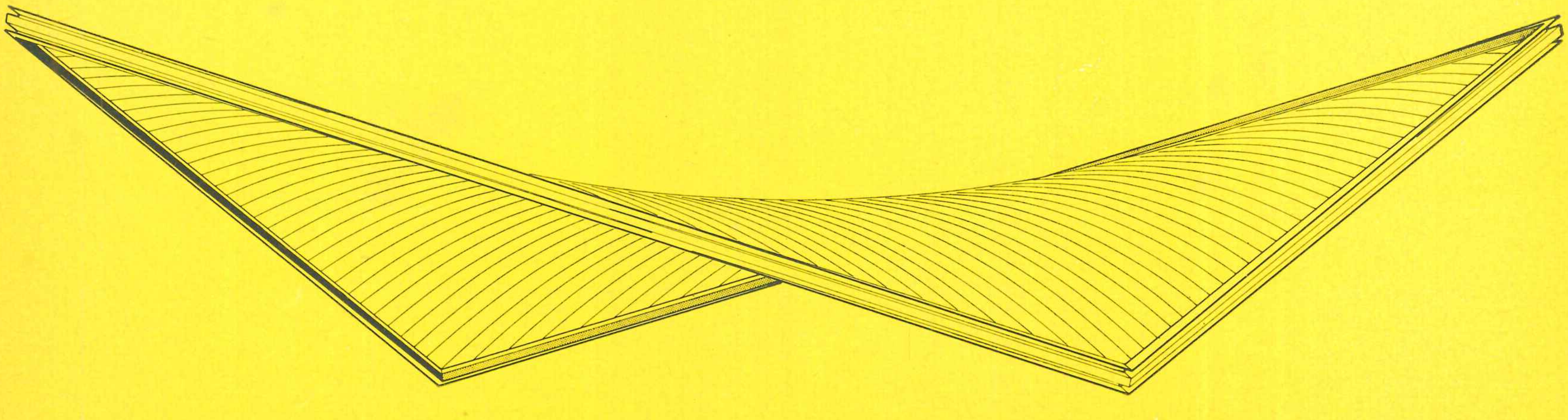
house in Raleigh

LOCATION: Raleigh, N.C.
EDUARDO F. CATALANO,
architect (Argentina)
E. M. UYANIK, structural engineer
ATILIO GALLO, structural engineer
FRANK WALSER, general contractor
FRANK CALDWELL, associate

Drawing (below) explains double-twist of roof shell, seen also in picture at top of page. Roof surface is a glass fiber mat finished off with a plastic coating. Two low points of roof are supported on concrete buttresses. Note carport under roof overhang in picture at right.



WHY ARE PEOPLE TALKING ABOUT THIS HOUSE?

©Ezra Stoller

For three reasons—

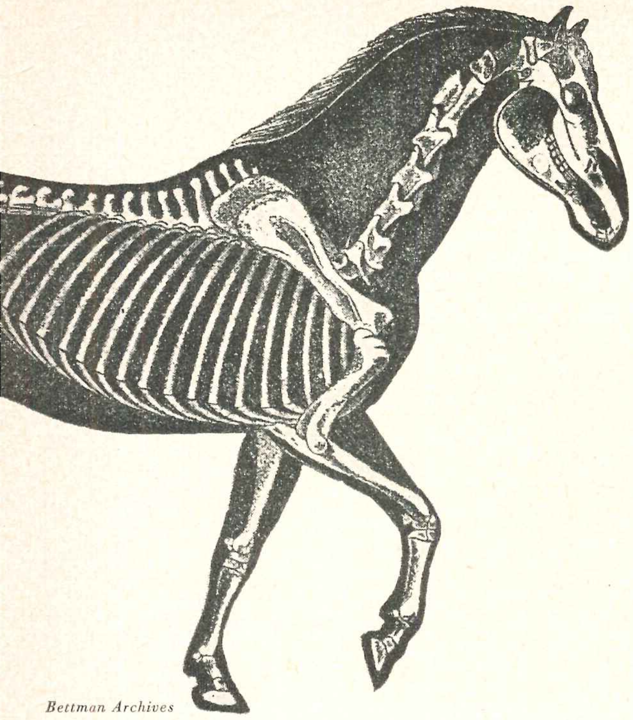
—because the house has a 4,000 sq. ft. roof supported on only two points;

