Progressive Architecture

First Village, Santa Fe, NM

Living proof

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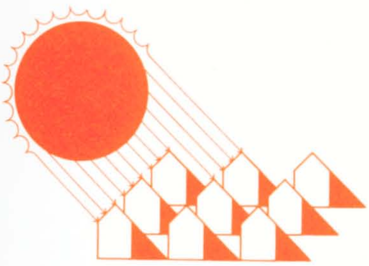


A cluster of houses in Santa Fe offers a laboratory for living with solar heating by experimenting with several methods.

Santa Fe could be called the hotbed of solar heat housing. In this area of adobe walls, pueblo style architecture, 70 percent sun all year around, a new regional type of architecture is taking shape—some call it "solar adobe." While many of the designers, architects, and builders started out experimenting with "active" solar heated environments, "these days you find nine out of ten switching to passive solar heating," guesses one staunch convert.

Susan and Wayne Nichols count in this number, for they have developed, designed, and built a solar-heated housing subdivision in Santa Fe that is both a model for different kinds of heating approaches and an experimental laboratory to test out the best kinds of solutions. Because solar scientist Douglas Balcomb of the Los Alamos Scientific Laboratory (p. 109) lives there, much of the information being gathered can be translated directly into computers.

The Nicholses, with Douglas and Sara Balcomb and Albuquerque architect Edward Mazria, in fact have formed Passive Solar Associates. This group travels to various cities giving workshops on solar heat and its movement by natural (passive) means—conduction, convection, and natural circulation, through any number of methods such as water walls, Trombe walls, clerestories, greenhouses, and direct gain. These designers, developers, and scientists obviously believe in spreading the word.

The Nicholses began to see the development potential of solar heated housing in 1973 when they relocated to Santa Fe from California. Wayne, a Harvard-trained businessman, and Susan, a Stanford University-trained mathematician, made the transition into architecture and development of solar heated houses rather smoothly. They first began as part of the Sun Mountain Design group with architects and designers Bill Lumpkin, David Wright, Travis Price, Keith Haggard, and others, then proceeded to build their own active solar home.

And soon they formed their firm of Communico Inc. and bought a 40-acre tract of land on which they planned two clustered developments sharing common open space. Owing to costs and marketing factors, the Nicholses changed the program to eight luxury-priced homes on five-acre plots. This community, called First Village, lies six miles south of Santa Fe. Beginning work on two houses simultaneously—the first solar homes built on speculation in New Mexico—they decided to design one according to passive solar heating methods, the other according to active—with a solar collector. Both houses (the Balcomb House and the McDowell House) proved marketable, although it has become clear that the passive solar house was not only cheaper and easier to build but lower in cost to maintain than the active one. The rest of the houses, of which five were built on spec and three for clients, employ passive solar heating methods and construction.

Because of the experimental nature of this kind of housing, the Nicholses geared the development to a professional affluent market that can afford homes in the $100,000–$170,000 range. The buyers of these homes often tend to be in their thirties and forties, some single, some with small families, all with individual lifestyles and strong environmental concerns. Like the passive solar designers and builders, this community seems convinced about and committed to passive solar heating.

Now that the Nicholses have reached a point where they can easily identify which combinations of passive solar heating and

natural cooling work best, they plan to pursue lower-cost housing developments. With their next project, La Vereda, they are building 19 passive solar homes in a planned unit development of quarter-acre lots on five acres, with five left as common space.

These two- to three-bedroom houses will range from homes 1100 sq ft in size, priced around $80,000, to ones about 1950 sq ft selling for $110,000. In a sense they hope the "standardization" benefits seen in manufacturing will operate: that as the alternate technology designs become more refined, lower-cost passive solar housing can reach a broader public. Right now they face the problem that some solar (passive and active) homes work well but cost 15 to 20 percent more than conventional houses. As Wayne Nichols pithily states, "We know that the passive solar home costs more and anybody who says it doesn't has never built one." To keep costs under control, Communico Inc. uses its own building crews as much as possible—with only plumbing, electrical work, and roof construction subcontracted. Whereas costs in First Village ran about $48 per sq ft because of the prototypical nature of their design, with La Vereda they think they can keep the price to $40 to $42 per sq ft with a 15 percent overhead and profit. Nevertheless, with the houses selling for less money, there is less margin to offset the risk. Furthermore, the buyer will be getting about 200 to 300 sq ft less space for the price in return for passive solar features.

