing fixtures: Crane. Shower equipment: Bradley. Flush valves: Sloan. Water fountains: Halsey Taylor. Sprinklers: Longhorn Fire Sprinkling Co. Temperature controls: Powers Regulator Co. Solar collectors: Cole Solar Systems. Solar circulation pump: Armstrong Pumps, Inc. Piping control valves: Powers Regulator. Solar storage tanks: Holland Equipment Co. Heat exchangers: Adamson Co. Water-to-water storage tanks: PVI. Automatic temperature controls: Powers Regulator. Gas-fired boilers: Cleaver-Brooks. Hot water pumps: Pacific Pumping Co. Absorption water chiller, air handling equipment, fan coil units, centrifugal chillers: York Div., Borg-Warner Corp. Cooling tower: Marley Company. Chilled water pumps: Pacific Pumping Co. Office panels in the administration area: Herman Miller.

**Stockebrand Residence, Albuquerque, NM (p. 134).** *Architect: Edward Mazria & Associates, Albuquerque, NM.* Concrete foundation: Chihuahua Concrete. Concrete block walls: Crego Block Co. Exterior insulation: Dryvit System, Inc. Windows: Marvin Window. Translucent panels: Kalwall. Exterior paving brick: Pueblo Brick Co. Interior paving brick: Kinney Brick Co. Silicone sealant: General Electric. Polysulfide sealants: Dow Chemical. Cellulose fiber, rigid urethane board: Celotex Corp. Wood sealer: Flood Co. Paint: Wellborn Paint Co. Hardware: Stanley. Locksets: Emhart Corp. Lighting: Sterling Scoville. Tubs, lavatories, water closets, whirlpool baths: Kohler. Plumbing fittings & showerheads: American-Standard. Bathroom accessories: Nu Tone.

**Brodhead House, La Honda, Ca (p. 138).** *Architects: Robert Fernau and Laura Hartman, Berkeley, Ca.* Concrete block: Basalt. Redwood bevel siding: Arcata. Aluminum and wood windows and wood doors: Paramount and Buckley. Single-pitched skylights: O'Keefe's. Quarry tile: Kraft Tile. Composition shingles: Johns-Manville. Paint: Martin Senour. Stove: Wolf. Light fixtures: [*Building materials cont. on page 258*]


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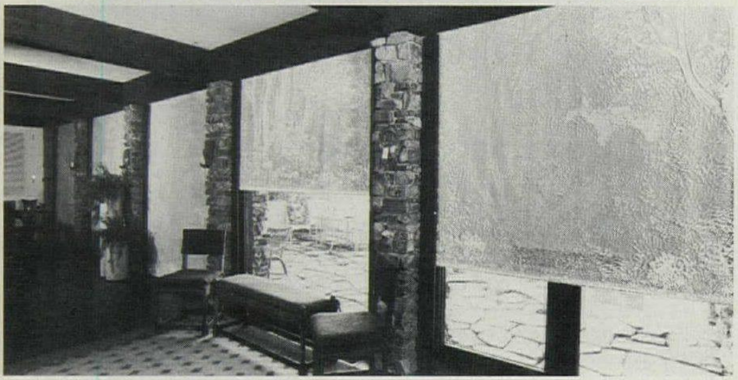

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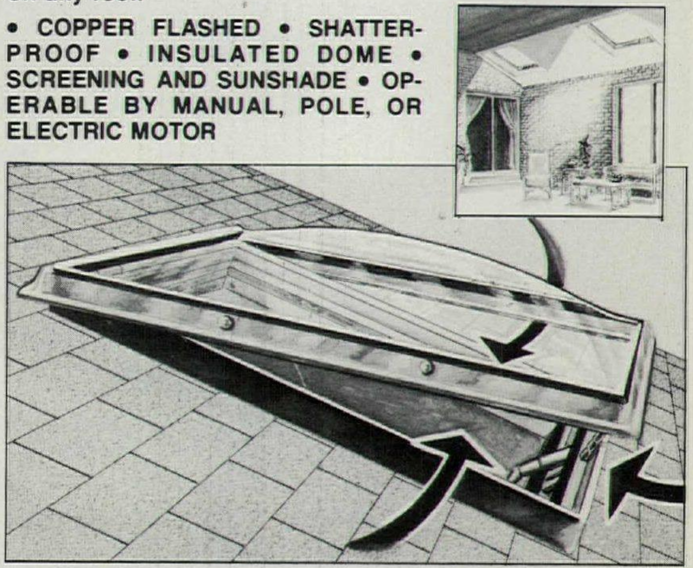