—because its roof is a 2¼″ thick wooden "slab" that spans 87½′ in one fantastic leap;

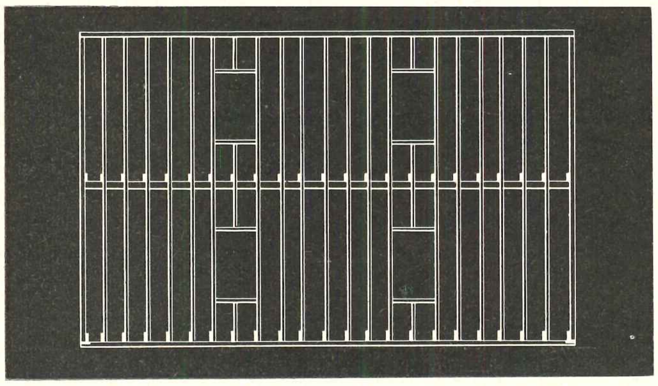
—and because this is a structure that is all "skin" and no "bones," a structure that reaches into the magic design world of the soap bubble and the cobweb, a structure that reflects the most advanced engineering know-how of our time.

In brief, the house is a glassy square sheltered under a laminated wood shell twisted into the shape of a giant potato chip. The result is a flight of engineering fancy so daring, so nearly unbelievable as to make most structures of 1955 seem ponderous and obsolete by comparison. The house was designed and built in Raleigh, N.C., by the young Argentine architect Eduardo Catalano, for his own use.

But this is not just an essay in science fiction. The implications of Catalano's roof bear directly upon important structural problems of today. For details, please turn the page.



Bettman Archives



Animal skeleton and balloon-frame diagram from 19th Century carpenters' manual symbolize traditional building techniques using a "bone structure" which is then finished off with a nonstructural "skin." Catalano's approach uses the skin only and then structurally.

THE STRUCTURE: FROM BONES...

Most buildings today are "skin and bones"—"bones" of wood, steel or concrete, with "skins" of sheet materials applied to that structural skeleton.

Architects and engineers have known for years that "skin and bones" construction can be both wasteful and inefficient: if the typical one-story frame house were re-evaluated today, chances are that the true structural strength of such materials as plywood sheathing or plate glass would prove to be actually greater (in some respects) than the strength of the "bones"—the 2 x 4s and so on. Yet the "skin" is rarely given structural credit in the engineering of houses: more often than not its weight is considered a structural liability, while its structural assets are completely ignored.

Designers in other fields long ago recognized the tremendous potential strength inherent in the skin, and *particularly in the curved skin.* And so, step by step, the "bones" started to disappear—and the "skin" was made structural. This is as striking an advance in the history of building as the progress from lintel to arch.

One way to make the skin structural is the way of the egg—a parabolic shell, the dome of old. Another is to twist the skin in such a way that its resistance to bending becomes vastly increased. To explain: a flat shoehorn would bend, but a scooped shoehorn of equal thickness is strong enough to push a size 9 foot into a size 8 shoe.

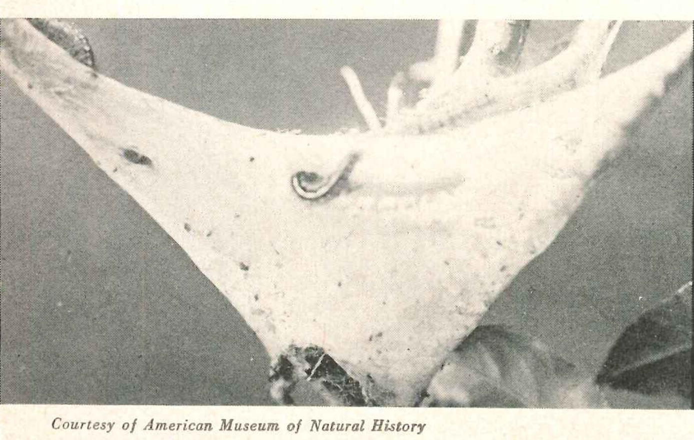
All of which is by way of an explanation of the significance of Catalano's roof structure. He has taken a ridiculously ($2\frac{1}{4}''$) thin wooden "slab," and by giving it a double-twist added enormously to its structural strength: few US codes would permit a span of more than 8′ for a $2\frac{1}{4}''$ thick plank deck. *Yet Catalano's $2\frac{1}{4}''$ deck has a clear span of 87′-6″!*

