Stunning Form Optimized through Simulation - Zaha Hadid's Volu Pavilion

The design atelier of Zaha Hadid, founded in 1979, was an early pioneer and adopter of key necessities of innovation: theoretical guidance, systemic knowledge generation, and collaborative design. Initiated in 2007, the company's Computation and Design research group (co|de) endeavors to develop early-design methods enabling a directed search for physically, economically and ergonomically feasible solutions within a vast universe of architectural possibilities provided by digital design and construction methods. The co|de team, which currently consists of 10 members, distributes its activities between research, contributions to commercial projects, technological incubation of novel supporting architectural services, communication and dissemination of design discourse, research, and more.

A Dining Pavilion with a Difference

A global forum for design, Design Miami is an international fair for gallerists, designers and curators from around the globe. For the 2015 exhibition, using a design commissioned by designer Robbie Antonio, the Zaha Hadid co|de team created a contemporary dining pavilion that combines computational design, lightweight engineering, and precision fabrication. Part of the Revolution Project initiated to explore the use of advanced design and fabrication technologies in the creation of cost-efficient living spaces, Volu is the contribution of Zaha Hadid and Patrik Schumacher, now principal at Zaha Hadid Architects.

A unique dining environment shaped like an open clam shell, the Volu Pavilion is visually stunning. Comprised of a series of structural bands that collect at the spine and expand overhead, the pavilion's patterning is guided by its varied structural loading conditions.

The structure is made of metal beams and houses a circular wooden dining table and three curved benches. The furniture of table and benches is conceived in sustainably-sourced American Oak to the same architectural principles as the pavilion itself, shaped further by typological, functional and ergonomic considerations, and hand-finished to a seamless

Zaha Hadid Architects

Architect
Zaha Hadid Architects

Design
Zaha Hadid with Patrik Schumacher

Design Team
Shajay Bhooshan, Henry Louth, David Reeves, Maha Kutay, Woody Yao

Installation Coordination
Ilya Pereyaslavtsev

Fabrication
One to One (Benjamin Koren, production geometry development)
Ackemann Gmbh (fabricator: prototype 1)
UAP (fabricator: prototype 2)

Animation
David Reeves, Ilya Pereyaslavtsev, Tommaso Casucci, Filippo Nassetti

surface throughout. While appearing to be monolithic, the pavilion structure is actually an assembly of irregular laser-cut polygons fixed within perforated steel elements.

Innovation through Collaboration: Topology optimization within the familiar design environment

Innovation at the Zaha Hadid co|de team forms around structure, geometry, and fabrication. In collaboration with structural engineers, simulation helps to inform design with structural and fabrication data. "We believe in a collaborative way to come up with innovation, hence we set up collaborations with companies such as Altair to implement innovation and new technologies," said Vishu Bhooshan, designer at Zaha Hadid Architects and member of the co|de group in London. "Once a workflow has been successfully implemented and tested within the co|de team, we push it to other architectural projects in the offices."

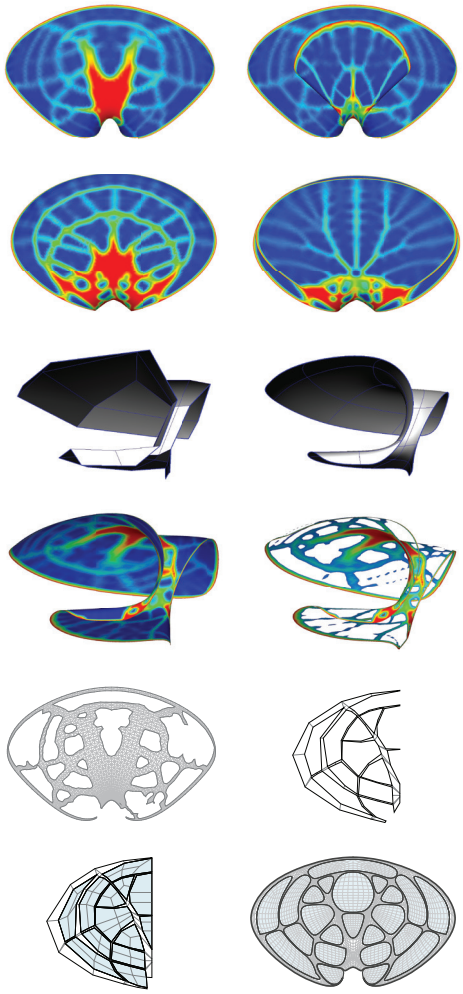
To create this unique lightweight, stable structure, the co|de team used the Altair HyperWorksTM platform for computer-aided engineering. The HyperWorks tools helped inform the design very early in the process, paving the way to create better designs from the onset. The geometry under structural loads was analyzed using a topology optimization algorithm in the Altair OptiStruct™, and the structural system and skin were optimized to remove unnecessary material, resulting in a stable, yet lightest possible design. Optimization provided guidance for placement of the metal beams to create a stable form. The results received using Altair OptiStruct allowed for faster rationalization of the topology optimization results, serving as the blueprint for the designers to develop innovative shapes. An iterative process allowed for engineering feedback and the comprehensive design development of complex and expressive forms through the single bending of flat sheet materials.

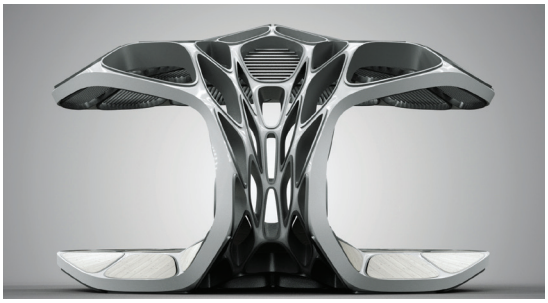
"We first learned about Altair HyperWorks in 2015, when Dr. Luca Frattari introduced HyperWorks in a lecture at the Architectual Association (AA). Following this introduction, we started using it within the co|de team," said Vishu. "Our goal was to find more efficient shapes, reduce material weight and increase the stability of our designs. With Altair's support, we created a custom plug-in to quickly integrate HyperWorks into our design workflow. The plug-in allowed us to get started with topology optimization and to use the Altair OptiStruct algorithms in the backend, without having to leave our design software interface."

Through analysis of the geometry under load, the pavilion's topology was digitally optimized to remove unnecessary material, resulting in the lightest possible, most stable design solution that follows the organic structural logic found in nature.

HyperWorks at Zaha Hadid: larger projects and more users

After the successful verification of the tools and workflows via projects such as the Volu Pavilion and the successful creation and implementation of the custom HyperWorks workflow integration, Zaha Hadid is now planning to apply Altair HyperWorks for larger projects within its global architectural offices. Workshops are scheduled to deploy the latest advancements in FEA optimization disciplines and much more.





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