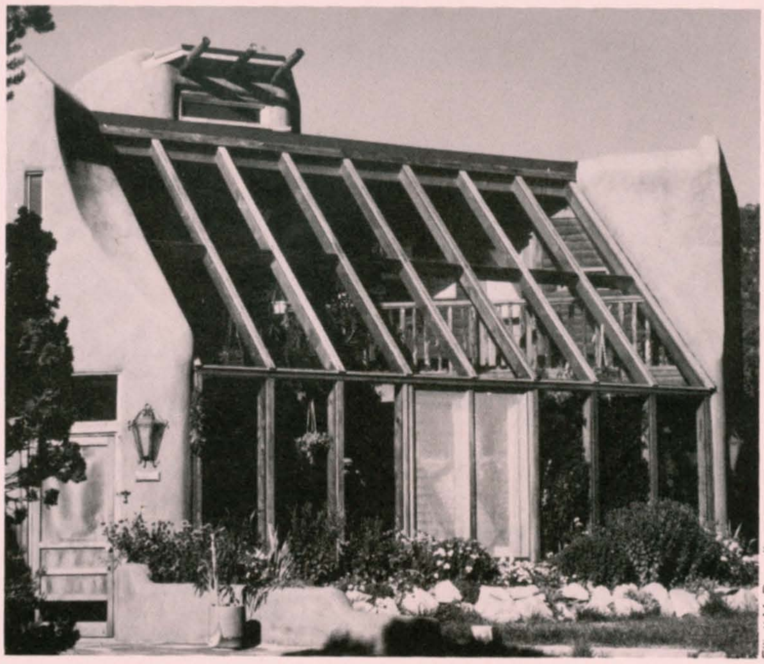
The Nicholses do run into obstacles, of course, in these incipient years of passive solar construction. Appraisers and mortgage companies tend to be conservative, requiring a course in passive solar methods before they will take the risk. It is to Communico Inc.'s benefit that it can provide engineering and financing figures, along with a crash course in solar heating. Susan Nichols does most of the design assisted by architect John Pryor.

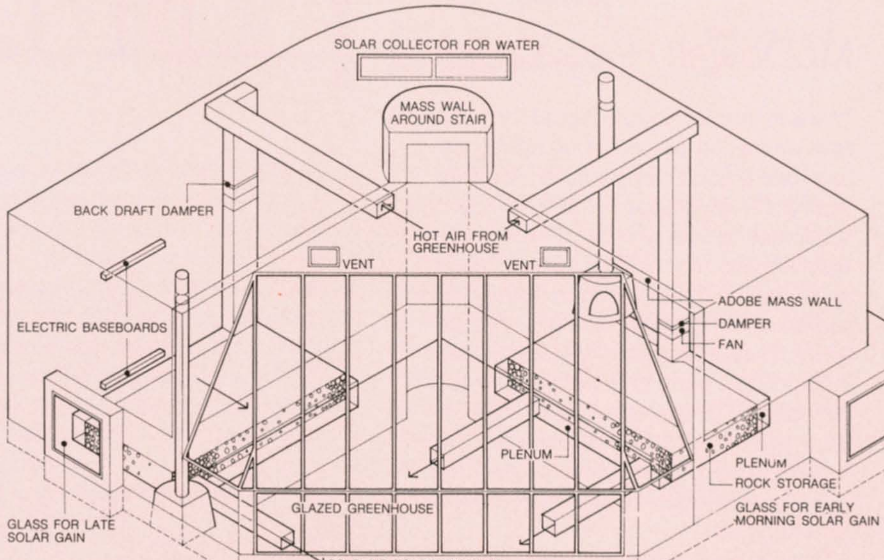
In the initial work of the Nicholses shown on these pages, certain architectural features go hand in hand with their passive solar approach. Clerestory windows, stagnated Trombe walls with direct gain expanses of glazing, and greenhouses have become a prevalent trademark—a definite architectural character. Other features, such as sinking the houses partially into the earth, using thick-walled construction, or including many fireplaces, are less obvious, because they are less visible and are more historically familiar.

