THE FUNCTION OF THE ROOF

DAVID KARLE
University of Nebraska-Lincoln

In recent years global awareness and advocacy groups have asked architects and designers to reconsider the performance of the roof. Based on historical typologies and contemporary precedents Europe is leading this charge. But how can the United States become a leader? Have globalization and the modularization of materials standardized roof technology?

Currently, within the United States roof typologies are stagnant; pitched roofs for residential buildings and flat roofs for commercial buildings dominate the built environment. However, the roof has great significance throughout history. The Florence Cathedral, Filippo Brunelleschi; Sydney Opera House, Jørn Utzon; Kimble Art Museum, Louis I. Kahn; and the Yokohama Terminal, FOA; are all significant cultural and technological buildings. These examples use "the roof as an archetypal and generative motif of built space and form." (Andrea Deplazes) The roof is the last line of defense from the weather, but if delaminated can a roof serve more than one function?

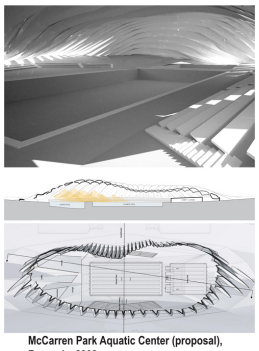
In the 18th century, the pitched roof had an environmental function. It was built-up with thick, heavy material and pitched to shed rain and snow. In the 19th century, the long span light-roof emerged as the driving form and construction typology referencing the era of factories, train stations, and market halls. These building typologies coupled with the long span roof made a combination of lightness, thinness, and porosity possible. The flat roof, as expressed by Le Corbusier's 1914 Domino House, had a formal function that allowed for flexible distribution of structure, walls, facade, and roof. These options traditionally simplified the roof and constructed it as an impenetrable datum, completely disregard its relationship to the interior.

Provided this brief history of roofs, it is ironic that today the most common function of flat roofs has been passive storage of mechanical units. The horizontal datum provides a continuous barrier against moisture and a barrier against light and sectional space. With an increase in knowledge, and a nod towards environmental awareness, suburban malls and strip malls are reducing their dependence on air-conditioning. The scale of the suburban strip mall varies but the roof is often greater than all the microclimates of the interior space. (Farshid Moussavi)

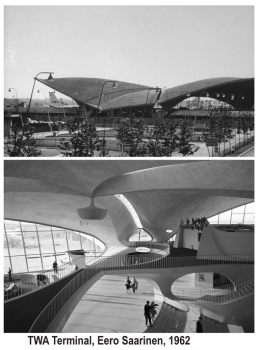
The flat roof of a suburban strip mall became the focus of investigation by a senior-level architectural design studio at The University of Nebraska-Lincoln, College of Architecture. The studio took on the challenge to study and propose a new roof for a 1970's suburban strip mall in Lincoln, Nebraska. The studio researched the implications of the roof's vast scale that disconnects the interior from exterior. By conceptually delaminating the layers of the roof, the interior is exposed and corresponds with the exterior. This delaminated space provides opportunities for designers to re-conceptualized the role of the roof within the built environment.

The design-research project was divided into three phases; structural taxonomy, descriptive geometry, and implementation. The project investigated both technological and parametric relationships at all stages. The primary process identified structural logics, established variables within each typology, and augmented the components towards a new roof proposal.

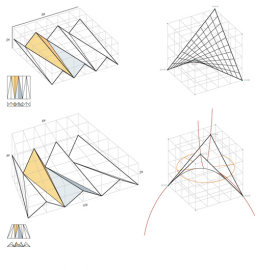
LIGHT

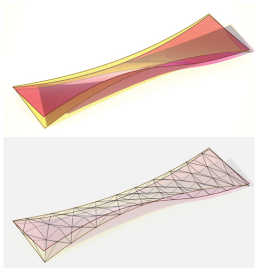


McCarren Park Aquatic Center (proposal), Form-ula, 2008
This unbuilt proposal for an aquatics center in Brooklyn combines an arch system and concrete folded plate system. Light shines in shafts through gaps between the plates.