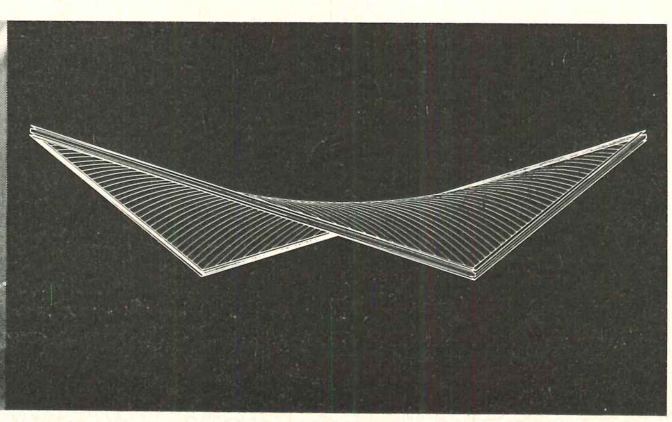
His double-twisted shell is called a hyperbolic paraboloid, because you will always get a pair of hyperbolas when slicing the shell horizontally, and a parabola when slicing it vertically. In plan, the roof is a 62′ square. One of its diagonals is a parabolic arch, while the other is an upside-down parabola. Hence the double-twist.

The entire roof area of about 4,000 sq. ft. is supported on only two points—i.e. at each end of the arched parabola. These two ends are set on hinged steel joints embedded in deep concrete buttresses. Two 4″ H-struts in tension balance the other two ends of the roof against high winds. The fascia is made of steel to absorb the outward compression stresses concentrated along the four edges of the roof. The $2\frac{1}{4}''$ thick wood shell consists of three layers of fir flooring strips, laminated with nails and topped off with plastic-on-glass-fiber roofing. The cost of the finished roof with all footings was about $10,000—only $2.50 a sq. ft.

The shell was built in place on a scaffold consisting of straight-line members, each one with a different slope. Work on this structure was done by Catalano at North Carolina State College, where he teaches. His house is the first practical application of his experiments.

...TO SKIN



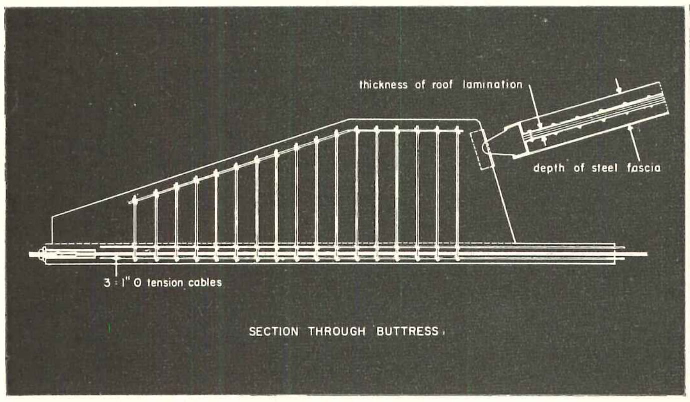


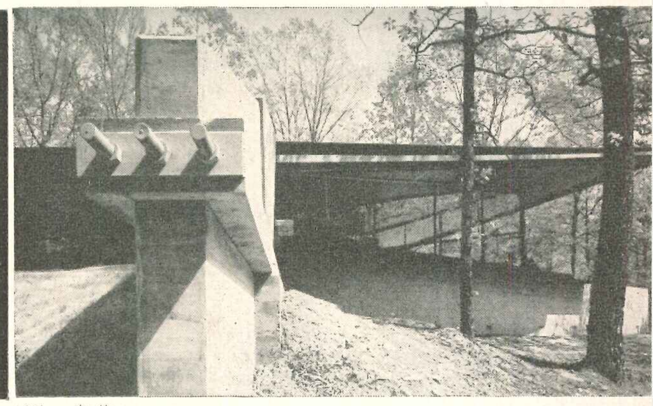
Tent caterpillars build "skin structures" very similar in form to Catalano's hyperbolic paraboloid. In these structures, the skeleton is eliminated altogether and the skin is given tremendous structural strength by being warped in two directions. The diagram at left shows how.

