RESEARCH&DESIGN
The Quarterly of the AIA Research Corporation

Passive Technology

Energy and architecture in a new design paradigm

COMMENTARY

Ruminations and resolutions

This issue marks both the anniversary of *Research & Design's* first full year of publication and the advent of its second. There is, therefore, every good reason to indulge here in January's traditional glances back to the past year and forward to the one ahead.

Last year was a good year for *R&D.* Our first issue, on solar architecture, generated more letters (as a percentage of the 12,000 architects, educators, researchers, and policymakers who received it) than the year's most controversial issue of *Time,* including enough requests to exhaust our store of single copies. This from a profession said rarely to read and never to write. Designed by magazine designer Jack Beveridge, whose other works include *Smithsonian* and *Saturday Review,* the issue was also selected for the prestigious Washington, D.C. Art Directors' annual awards exhibition. Succeeding issues on seismic design, post occupancy evaluation, and building energy performance were similarly welcomed—the seismic number particularly. The first issue executed by art director Fred Greenberg (whose architectural sketches appear frequently in *R&D*), it was requested by the U.S. Geological Survey, center of the nation's seismic research, for reprinting as a resource on the architectural mitigation of earthquake hazards.

The year ahead holds equal promise. This first issue focuses on energy in architecture, a subject of tremendous importance to designers, and one slated for a great deal of attention in 1979. *Progressive Architecture* will publish a special issue on energy conscious design this April, focusing on many of the techniques reported in this issue. *Newsweek,* which virtually ignored energy in a major article on new American architecture last November, plans a follow-up story on energy and architecture for later this year. And the federal energy performance standards due out this fall and aimed at design-stage determination of building energy performance in the '80s could constitute the most decisive architectural development of the decade.

The April issue of *Research & Design* will build on this issue's focus by examining climate—a critical factor in energy conscious design. It will report on the national Climate & Architecture Conference scheduled for Feb. 13-14 in Washington, D.C., sponsored by the AIA Research Corporation and underwritten by the Department of Energy and the National Oceanic & Atmospheric Administration. The July and October issues will look at new multihazard research on designing against fire, flood, earthquakes, and extreme winds, and update the continuing research behind the nation's first comprehensive standards for energy performance in new buildings.

Also in 1979, the AIA Research Corporation will support and assist AIA in publication of *The Journal of Architectural Research,* the scholarly journal of design research published jointly by AIA and the Royal Institute of British Architects. Produced for the past ten years in Britain, *JAR* will be published in the United States in 1979, appearing in March, July, and November. Domestic subscription will net readers not only the 1979 *JAR* volume, but the year's four issues of *Research & Design* as well. So if you're interested in staying in touch with architecture's leading edge this coming year, this is a good place to start.

Kevin W. Green

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Editor, Research & Design

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Cover: Detail of an arch at Cosanti, Paolo Soleri's first step in an indigenous and futuristic design experiment with passive technology. Photograph for *Research & Design* by Robert Lautman.

NOTEBOOK

Barnes of Texas succeeds Swager of Illinois as '79 AIA/RC Board Chairman

Above, from the top, '79 Board Chairman Barnes, Secretary Newman, and new directors Vosbeck and Rose.

Austin architect Jay W. Barnes, FAIA, has succeeded Eugene C. Swager, FAIA, as 1979 chairman of the AIA Research Corporation (AIA/RC) Board of Directors. Having served as AIA/RC Board secretary during 1978, he succeeded to the chair during the annual transitional meetings held at AIA and AIA/RC last month.

Barnes, one of three Texas representatives on the AIA Board of Directors, is partner in charge of governmental, educational, manufacturing, and commercial projects at Barnes Landes Goodman Youngblood in Austin.

Succeeding Barnes as secretary and chairman-elect of the AIA/RC Board is Michael D. Newman, AIA. Also an AIA director, Newman is managing partner of Newman Calloway Johnson VanEtten Winfree in Winston-Salem, N.C.

Joining AIA/RC's Board for the first time in 1979 are R. Randall Vosbeck, AIA, an Alexandria, Va. architect and newly-elected AIA vice president, and William A. Rose Jr., AIA, new AIA Board member from White Plains, N.Y.

Indianapolis practitioner Lynn H. Molzan, AIA, continues as a director and treasurer of the Research Corporation. He represents the East Central States on AIA's Board. Also continuing are public members Harold B. Finger, Martin D. Robbins, and Henry J. Lagorio, AIA. An honorary member of AIA, Finger is general manager of General Electric's Center for Energy Systems in Washington, D.C. Robbins directs the Colorado Energy Research Institute in Golden, Colo. Lagorio is a professor of architecture at the University of Hawaii at Manoa, where he also directs the department of architecture's programs of research.

New design manual focuses on earthquakes and critical facilities

In an earthquake, police and fire stations quickly become nerve centers for emergency operation. That's why designing police and fire facilities to withstand the destructive force of an earthquake is critically important.

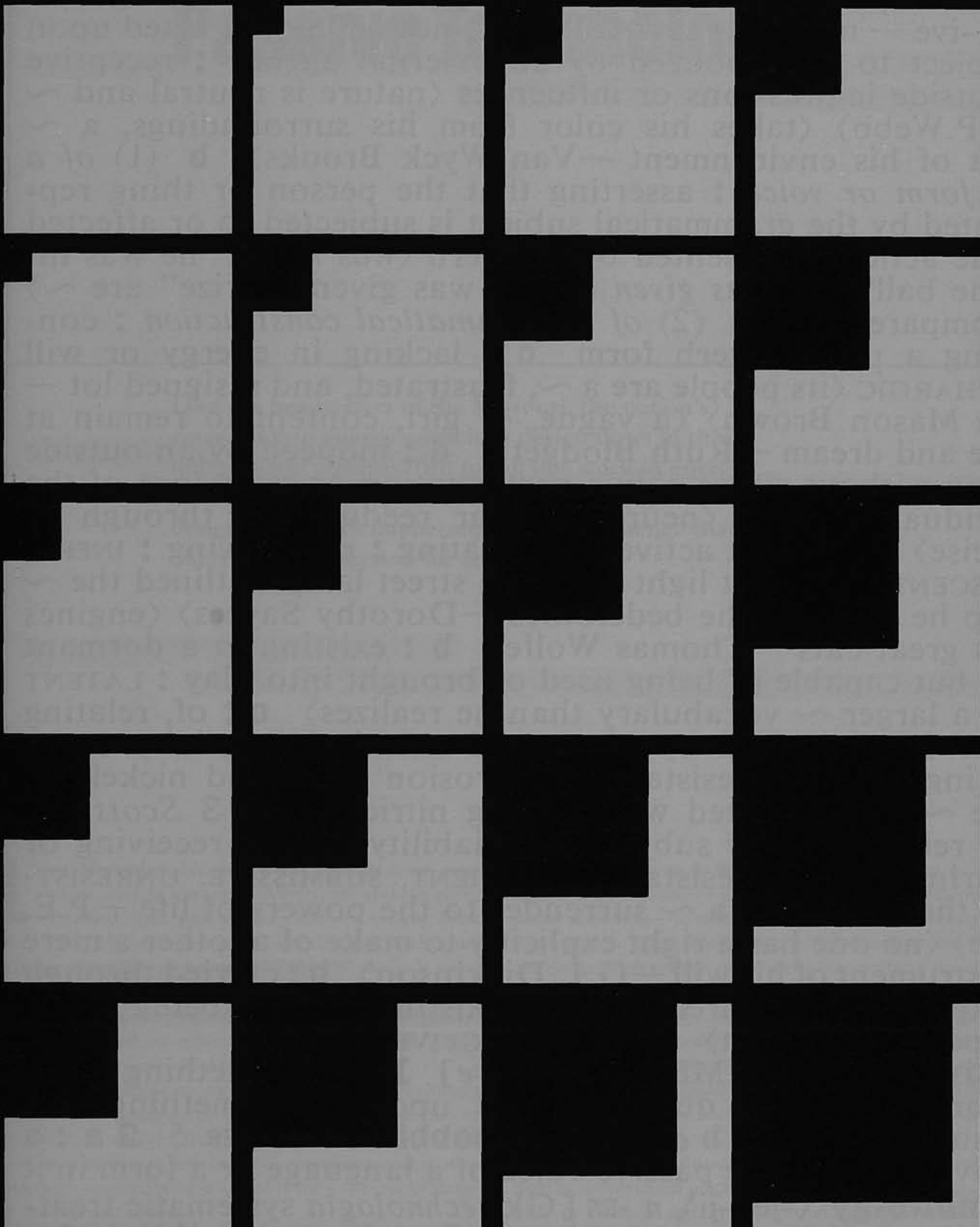
For the past year and a half, AIA/RC has worked with seven design firms and 17 representatives from police and fire departments around the nation to assemble a comprehensive manual for police and fire station design in areas threatened by seismic activity—a threat that touches 39 of the 50 states. Produced under a National Science Foundation grant, the 307-page manual covers everything from site and building considerations to space and equipment criteria and the special problems faced when disaster strikes. It's now available free from AIA/RC Hazards Program, but quantity is limited.

Now available: Two new videotape series on seismic and energy conscious design

Two AIA/RC research efforts in architectural education have spawned sets of videotapes on specialized design techniques, both now available to students, educators, and practitioners.

The 1978 Summer Institute on Energy Conscious Design, held at Harvard's Graduate School of Design under DOE sponsorship, yielded a series of five videotaped presentations. Ian McHarg, Ralph Knowles, Robert Stern, and Stanley Tigerman are among the speakers, and the subjects range from designing for solar access to integrating architecture and engineering in the energy conscious design process. Contact AIA/RC's Energy Conscious Design Program for details on renting (the handling charge should be small).

