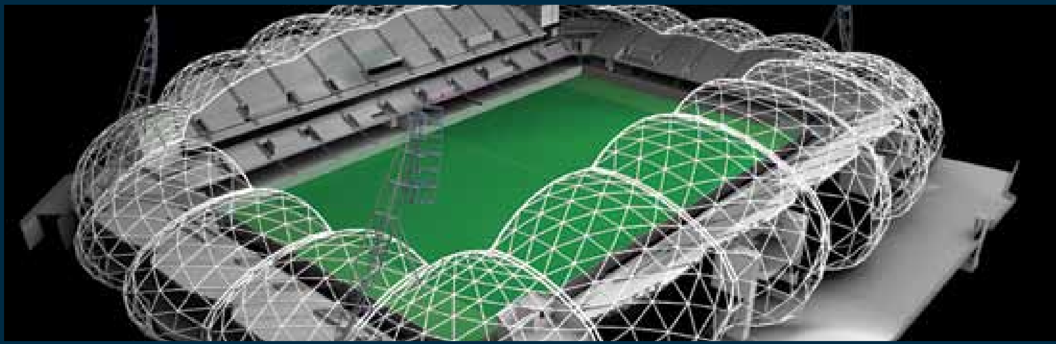


INNOVATIVE TECHNOLOGY PRODUCES CUTTING-EDGE BIOFRAME STADIUM DESIGN

WORLD-CLASS EVENT AND SPORTS ADMINISTRATION COMPLEX TO PROVIDE MISSING LINK IN MELBOURNE'S SPORTING INFRASTRUCTURE

PROJECT SUMMARY

Organization:
ARUP

Solution:
Building

Location:
Melbourne, Australia

Project Objective:
Create a new sports complex for the city of Melbourne to host soccer and rugby matches

Products used:
MicroStation®, Bentley Structural, & GenerativeComponents

FAST FACTS

- Seating for 31,000
- Unobstructed sight lines for fans
- 50% less steel in roof vs. conventional stadium roof
- Bio Frame roof based on the inherent structural efficiencies of the Buckminster Fuller geodesic dome
- Structure will be clad in a triangular panelized facade made up of a combination of glass, metal and louvers
- Rain water harvesting system
- Project completion date December 2009

Daunting structural and design challenges faced by a project development team can often lead to innovations that serve as a model for designing future projects. The Melbourne Rectangular Stadium, a $250 million project now under construction, is such a case.

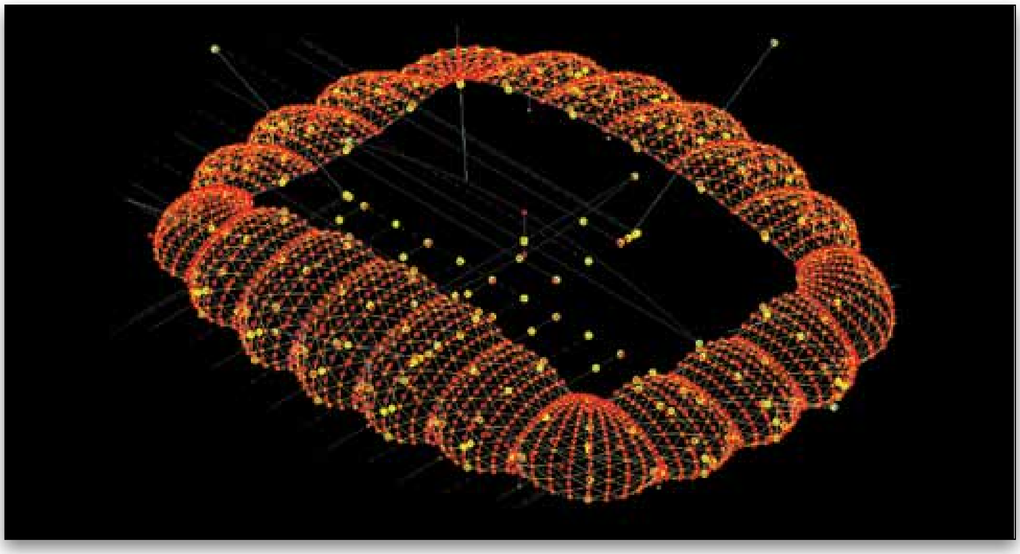
The medium-sized rectangular pitch stadium in Australia, which is expected to be completed by December 2009, will provide the missing link in Melbourne's sporting infrastructure. Designed by Cox Architects, Major Projects Victoria is developing the stadium on behalf of the state government and the Melbourne & Olympic Parks Trust. The builder is Grocon Constructors and structural and engineering design services are provided by Arup.

The world-class event and sports administration complex will include a sports campus, an elite training center, and the 31,000-seat stadium. The facility will host Melbourne Victory FC A-League soccer games and other international and national soccer matches, in addition to rugby league and rugby union matches in the Olympic Park Sports Precinct in this city of nearly 4 million people.

The stadium's cutting-edge bioframe design features a geodesic roof that covers the seating area. The roof will use 50 percent less steel than a typical stadium roof of the same size. Arup chose GenerativeComponents®, an associative parametric software application that captures and exploits the critical relationships between design intent and geometry, to develop the design. GenerativeComponents allowed Arup engineers to model the stadium's primary roof structure and test alternate geometric configurations as well as accommodate the final preset values for fabrication and steel construction.

"To generate the stadium roof geometry, a 3D model of the stadium structure was created using building information modeling (BIM) software," said John Legge-Wilkinson, Arup's CAD leader. "Since the roof geometry was subject to a variety of changes throughout its lifecycle, optimization studies of the stadium roof were undertaken that led to the development of final geometric and structural design."