Courtesy of American Museum of Natural History

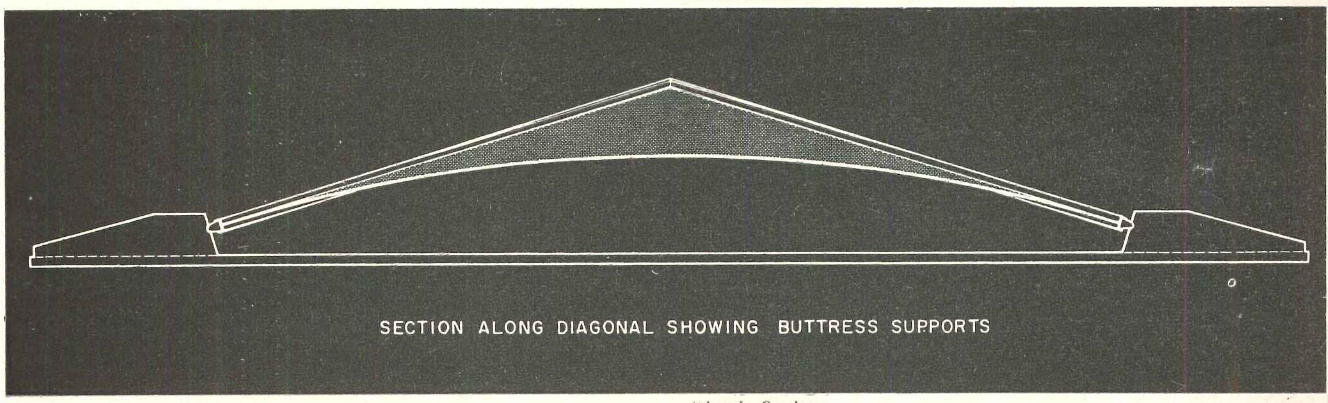
Construction details show (top to bottom): one of two concrete buttresses and wing-shaped roof beyond; section and close-up of buttress, explaining use of three 1" diam. cables to connect the two buttresses underground; section of house along one parabolic diagonal with its 87'-6" clear span between supports; and, at bottom, interior of huge laminated shell balanced on a hinge set into the concrete.

