POLITECNICO DI TORINO
SECOND SCHOOL OF ARCHITECTURE
Master of Science in Architecture
Honors theses

When the architecture comes from a water drop. The Blob structures
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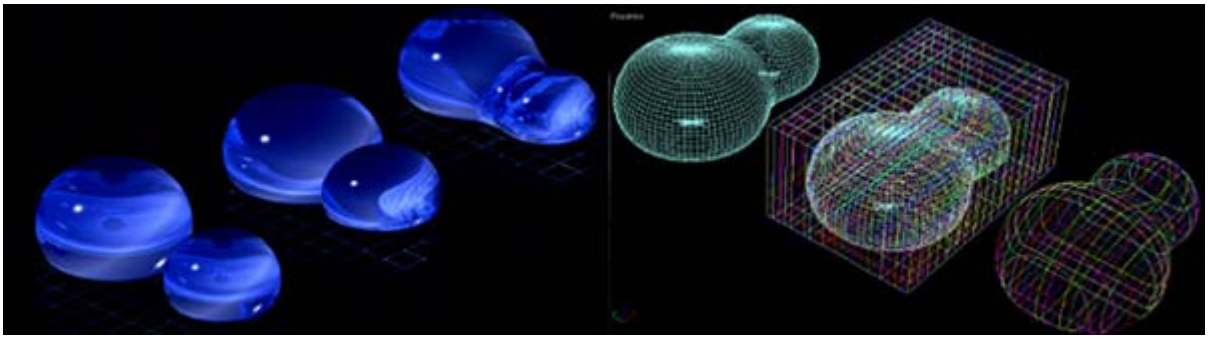
A new kind of free form architecture, known as Blob Architecture, has arised in the last years, along with more and more developments in shells and spatial structures and wide span enclosures. These forms are irregular and need forms of design, technological and structural systems different from the classical ones.
The geometry of Blobs can be defined as free-form, irregular, and not based on Euclidian (planar) surfaces. The designs are based on parameters which are defined by external forces, and they are devoid of formal composition. They undergo their surroundings rather than influencing them.

Blob architecture focuses on using ICT (information computer technology) to design, compute, build and produce their buildings. This requires an integrated 3D approach with CAD, FEM, CAMP and CAB.
Drawing/design programs like Rhinoceros and Maya enable the architect to simply draw complex 3 dimensional volumes. Finite Element Method programs like GSA (Arup), Diana, Ansys and Easy help engineers to analyse complex structures.
Within the last few years the innovations in digital technologies have started to impact on building design and construction practices. They opened up new opportunities by allowing production and construction of complex Blob forms that previously were very difficult and expensive to design, produce, and assemble using traditional construction technologies. The plan no longer "generates" the design; sections attain a purely analytical role. Grids, repetitions, and symmetries lose their past “raison d'etre” as infinite variability becomes as feasible as modularity and as mass-customization offers alternatives to mass-production.
The solutions for the structural production of functional space systems for Blob buildings are different: monolithic thin shell, panel systems, pneumatic structures, stretched membrane structures, space frame and plate irregular curved ribs.

Figures show the Bubble Pavilion, Frankfurt 1999. The architect Bernard Franken and the structural engineers Bollinger+Grohman designed this freeform by using a glass-covered ribs frame. One of the main goals of this case study is to demonstrate that bar structures are suitable as structural systems in Blob architecture. The permeability to light has been the main requirement considered during structural and shape designing of the building