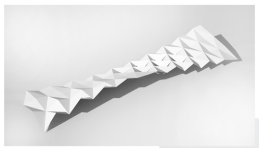


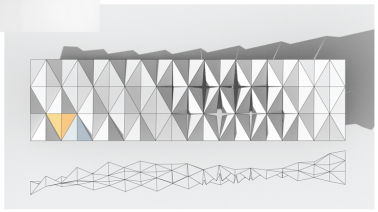
TWA Terminal, Eero Saarinen, 1962
Saarinen's terminal used massive, self-supporting thin concrete shells to bring in abundant light through the north and south "wings" as well as through gaps between each shell.



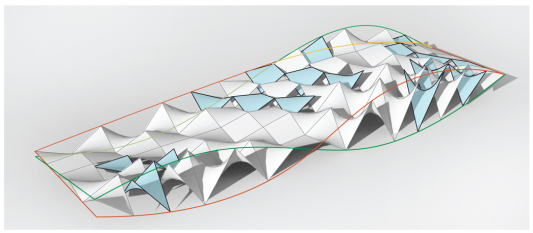


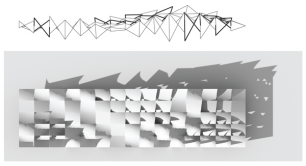
Generative diagrams
Both light schemes are generated from two intersecting surfaces, which will consider program and orientation on the actual site. The plates and hypars mediate between the two surfaces, creating tall volumes where they are further apart and more flat areas where they are close together.





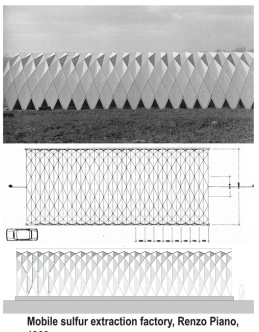
Folded plate
The diamond unit of the folded plate scheme can be split into four at its center and opened either upwards or downwards in varying degrees.



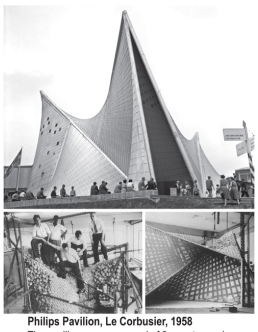


Hyper curved shell
By reversing the direction of some of the shells, light can be admitted in some areas while not in others.

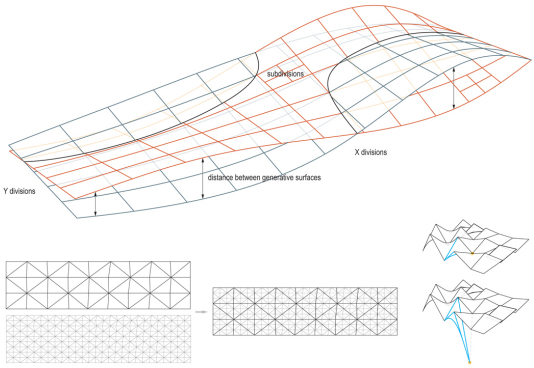
STRUCTURE

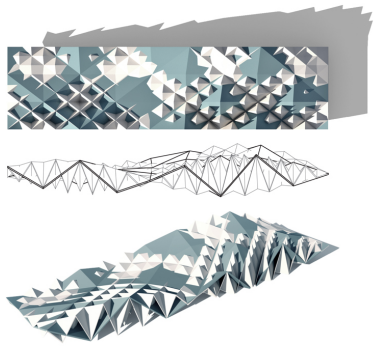


Mobile sulfur extraction factory, Renzo Piano, 1966
This mobile structure, open on both ends and at the dark triangles at the base, only partially screens the elements. The water runs down the channels in the folded diamonds to the ground.

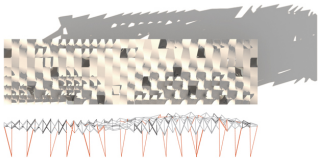


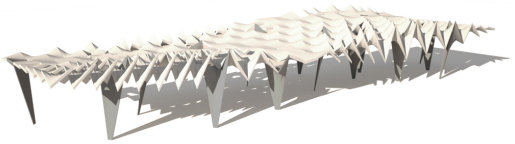
Philips Pavilion, Le Corbusier, 1958
The pavilion was composed of 9 pre-stressed concrete hyperbolic paraboloids, poured offsite.





