



A report for the Department of
Industry, Innovation, Science,
Research and Tertiary Education

NATIONAL BUILDING INFORMATION MODELLING INITIATIVE

VOLUME 1: STRATEGY

A strategy for the focussed adoption of
building information modelling and related
digital technologies and processes for the
Australian built environment sector

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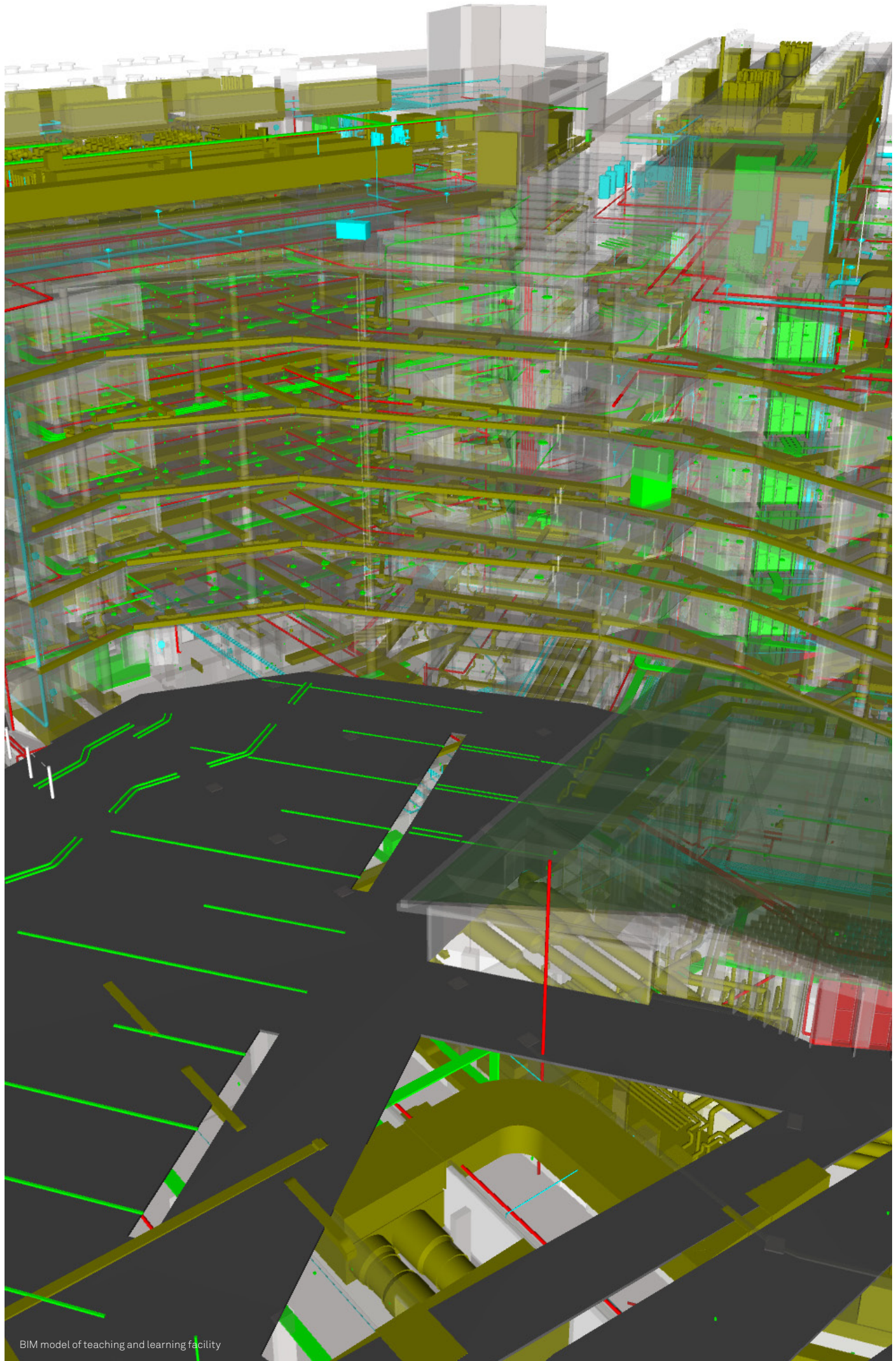
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BIM model of teaching and learning facility

Executive Summary

The report *Getting it Right The First Time: A Plan to Reverse Declining Standards in Project Design Documentation within the Building and Construction Industry* (Engineers Australia, 2005) identified that a declining standard of documentation in the building, engineering and construction industry in Queensland over twelve to fifteen years to 2005 had led to losses exceeding \$2 billion per annum in the Queensland construction budget – and probably six times that amount or \$12 billion per annum nationwide.