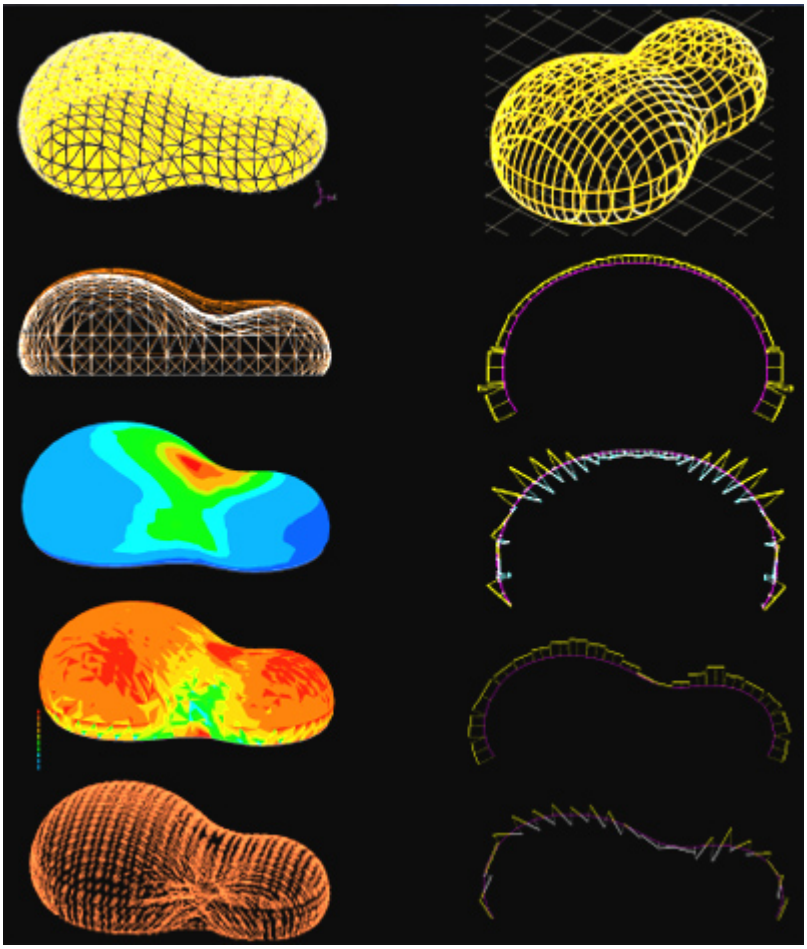
The complete control over design is abandoned in favour of strategic digital processes. Rather than directly influencing the end result, the shape is altered by manipulating the form-defining parameters representing the external forces used. This is a parameter-driven process in which the architect has to decide at some point to stop the process and fix the master geometry. Bernard Franken designed the Bubble Pavilion this way, by generating the form with a software. In the form-generation of this building Franken caught and crystallized the moment when two drops of water touch each other, just before they merge into a big one under the effect of gravity force.
The manufacturing of structural components and fiberglass panelling are done via the computer. Aluminum space-frame was cut directly from digital data using CNC water-jet technology.



Figures show the generation of a virtual prototype of the Bubble Pavilion. Upper figure shows the fluid form generation of 3D model powered by 3DStudioMax. Starting from the left, two different drops lay down on the horizontal plane, then they get in contact, they start merging and then the process is frozen. Figure below show 3DStudio processing of the monolithic model from the rationalization of the shell with quadrangular meshes to the generation of the ribs frame

The analysis is completed by the generation of a virtual prototype of the Bubble, done retracing the different phases of digital design and structural analysis. This prototype is made in two alternatives: the integral aluminium shell and steel rib structure. The two structural analysis are compared and matched also presenting the total walkthrough from parametric modelling (3DStudioMax), via structural analysis (DIANA).

The orthogonal structural rib frame, chosen by Franken, was initially laid out as intersections between the design surface and a pattern of parallel, vertically oriented planes, placed at regular intervals. The resulting planar curves were offset from the finish surface to fix the acrylic-glass panes system.
Finite Element modelling by DIANA has determined the structural behaviour of both alternatives and the necessary stiffness for each rib. The thickness of the beam profile was calculated for each rib and then reflected in the CAD model of the system by simply offsetting the external curves of the ribs.



Figures show FEM analysis by DIANA of both structural options. On the left: thin shell structure rationalized by 6 nodes triangular curved shell elements. On the right: ribs irregular curved frame rationalized by 3 nodes curved beam elements

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