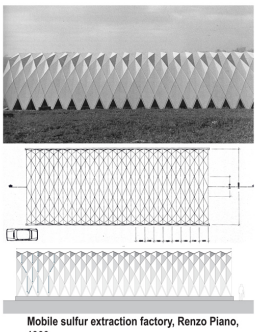
Folded plate
Two overlayed folded plate systems, mediating between the same two generative surfaces, interlock and increase structural stability while providing interior volumes in the roof system and an additional layer of surface conditions.



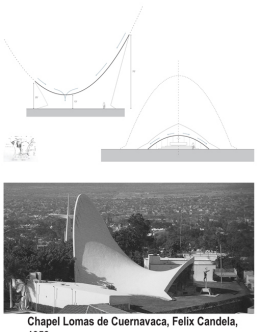


Hyper curved shell
To create vertical members in the hypar system, one point from some of the four-point units is pulled down to the ground (see diagram mid-page right) without destroying the integrity of the hypar shape

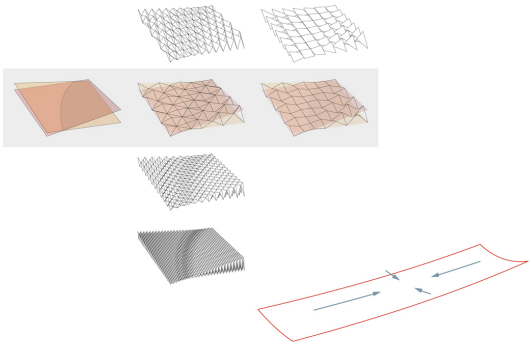
WATER



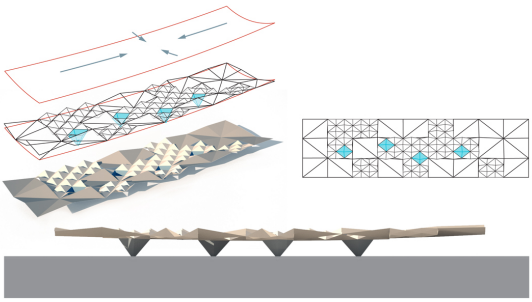
Mobile sulfur extraction factory, Renzo Piano, 1966
This mobile structure, open on both ends and at the dark triangles at the base, only partially screens the elements. The water runs down the channels in the folded diamonds to the ground.



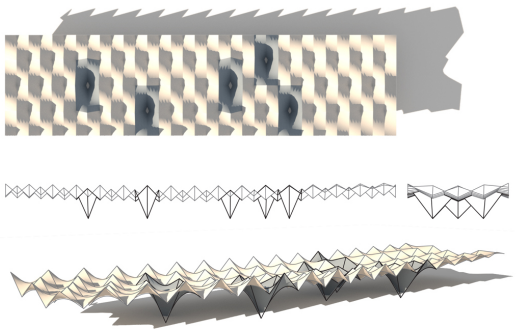
Chapel Lomas de Cuernavaca, Felix Candela, 1958
The chapel is a section of a single hyperbolic parabola ("hypar") in thin shell concrete. The water simply runs down the sides of the hypar and is collected at the base.



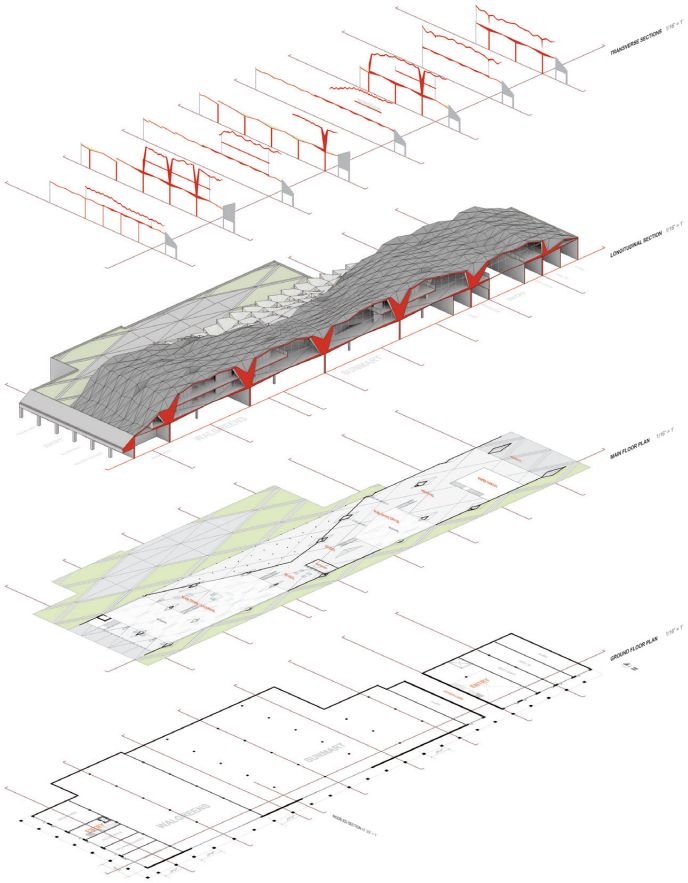
Generative diagrams
The water schemes differ from the light in two ways: the generative surfaces both slope towards the center and are arranged so that every diamond unit is convex.

