

The Hypar Turns 50

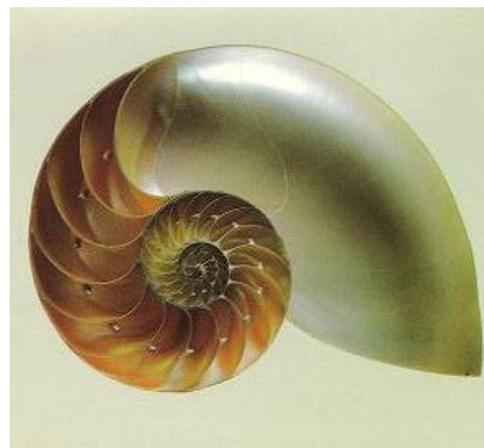
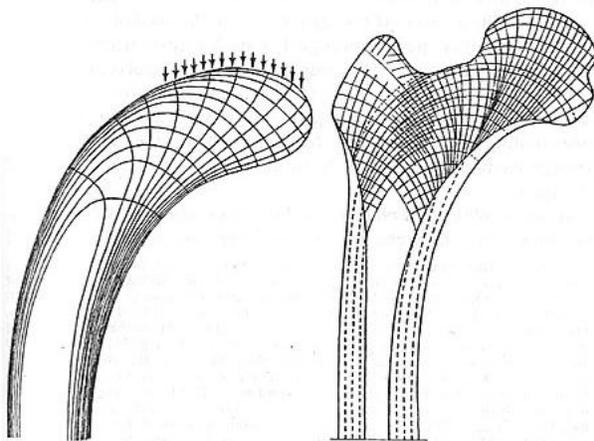
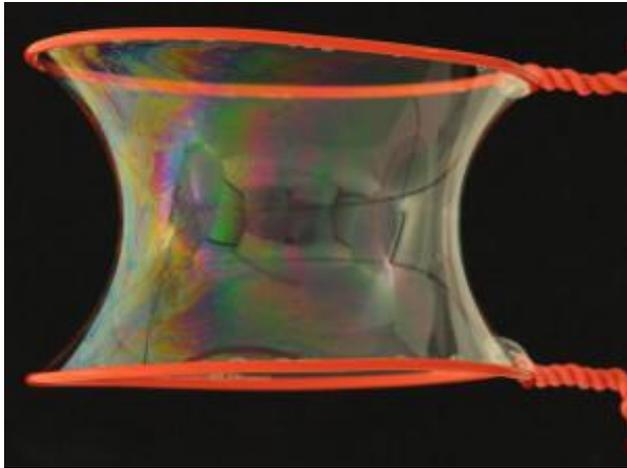


Cornell's hyperbolic paraboloid, the "Flying Diaper" located at the Forest Home entrance to the plantations.

In May 1966, Cornell students put finishing touches on the hyperbolic paraboloid structure on the Cornell Plantations. The Hypar, affectionately known as "The Flying Diaper" was built as part of an interdisciplinary course devoted to teaching the fundamentals of surface (shell) structures to structural engineering and architecture students. Within the class of fourteen students, seven projects were submitted, and the winning project, designed by Thomas Zimmerman, William Maxfield and Mitchell (Buzz) Levine, was selected. All fourteen students had committed to build the winning design of the competition. According to Dr. Greenberg, at the time it was built the Hypar may have been the first of its kind in the United States. Fifty years later, the structure still stands at the entrance to the Cornell Plantations.

Shells structures, such as domes, cylinders and folded plates derive their strength through their inherent geometry enabling the construction of thin sculptural, "gravity-defying" shapes with minimal material.

Excellent examples can be illustrated using soap bubbles, or suspension structures, or “biomimicry” by emulating the forms of snails, leaves, or bones to name a few efficient shapes.



The imitation of natural biological forms frequently results in the most efficient geometric shapes. Emulating these forms results in minimal structures. Clockwise from the top, the soap bubble, leaf structures, human bones, and the exoskeleton of the snail.