The above report found that poor documentation was leading to:

- _ An inefficient, non-competitive industry;
- _ Cost overruns, rework, extensions of time;
- _ High stress levels, loss of morale, reduced personal output;
- _ Adversarial behaviour, diminished reputations; and
- _ A decline in safety standards.

buildingSMART Australasia, the Department of Industry, Innovation, Science, Research and Tertiary Education (DIISRTE) and others co funded a report *Productivity in the Buildings Network: Assessing the Impacts of Building Information Models* (Allen Consulting Group, 2010), which found that accelerating the adoption of building information modelling (BIM) in the Australian built environment sector could improve productivity by between six to nine percent. It found that concerted government support for the use of BIM by the architects, engineers, builders, contractors, owners and facility managers involved in a building's lifecycle would increase BIM adoption in 2025 by six to sixteen percent and produce an economic benefit equivalent to \$5 billion added to Australia's Gross Domestic Product (GDP).

During a series of MESH conferences in Brisbane, Melbourne and Sydney in early 2011 held to follow up on the implications of the Productivity in the Buildings Network report, the following six areas were identified as requiring priority attention to accelerate the adoption of BIM in the Australian built environment sector:

- _ Procurement and legal issues;
- _ BIM guidelines;
- _ Multi-disciplinary BIM education;
- _ Product information libraries;
- _ Business process change; and
- _ Compliance and certification issues.

buildingSMART Australasia conducted stakeholder consultation workshops in early 2012 in Adelaide, Brisbane, Canberra, Hobart, Melbourne, Perth and Sydney with 160 participants representing a broad cross section of the Australian building and construction industry – including clients, consultants, contractors, educators and government representatives. The workshop participants unanimously endorsed the need for national action on the above listed six areas as a matter of priority.

Executive Summary

- 2 The participants at the stakeholder consultation workshops proposed the following further key recommendations, listed according to priority:
- _ A BIM adoption Roadmap should be completed, with value itemised at each stage;
 - _ The Commonwealth and State and Territory governments should be encouraged to introduce mandatory use of BIM for their building procurements;
 - _ The legal and technical instruments needed to support the above should be developed as soon as possible, and aligned with the relevant international codes and standards;
 - _ Governments should consider the development of procurement processes and assistance packages to encourage the accelerated adoption of BIM in the built environment sector; and
 - _ Clients and operators should be educated on the benefits of BIM to increase the demand for BIM services.

This report recommends that the Australian Government set a date of 1 July 2016 from which procurement for all its buildings will require full collaborative BIM based on open standards for information exchange (commonly referred to as Open BIM). The report further recommends that the Australian Government encourage the State and Territory Governments, through the Council of Australian Governments, to commit to a similar timeframe for full collaborative BIM based on open standards to be required for procurement of their buildings. International experience indicates that when governments have required BIM for their procurements other public bodies and the private property industry have been motivated to follow suit.

This report further recommends that a joint government and industry taskforce be established to oversee a five-year program of works to address the six priority areas listed above to facilitate the Australian Government's adoption of full collaborative BIM for all of its building procurements from 2016. A National BIM Initiative Blueprint detailing the proposed work programs is set out at Figure 1.

This report also recommends that pilot projects be undertaken to validate and demonstrate the readiness of the outputs from each of the six work programs for deployment on an economy-wide basis. This will help promote the merit, and mitigate the risk, of using new technologies and processes such that prospective building owners will understand the benefits, and increase the demand for, BIM services and products.

The execution of the National BIM Initiative will drive much needed change in the Australian building and construction sector, and make a significant contribution toward other Australian Government agendas including: preparation for a low carbon future; realisation of the Government's digital economy strategy; boosting Australia's international competitiveness and enhancing world trade in building and construction services.