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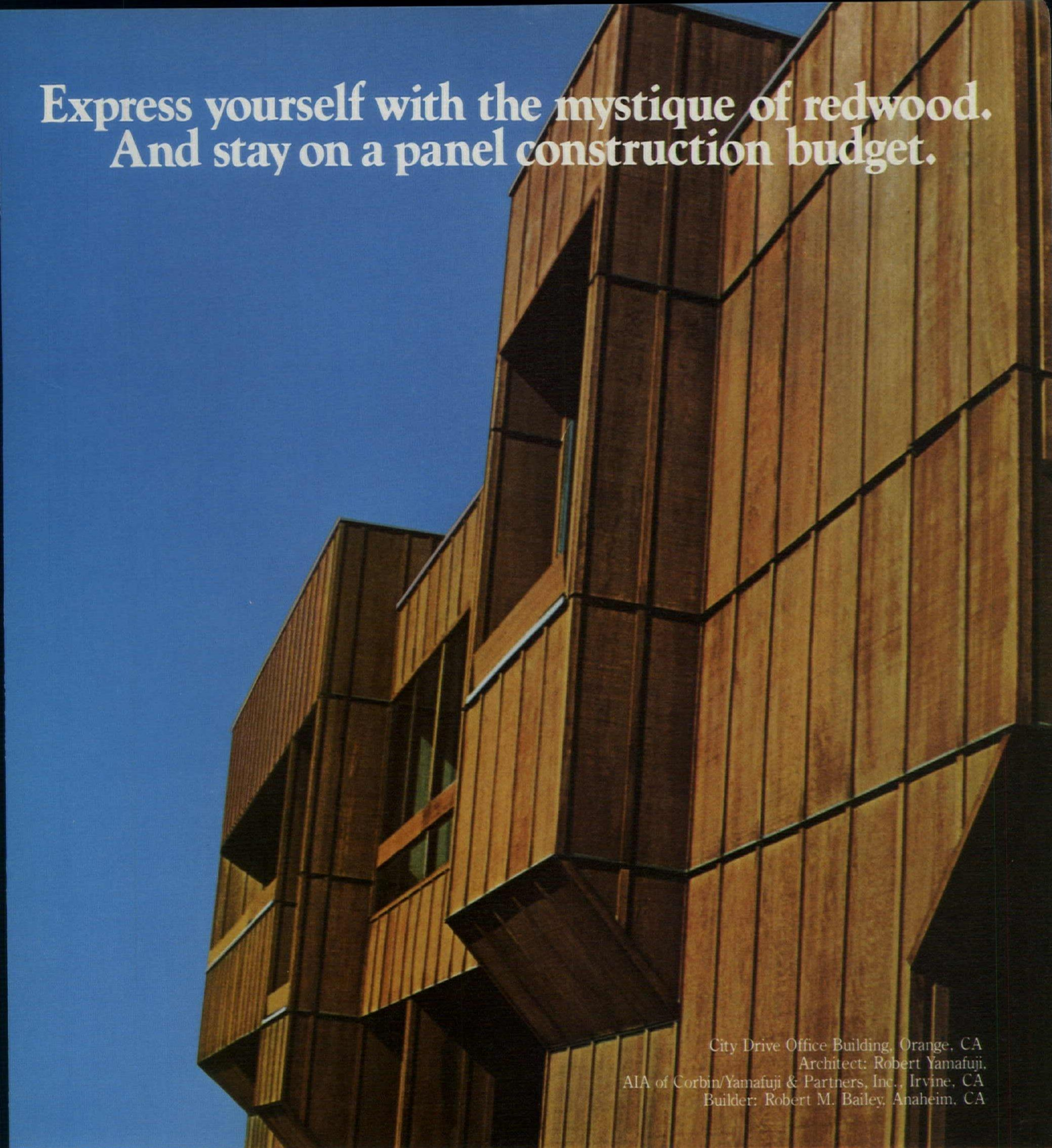