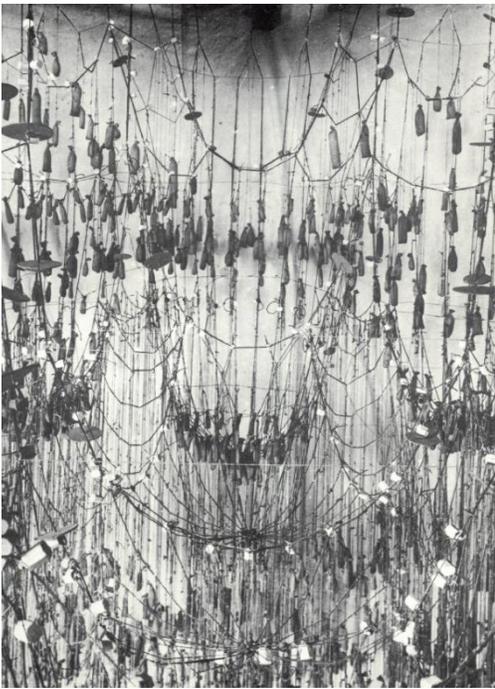
Notable designs, experimental methods, and mathematical analyses, which served as inspiration for the course, were developed by such early pioneers as Eduardo Torroja (Spain) and Felix Candela (Mexico and former A.D. White Professor), or even earlier, Gaudi, the famous Spanish architect, who photographed his “hanging watchfobs”, and turned the pictures upside down to provide the genesis for Park Guell and La Iglesia de la Sagrada Familia in Barcelona.



Hyperbolic paraboloid roof of the hippodrome, “La Zarzuela” Racetrack in Madrid, Spain, designed in 1935 by Eduardo Torroja and Martin Dominiguez (former Cornell Architecture Professor).



Four intersecting “hypars” form the roof of a restaurant in Xochimilco, Mexico, design by Felix Candela in 1957.



A



B



C



D

Gaudi experimented with “funicular” structures by creating hanging models (rope structures, (A), photographing them, and turning the images upside-down (B). The resulting geometric forms, changes from a tensile suspension structure to compressive arches, and serves as the basis for his later designs at Park Guell (1900-1914) (C) and the famous church, La Iglesia de la Sagrada Familia (started in 1882 and still not finished) (D).

Shells became popular in countries where labor was relatively cheap and materials, particularly steel, was expensive. For locations within temperate zones, where snow loads were non-existent, and it was only necessary to carry its own weight, even optimal shapes could be designed.

Among all of the possible shapes, the hyperbolic paraboloid, “hypar”, is particularly unique in that the structures which initially appear curved in two directions, it can really be constructed out of straight line segments.



This photograph of the Cornell Hypar reveals the curvature of the shell. The “anticlastic” surface supports tensile stresses in the hanging direction and compressive stresses in the arch direction.

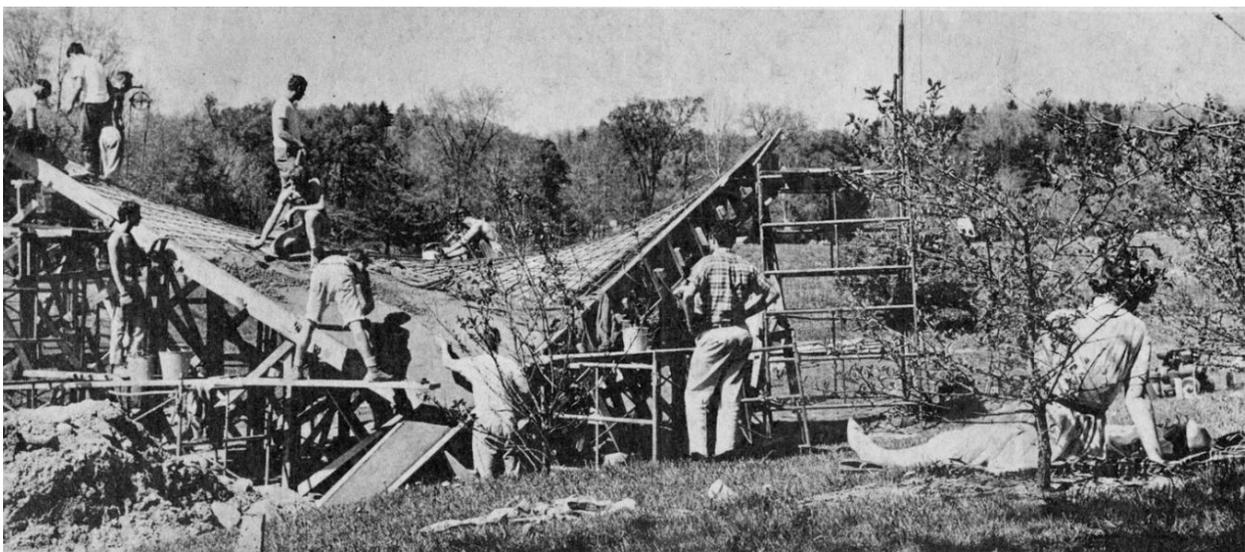


In this picture, students are preparing the steel reinforcements for the thin concrete shell. Comparing the photo to the previous image one can see that the curved surface can actually be constructed with straight lines. Notice the reinforcing bars at 45-degree angles to the primary curvatures.

