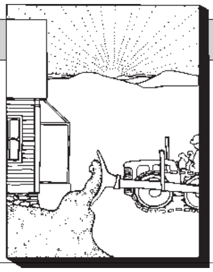
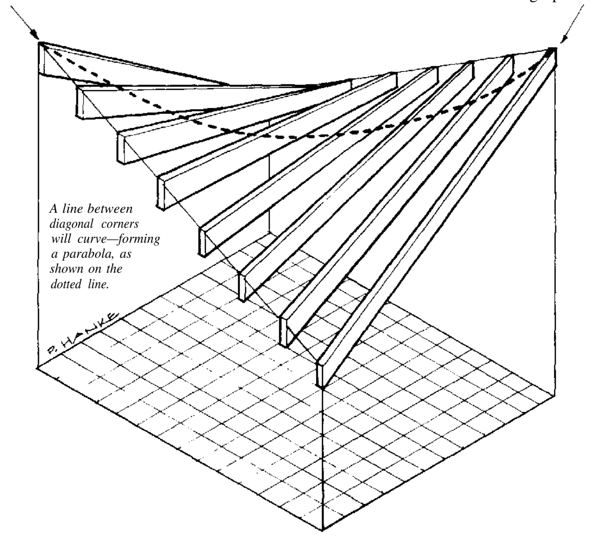


High on Hypars: The Joys of Polysyllabic Roofs

by Paul Hanke

Wood shakes accentuate the curves on this Californian roof, shown on the cover of the book, Handmade Houses.



Reversing a pitch of shred roofs at opposite ends of a building generates a curved surface composed entirely of straight lines, called a hyperbolic paraboloid, *or "hypar."*

Ever since I first saw the funky but beautifully curved shingle roof that graces the music studio on the cover of Boericke and Shapiro's *Handmade Houses,* hyperbolic paraboloids (*hypars* for short) have been among my favorite roof forms. Every winter, as the sagging woodshed roof on my former home in Plainfield inches closer to collapse, I vow that when I rebuild it, it will be a hypar — in homage to its long distorted condition.

The simplest description of a hypar may be to call it a "warped parallelogram"—like a picture frame that won't lie flat. To visualize this, imagine a rectangular building with a wall at one end forming a shed roof (see illustration). Now suppose the pitch of the rafter at the other end were reversed, so that the high points were kitty-corner from each other.

Framing the rest of this roof would require a series of single-pitch rafters at constantly changing slopes. As you added sticks, each would be at a pitch slightly less than its predecessor until you reached the midpoint. From there on the slope would gradually increase again—but in the opposite direction. The result would be a bunch of rafters vaguely resembling the "string art" you may have seen in hobby stores. Cover this framework with thin layers of plywood and you'll have a *curved* surface created solely by straight lines. The photos show how hypars have been used for a variety of buildings, from an (abandoned) car showroom to the stunning tent-like roof on the field house at Middlebury College.

The Middlebury roof is a good example of the four-gable type of hypar (this time in an extended version). The "valleys" springing from the low point of each gable rise gracefully to a pointed spire at the peak. A more beautiful form is hard to imagine, and the visual impact as you drive by is memorable. Other uses of hypars have included a workshop at Rocky Mountain National Park, a backyard gazebo, and a soaring white cathedral in San Francisco.

Warped surfaces gain considerable strength from their curvature. As a result, thin-shell concrete hypars can efficiently span large distances with very little material.

Architectural Graphic Standards says that spans up to 150 feet are possible with reinforced slabs 4 inches in thickness. Additional stiffness is provided by thickening the edge into a beam which transfers loads to two points of support at opposite corners—the rest of the roof cantilevers off into space.

An example of this incredible efficiency is the roof of the Cosmic Ray Pavilion at the University of Mexico. This engineering marvel is a mere 5/8-inch thick. Architect and engineer Felix Candela has used hypars extensively in his work in Mexico and elsewhere. Examples of his work and details of the complex geometry of hypars are provided in the book, Candela, *The Shell Builder*, by Colin Faber, Reinholt, N.Y., 1963.

Hypars get their name from the fact that their geometry is related to the *hyperbola* of a circle, while all cross sections parallel to the diagonals will be *parabolas* (see illustration.) If you can relate to that, or if you love fluid lines and Alice-in-Wonderland ideas, you too may be captivated by hypars. ■

A gas station roof makes good use of the saddle-shuped hypar.

Hypars can join one to the next to form a graceful roofscape, such as on this field house at Vermont's Middlebury College.