THE **BRITE** PROJECT

Innovation
Case Study
No 11

Better Project Outcomes with Relationship Management and 3D CAD

*This series of innovation case studies has been developed by the BRITE Project of the Cooperative Research Centre for **Construction Innovation**. The case studies demonstrate the benefits of innovation and successful implementation strategies in the Australian property and construction industry. Many highlight the strengths of small and medium-sized businesses in regional areas.*

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Better Project Outcomes with Relationship Management and 3D CAD

An innovative procurement process provided the high level of cooperation necessary to extensively redevelop the Adelaide Oval within a highly compressed timeframe and on budget.

The project delivery process supported a range of innovations, including advanced use of 3D CAD.

Temporary supports for steelwork during erection

Selected Project Participants

Client:
South Australian Cricket Association (SACA)

Architects: HASSELL Pty Ltd

Structural Engineers:
Connell Mott MacDonald

Head Contractor: Built Environs Pty Ltd

Primary Subcontractors:
Taiyo Membrane Corporation (formerly BirdAir)
Samaras Structural Engineers
SA Precast Pty Ltd

Organisations consulted in preparing this report:
SACA, Built Environs, HASSELL Pty Ltd, Taiyo Membrane Corporation, Finlaysons Lawyers and Connell Mott MacDonald

Cover photo:
Adelaide Oval Stadium

The Project

During 2003, SACA commissioned a major project to redevelop the eastern side of the grounds at Adelaide Oval, to extend its competitive standing as a national and international sporting and events facility. The project provided three spectator stands covered with tensile membrane roofs, storage bunker facilities, a video replay screen, event control rooms, a new gatehouse, relocation and restoration of the heritage-listed Victor Richardson Gates, and landscaping works.

Completed at a cost of $22M, this complex project was delivered on budget and within a tight design and construction timeframe, over a seven-month construction period prior to the World Cup Rugby.

The Achievement

The time, cost and quality outcomes of the Adelaide Oval Redevelopment project have earned it awards across a range of disciplines including:

- Master Builders Association, Award for Excellence 2004
- Australian Institute of Building, Professional Excellence Awards 2004
- Royal Australian Institute of Architects (SA), Award of Merit 2004
- Engineers Australia, Excellence Award 2004
- Association of Consulting Engineers Australia, Award of Excellence 2004
- Australian Steel Institute (SA), Architectural Steel Design Award 2004
- Property Council (SA), Commendation Award 2005

Michael Deare
Chief Executive, South Australian Cricket Association

'We were impressed by the 'can do' approach taken by all concerned'

The Innovation

SACA and the project team decided that a conventional procurement approach would not deliver the level of cooperation and innovation required to fast-track the design and construction processes, nor to respond proactively to emerging problems. In response, a hybrid contract was adopted containing managing contractor and cooperative contracting elements. Operating under a lump sum management fee arrangement, the managing contractor contributed to the review of contract documentation and provided advice on the practicality and 'buildability' of the design, then managed the construction process, including the sub-contractor packages.

This hybrid contract encouraged greater integration of the supply chain than under a more traditional contract, promoting a higher level of cooperation between team members, including sub-contractors. In this regard, the contract listed the client's requirements as:

- a 'best for project', integrated approach
- aligned objectives for all stakeholders and the project team members
- a clear understanding of the roles and responsibilities of all stakeholders and team members
- open and honest communications between all parties
- innovation and intelligent risk-taking to achieve exceptional results.

Unlike traditional contracts, where participants can try to maximise their own gain and minimise their risk, the specification of these behaviours sought a more collective approach to problem solving and risk allocation. 'Specifying' the behaviours rather than 'negotiating' them might have worked against the client, however the contract was effectively backed up by regular collaborative meetings, a free flow of communication, and social events, such as barbeques and attendance at cricket games, to support the desired behaviours.

The cooperative intentions of the contract were reinforced by a full day workshop at the start of the project which aimed to encourage 'best-for-project' thinking. The full project team, including sub-contractors, attended the workshop. The sound relationships that developed allowed parties to explore options and resolve conflict rather than turn to the contract for solutions.

A key element of the project was the early engagement of those specialist sub-contractors who delivered tensioned steel roof structures, precast elements, and tensile roof membranes. Their expert knowledge was sought early to enhance the design, and reduce time for finalising it before going to tender. They were engaged under a two-stage preferred subcontractor arrangement, which encouraged and rewarded their input to the design process, while protecting the client from opportunistic behaviour and price increases.