Seismic design is the subject of five videotapes developed from AIA/RC's two recent NSF-sponsored Summer Seismic Institutes. Land use planning, building form, structural considerations, nonstructural hazards, and seismic renovation are the topics, and AIA/RC's Hazards Program has the information on cost and availability.



protective film on a metal

¹pas•sive \\'pasiv, 'paas-, 'pais-, -sēv *also* -səv\\ *adj* [ME, fr. L *passivus*, fr. *passus* (past part. of *pati* to suffer, undergo) + *-ivus* -ive — more at PATIENT] **1 a :** not acting but acted upon **:** subject to or produced by an external agency **:** receptive to outside impressions or influences ⟨nature is neutral and ~ —W.P.Webb⟩ ⟨takes his color from his surroundings, a ~ agent of his environment —Van Wyck Brooks⟩ **b** (1) *of a verb form or voice* **:** asserting that the person or thing represented by the grammatical subject is subjected to or affected by the action represented by the verb ⟨*was hit* in "he was hit by the ball" and *was given* in "he was given a prize" are ~⟩ — compare ACTIVE (2) *of a grammatical construction* **:** containing a passive verb form **c :** lacking in energy or will **:** LETHARGIC ⟨its people are a ~, frustrated, and resigned lot —John Mason Brown⟩ ⟨a vague, ~ girl, content to remain at home and dream —Ruth Blodgett⟩ **d :** induced by an outside agency without either active participation or resistance of the individual affected ⟨neuromuscular reeducation through ~ exercise⟩ **2 a :** not active or operating **:** not moving **:** INERT, QUIESCENT ⟨the faint light from the street lamp outlined the ~ hump he made in the bedclothes —Dorothy Sayers⟩ ⟨engines ~ as great cats —Thomas Wolfe⟩ **b :** existing in a dormant state but capable of being used or brought into play **:** LATENT ⟨has a larger ~ vocabulary than he realizes⟩ **c :** of, relating to, or characterized by a state of chemical inactivity **:** not reacting readily **:** resistant to corrosion ⟨iron and nickel become ~ when treated with fuming nitric acid⟩ **3** *Scots law* **:** of, relating to, or subject to a liability **4 a :** receiving or enduring without resistance **:** PATIENT, SUBMISSIVE, UNRESISTING ⟨there is in her a ~ surrender to the powers of life —P.E. More⟩ ⟨no one has a right explicitly to make of another a mere ~ instrument of his will —G.L.Dickinson⟩ **b :** carried through or expressed by indirect means **:** existing without being active or open ⟨~ support⟩ **syn** see INACTIVE

²passive \\"\\ *n* -s [ME, fr. ¹*passive*] **1 a :** something (as a person, object, or quality) acted upon by something else — usu. used in pl. **b** *or* **passive bobbin :** HANGER 5 **2 a :** a passive verb **b :** the passive voice of a language or a form in it

tech•nol•o•gy \\-jē, -ji\\ *n* -ES [Gk *technologia* systematic treatment, fr. *techno-* + *-logia* -logy] **1 :** the terminology of a particular subject **:** technical language **2 a :** the science of the application of knowledge to practical purposes **:** applied science ⟨the great American achievement has been . . . less in science itself than in ~ and engineering —Max Lerner⟩ **b** (1) **:** the application of scientific knowledge to practical purposes in a particular field ⟨studies are also made of polymeric materials to dental ~ —*Report: Nat'l Bureau of Standards*⟩ (2) **:** a technical method of achieving a practical purpose ⟨a ~ for extracting petroleum from shale⟩ **3 :** the totality of the means employed by a people to provide itself with the objects of material culture

-tech•ny \\ teknē, -ni\\ *n comb form* -ES [F *-technie*, fr. Gk

Passive Technology

Like the headwaters of the Missouri, the nation's research into energy conscious design flows in three independent streams. But for all our work in energy conservation, active solar engineering, and passive design, it's what's happening at the confluence that charts a new direction for architecture.

Last November, Newsweek ran a special seven-page color article on new American architecture, splashed with photos and close-ups on the New York Five, Houston developer Gerald Hines, and "chief scourge of modern architecture" Robert Venturi. It was a look at the *avant garde,* at what writer Douglas Davis called "the biggest revolution in architecture in 50 years," and it may well have been the year's most widely read story on architecture in America.

Newsweek chose to focus on those *avant* architects whose visual imagery is literally changing the face of architectural design. But its emphasis on the visual—a trait as common in architectural commentary as it is in practice—ignored what is arguably the most crucial factor in architecture today.

Energy. For architects particularly, it is a pivotal issue. The built environment continues to account for between a quarter and a third of *all* the energy consumed in America. The price of that energy, already staggering, cannot help but escalate. As it does, and as the federal energy performance standards due out late this year approach, building energy performance will become—moreso than it is already—a highly visible and volatile subject of debate. And designers will stand firmly at the center of the issue.

Last year, as part of an AIA Research Corporation project tied to the performance standards development, close to 200 design teams took another look at buildings they designed three to four years ago. Then they redesigned those buildings—meeting the same requirements, on the same sites—to average a 40 per reduction in energy consumption. That figure alone indicates that architects *can* design with energy as a priority—something the approaching federal standards will fully recognize.

Another research project now underway in New York City has found that office buildings designed since 1945 are using over 50 per cent more energy per square foot than buildings designed before 1945 are using. That performance record indicates that architects *must* begin designing with energy in mind.

Newsweek notwithstanding, energy's status as a fringe issue in architectural practice does appear to be nearing its end. In research and in application, energy conscious design has matured tremendously over the past few years. Its curious evolution over that time accounts for its stay on the practicing fringe as well as its apparent readiness now for the quantum leap into mainstream design.

The short history of energy use in the built environment began in earnest only after the oil embargo of 1973-74. Since that watershed winter, research efforts have focused on two key areas: energy conservation and the use of alternative (non-fossil) energies.

In energy conservation, the research has focused on tightening the structure—refining techniques to seal out the adversities of climate and relying on mechanical means to condition the interior. For most architects, that's what "energy conscious design" means—insulation, weatherstripping, airlock entries, double-glazing—techniques now a part of day-to-day practice.

The research into alternative energies has focused on nature's most abundant resource, solar energy, and dealt primarily with concepts and systems—photovoltaic cells, solar furnaces, trickle-down collectors—that are mechanical in nature.

In many ways this mechanical emphasis has been the bane of solar architecture; it's where the research funding has been, but it hasn't done much to help designers. Still, it represents a logical step in the research progression. For one thing, it builds well on the tight-structure notions of energy conscious design. In a sealed building designed to be artificially conditioned, an active solar system supplies heat in substantially the same way a vintage oil burner does. For another, engineering has always been the forte of the large, highly technological corporations who moved first into energy systems research—and who now own most of the market for active system components. For a third, the active emphasis has had federal support. The original legislation for the nation's first residential solar heating demonstrations, for instance, suggested that direction of the program go not to the energy, housing, commerce, or design agencies, but to the National Aeronautics & Space Administration. NASA was the only agency equipped to deal with the space-age hardware required to harness solar energy.

That attitude no longer prevails on the federal level. Nor was it ever absolute in its prevalence. The agencies now responsible for the nation's solar research in buildings—the Departments of Energy (DOE) and Housing & Urban Development (HUD)—have pursued research into passive solar design. But the passive research has been conducted in a separate stream, as have concurrent streams of research into energy conservation and active technology. In consequence, results in all three areas have been less than optimal.

This multi-stream dilemma first became apparent during the early cycles of the HUD/DOE solar heating and cooling demonstration programs, when a preponderance of proposals for active system projects produced a great number of conventional buildings with collectors on their roofs. As those projects reached completion and began to perform, researchers discovered that although the active systems might be functioning properly (and that wasn't always the case), the buildings themselves were often energy inefficient. It dawned then that while the development of energy conserving design techniques was occurring parallel to the development of engineering techniques—both with federal support—the government's key solar demonstration programs were unable to tie those streams together to demonstrate optimal energy efficiency.

The same epiphany came with passive design research. Perhaps in reaction to the early parochialism of active system research, passive designers defined a passive energy system as one capable of controlling the flow of thermal energy into, through, and out of a building solely by natural means, and they followed that definition to the letter. They avoided all mechanical elements in their energy systems and, like their active counterparts, came up with mixed results. Their work produced some extraordinarily innovative and refined design concepts. It carried the principles and jargon of passive design—direct gain, sunspace, siting, orientation, trombe walls, thermal massing—into the practitioner's lexicon. Passive projects from coast to coast defined for the first time the regional and climatic parameters of passive design.

But on the negative side came the realization that passive design alone often fails to optimize energy efficiency, and that with mechanical assistance—not in the collection of energy but in its movement from point to point within a building—the performance of a passive design can soar. Another realization: The low-temperature limitations of pure passive design make it most appropriate for residential and small-scale commercial applications; large-scale applications usually require some kind of mechanical assistance. Another: The key tenet of energy conservation—seal the building against the elements of climate—often contradicts the principles of passive design, which call for a building capable of relating and responding to its environment, capable of using the sun's energy for light and heat, the wind for ventilation and cooling, humidity for its impact on comfort, and temperature for the energy inherent in its day-night swings.

The sum of these realizations, of course, was that research into energy conservation, active technology, and passive design had developed techniques in all three areas. But it had hampered our ability to design buildings that are optimally energy efficient because neither researchers nor designers were cross-breeding those three distinct fields of design.

Today, that cross-breeding is occurring. For some time now designers have contrived hybrid energy systems that combine conservation techniques and active mechanical elements within a general passive framework—a synthesis these designers think of as architecture's true leading edge. It represents for them the synthesis of "soft" design and "hard" technology that architects and engineers have long sought. It represents the merging of three disparate streams of modern research, and the culmination of that research with traditional architectural goals and indigenous design solutions that date back to the pueblos of New Mexico and the saltboxes of New England. It also represents a synthesis of the built and natural environments, something a great many designers consider one of architecture's primary responsibilities.

The buildings on the following pages represent some of the best of this new synthesis. Designers working in the field call them applications of passive technology, and that reference has particular value. Like the idiom it represents, it's an oxymoron, combining opposite elements. These buildings are passive not because they exclude all things mechanical, but because they treat the natural flow of energy as an integral part of design. And they are the products of technology not solely because they apply technologically developed concepts—reflective glass is hardly an indigenous material—but because their design manifests, as Webster's defines technology, "the science of the application of knowledge to practical purposes." Whether architecture is in fact science or more accurately the exercise of art, its practical purpose in this energy conscious age grows more clear with every winter day.