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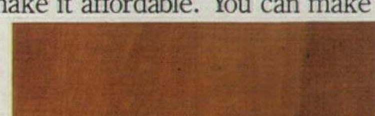

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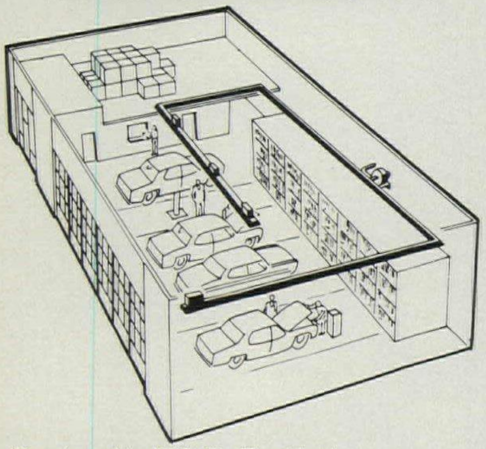

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**Building materials** cont. from page 256

Appleton. Tubs, lavatories, etc.: American-Standard.

**Raven Run house, Lexington, Ky (p. 142).** *Architect: Richard S. Levine, Lexington, Ky.* Exterior walls: Eastern red cedar beveled siding. Interior trim: white oak. Floors: white oak and quarry tile. Collector glass: ASG Water White tempered. Passive glazing ("Sundows"): ASG Lo-Iron tempered. Light windows: Kalwall and Tedlar. Sealants: Tremco and Dow Corning silicone. Urea formaldehyde insulation: Insulspray Div., Borden Co. Thermax insulation: Celotex Co. Fiberglass insulation: Owens-Corning and Johns-Manville. Interior paint: Martin Senour. Interior floor finish: Watco Danish Finish. Laundry equipment: Maytag. Composting toilet: Clivus Multrum. Control systems (dampers, actuators, relays, thermostats, aquastats): Honeywell. Blower: Dayton.

**Autonomous Dwelling Vehicle (p. 146).** *Designers: Ted Bakewell III and Michael Jantzen.* Mobile office chassis (recycled). Walls and roof of aluminized steel silo and grain conveyor components, white enameled: Railoc Co. Sprayed urethane foam insulation (Upjohn). Interior sprayed fireproofing/sound-absorber: "Durafiber" by National Cellulose Co. Portions of wall and floor, plastic "Tiledeck": Uniroyal. Custom skylights: Plexiglas. Inner skylight panel: "Coroplast" twinwall. Sliding glass doors: Bee Cee Co. V.A.T. flooring. Urethane and silicone caulking as required. Smoke detector: G.E. Aluminum grip strut ramps: U.S. Gypsum. Aluminum safety grating decks. Dimmable fluorescent lighting fixtures: Iota Engineering. Incandescent aircraft reading lights. Halogen task light. Swedish composting toilet: "Bioloo" by Clivus Multrum. Polyethylene plumbing tubing and fittings. Showerhead: Spraying Systems, Inc. Solar collectors (active, air) of "Filon" over black-coated silo panels. Collector fans, 3.4 W, 12 V. Heat storage rods (84 cu ft), "Thermol 81" by Pipe Systems, Inc. Collector and sunspace shades: Pease. Blinds (black solar absorptive one side, silver reflective other): Levolor. Solar hot water heater, heat exchange fluid: "Suntemp" oil by Shell (expansion tank: Well-X-Trol). Waste paper incinerator/back-up water heater: Appropriate Tech Importers. PVC and polyethylene plumbing components: Corrosion Products. Portable pressurized water container: Water Caddy. Gray water recycling equipment: Water Equipment Technologies. Photovoltaic panels (20 W): ARCO Solar. Storage batteries (four, 12 V, 96 amp hr): Exide (ESB, Inc.). Wind generator, vertical axis: Thermax Corp. Refrigerator unit: Norcold. Air-to-air heat exchanger (for toilet vent): "Lossnay" by Mitsubishi. Carpet (contract): Command. Foam pad: "Omalon" by Olin. Vacuum-formed industrial storage trays: Hy-Vac Plastics. Insulated shades: Insulated Shade Co.