The more harmonious relationships and greater sense of commitment to the project engendered by the contract and associated relationship-building activities encouraged the uptake of innovative ideas and practices which may not have emerged under a more conventional contract.

Key among these was using 3D CAD for structural and fabric design, detailing, engineering, sun shading, fire engineering, wind analysis, shop drawings, and subsequent documentation. By extending the conventional visualisation and presentation application of 3D CAD to provide a 'virtual design environment' in which all parties were working on a shared model, the three early sub-contractors were able to undertake shop drawings simultaneously, which reduced lead time for construction.

The 3D CAD system:

- minimised documentation time and output
- minimised technical queries between consultants and contractors
- reduced errors by virtual representation of the end product
- negated the risk of misalignment of core construction components like the pre-cast and steel roof support elements
- identified potential constructability problems.

This is one of the first times that 3D CAD documentation has been made readily available by design consultants to contractors for construction, on a project in Adelaide.

Across Australia, only the most complex projects are likely to use it this way. 3D CAD emerged 10-15 years ago in complex industries such as aeronautics and ship building. Its up-take globally in the construction industry has been limited by the training requirements across the supply chain and the power of personal computers.

Finally, the relationship-building elements of the contract, and particularly the early inclusion of sub-contractors, are also relatively rare in Australia and overseas. Managing contractor contracts and relationship-based contracts have emerged globally over the past decade as a means of improving project outcomes. In Australia, such approaches have been trialled with success from the mid-1990s, and are increasingly being adopted by repeat public sector clients. However, private sector clients have been slower to adopt them, which makes the SACA project particularly novel.

The Benefits

The project team considers that this challenging project was completed on time and within budget because of the relationship-based procurement strategy and 'best-for-project' thinking adopted. The project also had no lost time or accidents during its 300,000 hours.

Focusing on the use of 3D CAD to create a virtual design environment, the following benefits have been estimated compared to a traditional 2D environment:

- reduction in 'Requests for Information' of over 90%
- reduction in site errors, which could have meant rework costs of up to $100,000 and a week's lost time
- reduction in prefabrication time of 50 % because:
  - 3D modelling saved a month during shop detailing, as the three early trades were able to work concurrently on their shop drawings
  - there was a reduction in the cost of transferring 2D fabrication drafting to 3D.

The Implementation Process

Both the 3D CAD and innovative procurement model owe their adoption to the complexity of the Adelaide Oval redevelopment. Trialling these new approaches may not have been justified on a more straightforward project.

3D CAD

Very early in the design stage, it was decided that using 3D to document the specifications for the pre-cast concrete, structural steelwork and tensile fabric would expedite the design and construction process. The complex curvilinear shapes of the tensile membrane roofs in particular required 3D resolution at a high level so that fabrication of the elements could proceed simultaneously, without the need for the components to be corrected or reworked during assembly on site.

The architectural and structural engineering firms each developed a complete 3D model, which were subsequently merged to facilitate quick and accurate changes to the design. The final model was sent to the main sub-contractors for manufacture.

Some of the smaller sub-contractors did not have the technical abilities to access and fully utilise the virtual design model, so some 2D drawings were produced. The amount of extra work involved was minimal because the 3D model could be used as the basis for drawings generated in 2D.

The use of the 3D CAD model contributed significantly to on-time delivery of the project within an extremely tight design and construction schedule.

Innovative Contract

A key driver for the good relationships that developed on the project was the cooperative procurement model, which in turn, was driven by the client's concern in relation to the importance of meeting extremely tight time frames. The client felt that conventional contractual arrangements may have limited their ability to influence and contribute to the on-going process. The client also knew of the positive experiences of public sector clients who had used more innovative contracts successfully.

While no systems and procedures had to be dramatically altered or adjusted to implement the cooperative contracting approach, changes in culture and attitude were required. Participants needed to shift from an individual to a team orientation, in terms of contributing to the whole project and not just looking after their own interests. On the other hand, widespread implementation of 3D CAD will require changes in industry systems, procedures and culture.