Due to the Ithaca weather (both winter and spring) the construction actually started by building sixteen formwork panels in the basement of East Sibley Hall. These were then transported to the Cornell Plantations and panels were pieced together to create the formwork of the structure.



The sixteen segments of the formwork, built in the basement of Sibley Hall, were bolted together and supported on wooden posts on site.



Once the formwork was completed and the steel reinforcing placed, the concrete was poured and troweled to form the thin concrete structure. Photograph by Ralph Baker from the May 26, 1996 issue of "Ithaca Journal", documenting the construction of the Hypar.

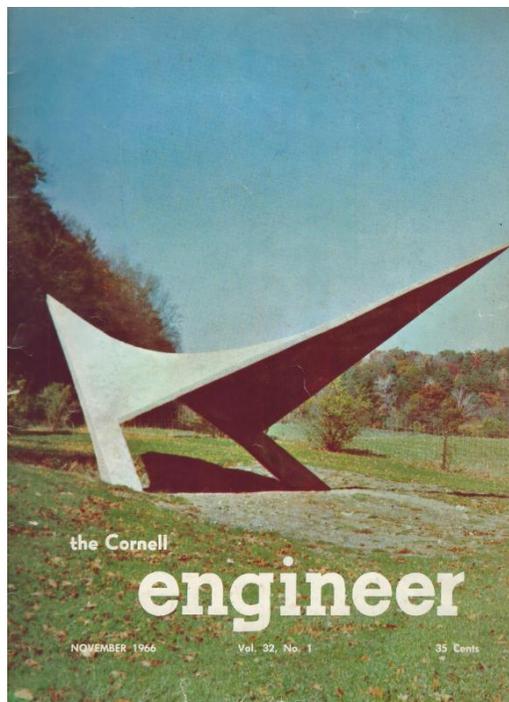
After the concrete was poured on the assembled framework, and sufficiently cured, the supporting wooden panels were removed.

Significantly, there were many predictions that the structure would collapse. Supposedly, it could not stand because it only had two supports? Furthermore, it was too thin to even support its own weight? Many students from the Civil Engineering (as well as some skeptical faculty) came to watch its imminent demise when the forms were taken down.

But the mathematics and stress calculations held true. Significant publicity followed. The photograph below (unknown person and unknown photograph) was picked up by the UP (United Press) and AP (Associated Press) and was published world-wide. And this was in the pre-Internet world! It was also featured on the cover of the Cornell Engineer.



This picture was distributed by the Associated (AP) and United (UP) Press worldwide (photographer unknown).



Cover of "The Cornell Engineer" magazine from November 1966 (Photo by Lee Beardsley).

Despite the cowardly Professor's chagrin and hesitation, and as early as the first day the formwork was removed, one-by-one we climbed on the structure.



Eleven of the fourteen students involved in the project and Dr. Greenberg stand on the Hypar. The structure exhibits amazing strength despite being only 2.25 inches thick. The picture was taken shortly after the forms were removed.

Today the Hypar serves as a shelter for visitors to the Cornell Plantations. The students who worked on the construction were: William Maxfield (C. Engineering, 1966), Buzz Lavine (Architecture 1968), Kenneth Dunker, Dominic Michaelis, Thomas Moran, Timothy Mead, Brian Williamson (Arch. Grad. 1967), Nicolaus Zettlemoyer (C. Engineering 1966), Robert Cane, James Tice, Harvey Montaque, Jack Kleymeyer, and Michael Woodbury (Architecture 1968).

This year, members of the class of 1966 celebrate their 50th Reunion. Some of the architects and engineers involved in the construction of "The Flying Diaper" are returning (I hope most). We look forward to seeing them again, and hopefully making a group visit to the Cornell Plantations to see the structure!