Lighter than Air

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Almost every permanent structure in the world, until 60 years ago was based on compression system in spite of the fact that tension architecture has been in use since ancient times. In the 1950s there was a renewed interest in tension structures led by Frei Otto. He carried out research into the ideas that govern tension membrane structures and developed further into studies of forms in nature.

Tension membrane/fabric is a versatile building material due to its basic construction. Its lightweight, translucent and reflective properties allow for energy and material conservation. Architects continue to experiment with the effect of varying translucency material and the quality of light through these membranes.

Tension membrane structures utilise membrane in complete tension or the act of pulling apart, as a primary building material.

Today, we continue to push and stretch the envelope of form and function using membrane and film. This paper looks at a select number of projects that illustrates this point.

Some buildings add a new twist and dimension to the classical circus tent form and function. Conceived by Darryl Jackson Architecture is the new Grand Pavilion at the Royal Melbourne Showgrounds.

The growth of use and architectural interest in ETFE foil as a cladding material is probably one of the strongest phenomena in Europe and continues push the shape form finding boundaries with this new project in Madrid.

In the early days of the lightweight fabric industry, technological advances in the sailing industry played a major role in moulding it. The humble beginnings of a number of fabric structure specialists' were in the sail loft. More recently Tensys have become involved in lighter than air projects including high altitude scientific balloons and hybrid air vehicles.

ROYAL MELBOURNE SHOWGROUNDS GRAND PAVILION

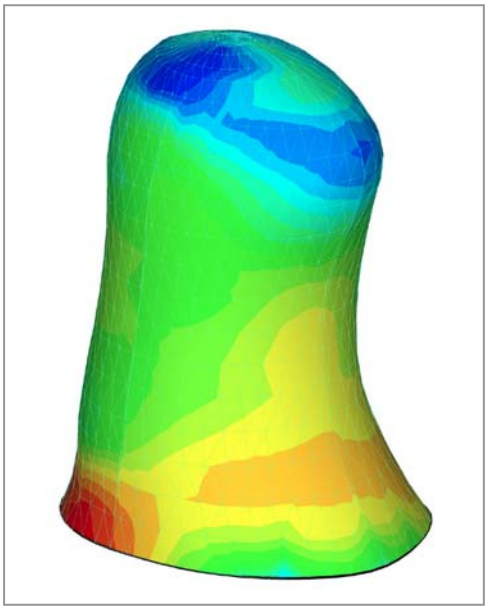
This tension membrane roof structure is grand in every sense as the scale of the elements and geometric configuration emphasizes the enclosed area of the pavilion. The plan coverage area of 98 metres x 87metres provides a useable floor space of 8,000 square metres.

Ventilation and light control elements are integrated with the principal structural steelwork structure. This forms a spectacular interior experience of space. The translucent light through the canopy membrane further emphasizes the lyrical forms creating a new landmark structure in Melbourne.

The structure demonstrates the integration of the need to design with "construction in mind'. The end result is a very lightweight support steel structure (less than 10 kg per square metres) with clean and simple lines and form.

INFLATABLE SCULPTURE: MARCH 11 2004 MEMORIAL, MADRID

Designed by Spanish architects Studio FAM, engineered by Schlaich Bergermann, the memorial to the victims of the Madrid railway bombings features an external monumental shell constructed from glass blocks. A free-form single skin ETFE foil shape is located inside the shell, stabilized by internal pressure. Viewable from underground beneath the monument, the foil is printed with extracts from international letters of condolence.

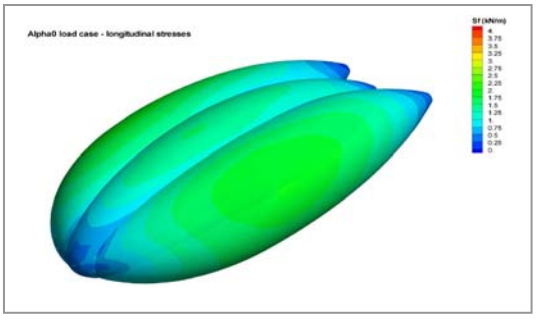


Tensys provided membrane engineering services to the foil fabricators Hightex GmbH. The challenge of the shape finding was to meet the architectural requirements whilst minimizing the foil stress and possibilities of wrinkling.

Converting this shape to cutting patterns for fabrication was further constrained by the requirements of printing.. The seams themselves needed to be horizontal, with additional horizontal reference lines provided for the text itself.

HYBRID AIR VEHICLE: LOCKHEED MARTIN P791

Hybrid air vehicles derive their total lift from a combination of helium buoyancy and aerodynamic lift. Thus the body shape is considerably more complex than conventional airships, with a multi-lobe hull enabling a closer approximation to a wing profile.



The Lockheed Martin P791 is a two-man demonstrator, built as a proof of concept vehicle to verify both the basic design principles and the design process. Designed by the Lockheed

Martin Skunk Works, the envelope was manufactured by TCOM LLP. Tensys Dynamics were responsible for the structural analysis and patterning of the vehicle, together with broader airship design consultancy.

HIGH ALTITUDE SCIENTIFIC BALLOONS: NASA ULDB PROGRAM

The NASA Ultra Long Duration Balloon is intended to carry scientific payloads around the globe on flights of up to 100 days duration at altitudes of between 35,000 and 40,000m. Of 'pumpkin' form, these balloons are fabricated from 38micron polyethylene film combined with PBO tendons deployed between the base and apex end fittings. Development of these balloons, which may be up to 120m in diameter, has encountered problems of geometric instability. Tensys are providing consulting services to NASA for stress and stability analysis of the ULDB. The polyethylene film used for the balloon construction undergoes non-linear visco-elastic creep according to temperature and stress. The inTENS software has been enhanced to include numerical simulation of these time dependent phenomena.

Heading even further afield, Tensys are also acting as consultants on vehicle configuration and design to the NASA Jet Propulsion Laboratory (JPL) for Titan exploration platforms.