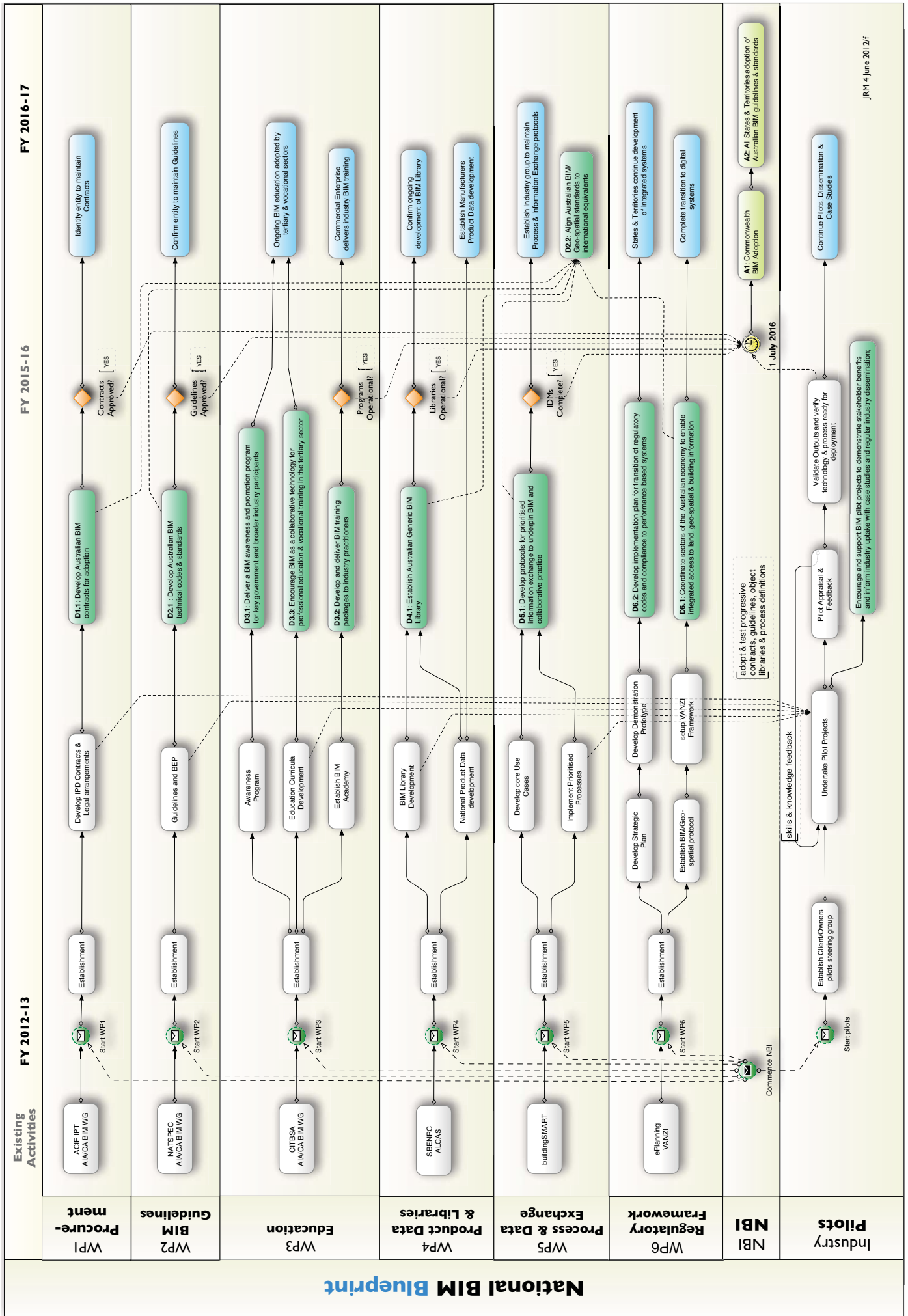


Figure 1: NBI Blueprint

Recommendations

- 4 This report recommends that industry and the Australian Government work together to co-ordinate initiatives that will accelerate the adoption of BIM in Australia and ensure Australian business are well placed to compete in a growing global construction sector. Key Initiatives recommended include:
 1. Require full 3D collaborative BIM based on open standards for information exchange for all Australian Government building procurements by 1 July 2016
 2. Encourage the Australian States and Territories through the Council of Australian Governments to require full 3D collaborative BIM based on open standards for information exchange for their building procurements by 1 July 2016
 3. The National BIM Initiative Implementation Plan accompanying this report, which requires execution of the following project work programs:
 - a) **Procurement:** Manage risk, intellectual property, insurance and warranty requirements for clients, consultants and constructors through new forms of procurement contracts that support collaborative, model-based procurement processes.
 - b) **BIM Guidelines:** Provide industry and government clients, consultants and constructors with a set of Australian BIM Guidelines based on collaborative working, open standards and alignment with global best practice.
 - c) **Education:** Deliver a broad industry awareness and re-training program through a national BIM education taskforce based on core multi-disciplinary BIM curriculum, vocational training and professional development.
 - d) **Product Data and BIM Libraries:** Enable easy access to building product manufacturers' certified information for use in all types of model-based applications through an Australian on-line BIM Products Library.
 - e) **Process and Data Exchange:** Establish open standard data exchange protocols that will support collaboration and facilitate integration of the briefing, design, construction, manufacturing and maintenance supply chain throughout the entire life of a built facility.
 - f) **Regulatory Framework:** Establish a mechanism for planners, local government and government regulatory bodies with integrated data of building and service system elements, land, geospatial and definition of human and related activities to measure and analyse performance of built form.
 - g) **Pilot Projects:** Encourage pilot projects to be undertaken to demonstrate and verify the readiness of the outputs from the above six work programs to be deployed on an economy-wide basis.
 4. Establish a taskforce with key stakeholder representation to manage a 5-year program for the delivery of the National BIM Initiative Implementation Plan.

1.0 Introduction

“There is a BIM revolution happening across our industry – those organising themselves now, will be best placed to do business in the future”

Peter Bowtell - Buildings Practice Leader
Australasia - Arup

This report sets out a strategy for the accelerated adoption of BIM in the Australian built environment sector.

This report is accompanied by a National BIM Initiative Implementation Plan that sets out a proposed management structure plus details and costings for work programs proposed to address six areas identified for priority attention to support the accelerated adoption of BIM. The six identified issues proposed to be addressed are listed in the left column of Table 1.1. The proposed matching work programs are set out in the right column of Table 1.1.

