PROJECT 3.28

National BIM guidelines and case studies for infrastructure

INTRODUCTION

Building information modelling (BIM) has become an important strategy for improving productivity and profitability in building construction; however, using BIM in infrastructure construction is relatively new.

The application of BIM for infrastructure is now accelerating as owners and engineering service providers recognise the benefits of 3D modelling with intelligent objects. Using BIM for infrastructure ensures data fidelity and continuity across the lifecycle of a project, ultimately improving the quality and efficiency of infrastructure.

This brochure describes using BIM in infrastructure, with a focus on transportation (main roads, highways and rail), bridges and tunnels. The brochure is intended as a reference guide to implementing BIM for transport infrastructure. It outlines BIM uses and models, modelling guidelines and BIM management.

In this snapshot of the full National BIM Guidelines, the Great Eastern Highway project in Western Australia is outlined as a case study in successful BIM practice. To read about the additional case studies, please request the full report from the SBEnrc.

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ABOUT BUILDING INFORMATION MODELLING

Building information modelling (BIM) is an intelligent, 3D model-based process that informs and anticipates decision making across the entire 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. These insights enable stakeholders to remain responsive and competitive throughout a project's development.

BIM MODEL DEVELOPMENT

This research uses City Geography Markup Language (CityGML), an open data model and Extensible Markup Language (XML)-based format that stores and exchanges virtual 3D city models, to develop BIM models.

TRANSPORTATION (MAIN ROADS, HIGHWAYS AND RAIL)

The CityGML transportation model focuses on thematic, functional and geometrical/topological aspects. Transportation features are represented as a linear network in level of detail (LOD) 0, and then in 3D from LOD 1 onwards (Figure 2.0).

The program's aerial modelling allows geometric route-planning algorithms to help determine any restrictions and manoeuvres required along a transportation route. This information can also help plan the trajectory of real-world mobile robots, and automatically place virtual pedestrians and vehicles in 3D visualisations and training simulators.
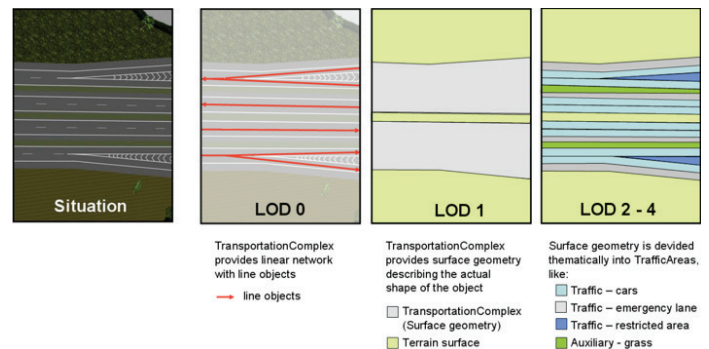

Figure 2.0: *TransportationComplex* **in LOD0, 1, and 2-4 (example shows part of a motorway) (Source: Rheinmetall Defence Electronics).**

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BRIDGES

The bridge model allows for the representation of the thematic, spatial and visual aspects of bridges and bridge parts in four levels of detail: LOD 1-4 (Figure 2.1). The semantic and geometrical richness increases from LOD 1 (blocks model) to LOD 3 (architectural model). Interior structures such as rooms are included at LOD 4. A multi-surface representation can be used in cases where the topology does not satisfy the properties of a solid.
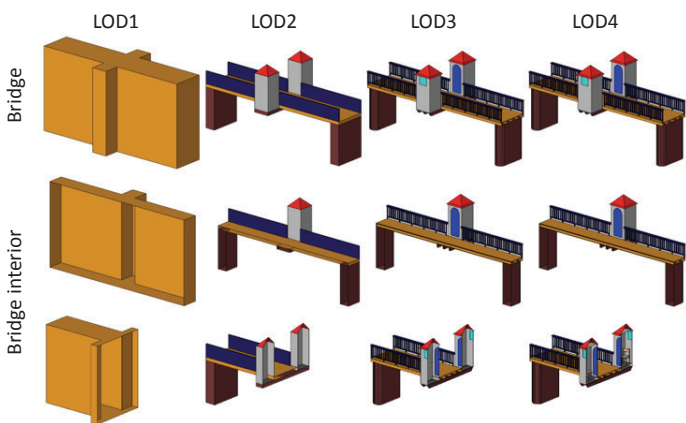

Figure 2.1: Bridge model in LOD 1-4. (Source: Karlsruhe Institute of Technology).