According to Legge-Wilkinson, GenerativeComponents was used to create a center line wire frame model of the stadium roof. This model was then passed on to Cox Architects for coordination and approval, and used by the structural engineers for analysis.



GC Script- Complete Shell Lacing

> *"The Arup team was able to create and rationalize the roof geometry to eliminate errors that might result from manual modeling methods"*

ABOUT BENTLEY

BENTLEY OFFICES

Corporate Headquarters
685 Stockton Drive
Exton, PA 19341 USA
1-800-BENTLEY (1-800-236-8539)
Outside the US +1 610-458-5000

Bentley Systems Europe B.V.
Wegalaan 2
2132 JC Hoofddorp
Netherlands
+31 23 556 0560

Bentley Asia
Unit 1402-06, Tower 1,
China Central Place,
No. 81 Jianguo Road,
Beijing, 100025, China
+86 108 518 5220

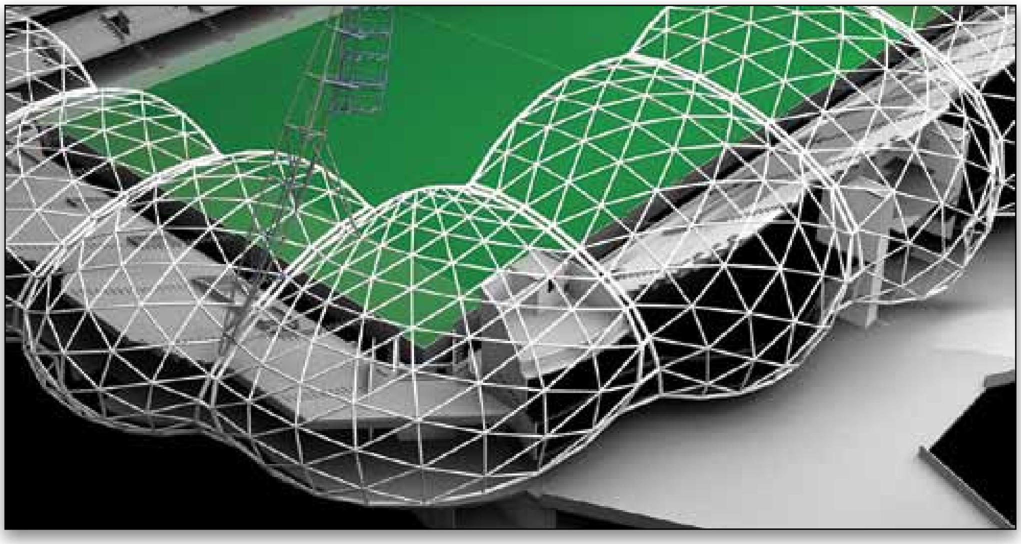


Image of a model designed with Bentley Structural

The GenerativeComponents model was created using two scripts; the first containing variables written into the script to help define the base geometry and to provide the ability to test alternate geometric configurations during the structural optimization studies; the second written to generate the typical lacing configuration for each individual shell. This too contained variables that provided the flexibility to change the internal lacing options and configurations. The second script was made into a GenerativeComponents library component and imported into the first script to complete the lacing for each shell.

Data exported from GenerativeComponents model was used for optimization studies of the roof steelwork members, which investigated a large number of separate geometric configurations. The alternatives studied included changes to the profile of the overall lip arch at the sides and ends of the roof, changes in the height-to-chord ratio of the arc profile at the tip of each individual shell, and a combination of both – which resulted in an initial study of 18 separate geometric configurations.

A final study was undertaken using a combination of the best results from the previous exercise, resulting in six additional configurations. Optimization studies were completed by Arup engineers using Strand Design analysis software. An internal script was written by Arup to link the data generated from GenerativeComponents with the data in the Strand analysis model. The final design analysis model was imported into Bentley Structural and used for project documentation and scheduling, including member schedules containing the member mark, section size, and length for all of the individual members in the roof. A final wireframe model was created in GenerativeComponents, making allowance for the calculated deflection of the structural steelwork members at the lip edge of the roof. This preset model was passed on to the contractor and used as the primary set out for the roof geometry and for the preparation of the structural steelwork shop detail drawings used for steelwork fabrication.

Using GenerativeComponents and Bentley® Structural, the Arup team was able to create and rationalize the roof geometry to eliminate errors that might result from manual modeling methods; the ability to quickly regenerate a number of geometric configurations for the optimization studies, which yielded a cost-effective and efficient final design; and the ability to measure the total length and surface area of the roof steelwork for comparison between the different geometric combinations used during the optimization studies.

The team was also able to produce a complete set of coordinated drawings and documentation for each of the roof members; make allowances for the actual deflection values at the edge of the roof, providing a substantial time savings when compared with alternative remodeling methods; and provide the contractor and steel fabricator with an accurate 3D model of the roof steelwork and geometry.

Using GenerativeComponents for the optimization studies yielded a 500-percent return on investment, while using Bentley Structural for documentation and scheduling resulted in a 200-percent return on investment. A summary of the final optimization results identified a 10-percent savings in roof tonnage in the steel members and an optimum roof profile.

In all, the design team regenerated and exported 24 different geometric configurations using GenerativeComponents. "The optimization studies would not have been feasible without the ability of GenerativeComponents to quickly regenerate the different geometric configurations and to export the data in a format that could be linked to the analysis software," said Legge-Wilkinson.

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