This report details the outcomes of stakeholder consultation undertaken at workshops conducted in March and April 2012 in Adelaide, Brisbane, Canberra, Hobart, Melbourne, Perth and Sydney with a broad cross section of the Australian building and construction industry. The workshop participants were invited to identify the key barriers to the rapid adoption of BIM and how these might be resolved in a national, Australasian and international context. As a starting point, they were asked to address the six areas set out above.

The production of this report was made possible by funding provided by DIISRTE and matching in-kind contributions provided by buildingSMART Australasia and Australian industry.

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Table 1.1 Proposed Work Programs

Issues Requiring Attention	Proposed Work Programs
Procurement and legal issues	Procurement
BIM guidelines	BIM Guidelines
Multi-disciplinary BIM education	Education
Product information libraries	Product Data and BIM Libraries
Business process change	Process and Data Exchange
Compliance and certification	Regulatory Framework

2.0 The Need for Action

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2.1 Problem Definition

The advent of two-dimensional computer aided design (CAD) tools in the 1980s and 1990s was the first time a radically different technology had changed work practices in the design and documentation component of the Australian construction industry, which had traditionally used manual drafting and hardcopy documents. CAD was expected to bring better levels of accuracy and improved methods of designing and documenting. A new computer technology was the medium for these tools, and since that time the impact of computing has been profound, bringing a radical change to the way we transact business – the digital economy.

In the Australian construction sector the new CAD environment was not fully utilised due to the sector being hesitant to adopt the digital paradigm. It continues to be less productive than other sectors of the economy, with lower quality and investment value. The report *Getting it Right The First Time* identified declining standards over the preceding 15 years and a complementary report by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) estimated the cost to the Australian property industry attributable to problems in the construction process at \$12 billion per year.

The authors of the *Getting it Right The First Time* report analysed the industry issues underlying the problem, and identified:

- Lack of integration along the supply chain linking parties, and between the project phases;

- Lowest bid selection strategy rather than value for money;
- Poor understanding of optimised and properly documented designs;
- Inadequate/ineffective use of technology in design; and
- Lack of appreciation of the benefits of open communication.

Technology by itself is clearly not the only issue – culture, management, processes, skills and technology need to be addressed together. The industry is at a crucial stage of a major shift of technology and process innovation. Some of the key challenges are discussed below.

2.1.1 Practice is Still Not Changing

The Building the Education Revolution (BER) Implementation Taskforce's *Final Report* published in July 2011 makes many observations about the construction industry comparable to those made in the *Getting it Right The First Time* report, almost 10 years earlier.

