PROJECT 3.27

Using building information modelling for smarter and safer scaffolding construction

INTRODUCTION

This brochure introduces a new framework for improving the safety and design of scaffolding using building information modelling (BIM). It is based on recent research conducted by the Australasian Joint Research Centre for Building Information Modelling in collaboration with the Sustainable Built Environment National Research Centre and is intended as a reference tool.

ABOUT BUILDING INFORMATION MODELLING

Building information modelling (BIM) is an intelligent, 3D model-based process that informs and anticipates decision making across the lifecycle of a constructed project

Using parametric design, visualisation and simulation technology, BIM gathers, gives shape to and communicates information to the right stakeholders at the right time. BIM tools can encompass not only building geometry but also a project's non-physical economic, environmental and sociocultural components. These insights enable stakeholders to remain responsive and competitive throughout the project.

ALIGNMENT WITH AUSTRALIA'S RESEARCH PRIORITIES

This project is aligned with a number of goals in the Australian Government's National Research Priorities:

Investing in frontier technologies: The industry-wide uptake of new digital technologies is critical to ensuring the health and safety of workers and the construction industry's ability to compete globally.

Promoting an innovation culture and economy: Boosting the productivity of one of Australia's largest industries through digital modelling tools will foreseeably improve national living standards, the production of other goods and services, and trade.

Strengthening Australia's social and economic fabric: Fostering safer work practices through Australian Government and industry engagement will reduce construction accidents, providing direct benefits to workers and their families, as well as the healthcare system.

MODEL WORKPLACE HEALTH AND SAFETY ACT

The project complies with the Australian Model Workplace Health and Safety (WHS) Act, which requires designers to consider and assess safety and construction issues early on in a project.

The WHS Act also aims to improve the industry's ability to meet the design requirements of structures that pose a health and safety risk to people using them. Streamlining the links between the design and construction of temporary structures in this way significantly improves productivity.

PROJECT OUTCOMES

Building on existing research, this project has integrated virtual design, a decision support system, and construction and onsite monitoring into a single dynamic planning system. Armed with contemporary BIM tools, the system works to ensure scaffolding safety across a project's entire lifecycle.

At any stage of a project, the system can provide designers and contractors with:

- automated model and drawing outputs
- quantity takeoffs for competitive tendering
- visualisations for 4D scheduling and onsite assembly
- inspection and disassembly processes
- direct links to structural analysis for performance compliance
- onsite safety checks
- real-time tracking of construction works.

Sustainable Built Environment National Research Centre

THE NEED FOR SAFER SCAFFOLDING

In 2010, Australian workplace safety authorities found approximately 40 per cent of construction worksites nationwide did not adhere to the legislated scaffolding standards or jurisdictional regulations.

Non-compliance is a contributing factor to productivity stagnation in Australia's construction industry. In the last two decades, the industry has grown at less than half the rate of the non-farming market sector (Independent Economics 2012; Australian Bureau of Statistics 2008).

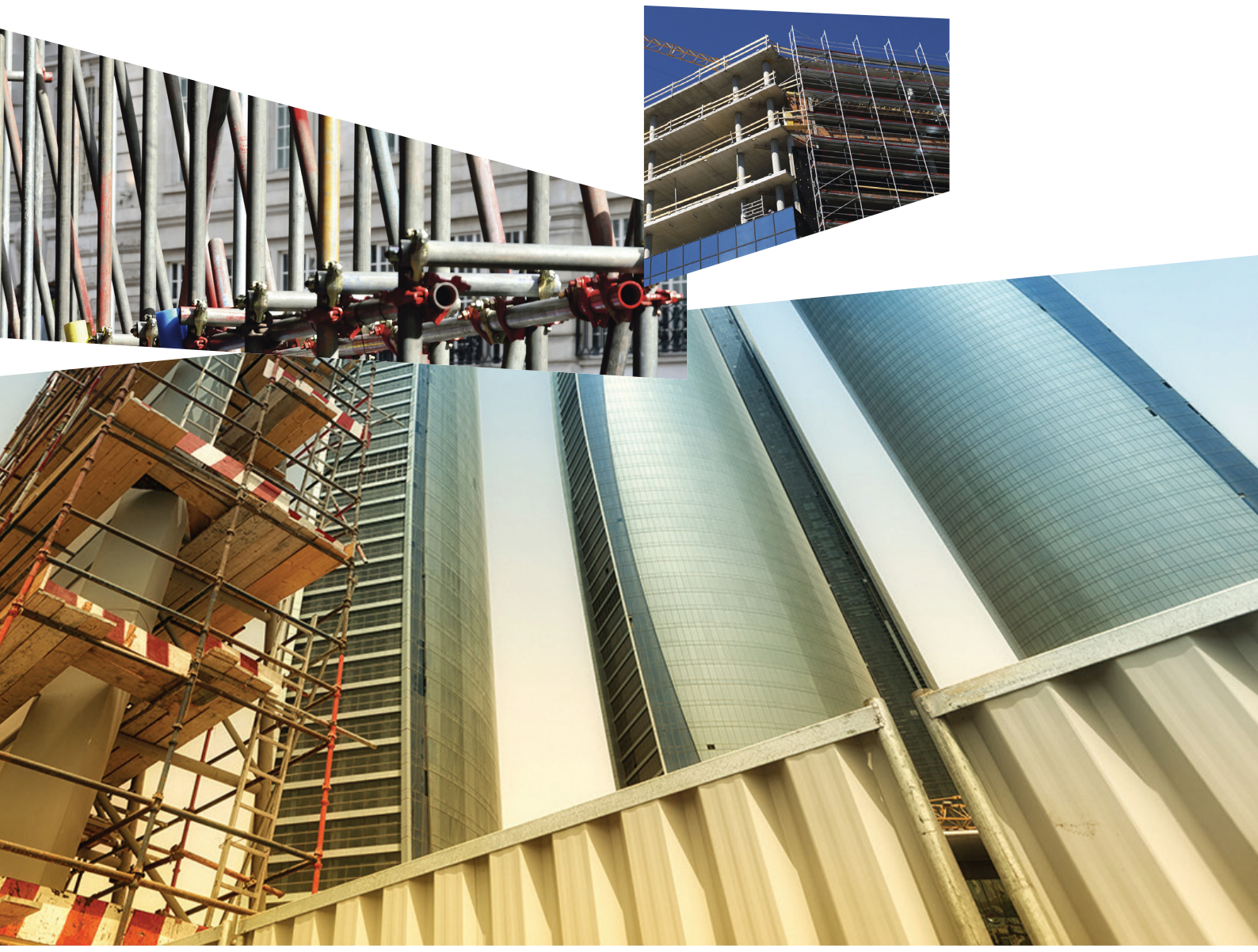
These statistics indicate a need for safety considerations to more directly inform the industry's design and evaluation processes. BIM presents a significant opportunity to improve construction safety for temporary works.