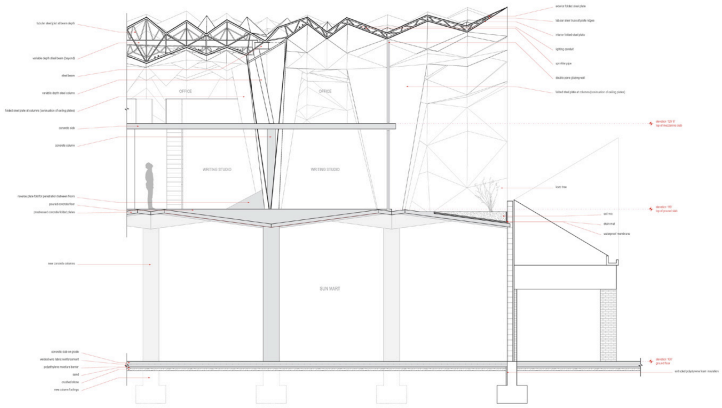


Folded plate
This folded plate scheme incorporates two different unit sizes. To accomodate water, some of the small interior units are inverted and brought down to ground level.

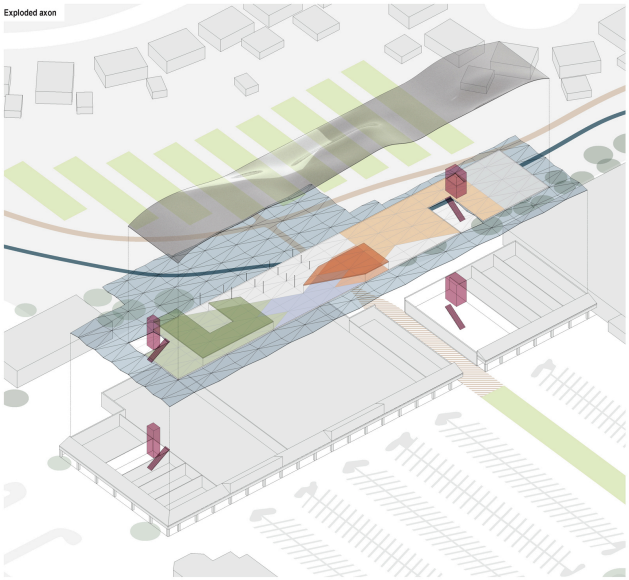


Hyper curved shell
The hypar water scheme only differs from the folded plate scheme in that it takes four hypar units to form a drain unit.





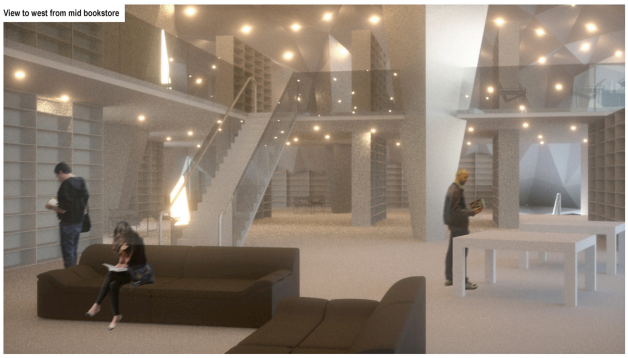
Exploded axon



Site plan

View to east from mezzanine

View to west from mid bookstore



View to east along south façade