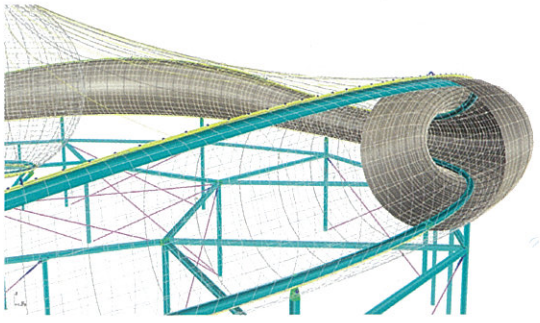
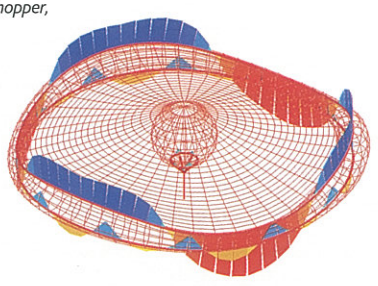
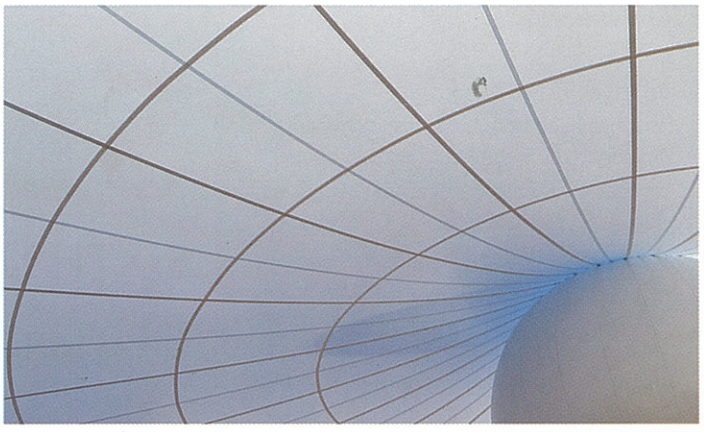


Figure 1: Developing the waving shape in Grasshopper, a parametric plug-in of Rhino3d and structural calculation



Inno-WAVE-tion

TENSAIRITY PRINCIPLE FOR AROUND-THE-WORLD TRAVELING PAVILION



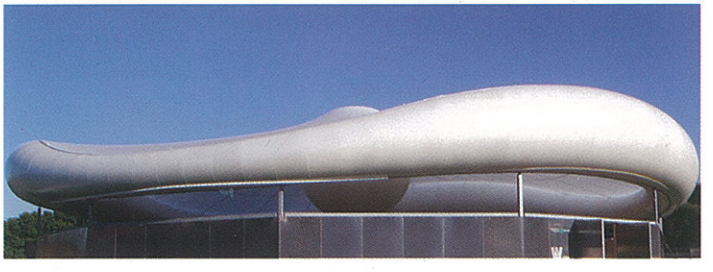


Figure 2. Outside and interior views

Context

For an around-the-world traveling pavilion, designed by Silvain Dubuisson Architecte, Tentech engineered a light weight roof structure based on the so-called Tensairity principle. The project was commissioned by High Point Structures (from France) and Buitink Technology (from the Netherlands). The roof structure is part of the main pavilion for exposition WAVE, organized by BNP Paris-Bas, starting in Parc de la Villette, Paris, and now traveling through France and the world.

In this exposition the collective ingenuity and innovation of men is highlighted, showing examples of economic movements that occur worldwide, such as sharing-economy, co-creation and the creator-movement. In his design and materialization, architect Silvain Dubuission, aimed to reflect the enthusiasm, experimentally and fluidity of these movements.

Concept

The design was presented as sketches so the first task for the engineers was to digitally rebuild the shape. Using Rhino's Grasshopper the initially arbitrary shape could be rationalized in such extend that structural engineering became straightforward.

The roof structure has a UFO-like appearance. It consists of a 24m torus-shaped outer ring, a 4m sphere dominating the central area in the pavilion and a roof membrane stretched between the outer ring and levitated by the central sphere creating the distinctive design. The torus' centerline is divided in six parts and given two different inclinations. Next, a varying minor diameter creates a wave around the perimeter.

The waving shape of the torus is constructed in Grasshopper, a parametric plug-in of Rhino3d. This gave the opportunity to change and optimize the shape during design and engineering. Meshes created in Grasshopper were directly linked to engineering and patterning software, hence greatly organized the process (Fig. 1).

Structure

The structural system works as a combination of a tensile compression ring with Tensairity. The donut spreads the roof membrane and the central sphere's pressure controls its tension. The tension forces of the membrane are transferred into a steel ring inside the torus. A second steel ring transfers the forces to the columns below. The air pressure in the inflated tube is structurally twofold; it doesn't only support the upper steel ring, it also increases its buckling resistance. The combination of pressure elements and inflated elements are considered Tensairity.

The earlier rationalization of the design eased the production of the pavilion. For example, both steel tubes inside the donuts have, unlike their appearance, only one radius.

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Name of the project:	WAVE
Year of construction:	2014
Architect:	Silvain Dubuisson Architecte
Structural Engineering & membrane consultancy:	Tentech
Contractor:	High Point Structures & Buitink Technology
Fabric Roof:	Ferrari 402
Fabric Sphere & Torus:	Ferrari 1202
Covered Area:	490m²