TUNNELS

The tunnel model supports the representation of thematic and spatial aspects of tunnels and tunnel parts in four levels of detail: LOD 1-4 (Figure 2.2). In LOD 1, the tunnel model consists of a geometric representation of the tunnel volume. Optionally, Terrain Intersection Curves can be specified. These curves denote the exact position where the terrain touches the 3D object.
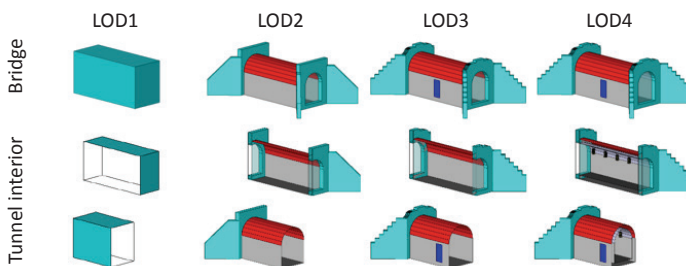

Figure 2.2: Tunnel model in LOD 1-4. (Source: Karlsruhe Institute of Technology).

BIM MODEL MANAGEMENT

Good model management produces better quality BIM models. Setting modelling guidelines, carrying out BIM model assessments and implementing BIM roles and responsibilities are key to developing clear and useful BIM models.

RECOMMENDED MODELLING GUIDELINES

- Develop appropriate and timely BIM elements, which increase in accuracy as the project progresses.
- Set a clearly defined model origin point and configure the site based on the Australian Standard Datum.
- Appropriately divide buildings, zones and levels early on in the process.
- Track and catalogue model changes using appropriate software.

RECOMMENDED QUALITY CONTROL CHECKS

- **Visual check:** Use navigation software to ensure there are no unintended model components and the design intent has been followed.
- **Interference check:** Use conflict detection software to detect problems in the model where two building components are clashing.
- **Standards check:** Ensure the model is to the agreed upon standards.
- **Element validation:** Ensure the dataset has no undefined or incorrectly defined elements.

Each stakeholder should also designate a responsible party to make sure that the agreed upon process for quality control of models and data has been followed before accepting submittals and model revisions.
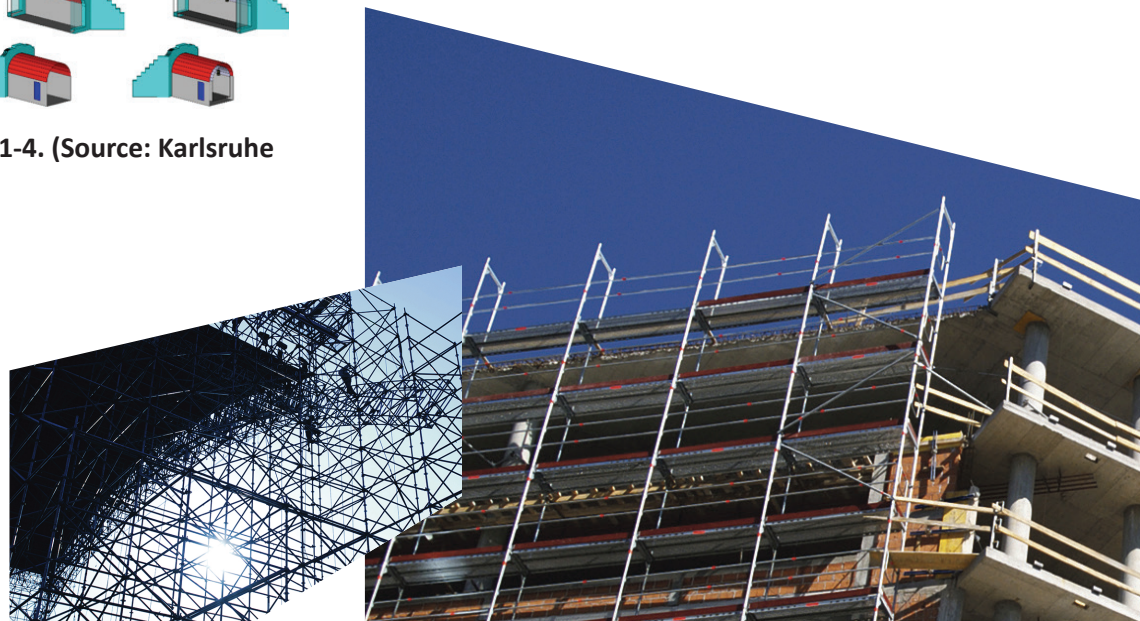
ROLES AND RESPONSIBILITIES OF BIM COLLABORATORS