THE CURRENT ROLE OF BIM IN SCAFFOLDING SAFETY

Recent research shows BIM can improve safety practices, planning and management by detecting clashes in construction sequences and analysing risk factors within site plans. Construction firms use this type of analysis to aid in design and support onsite compliance checking.

However, current BIM tools used in large projects are not well suited to addressing practical safety considerations. BIM-based applications for temporary works such as scaffolding are often stand-alone and focus on one specific phase or task, not on the whole project lifecycle.

More work is needed to develop tools and knowledge that reduce the likelihood of accidents arising from non-compliant scaffolding structures.



TACKLING RISK WITH BIM

BIM can provide a powerful new platform for developing and implementing ‘prevention through design’ concepts. During the design and construction stage of a project, these concepts facilitate both engineering and administrative safety tasks. BIM-enabled safety controls can detect potential safety hazards or ‘clashes’, while 3D visualisation and 4D simulations can smooth out and illuminate construction processes.

These features are inherent to BIM and can thus enable more effective safety planning before and during construction. Such technology can enhance safety through automated hazard identification early in the process, and propose inexpensive and easier ways to solve safety clashes.

The following BIM features and processes can be employed for safer scaffolding design and construction.

AUTOMATED RULE-BASED FEEDBACK

This project has formulated an automated rule-based design and construction system. The system detects hazards automatically, visualises their location in a virtual 3D space, and provides visualised protective systems to mitigate the identified hazards in the design and construction phases.

INTERACTIVE DESIGN ITERATION

The productivity gains associated with automating layout are void if users can’t manually modify the assembly when conditions change. Design rules must be flexible enough for users to manipulate individual scaffolding components directly, and should be open to evaluation and adaptation.

A three-part design process highlights the hierarchical distinction between object- and system-level controls. Rules must be maintained in separate automation routines so users can, when necessary, invoke them to generate and evaluate scaffolding models.

USER-FRIENDLY SYSTEM

It is critical that the overall BIM system is simple and intuitive to operate, so that users who do not possess a detailed knowledge of BIM can still take advantage of the benefits that it offers. Above all, quick, easy and flexible visualisation of scaffolding models is needed to assist designers and contractors with the safe assembly and disassembly of these structures.

BENEFITS

The key benefits of this project are improvements to the efficiency, communication and knowledge of construction processes.

By using BIM tools and processes, iterations of scaffolding design that previously took days to compute now take less than a minute. All stakeholders are made privy to design assumptions, reducing duplications in tender estimation across the contractual chain.

In addition, the research has widened the industry's understanding of rule-based design logics, object relationships, and dependencies between scaffolding design, analysis and construction tasks.

CONCLUSIONS

This project enhances the integration between building design and construction stakeholders, and eases the knowledge gap in the management interface between design and construction activities.

The project's alignment to national research priorities places it at the forefront of safety and BIM innovation in Australia. As worldwide use of digital modelling tools continues to grow, this research will significantly contribute to the Australian construction industry's ability to operate in safer, smarter and more globally competitive ways.

The Sustainable Built Environment National Research Centre (SBEnrc) is the successor to Australia's CRC for Construction Innovation. The SBEnrc is a key research broker between industry, government and research organisations servicing the built environment.

The SBEnrc is continuing to build an enduring value-adding national research and development centre in sustainable infrastructure and building with significant support from public and private partners around Australia and internationally.

Benefits from SBEnrc activities are realised through national, industry and firm-level competitive advantages; market premiums through engagement in the collaborative research and development process; and early adoption of Centre outputs. The Centre integrates research across the economic, social and environmental sustainability areas in programs respectively titled: Greening the Built Environment; People, Processes and Procurement; and Productivity Through Innovation.

This research would not have been possible without the ongoing support of our industry, government and research partners:

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