The style the Nicholses work in (solar adobe) represents an amalgam of the regional pueblo style with its adobe walls (usually stuccoed), *vigas,* and chunky forms. So far the grafting of solar technology onto a regional vocabulary lacks a sense of refinement in the formal integration or at the level of detail—a characteristic generally true of other work than just the Nicholses'. If anything, their schemes offer more of a sense of integration, and their designs are often more refined, functionally and spatially. Still the inclusion of a Trombe wall, for example, into the pueblo style leaves something to be desired.

Even if solar adobe becomes a "style" with a degree of architectural sophistication, it still makes sense only in this regional context. Other architects are developing an architecture incorporating the passive solar components for other areas. (For more discussion about regional solar architecture see p. 144.)

Of course the other main question that comes to mind with regard to this effort centers on the single-family home versus multifamily housing. Row housing with shared party walls would make better use of solar heating techniques. Can that kind of development gamble be taken soon? The Nicholses are to be commended for striking out in this new terrain of housing development, and for advancing the design and construction of solar architecture this far. They—and others—will no doubt advance this effort even further.
[Suzanne Stephens]


Elliott McDowell



PASSIVE SOLAR HOUSE

The Balcomb house (Unit 1)

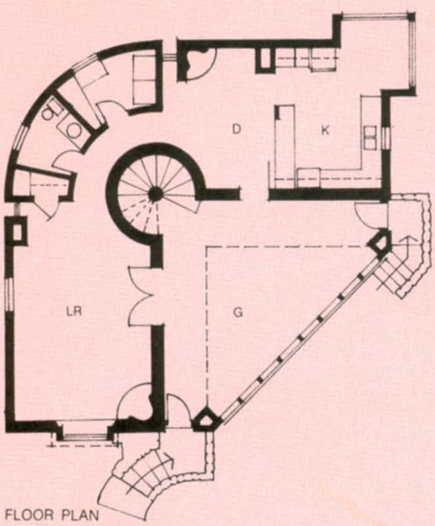
Built on speculation, this house, now owned by Douglas and Sara Balcomb, was designed by Santa Fe architect William Lumpkin with Susan Nichols. It represents a hybrid passive solar approach, using the direct-gain method of introducing the sun into a 400-sq-ft double height greenhouse, backed with a thermal mass wall of adobe brick, 1050 cu ft and 10 to 14 in. thick, with a heat storage capacity of 25,200 Btu per degree F.

The living areas on both levels have openings onto the greenhouse otherwise separated from them by a mass interior wall that also wraps around a central stair. Spaces from both levels thus receive the sun's heat, stored in the wall and then reradiated after a delay of about ten hours. "Active" solar components—in the form of small fans—draw off excess warmed air from the greenhouse. The air is directed through ducts over 2-ft-deep rock beds (1165 cu ft, storing 20,000 Btu per degree F) placed under the tiles and floor slab of the living room and dining room. The distribution figures for the mass wall average 1575 Btu per hr per degree F; for rock bins, 792 Btu per hr per degree F.

The greenhouse/wall concept not only counters disadvantages of direct-gain solar heating—glare and fading of fabrics—but because of the cold Santa Fe winters, makes a very marketable addition.

The Balcomb greenhouse averages about 50 degrees higher than the outside, and the temperature in the house rarely varies from 70 F. While the south (greenhouse) mass wall needs an R-factor of only about 2, the Nicholses found that the R-factor on east, west, and north walls had to be raised to 33 because of the location. Thus they built walls with 2" x 8" studs rather than the normal 2" x 6", and sank the perimeter walls into the ground several feet to take advantage of the earth's insulative properties.

First Village



FLOOR PLAN

Insulation materials include 7½-in. blown-in wood-fiber insulation, and six-mil polyvinyl vapor barrier on walls under plaster. Windows naturally have weather stripping, storm panels, and some are shuttered, while the greenhouse employs double glazing. In the summer when the temperature rarely exceeds 80 F, fans are turned off and vents opened, including one at the top of the stair. Natural convection draws hot air out of the house; in addition, night air can be circulated over rock beds for daytime cooling.