Eduardo Catalano

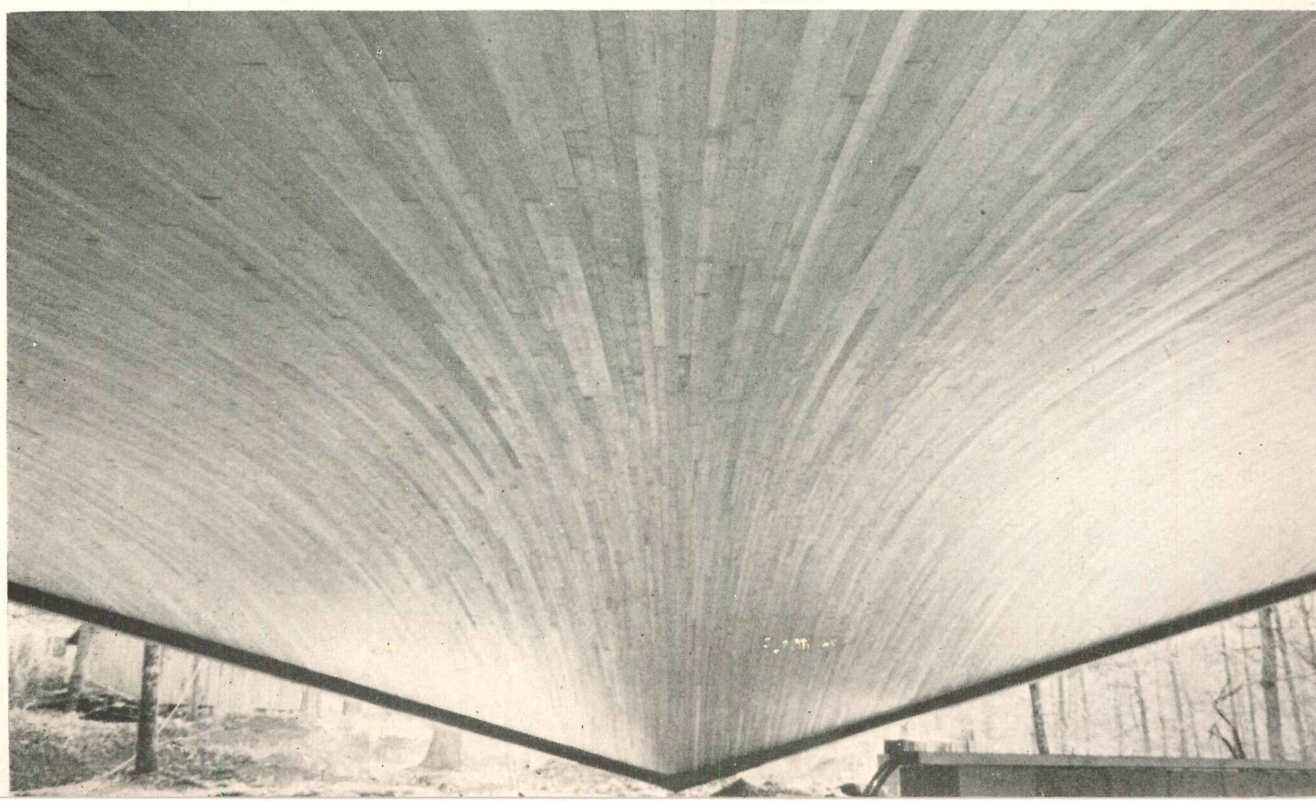




©Ezra Stoller



Eduardo Catalano

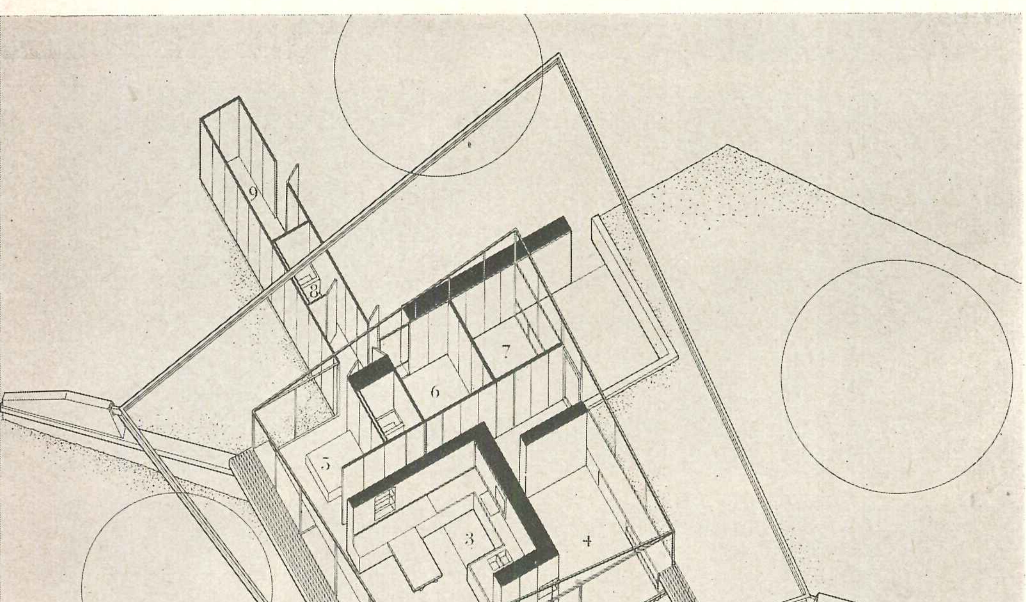


©Ezra Stoller

Gene Heil

Paved terrace (left) is an extension of the family and living rooms at the south end of the house. Most cabinetwork and the sunbathing platform outside were kept at uniform 28″ height above floor to establish a continuous line of reference throughout the plastic structure. This line is the sill-height on two sides of the house (opposite).

THE PLAN: A TERRACE AND A PARASOL



1. Terrace 2. Family room 3. Kitchen 4. Living room 5. Master bedroom 6. Girl's bedroom 7. Boy's bedroom 8. Laundry 9. Air conditioning

The 62′ square roof covers a square interior that is recessed 12′ on all four sides to measure 38′ x 38′. To the north, beyond the bedroom areas, there is a narrow spur that projects out from under the roof and contains all utilities; to the south, beyond the family and living rooms, a large, paved terrace forms an extension of the indoors.