—Kevin W. Green

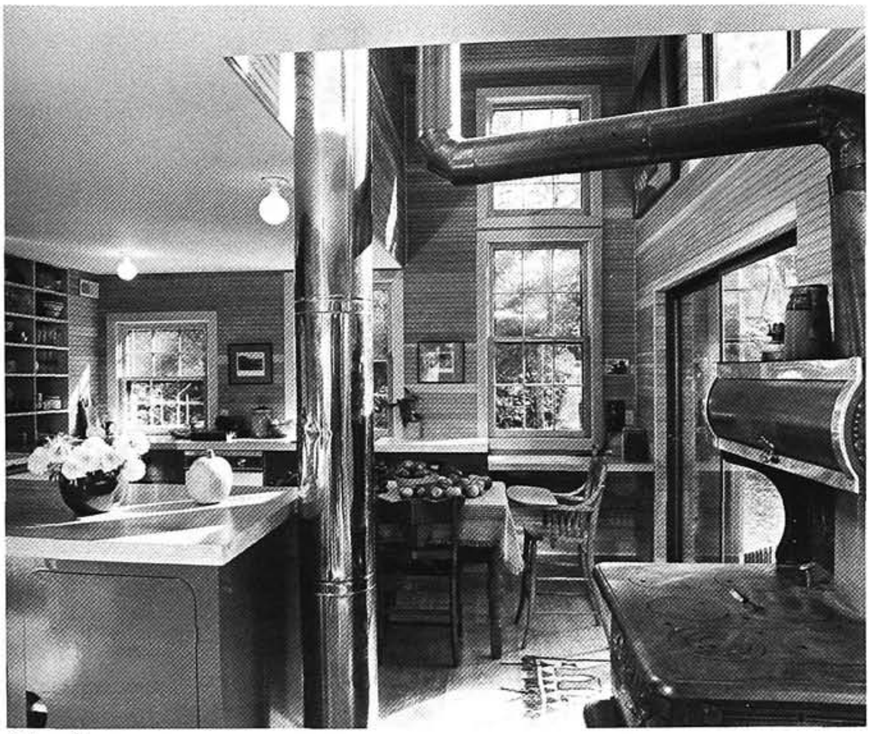
The architects exploring passive residential design over the last ten years have fit the avant garde archetype perfectly—young, ready to experiment, and more willing than most practitioners to lose their shirts pursuing a new concept in design. Their projects, typically, have been totally reliant on natural energy, costly in terms of dollars, design time, and construction techniques, and a little strange-looking to eyes accustomed to standard residential design.

But while that may be a reasonably accurate description of past experience, it doesn't fit today's work in passive residential design. Like any new technology, passive design has gone through an experimental phase in which awkward systems, bad design, and innumerable lesser bugs have had to be worked out. Today, it's emerging from that phase with surprising esthetic and technological sophistication—surprising only because of the rapid pace of that development.

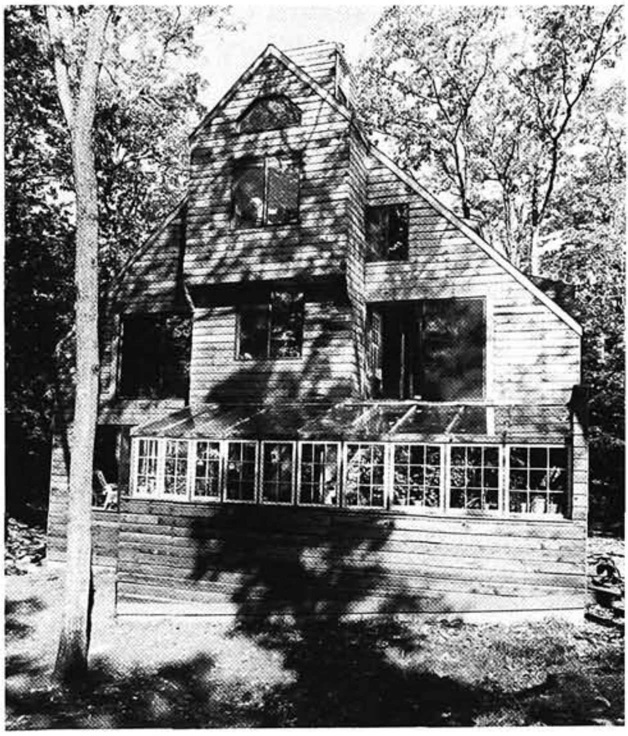
An inexpensive solar solution for New England

Thrift was architect Jefferson Riley's byword when he did his own house in southern Connecticut. So he designed a small home that was inexpensive to construct, takes maximum advantage of its site adjacent to a state forest, echoes New England's traditional styling, and costs next to nothing to heat.

With its entrance to the east (below right), Riley's house turns a wide but minimally opened face to the north. Its southern wall (right) opens to the sun and the forest view with windows that let warm sunlight penetrate the width of the narrow house. Entrance is into a direct gain airlock/greenhouse. Oil furnace and wood stove back up the passive system, but the Rileys reached last Christmas having burned only wood—and not much of that.



Robert Perron



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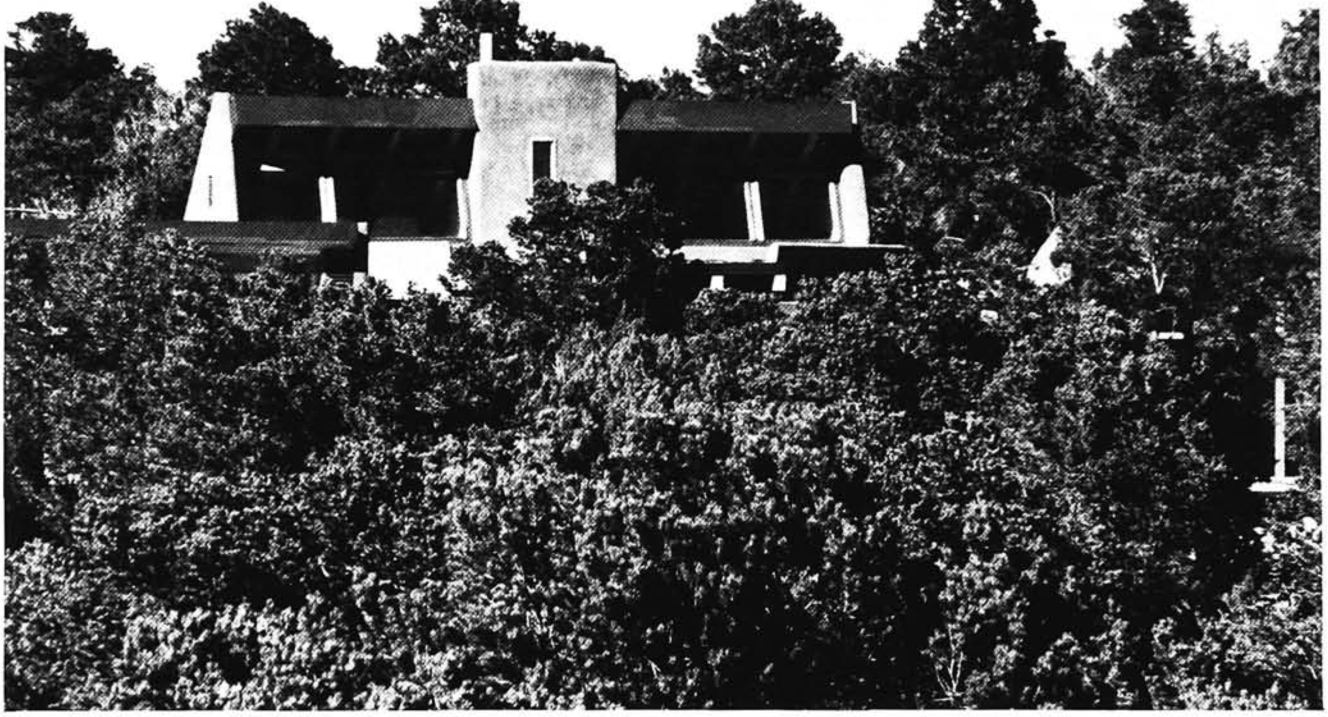
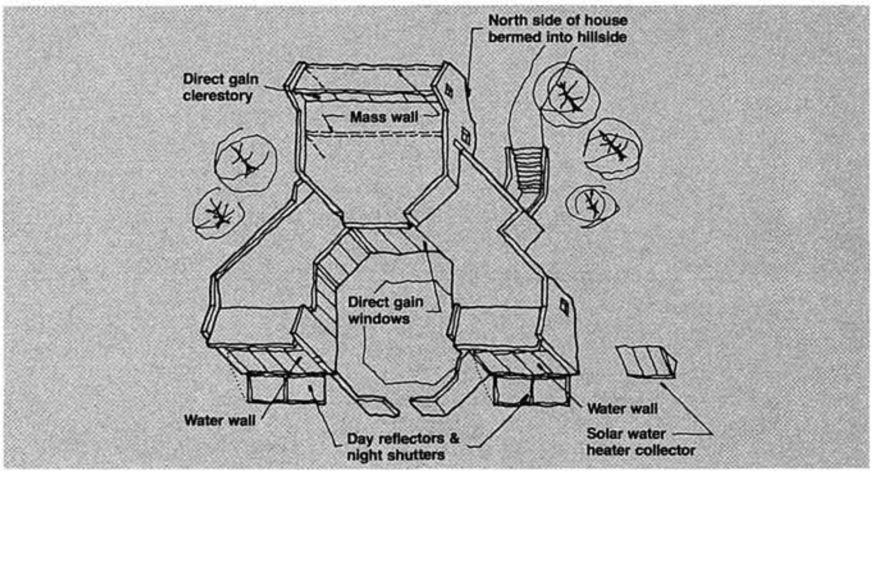


A design for one of the nation's first passive solar villages

New Mexico's climate is such that given the ingenuity of designer William Lumpkins, this passive residence meets 75 per cent of its heating and cooling requirements naturally.

Located outside Santa Fe in First Village, one of the nation's first passive solar developments, this wishbone-shaped house surrounds a central court which traps warm air and eases the building's overall heating load. The southfacing arms of the wishbone are fronted with glazed, water-filled mass trombe walls that store and radiate heat to the private quarters inside. Additional heat is gained directly through clerestories above the trombe walls, and heat loss is stemmed with insulating shutters and massive construction.

The central living core of the 2,200-sf residence, with its north face perched on a hillside (top photo), is also heated with direct solar gain through windows and clerestories. Heat storage is a function of massive floors, a massive central wall, and a 12-inch poured concrete rear wall.