Defined Role	Responsibility in BIM implementation	BIM responsibility
Project Manager	Manages and coordinates project execution and BIM to meet procurement strategy and cost containment.	Oversight.
Design Team Project Manager	Team manager and coordinator, BIM Management Plan.	Coordination and review.
(Design Team or Construction) BIM Manager	Coordinate BIM use on project, determine schedule of use, sharing activities, quality control, modelling responsibilities and documentation in BIM Management Plan.	Oversight, management execution and model exchange.
Lead BIM Coordinator	Assist BIM Manager.	Implementing BIM Manager instructions with design or construction team. Representing BIM Manager.
Survey and Mapping Team	Engineering – formulate with BIM Manager. Map BIM use for surveying and mapping. Identify tools.	Data development, modelling and model exchange.
Transport Planning Team	Engineering – formulate with BIM Manager. Map BIM use for transport planning. Identify tools.	Data development, modelling and model exchange.
Bridge Design Team	Engineering – formulate with BIM Manager. Map BIM use for bridge design. Identify tools.	Data development, modelling and model exchange.
Tunnel Design Team	Engineering – formulate with BIM Manager. Map BIM use for tunnel design. Identify tools.	Data development, modelling and model exchange.
Landscape Design Team	Engineering – formulate with BIM Manager. Map BIM use for landscape design. Identify tools.	Data development, modelling and model exchange.
Drainage Design Team	Manager – Map BIM use for drainage design. Identify tools.	Data development, modelling and model exchange.
Traffic Design Team	Engineering – formulate with BIM Manager. Map BIM use for traffic design. Identify tools.	Data development, modelling and model exchange.
Building Users Group	Determine facility functionality issues to be modelled and tested.	Development of critical building use issues and inputs for testing and review.
Commissioning Agent	Support – Provide architectural, engineering, equipment compliance reports produced in the specified exchange format.	Data development, review and use of model.
BIM Modelling Application Expert	Support BIM Manager on application specific content and issues.	Modelling and data integration.
Quantity Surveyor/ Cost Planner	Support alignment of project procurement to BIM development and cost containment strategies.	Data development and integration. Use of model.
Contractor	Receive or help create BIM for constructability and handover for field use. Determine interference checking responsibility.	Use of model, review and model exchange.
Subcontractor and/or Fabricator (as appropriate)	Off-Site fabrication – formulate with BIM Manager and designer. Map BIM use for fabrication and shop drawing design. Determine BIM use for simulations of maintenance space analysis and documentation. Identify tools.	Use of model, modelling and integration.

CASE STUDY

Upgrade of Great Eastern Highway, Western Australia
Major access route between the domestic airport and the Graham Farmer Freeway, Perth.

Major stakeholders
Main Roads WA (client), City East Alliance (MRWA, GHD, Leighton Contactors and NRW Civil and Mining), Swan River Trust.

BIM tools
AutoCAD, AutoCAD Civil 3D, Navisworks, 12D and MX.

Project aims
- Ease traffic congestion by increasing capacity by 70 per cent
- Improve access to the airport and surrounding areas
- Improve safety for local residents and other users of the highway
- Deliver better facilities for pedestrians and cyclists.

Project description
The upgrade consisted of expanding 4.2 km of the highway from four to six lanes between Kooyong Road and Tonkin Highway. These upgrades included the addition of pedestrian, bus and cycling lanes, along with the addition of CCTV cameras. The upgrades also involved modifications to affected major intersections and the addition of a central median strip.

BIM 3D, 4D and 5D modellings were adopted in the virtual design and construction of the project. Other BIM tools were also applied, including constructability reviews, traffic impact simulations, 3D coordination, engineering analysis, clash detection, product master data and field surveys.

Conclusions
Overall, the project ran $7 million under the targeted budget and three months ahead of the targeted completion date.

The total savings attributable to BIM were $24 million or 14 per cent of the total project cost of $175 million.

The project involved a total of 1.2 million man-hours with no lost time due to injury. The Leighton Group received a national HSE Award for the project.

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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Curtin University | QUT Queensland University of Technology | SWINBURNE

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