RESEARCH

The making of two structural sculptures
Tridacna Gigas & Vectorium

Faculty of Architecture, KU Leuven, Belgium
Course Form & Force 2024

In the elective course Form & Force at KU Leuven's Faculty of Architecture, master's students explore structural form-finding through a combination of theory, computational methods, and hands-on experimentation. The course culminates in the design and construction of a structural sculpture that translates structural principles into physical forms. Beyond introducing students to form-finding methods and the use of form-finding as a design approach, the primary objectives of the course are to deepen students' understanding of structural design and to raise awareness of the interplay between form and structural behaviour. This latter aim extends beyond form-found structures, encouraging students to integrate their structural knowledge and detailing considerations more actively into future design projects. Through this process, students enrich their tacit knowledge, enabling them to design while navigating technical and practical constraints that may initially be unfamiliar.

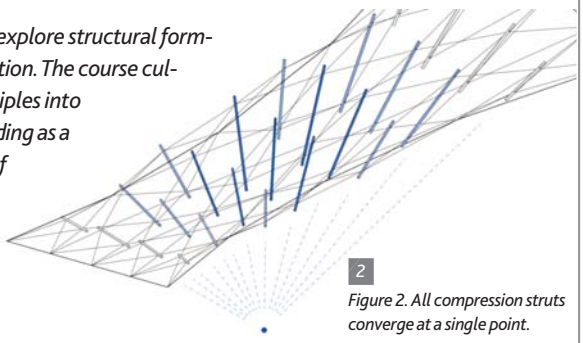

Figure 2. All compression struts converge at a single point.

Structural Sculptures

Two structural sculptures were designed and constructed: the Vectorium and the Tridacna Gigas. The membrane structure was inspired by the undulating forms of the Tridacna gigas, a giant clam species. This sculpture exhibits a precise interplay between the tension of the membrane and the action of the surrounding flexible rod, demonstrating how equilibrium drives the design process. Rather than being imposed, the resulting form emerges naturally through structural behaviour (Fig. 1).

The Vectorium project is a cable net structure in which compression rods separate two cable nets. The structure was developed using geometrically constrained form-finding, ensuring that all compression struts converge at a single point (Fig. 2). When viewed from this precise location, the compression struts appear to disappear. The resulting sculpture is a dynamic interplay between tension and compression, showcasing geometric control through equilibrium principles (Fig. 3).

Design Process, Tools, and Fabrication

Approximately thirty students participated in the Form & Force course of 2024. Initially, students individually prepared proposals for the concept, general shape, and structural typology of a structural sculpture. After comparing the initial ideas, two groups were formed based on student interest—one focused on tensegrity or cable net structures, while the other concentrated on tensioned membranes. To structure the design process and define workable boundary conditions, smaller "expert groups" were established, each addressing specific aspects of the design, such as form-finding and digital modelling, physical experimentation, materialisation, and detailing. Each expert group developed proposals with a strong emphasis on its respective focus, and the final designs emerged through an iterative process that integrated findings from all groups.

Grasshopper3D and Kangaroo2 were used for the exploration and form-finding of the geometry of the membrane and cable net, defining the cutting patterns, and detailing the design. SOFiSTiK was used to analyse and verify the structural behaviour of the sculptures and the pretension of the membranes and cables (Fig 3).

The completed Tridacna Gigas membrane encloses a space topologically defined as a single-surface toroidal shape, wrapping around an existing column. To accommodate this, a zipper was subtly integrated into the membrane, allowing it to enclose the column seamlessly. The compression struts of the Vectorium project contain precisely oriented, drilled holes that guide the ropes through at specific angles. The ropes were measured and marked at the correct positions before all struts were threaded together in the correct sequence. By fixating the intersections of the ropes and compression struts, the intended geometry was achieved, ensuring the structure was ready for installation.

Tutor: *prof. dr. ir. arch. Lennert Loos*

Students Vectorium Project: *Van Den Bosch Robbe, Van Hove Léon, Celis Saartje, Van Camp Matthias, Villa Gamboa Hugo, Rogachev Michel, Grossen Thibaut, Muhammad Edwin Nanda, Sabet Azad Yalda, Vaghar Fard Nazanin, Duran Rabia, Kleindienst Théophile, Patrick Jean-Pierre, Pavelková Anna, Micallef Cason.*

Students Tridacna Gigas Project: *Van Laer Sebastian, De Sutter Anke, Verweire Justine, Hendrickx Pepijn, Soenens Lennard, Lepoutre Camille, Truong Xuan, Guo Xinye, Tong Zitian, van Boetzelaer Aeneas, Van Bosbeke Loreley, Van Der Velden Tine.*

Lennert Loos, KU LEUVEN, Faculty of Architecture
lennert.loos@kuleuven.be
lennertloos.be

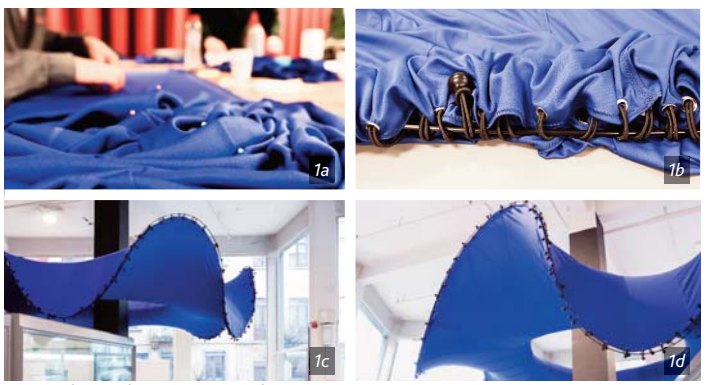

Figure 1. The membrane structure Tridacna gigas

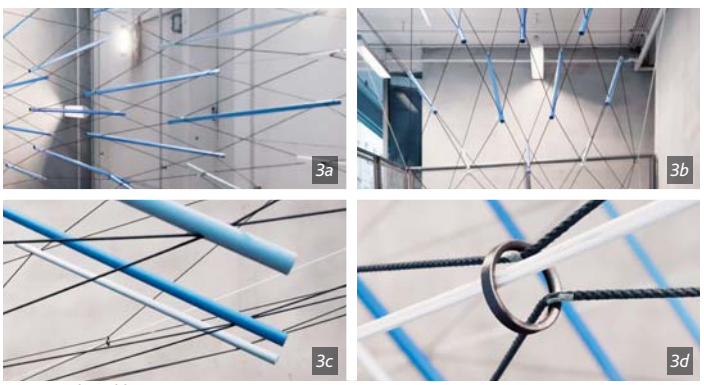

Figure 3. The cable net structure Vectorium