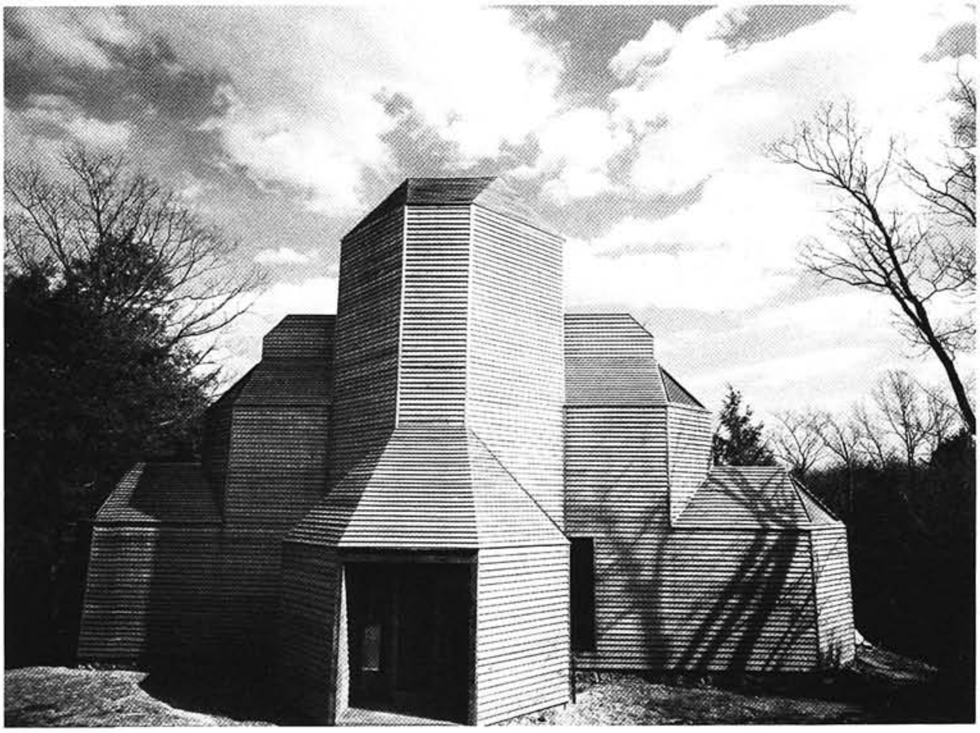
Bay windows for sun and a view of Long Island Sound

This Guilford, Conn. residence, designed by Paul Lytle, David Conger, and Steven Conger of Leela Design Inc., satisfies 40 per cent of its heating requirements through a passive solar system worked into an intriguing overall design.

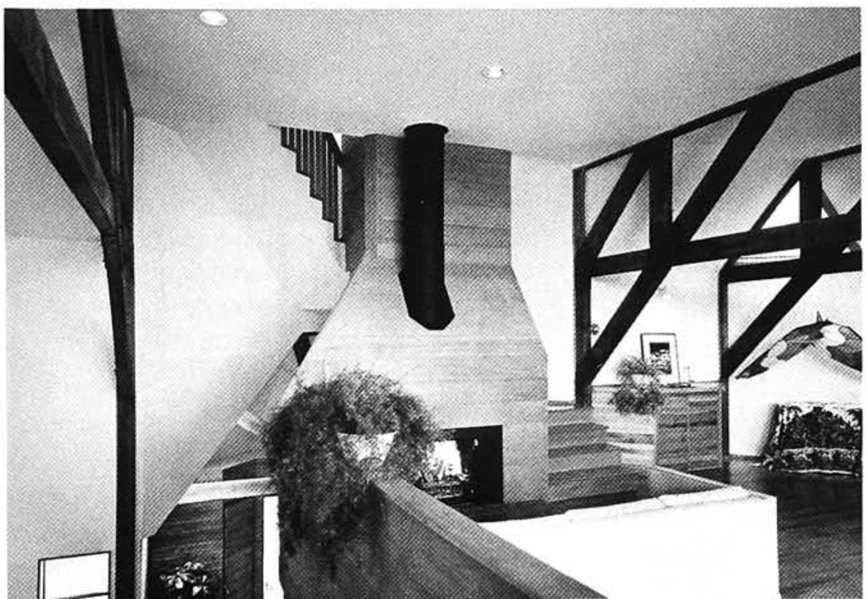
The crux of the system is the 35-foot bay window-wall, double-glazed, on the building's south side (photo at right). At the first floor level, sunlight bears through the bay onto a radiant concrete slab above a 21-cubic-yard rock thermal storage area. Heat stored there reradiates upward through the 2,800-sf home's three floors, eventually being caught at the upper-level and recycled down to the rock storage bed for reheating. The recycling is accomplished with a thermostatically controlled fan that modulates heat flow through the house. A windowless, full-height air column on the north side buffers the house from inclement climatic elements.

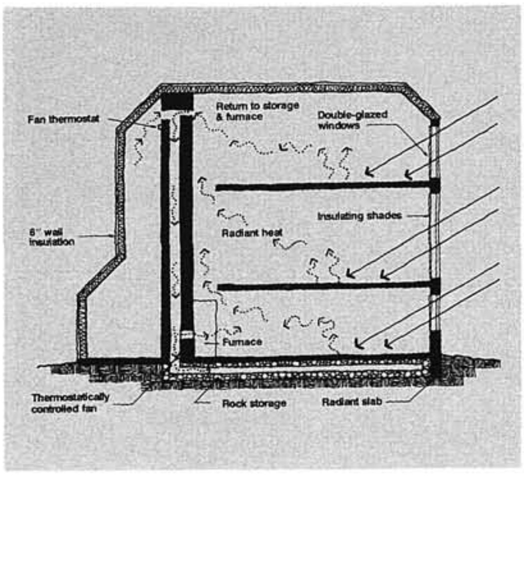
The house has both oil furnace and wood stove for auxiliary winter heating. In summer—the site in southern Connecticut overlooks Long Island Sound—all glazing areas open to transmit breezes, and night air blown through the rock storage provides additional daytime cooling.

Robert Perron



Robert Perron





A hybrid energy system for Rhode Island's winters

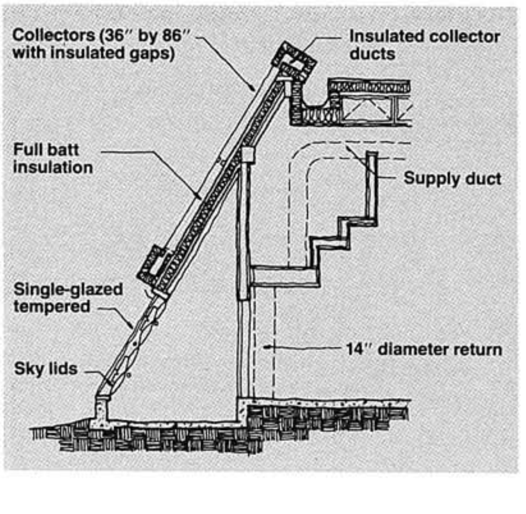
Architect Travis Price combined an active, air-type solar collection system with a wood stove and direct gain greenhouse heating to make this Little Compton, R.I. house warmly self-reliant in winter.

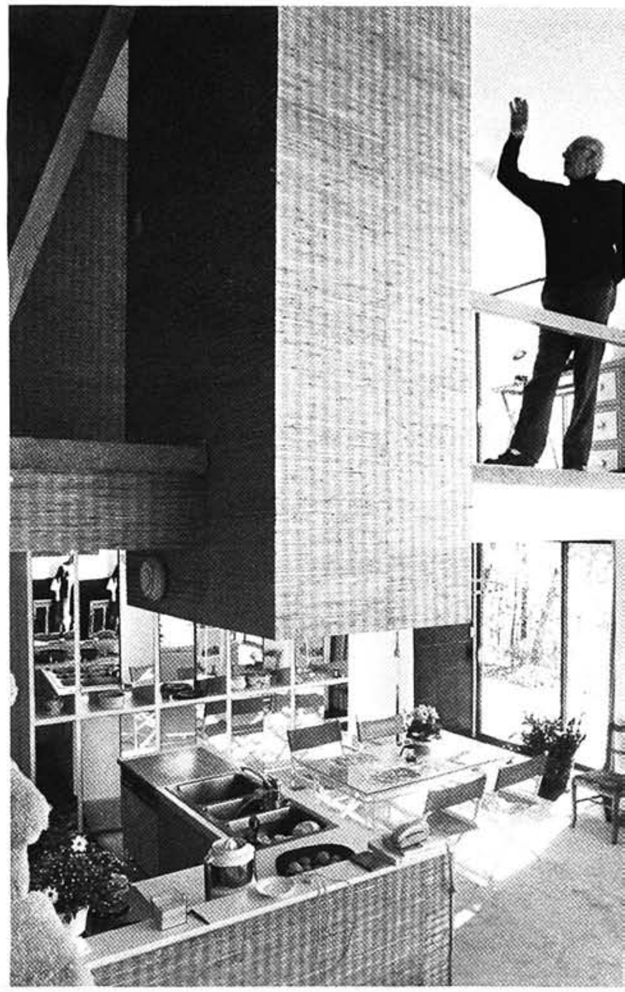
The active/passive energy system is actually part of a 1,500-sf addition to the building, which enables the occupants to close off the main house and weather winter in a solar environment. Eighteen air-type solar collectors front the upper story of the building's southeast facade. Air warmed there is cycled with a small fan either to the interior spaces or to a 1,440-sf insulated rock storage bin, where summer collection can provide up to nine days' storage for winter heating.

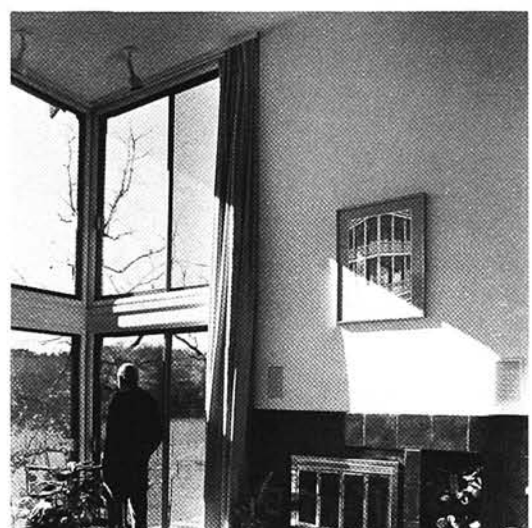
Below the collectors is a single-glazed greenhouse warmed through direct solar gain. Self-operating Skylids admit sunlight to heat the greenhouse, and close down to insulate the space at night.

The home's double-glazed southern side (with a water view) also gains heat directly, alone meeting up to 30 per cent of overall heating requirement.

Three water-type collectors supply domestic hot water to the house, rounding out Price's hybrid energy matrix.