Owing to the nature of Douglas Balcomb's work, the house is being heavily monitored by small computers at 15-minute intervals. According to the winter average, these houses take about 1160 Btu per sq ft a day from the sun, with a solar fraction—the percentage of heat supplied by the sun—of about 90 to 95 percent in this one. Thus the Balcombs find the cost of heating the 2400-sq-ft house (no heat is required before November 15) comes to about $15 a month for the electric backup heating.

McDowell House (Unit 2)

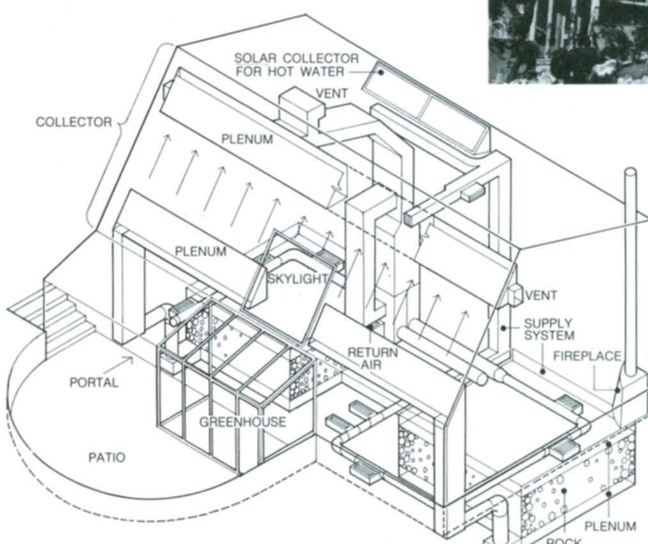
This active solar house, built at the same time as the first passive solar residence, provided a good comparative model for testing the advantages of one method of solar heating over another. The Nicholses installed 365 sq ft of solar collectors with an aluminum modular finned configuration on the roof over 3½-in. fiberglass insulation. A forced-air system distributes heat (400,000 Btu per day generated) through the house. Excess heat—up to 1 million Btu—can be stored in rock bins of 1150 cu ft, 3–4 in. deep, with backup heating provided by an electric duct heater in the air handling units.

Passive solar methods supplement the active one: a south-facing greenhouse with 125 sq ft of glass can heat the house during the day, so that the heat from collectors may be stored for night use. In addition, the master bedroom receives heat through direct gain—96 sq ft of windows—which is stored in the flagstone floors and concrete walls.

In warm weather, vents in the sides of the house and middle of the roof are opened individually to permit the collector to vent and the fan to pull the cool air through the windows on the shady side of the house. The fan also pulls air through the rocks at night.

Despite the fact that the 2200-sq-ft house is sunk several feet below grade and most windows are double-glazed, the electric heating bill averages $50 a month. The higher than normal bill is due partially to the lower R-factor (27) of the 2″ x 6″ stud walls. More to the point, of course, is the cost of power needed to operate the forced-air system—a main reason the Nicholses have been pursuing passive solar heating methods.

Wayne Nichols



ACTIVE SOLAR HOUSE

Elliott McDowell

The Hamilton House (Unit 3)

Elliott McDowell

The third house uses the Trombe wall (see p. 106) in combination with the greenhouse and direct-gain windows for its passive solar heating. The Trombe walls themselves are not the convective type, that is, vented at top and bottom to allow air to circulate throughout the living space. To avoid construction problems, need for backdraft dampers, and problems with spider webs, etc., the Nicholses specified a "stagnated" Trombe wall. Thus, 82 sq ft of glazing pierces the 285-sq-ft walls of 16-in. cellular adobe filled with concrete, allowing natural light and direct-gain heat into the living areas.

While a slight decrease in efficiency results with the Trombe wall (since only about 50 percent of the insolation hitting it is absorbed, or 506 Btu per hour) other factors compensate: the solar radiation is stored in the thermal mass of the concrete wall and brick floor, and then is radiated out with a lag of five to six hours, while the heat stored in the Trombe wall is radiated with a lag of eleven to twelve hours. Thus the house receives heat throughout the 24-hour cycle.

In addition, the greenhouse's 96 sq ft of glazing directs sun to 10-in.-thick adobe walls, totaling 271 cu ft, which release heat gradually to living spaces and the greenhouse. The clerestories, 97 sq ft of glass, provide direct-gain heating into the back parts of the house where heat is absorbed by the 8-in.-thick concrete perimeter wall and adobe brick interior wall.