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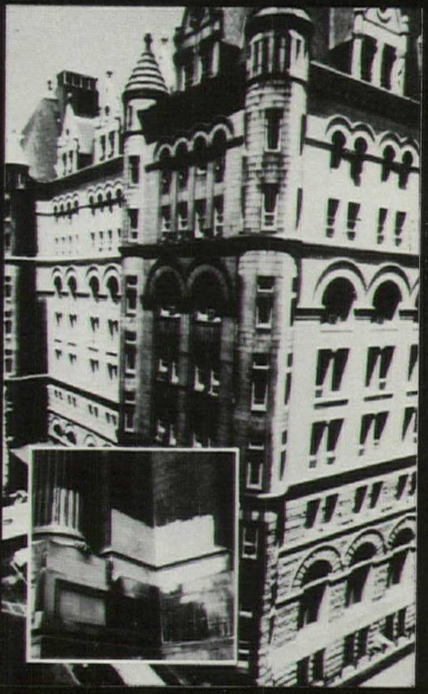

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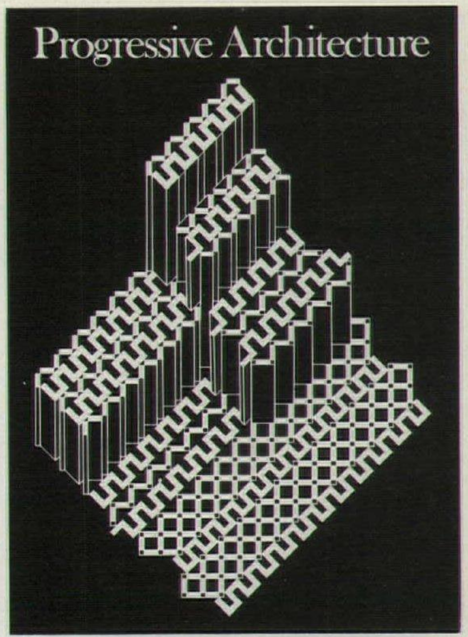


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Yvonne Melcher, *Manager*

**Orvieto (TR), Italy**
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Atrium and west face of Jeppesen Sanderson headquarters, Denver, Colorado. Johnson • Hopson & Partners Architects.

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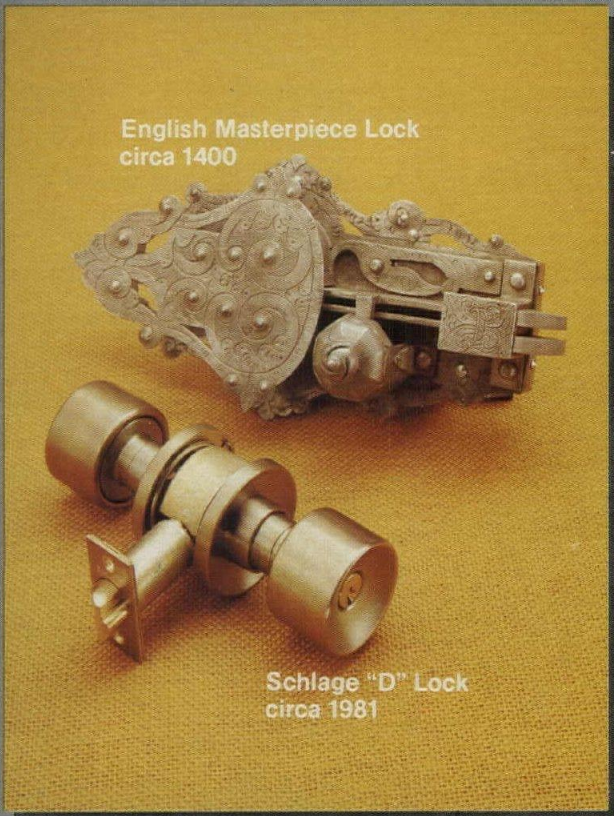