Thermal massing and solar gain warm Dr. Spock's new house

When baby doctor and political activist Benjamin Spock (photos at right) and his wife moved to the Ozark Mountains of Arkansas, they chose a lakeside site where the veteran sailor could both see and be on the water.

Architect James Lambeth responded by designing the southern elevation of the Spocks' new home to consist solely of eight-by-eight-foot sliding glass doors, offering an unbroken view of the water and allowing maximum penetration of sunlight in the winter months. The heat from that direct solar gain is stored in interior concrete walls and a foot-thick slab floor that total 700 cubic feet of thermal massing.

All rooms in the 2,000-sf house open to decks or patios, and a three-foot catwalk wraps the house on its south and west sides. Together with an overhanging roof, those elements shade the house from the high summer sun and ease a cooling load already minimized through natural ventilation.

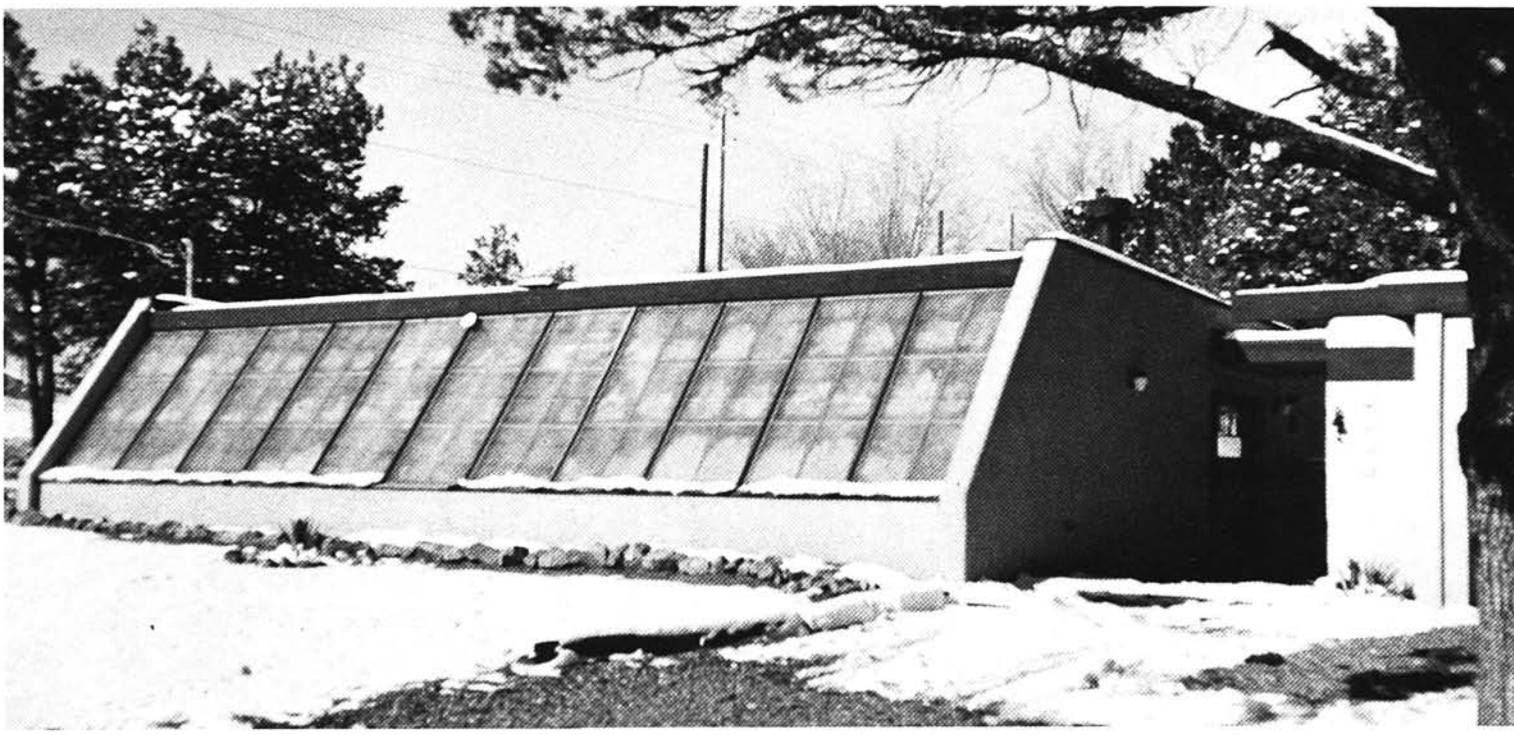
A 48-sf flat-plate solar collector provides for most of the Spocks' domestic hot water needs. A forced-air electric heat pump backs up the designer's passive space heating and cooling techniques. But the home's renowned residents say the first winter's utility bills have yet to rise above $30 a month.

From saltbox to direct solar gain in Connecticut

Architect Stephen Lasar was one of the first solar designers to design for northwestern Connecticut. He designed this residence in Washington, Conn., like his own in nearby New Milford, to be as totally passive as possible in the New England climate.

Situated in hilly, wooded country, the house opens to the south with a full wall of angled glazing that takes in sunlight throughout the winter day. The sunlit living/dining area is masonry-floored to absorb and reradiate thermal energy. Insulated shutters (photo below) can be closed over the southern glazing to retain that energy at night.

The 2,300-sf house, which includes two bedrooms, two baths, kitchen, and a sculptor's studio in addition to the living/dining space, uses an oil furnace to supplement its simple passive system. But not very often. The owners moved to Lasar's house from a saltbox—New England's indigenous solution to the winter cold—where their fuel bills were four times what they are today.



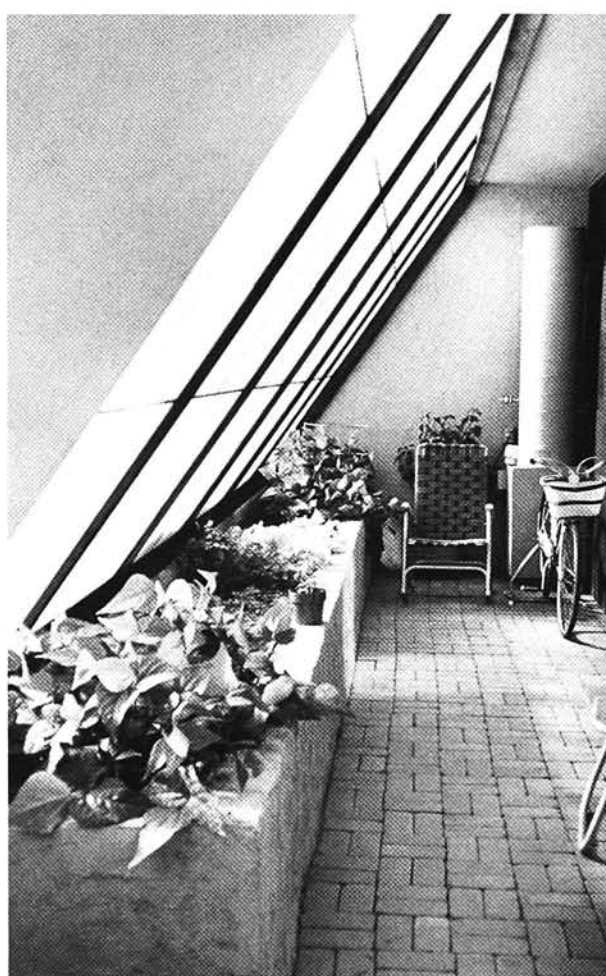
A greenhouse that shelters and warms the living spaces

Michael Frerking designed this 1,056-sf, two-bedroom house in Prescott, Ariz. to be affordable not only in terms of purchase price but in terms of energy.

Frerking estimates that 80 per cent of the home's heatings needs are met solely through its passive design. A double-glazed greenhouse fronts the house, while the east and west walls are minimally opened and the north face is bermed to provide natural insulation. Sunlight enters the angled glazing of the greenhouse to bear on massive adobe flooring, a massive planting bin (which runs the length of the greenhouse), and a 14-inch-thick adobe wall that separates the greenhouse from living quarters at the rear of the house. The massing retains solar heat in the daytime and radiates it as interior temperatures fall in the evening.

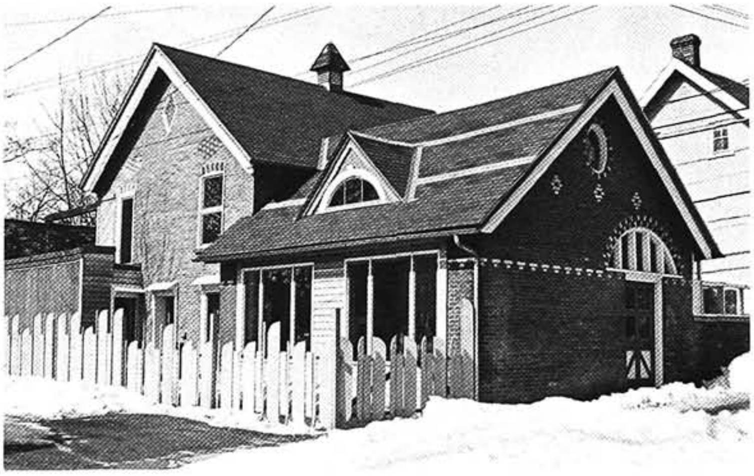
Hot air at the top of the greenhouse is fan-drawn into ducts above the central adobe wall, and channelled down into a symmetrical pair of 20-inch-deep rock storage beds beneath the living quarters. Heated air from the center of each rock bed rises to the living space through floor registers, combining natural thermal storage with a radiant floor heating system. For auxiliary heat, a wood burning stove is linked to ductwork in the home's heavily insulated ceiling for distribution around the house. The stove's heat can also be recycled to the rock beds for storage.