SECTION

FLOOR PLAN

To prevent loss of heat at night, the clerestories and windows in the Trombe wall will be shuttered. Overhangs shield the Trombe wall, the direct-gain windows, the greenhouse and clerestory windows from the sun's high angles in the summer to prevent overheating. Natural ventilation and radiation to the night sky through windows and doors should keep the mass of the house cool.

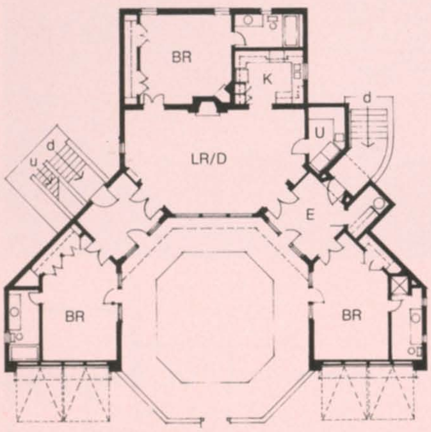
While it is difficult to definitively predict the electrical bills for backup heating until the house has been occupied for several months, the solar fraction ranges from 80 to 90 percent for the 1800-sq-ft house. The Nicholses see this design in particular as prototypical for other "tract" houses. They also installed a "skylight water heater" designed by Steven Baer, where an 80-gallon water tank hangs suspended from a skylight with a curved exterior reflector. Generally, water heaters in the village operate by detached solar collectors.

The Gunderson House (Unit 4)

The Gunderson House experiments with another component for passive solar heating—the water-filled Trombe wall. Eight precast modular sections of the concrete water wall were installed along the south side of bedroom wings. While this feature costs about $10 a sq ft, it is less expensive than the $18 to $25 a sq ft typical of "active" solar collectors. To defray the initial extra cost, designers for the house, architect William Lumpkin, engineer Buck Rogers, and Susan Nichols obtained a grant from HUD in the second cycle of the National Solar Demonstration Program.

The space between the Trombe wall exterior, painted black, and the double glazing that sheathes it can go as high as 190 degrees on a sunny January day. This heat conducts through the 2-in. layer of concrete to a 6-in.-thick area of water held in a

Wayne Nichols



FLOOR PLAN

Mary Peck

Elliott McDowell

plastic bag. The 77 cu ft of water stores the heat (4620 Btu per degree F), then radiates it through the other side of the concrete wall (which totals 132 cu ft with a heat capacity of 3960 Btu per degree F) to interior spaces at night. Mass walls and floors inside provide another 546 cu ft of storage for heat. Meanwhile, the living room and third bedroom are heated through direct gain, accomplished through 275 sq ft of glazing in windows and clerestories. Overhangs cut gain in summer.

To increase the performance of the water wall by 50 percent, the designers installed 8′ x 16′ shutter reflectors that in turn keep heat from escaping by night. Again the north wall is sunk into the hill to cut heat losses, and entry rooms or greenhouses serve as thermal air locks, with backup heating provided by electrical baseboard units in key areas.

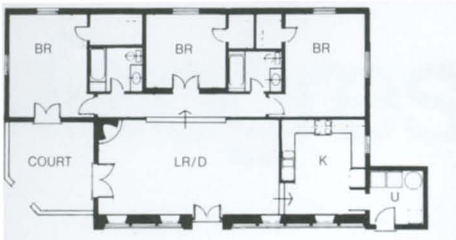
The Nicholses have found that the electric bill for the house averages $40 a month during the winter, higher for the 2200 sq ft than ideal. The water-wall rooms perform quite well, but the living room and third bedroom remain rather cold with just passive solar heating. The solar fraction comes to about 70 percent in contrast to the 90 percent of other houses.

The Schmidt House

This 1650-sq-ft house, designed and built for a particular client, uses two passive solar heating components—Trombe wall sections pierced with direct-gain windows along the south facing façade plus clerestories admitting solar heat into bedrooms at the back of the house. The 6000-lb Trombe wall is 16-in.-thick poured concrete, faced with 260 sq ft of double glazing. Again the convective type of Trombe wall was not used, with an acknowledged loss of efficiency, so that 100 sq ft of large, direct-gain double-glazed windows could admit light and heat to the living space. Brick-paved floors provide the thermal mass for storage, supplementing the heat being radiated from the thick Trombe wall sections.