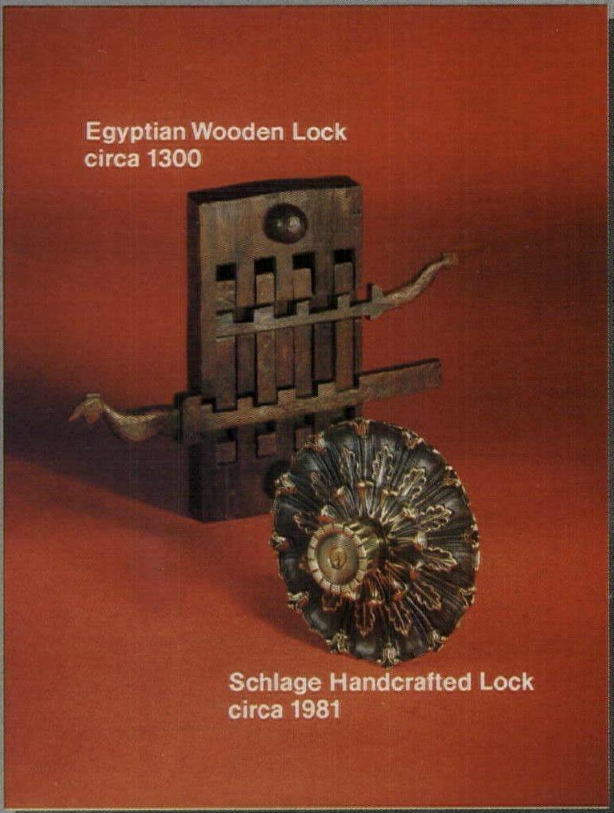


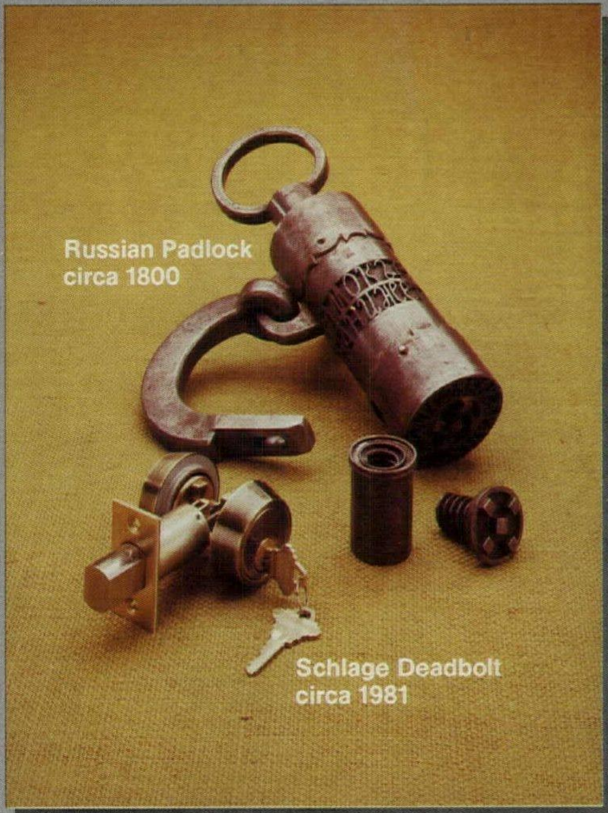


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