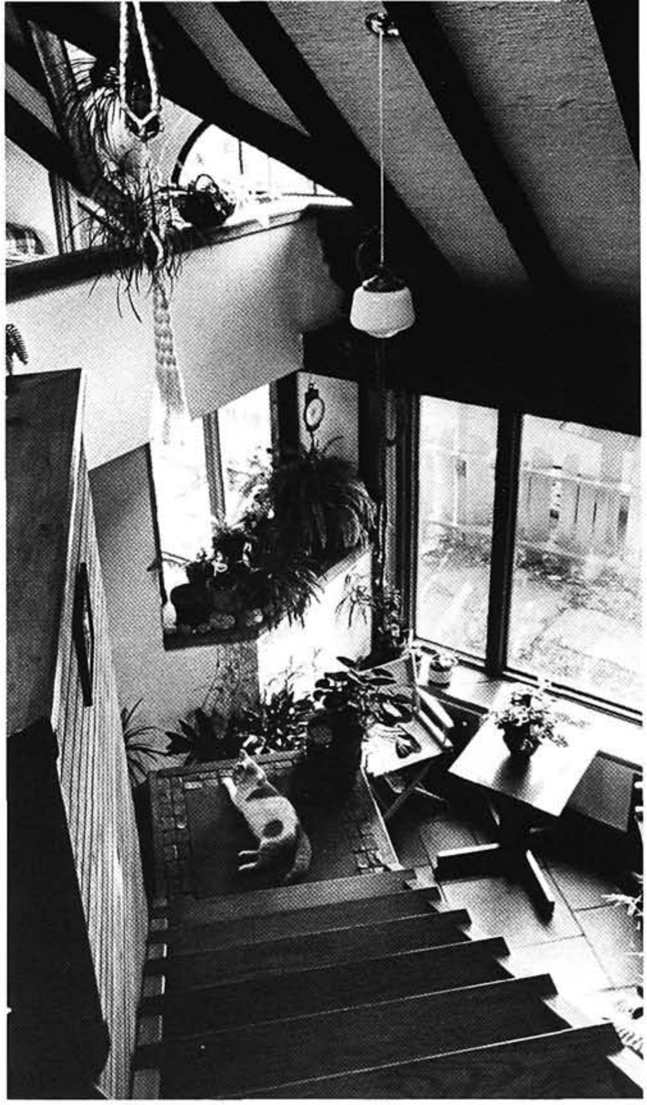
Frerking's design handles Arizona's summer heat as well. The massing of the house tends to stay cool throughout the daytime, and the greenhouse is vented to create convective currents that draw warm air out of the living spaces.

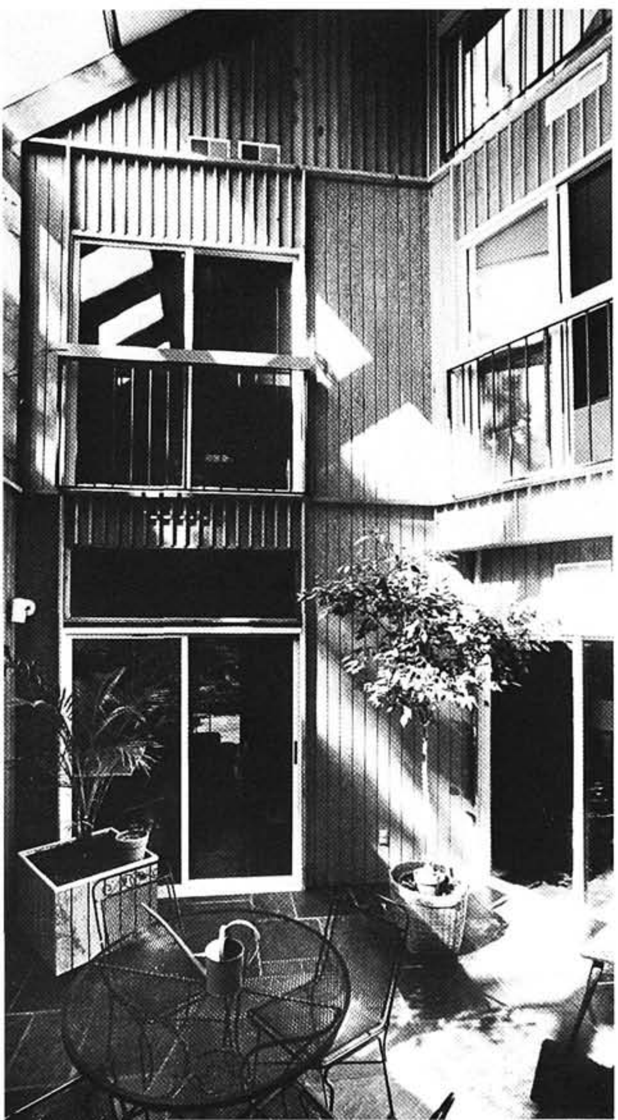


Passive solutions designed for historic contexts

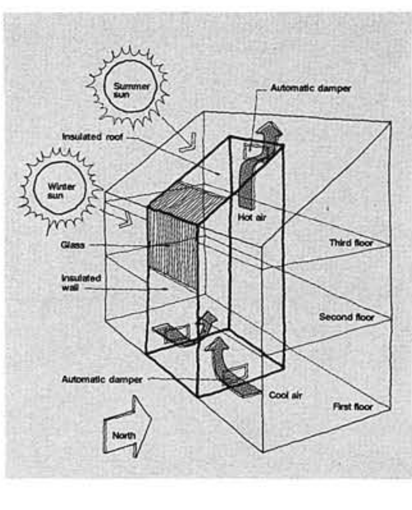
Architect Charles Klein had to conform to historic district appearance regulations on his 1976 renovation of a Bethlehem, Pa. carriage house (right and below), which made energy planning difficult. He solved the problem by







tucking a southfacing Kalwall water-tube trombe wall behind the house (far left in the photo at left above) and linking it to a conventional oil-fired furnace. Outside air is channelled through the trombe wall for pre-heating before it reaches the furnace, significantly lowering the conventional unit's heating load. Klein added a direct gain assist to the system by letting sunlight enter through southerly glazing to bear on the slate floor of a garden room (above). Insulating shutters keep the 1870 carriage house warm on winter nights. In summer, the furnace fan blows night air throughout the house to cool the slate and brick wall massing.



Third-generation Virginia contractor Tom Rust and his wife Susan faced similiar restrictions with their new house in Alèxandria's historic Old Town district. Their solution: A narrow, brick street facade that keeps with its colonial neighbors and harbors a three-story central atrium designed to heat and light the house.

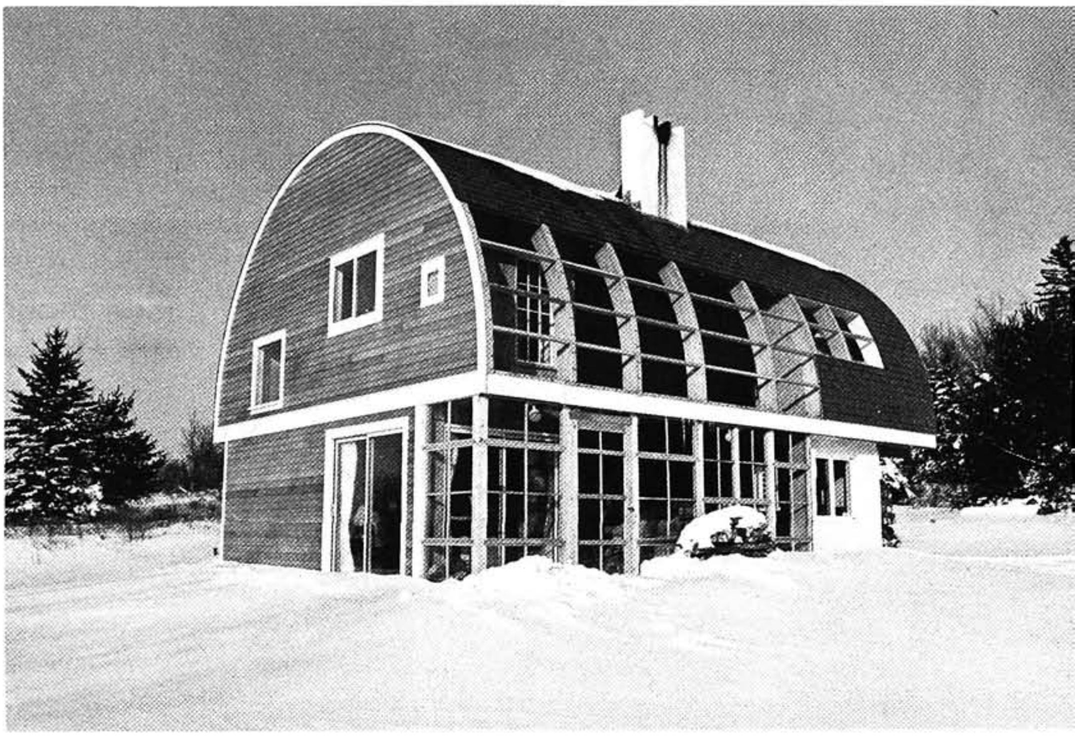
In winter, the atrium gains solar heat directly and warms to 80°F, at which point automatic dampers open to duct the warm air throughout the 3,000-sf house. In summer, the atrium exhausts hot air up and out of the house. Between the atrium's contribution and an active water-type solar collector on the roof (connected to a 1,000-gallon storage tank), up to 60 per cent of the Rust's heating requirements are met by the sun.

Designing a heat trap for the winter on Maine's coast

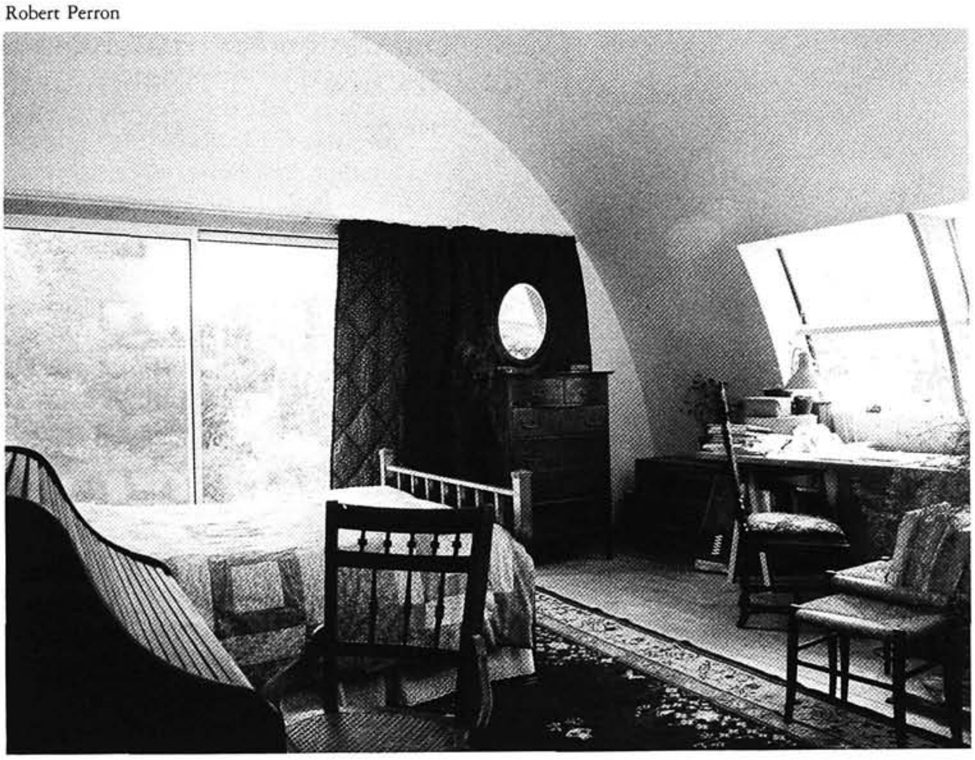
Maine architect Roc Caivano designed his own passive Bar Harbor residence to trap as much heat as possible in the predominantly cold, coastal climate of Mt. Desert Island.