Clerestory windows, 150 sq ft, also direct the sun's heat onto 8-in. adobe interior walls and an 8-in.-thick concrete rear wall.

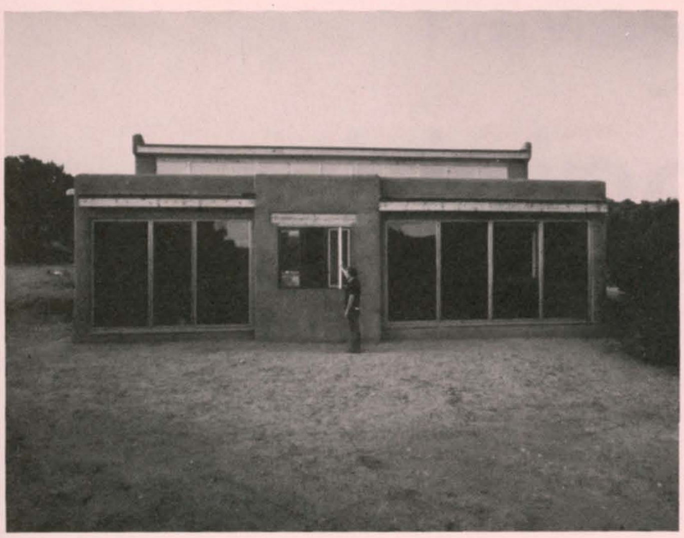
Elliott McDowell



FLOOR PLAN

To cut down loss of heat, the house was sunk into the ground several feet and its south-facing glass and clerestories fitted with custom canvas or fiberglass shutters. While the Schmidts have the usual backup electric heating system, they find the temperature in the house rarely falls below 50 F. The electric bill for heating in the winter averages $20 a month.

Elliott McDowell



Elliott McDowell

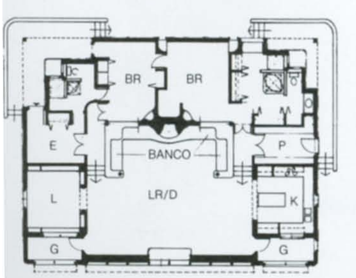
Bill Mathews

The Norquist House

The Norquist House was designed for a specific client, a young single person who didn't want to pay more than $50,000 for a house. The Nicholses gladly accepted the challenge since this was the type of residence they hoped could provide a prototype for the La Vereda project (p. 110). In spite of the compactness of the floor area—1100 sq ft—the house succeeds in being architecturally one of their most interesting: the height of the living room ceiling, the pitch of the roof, and the clerestory glazing vary the interior spatially.

While the plan is oriented so that kitchen and dining room face south, the living room receives sunlight from 88-sq-ft clerestory windows. Other clerestories introduce light and heat into a study and sleeping loft. Like the Schmidt house, the south-facing wall is a 16-in. concrete Trombe wall, 218 cu ft, covered with tempered double glazing and pierced with 38 sq ft of direct-gain glazing. The north mass wall is 8-in. block with 2″ x 6″ stud wall or 6-in. wall of cast concrete; other interior walls are composed of 2″ x 4″ and 2″ x 6″ stud frame. Because of the compact size and efficiency of the spaces, the passive solar heating components and the fireplace work quite well. In fact the owner rarely turns on the electric heating.

The Ogg House



FLOOR PLAN

Only just occupied, the 2200-sq-ft Ogg House uses a 240-cu-ft Trombe wall pierced by 50 sq ft of direct-gain glazing along the front part of the house. Clerestory windows, 54 sq ft in the living room, direct the sun's light onto a concrete mass wall which is combined with a fireplace and *banco* seating. However, since the clients preferred the sculptural wall, designed by Robert Peters, to remain open above eye level, a good part of the heat storage capacity is lost. A greenhouse with 128 sq ft of glazing supplements the other passive solar heating methods, and the northeast and west exterior walls are made of 2″ x 8″ studs with 7½-in. fiberglass for high insulative capacity.

Summer heat gain will be controlled through the use of overhangs and vents in the clerestories, plus operable vents along the bottom of the Trombe wall's direct-gain windows.