David Johnson
Principal,
Connell Mott MacDonald

'The two things go together – to make the 3D modelling process work you needed good relationships'

David Hassell
Managing Principal,
Hassell Pty Ltd

'Many believed the construction time frame was impossible. 3D CAD and a co-operative contracting approach were the two primary factors in achieving deadlines'

Overcoming Difficulties

Risk of failure

Failure to deliver the upgrade on time was likely to cost SACA the World Cup Rugby contract; and the reputation of all participants, particularly the managing contractor, would have been compromised. Along with the partnering style of contract method, the 3D computer modelling helped to reduce this risk by improving the integration of design through to construction shop drawings, using the same complex 3D CAD models.

Different way of working

Because cooperative contracts represent a departure from traditional arrangements, there was a risk that not all participants would fully align themselves with the intent of the contract. This concern was addressed by a start-up workshop, regular relationship-focussed project meetings and social events. The 3D modelling also promoted cooperation because it gave all participants equal access to information. Exposure to relationship-based contracting has affected participants positively; they appear to be translating the learnings and experiences to their roles on subsequent projects.

Heritage venue

The project attracted significant interest from the media and the public as Adelaide Oval is regarded as an international icon with significant heritage value. In the early stages of the project, there were some community doubts about the redevelopment design, particularly the spectator stands. In response, 3D computer models showing a virtual representation of the completed facility were used to demonstrate how effectively the design achieved a contemporary feel in keeping with the scale of the heritage environment, while achieving the sun shading specifications and safety standards (such as fire egress) required. This process helped alleviate early concerns.

Continued operation of venue

The client wished to continue operating the venue during the construction period, hosting state cricket matches and the tourism visitor program. Potential clashes between the construction and venue schedules were overcome through the allocation of significant resources to the planning process. The onsite building coordinator reviewed operations daily, and at times hourly, and there were regular meetings and information exchanges between all project participants. Subsequently, the redevelopment work was completed without disruption to the daily operation of the venue.

Connor Newble
Project Manager, Built Environs

'Flexibility and innovation were treated as site cultural issues and were constantly encouraged by the whole team'

Mike Lester
Director of Engineering, Taiyo Membrane Corporation

'The cooperative approach was probably the main item that allowed such a complex project to be undertaken in such a short timeframe'

Technological and cultural limitations

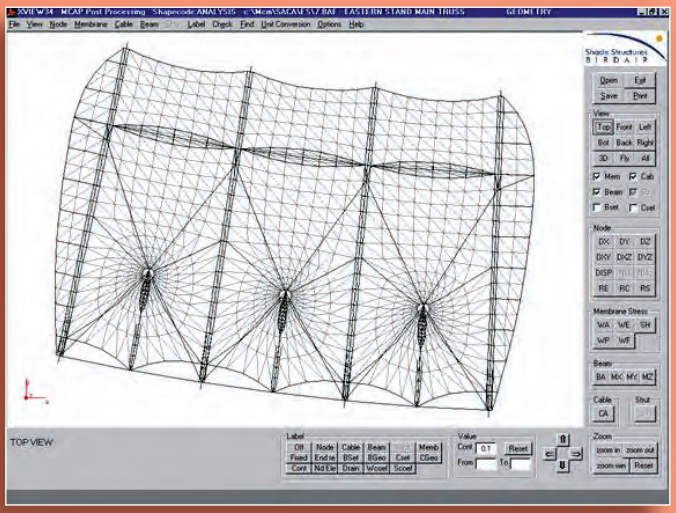
3D modelling appears to be broadly accepted by industry participants as an essential 'integrated design through to construction' tool. However, the uptake rate has been relatively slow. Only a small proportion of firms, in the trade sector in particular, are willing or able to invest in the resources required. Many don't have the technical skills or computing capacity to fully capitalise on the technology. Industry commentators note that cultural resistance to change is constraining adoption rates. Various knowledge brokers in the industry are addressing this problem. In Australia these include the Cooperative Research Centre for Construction Innovation, Universities and the TAFE system.

Lessons Learned

- Private sector clients can benefit from adopting cutting-edge contracting methods trialled by repeat public sector clients.
- Having expert advice on constructability from subcontractors during the design phase helps fast track production.
- Parties in relationship-based contracts can be motivated to solve problems in a more efficient manner than under traditional contracts.
- Cooperative contract approaches require a shift in the mindset of participants.
- 3D modelling can be used as a seamless 'design through to documentation and shop drawing' mechanism, helping to drive improved project relationships and outcomes.

Truss fabrication and inspection in the workshop

3D drawing model of steelwork connections



3D model of fabric form to determine applied forces

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