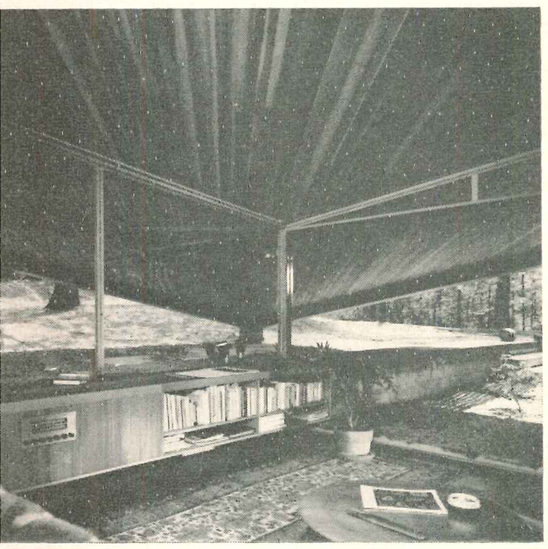
Catalano, with his Latin background, brought into this house an almost classical sense of formality: the terrace is really a patio, bounded by low masonry walls. You step down into that patio from above, then find the house proper to your right—in effect an extension of the patio, separated from it only by large sheets of sliding glass, and sheltered by a gigantic parasol.

To emphasize this continuity of indoor and outdoor space, Catalano made one horizontal the dominant plane both in the house and in the patio. This horizontal plane, 28″ high, is the sill line on two sides of the house; it is also the level of built-in cabinetwork (see opposite) and the level of the big wooden sunbathing platform that projects out over the terrace (see above).

This 28″ level is particularly important in Catalano's house because there is no effective ceiling plane—only the undulating shape of the wooden roof. In looking at the plan (left), you should remember that this double-twisted roof dips down over the southeast and northwest corners, rises up on the southwest and the northeast. Large trees on the site provide natural sun protection, help reduce air-conditioning costs. When the leaves are off in the winter, the sun reaches deep into the kitchen at the center of the plan. *continued on p. 99*

THE SPACE:

CAVES AND A BOWL OF GLASS



© *Ezra Stoller*

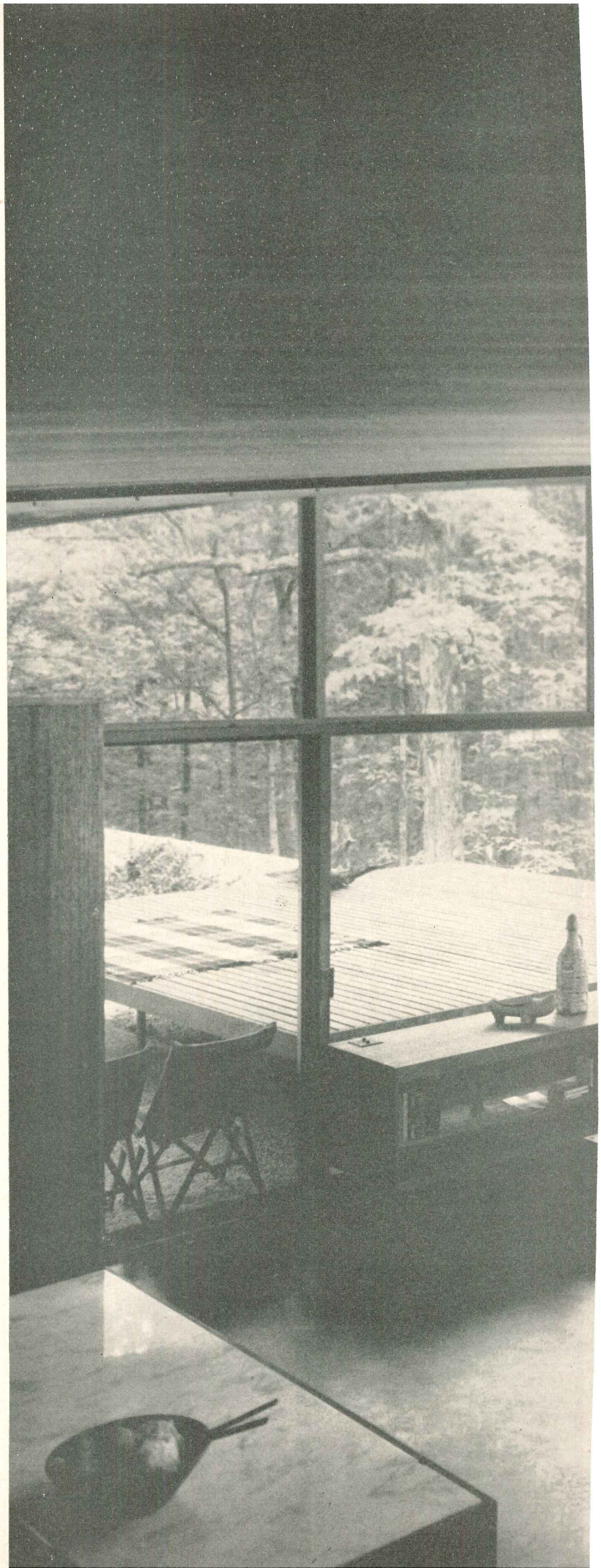
Although this house has walls of glass, it is no glass house in the familiar sense. For Catalano has used the undulations in his roof shell to give glass bowl openness to some of his spaces, cave-like privacy to others.

