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aesthetics, engineering and
installation



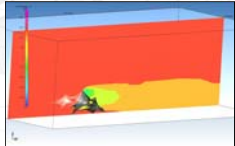
If you want to build a business in tensile membrane shade structures,
there's only one name to know...

Light Weight Structures
Advisory Service


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Optimizing Tensile Membrane Design
utilizing
Computational Fluid Dynamics (CFD)




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Computational Fluid Dynamics
in the Design Process

Identifying wind pressure co-efficients within a canopy
allows for the accurate nomination of structural steel
supports and foundation detail thus alleviating the issue of
either over compensating or underestimating design criteria.





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Light Weight Structures Advisory Service
Core Scope of Work

- Structural Project Design and Concept Realization
- Finite Element Analysis
- Computational Fluid Dynamics
- Engineering Certification
- Working Drawings
- Tensile Membrane Patterning


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Maximum Design Efficiency

- CFD coupled to FEA
- Fluid Structural Interface (FSI)
 - FSI utilizes the first iteration and pressure maps the
derived canopy loads from the CFD to the FEA program
Canopy Profile deforms
 - Deformed Shape imported back into CFD simulation to
perform second and subsequent iterations
 - FSI recognized by the Australian Technology Showcase

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Definition

Computational – having to do with mathematics, computing
Fluid Dynamics – the dynamics of things that flow

*'CFD is a sophisticated computationally-based design and analysis
technique. CFD software gives the user the power to simulate flows of
wind through computer modelling. Using CFD software, the user can build
a 'virtual prototype' of the system or device that is to be analysed and then
apply real-world physics to the model. The software will provide the user
with images and data, which will predict the performance of the design.'*

<http://www.fluent.com/solutions/whatcfd.htm> 7/10/2009)


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CFD an Alternative to Wind Tunnel Tests

- Small to medium creative tensile projects are not feasible to wind tunnel test due to both time deadlines and financial constraints
- Coupled CFD with FEA is a cost effective solution to determine wind action and pressures on canopy profiles
- CFD has been shown to be a reasonable prediction of wind pressure distributions. It conceivably could replace some wind tunnel tests (Susila I G 2000)

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Tensile Structures are unique in Design

- Within certain constraints designs are limited only by the imagination
- Often the free form design of a tensioned roof structure results in canopy profiles that do not fall within the guidelines of international codes.
- Even small changes in the profile of a conic canopy can significantly alter the loading on the roof canopy, and the zonal distribution of that loading (Burton J 2004)


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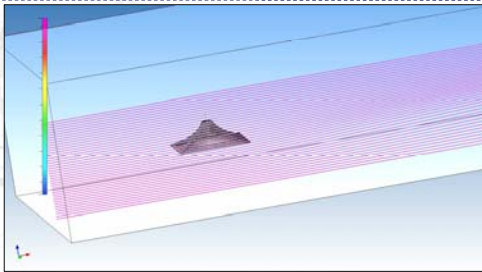
Conic Canopy Bale Ring Open CFD Visualization Slice




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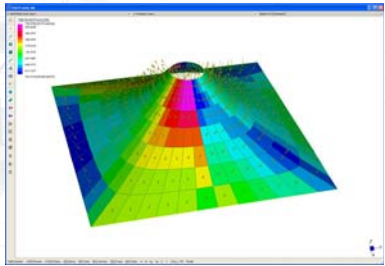
Conic Canopy Bale Ring Open CFD Particle Trace




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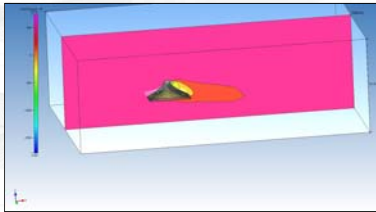
FEA Model of Conic Pressure Mapped directly onto Canopy Profile





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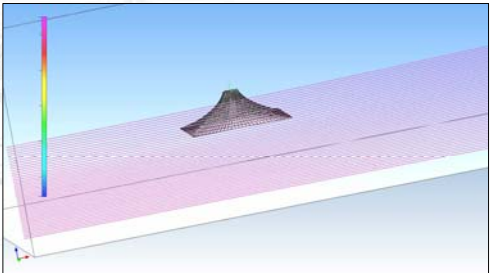
Conic Canopy Bale Ring Closed CFD Visualization Slice