Beneath a roof arched to echo the island's mountainous contours and insulated with nine-plus inches of fiberglass, are concrete block walls faced with three inches of foam insulation. Walls and foam are block-bonded with an exterior layer of fiberglass-impregnated, stucco-texture cement that reduces wind infiltration and leaves the interior walls open to solar radiation.

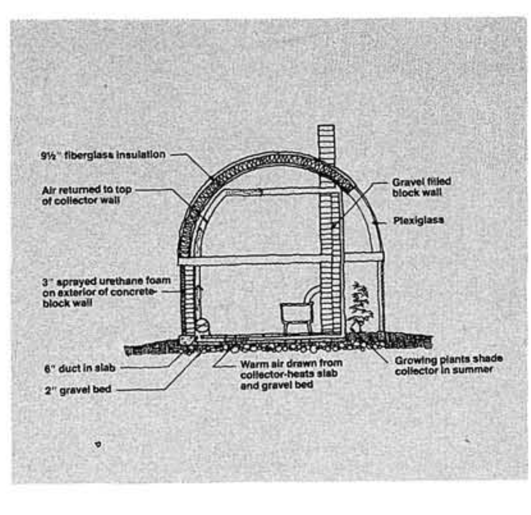
Interior thermal storage, the key to Caivano's design, hinges on the tremendous storage capacity of a two-story, 168-sf concrete-block trombe wall filled with gravel and painted dark brown to maximize heat gain. Sunlight strikes the wall through a southfacing greenhouse. As the wall warms, surrounding air is pulled—with the assistance of an electric fan—through ducting in the concrete-slab floor and recycled around the building perimeter to the top of the wall. Auxiliary to this hot air radiant system is a wood-burning stove exhausted through the trombe-wall's center flue. Caivano's system does its job with help from three cords of wood (last winter), recycled appliance heat, and quilted New England drapes.



Robert Perron



Robert Perron



Commercial applications of passive technology may constitute one of architecture's final frontiers. Like explorers who land on the coast but never penetrate the interior, architects have skirted the hard issues of energy consumption in commercial buildings. Beyond zoning for different consumption levels at building core and perimeter, weatherizing the perimeter against the external environment, and dabbling in active solar systems—which lend themselves to the sealed building concept of conservation—we've left most commercial energy considerations to the engineers.

But if passive commercial design is still unexplored territory, it's not without reason. Passive energy technology is inherently low- temperature and small-scale, instinctively appropriate for residential application. Engineered systems in general are more at home in commercial construction, where the installation and maintenance problems that can plague a homeowner are handled by a knowledgeable building engineer.

Nonetheless, a number of architects have translated passive design to commercial application, and done so successfully. Most of their work has been small-scale, where heating and cooling loads aren't much greater than residential. But the work points up the advantages of cross-breeding passive technology with active elements and overall energy conservative building design.

Clerestories warm a restaurant in Albuquerque, N.M.

Architects Edward Mazria and Robert Strell enclosed an existing, two-story, adobe and brick walled courtyard with four south-facing, translucent clerestories to create 1,600 square feet (sf) of passively heated dining space for this Albuquerque restaurant.

In winter, direct sunlight entering the space is diffused and distributed throughout the masonry interior for even and effective heat absorption. The massive walls and floor store heat in the daytime and release it at night. Warmed air migrating to the upper levels is recirculated with two small fans tucked below the clerestories.

In summer, the sun is too high to insolate the clerestories. The masonry stays cool all day, and in the event of overheating, warm air can be vented through the clerestories as cool air is drawn in from the shaded passage on the building's north face.

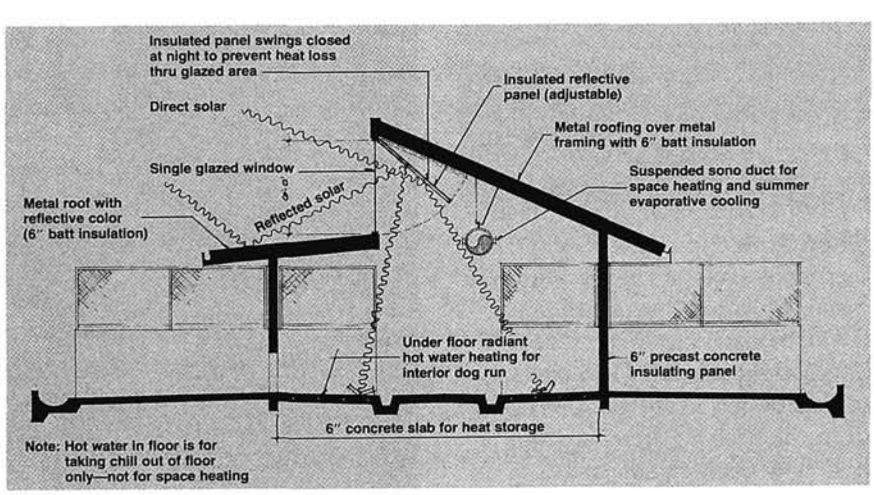
Active, passive, and energy conservative in an optimal blend

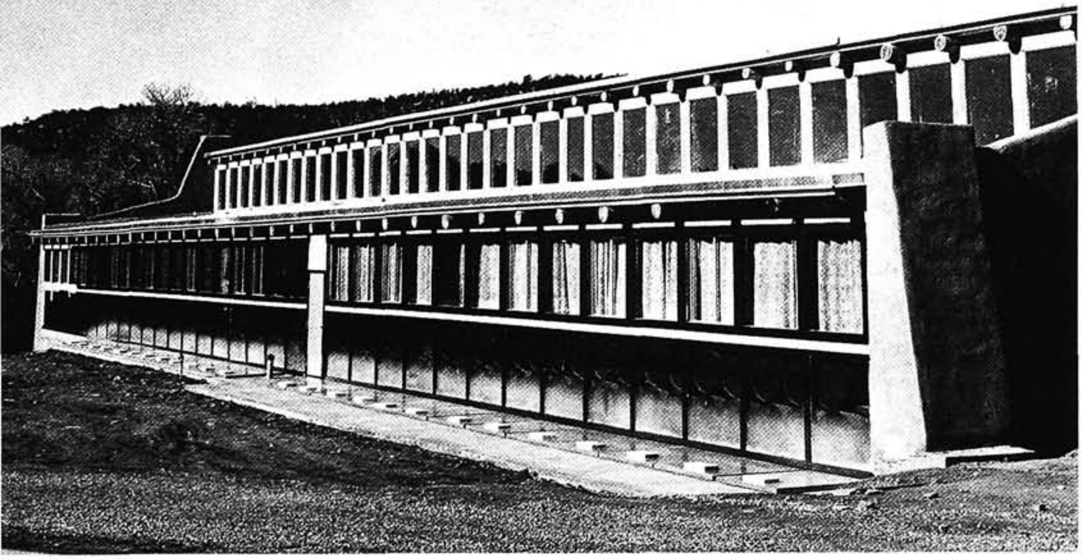
The city of Albuquerque gave architects Burns/Peters, AIA, and solar engineers L. W. Bickle & Associates an almost perfect opportunity to blend energy conservation, active solar utilization, and passive design in this municipal animal control center. The site allowed for maximum southern exposure. The simplicity, open plans, and masonry construction typical of animal shelter design fit a passive approach. The economical underfloor radiant heating typically employed in kennels was compatible with active solar collection. A 15-degree comfort range (50-65°F), broader than the normal range for human comfort, reduced peak demands on the solar system. The project's financing (low-interest municipal bonds) matched the 16-23 year solar payback period. And based on a preliminary feasibility study conducted by the project's designers, the federal Energy Research & Development Administration (ERDA) subsidized construction of the active system with a $39,250 demonstration grant.

The long and relatively narrow geometry of the project capitalizes on its southern exposure. The 2,200-sf office area (at left in the photo above) is heated primarily by the active solar system (48 rooftop collectors and a 1,500-gallon water-storage tank). Passive solar heat gain through the dark masonry walls and southern glazing (fascia-shaded in summer) supplies 15-20 per cent of the office's heat.

The 4,400-sf kennel and non-office spaces to the right of the offices are primarily passively heated through the 6-foot-tall single-glazed clerestory (upper right photo) running the length of the space and the combination solar reflector/night insulation panel above it. The stained concrete floor of the kennel space absorbs both direct and reflected solar radiation. When temperatures exceed 65°F, a thermostatically-controlled ventilation fan cools the space; on a winter night or when summer temperatures reach 70°F, the reflecting panel closes to cut off the heat exchange. Hot water from the active system can also be circulated underfloor to back-up the passive system.

The building's massive construction, insulation, active system, and passive features combine to answer not only 60-75 per cent of its heating needs but 15-20 per cent of its cooling load as well.