The family room (opposite) is very glassy, very open. The sun floods into it in the winter, and the view out from it shows lovely trees and slopes. Here the roof rises up and points toward a view.

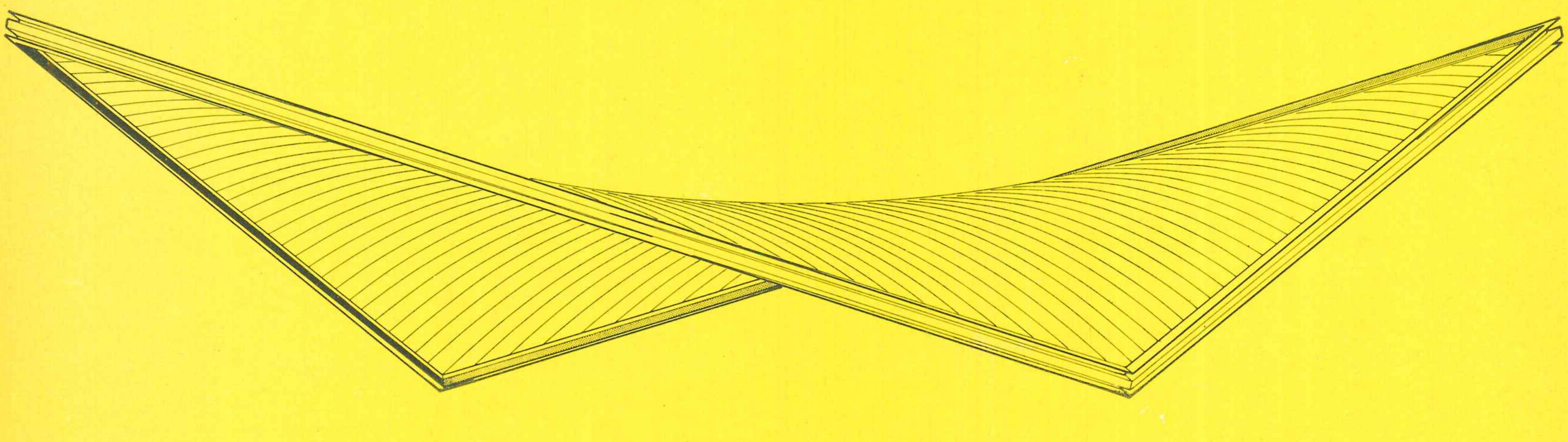
But only a few feet to the east there is a small intimate living room (see above). Its walls are glass also, but here the curve of the roof dips down, encloses the space and gives it privacy. At the opposite corner of the house, where the roof dips down again, it gives a similar sense of shelter and intimacy to the master bedroom. The fourth corner, up and out in the air, makes for a carport at the northeast end of the house.

It is in the nature of a hyperbolic paraboloid that, despite its double curvature, *all lines parallel to its straight edges are straight lines also.* Hence it was quite easy to scribe the glass walls to the soffit of the shell. To preserve the visual integrity of the undulating shell, Catalano kept all interior partitions away from its soffit, filled in the area above such partitions (and above storage walls) with straight-edged strips of clear glass.

For the time being, Catalano's house is still a labratory test. But let no one shrug off this house as impractical: for whatever form the "skin-structures" of the future may take, there is little question that they may replace much of our present "bone-construction" before many more years are out. When this happens, the world of building will recognize this house as a major experiment in that development.



Gene Heil



This article was first published in the August 1955 issue of **house+home**

The professional information contained in this reprint from HOUSE & HOME is not to be construed as the magazine's endorsement or recommendation of any product, service, company or individual.