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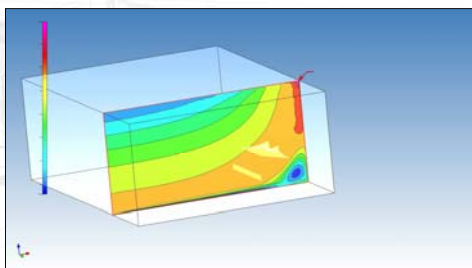
Conic Canopy Bale Ring Closed
CFD Particle Trace





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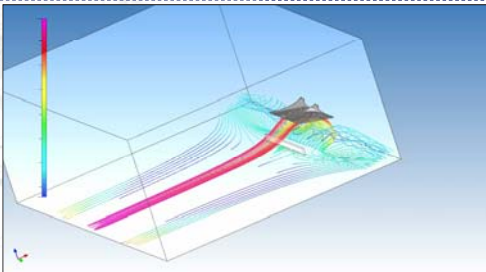
Double Conic Canopy attached to building
CFD Visualization Slice




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Double Conic Canopy attached to building
CFD Particle Trace




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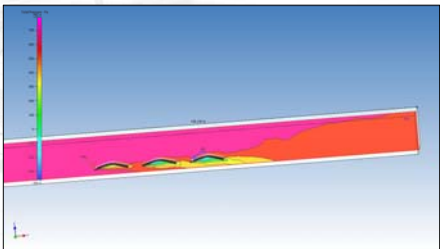
Double Conic Canopy Attached to Building
Completed Project




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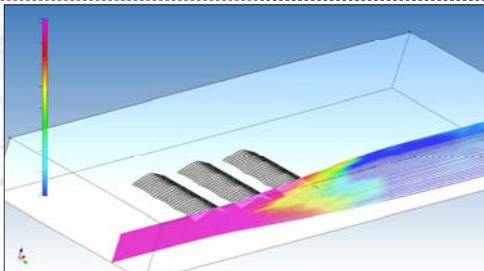
Multiple Configuration Barrel Vault Structure
CFD Visualization Slice




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Multiple Configuration Barrel Vault Structure
CFD Particle Trace

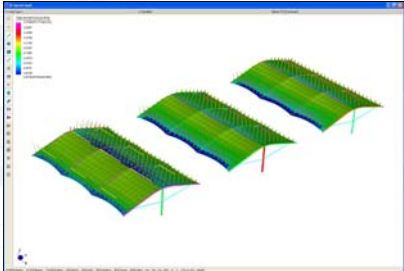


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FEA Model of Multiple Barrel Vault Structures

Pressure Mapped directly onto Canopy Profile

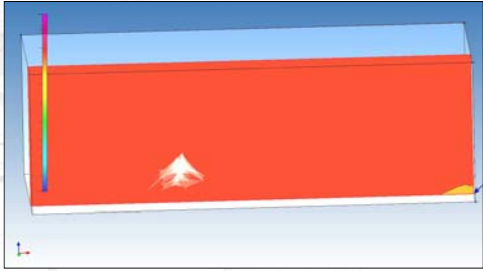


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Free Form PTFE Tensile Membrane Structure

CFD Visualization Slice

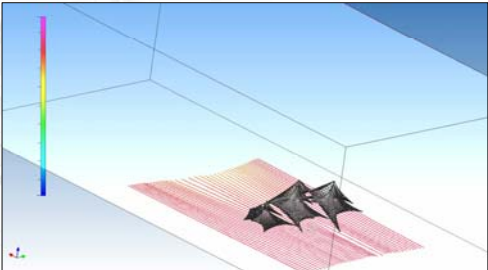


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Free Form PTFE Tensile Membrane Structure

CFD Particle Trace




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Free Form PTFE Tensile Membrane Structure

Completed Project



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The Benefits of Utilizing Coupled CFD Simulation and FEA include,

1. CFD coupled with FEA provides a cost effective solution determining the wind action on complex canopy profiles

2. CFD model simulations can be run to include all relevant wind directions as well as geographic topography and terrain categories

3. CFD offers cost efficiency over wind tunnel testing as there are no set up costs for scale models and or the testing facility

4. CFD offers timely results

5. CFD offers design flexibility as changes to the canopy profile and supporting structure can be made and the design optimized.

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