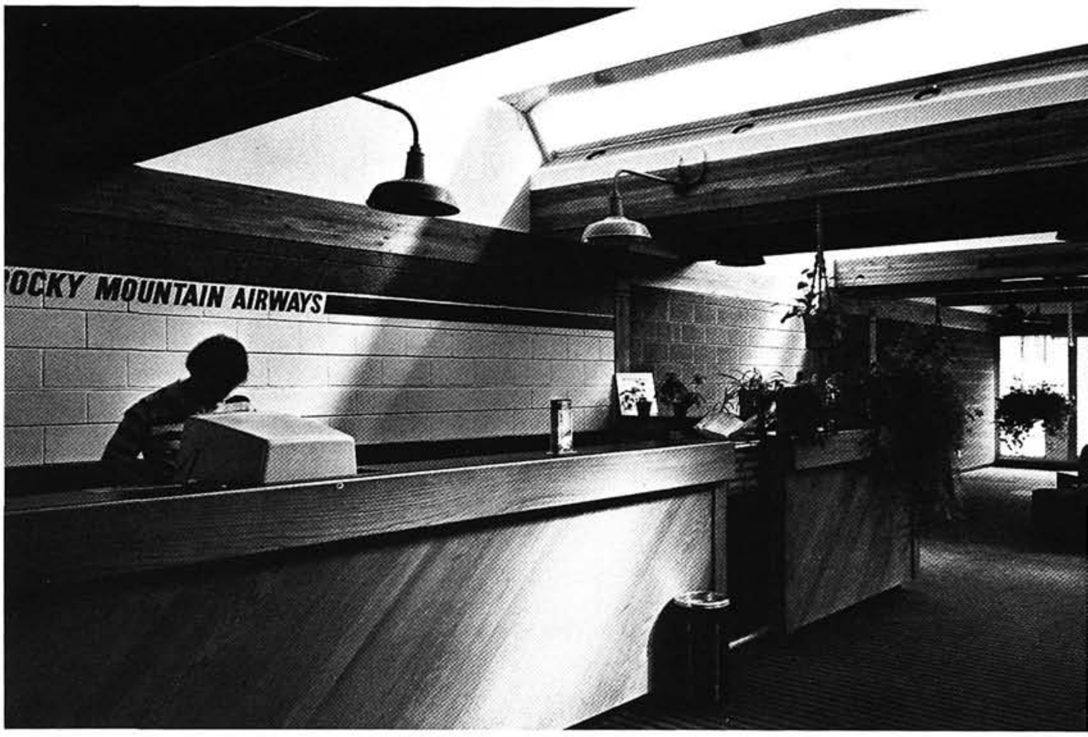
Zomeworks' unique solution for office and warehouse space

One of the better known—and better designed—nonresidential passive projects in the nation, this publications office and warehouse for a Pecos, N.M. Benedictine monastery was designed by architect Mike Hansen in conjunction with Steve Baer's Albuquerque-based Zomeworks firm.

The building's 7,000-sf single-level space is enclosed on three sides by sealed (except for summer cooling vents) 8-inch block construction. Its energy performance hinges on the 140-foot-long southern facade of insulated glass. A four-foot-high upper-level clerestory admits sunlight to heat and illuminate the warehouse space at the back of the building. A middle row of glazing warms the front office space in the same fashion, also allowing sunlight to strike the heat-retentive central masonry wall between the spaces.

The lower band of glazing fronts a trombe wall of 138 55-gallon water-filled barrels, painted black and stacked within an insulated interior cabinet that also provides counter space in the offices. The thermal storage of the trombe wall is tapped through standard counterside registers in each office (lower right photo). Cold air returns situated in the floor 3-4 feet from the heat registers facilitate heat flow through the space.

A hybrid approach for Aspen's Pitkin County Airport



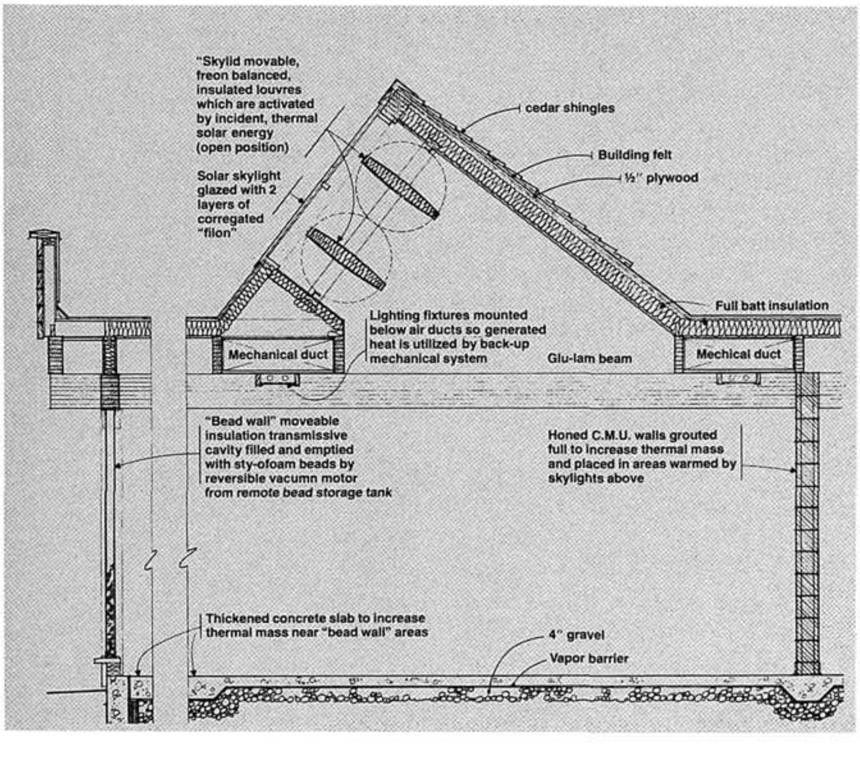
The Copeland, Sinholm, Hagman, Yaw architectural firm designed Aspen's predominantly passive airport terminal in 1975, with the assistance of the ubiquitous Zomeworks firm.

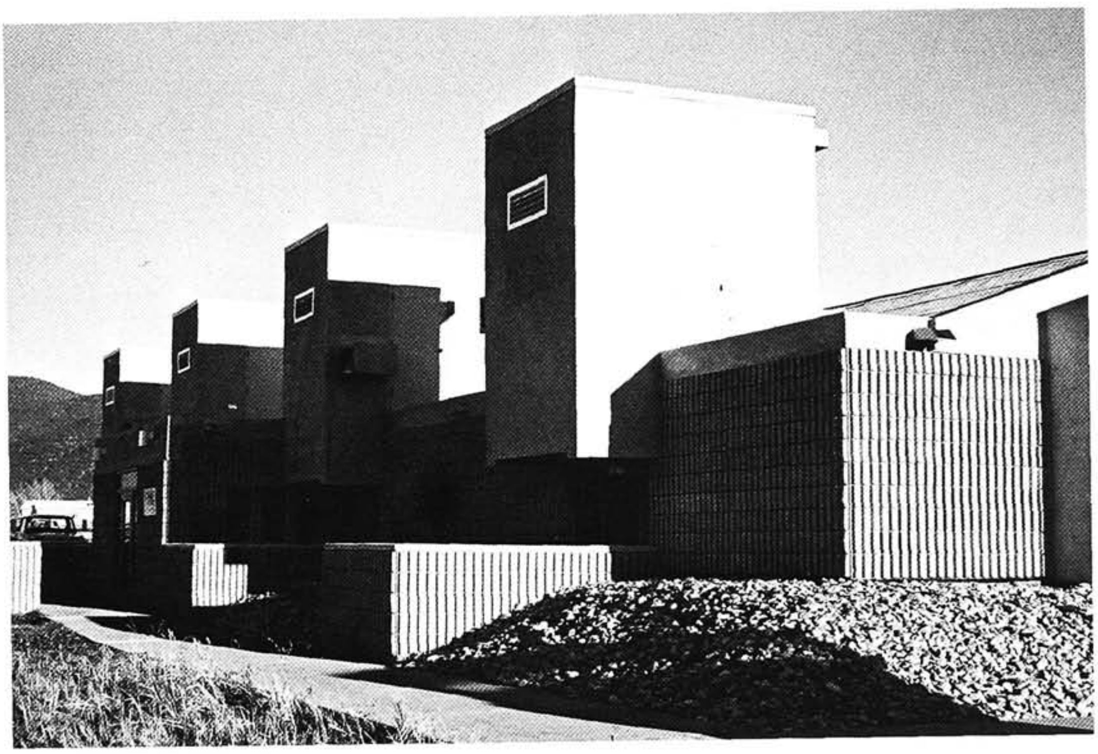
The single-story, 16,800-sf terminal contains offices and waiting rooms within 8-inch solid concrete block walls, set on a 5-inch concrete slab. The east walls are bermed (photo at right below) and all walls and ceiling are insulated to an R20 value.

The staggered southern facades of the building are Beadwall—a Zomeworks concept developed by Dave Harrison, consisting of two translucent fiberglass sheets spaced 2.7 inches apart and filled with styrofoam beads that can be drawn out to admit solar radiation, or blown back in at night to provide full-wall insulation.

Solar heat also enters the building through multiple clerestories oriented to the south and enclosing operable insulating louvers called Skylids—another Zomeworks concept. Actuated automatically by a solar-powered mechanism, the aluminum-sheathed louvers open to let sunlight bear on the mass of interior floor and walls, where heat is stored and radiated back into the interior space as temperatures drop. The louvers close at night to interpose five inches of insulation.

In the cold but sunny Aspen winter, the terminal's hybrid energy system meets 35-40 per cent of heating requirements; a gas-fired, forced air system supplies the difference.





Mixed systems heat an office building high in the Rockies

The climate in Taos, N.M. puts little cooling load on this state-owned office building by The Architects, Taos, but the heating requirements are sizeable. By berming the perimeter, opening the interior to solar radiation through 11 banks of clerestory glazing, and using masonry construction beneath a steel-frame roof, the designers contrived to meet 70-85 per cent of heating need with natural energy.

Sited to maximize southern insolation and minimize the effects of northern winds, the 12,000-sf building actually houses two state agencies with separate entrances, offices, and functions. The tall boxes rising above the roofline on the building's north face (left) enclose mechanical equipment—fans for ventilation and air circulation—and bracket pairs of rock regenerators used for evaporative cooling. The rock-covered earthberms surrounding the building perimeter serve to stabilize temperature swings.

The building's southfacing clerestory windows supply light to the office spaces inside—averaging 70-80 footcandles—and solar heat. Reflective insulating shutters—shown roughly three-quarters open in the photo at left below—are thermostat-controlled and positioned by a pneumatic drive device. When the shutters are open, incoming sunlight strikes both the space below and dark, ceiling-mounted thermal-storage drums that retain and radiate heat to the interior. The shutters close for nighttime insulation.

Construction costs on the project were $550,000, plus $85,000 attributable to the solar design elements. Half of the solar costs were picked up by an ERDA/Department of Energy grant in the second round of the federal solar heating and cooling demonstration program.

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