The BER Implementation Taskforce reported on a number of construction industry wide issues, including:

- inadequate use of technology to deliver coordinated project design documentation;
- substandard workmanship which may be a result of low completion rates of trade apprenticeships;
- a trend to generic skills for project managers rather than technical qualifications backed by significant hands on construction experience; and
- on occasion, insufficient collaboration across the professions resulting in poor project scoping and inadequate documentation coordination.

The BER Implementation Taskforce has been disappointed with the inadequate incorporation of environmentally sustainable design (ESD) features in school projects (see the BER *Final Report* Chapter 6 and Appendix 14)

The BER program highlighted the inconsistencies across the country in education authorities' policies and approaches to ESD. The discretion left to individual education authorities resulted in unsatisfactory outcomes." The report also documents the dramatic reduction of design and construction expertise in Government.

The Australian Innovation System Report (DIISRTE, 2010) observes that the construction sector has historically had and continues to have low levels of innovation, with only 30.8 % of business innovating. Of those construction businesses innovating only 15% were introducing organisational or managerial innovation, and only 11% were introducing process innovation, making the construction sector the lowest sector to implement or significantly improve innovation.

2.0 The Need for Action

What is BIM?

A Building Information Model is a 3D object database that can be easily visualised, has rich data and structured information. Building Information Modelling is a process of representing building and infrastructure over its whole life cycle from planning, design, construction, operations, maintenance and recycling. BIM importantly provides a framework for collaboration, a multi-disciplinary environment that brings together all the parties that design, construct and operate a facility, suggesting a new model of procurement Integrated Project Delivery (IPD). BIM's key benefits at present being exploited by the leading exponents in the industry, are substantial savings in time and cost and an improvement in quality.

2.1.2 Climate Change and Sustainability

Sustainability has become crucial in the use of resources, greenhouse gas (GHG) emissions and the state of the fabric of our major urban areas. The report *Capitalising on the Building Sector's potential to Lessen the Costs of a Broad Based Greenhouse Gas Emissions Cut* (ASBEC Climate Change Task Group, 2007) report identified the role the building sector plays in GHG emissions: "almost a quarter (23 per cent) of Australia's total greenhouse gas emissions are a result of energy demand in the building sector. The building sector, comprising residential and commercial buildings, houses a large proportion of Australia's economic activity".

2.1.3 BIM and the Geospatial Sectors Do Not Mix

If we are to address the poor state of built environment infrastructure in Australia's cities, a key issue is access to comprehensive data that provides context and regulation for a proposed development. To date, geospatial information has been extremely difficult to acquire, and the data is largely untrustworthy or lacks provenance and accuracy characteristics. The design professions are used to contacting a myriad of different public and private agencies to collect all the necessary information and are forced to convert it into a usable format. This is a significant barrier that increases cost, extends time and requires duplication and auditing to affirm the data in the field.

Local governments particularly, need more comprehensive data of their portfolios to carry out management, maintenance, compliance checking and strategic planning. Their asset information should be a seamless integration of all aspects of the physical, planning and operational context. BIM and geographic information systems (GIS) should coexist and harmonise.

2.1.4 International Competitiveness

Building information modelling is a process and technology that is replacing conventional drawings with a digital 3D object database, a technology that after 25 years of gestation is being adopted in all of the leading international construction economies. The pace of this adoption is gaining great momentum, and it is important that Australia synchronises with these international influences. It is essential that Australia be more proactive in contributing to this work and thus derive a truly national economic benefit from its use. The international activity identified in Appendix A indicates a need for Australia to move rapidly to maintain its place, or indeed, to take a lead, in these developments.

2.1.5 Barriers Preventing Wider Adoption of BIM

The MESH Conference series hosted by buildingSMART Australasia in early 2011 identified a number of barriers facing the wider adoption of BIM drawn from the Productivity in the Buildings Network report and emerging industry understanding.

2.0 The Need for Action

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For example: organisations are seeking a reputable industry source for BIM guidelines; client groups are not defining their BIM objectives for new projects; industry is concerned that IP was at risk using the new technology.

A major stumbling block is the limited availability of building objects incorporating product data in a form suitable for use in BIM. There is a complete lack of information needed for full performance analysis, product specifications and asset management. Product libraries are being developed by individual entities across the nation at significant cost to individual practices, and fall short of consistency, interoperability or comprehensive cover of object properties.

Key impediments to the widespread adoption of BIM that were identified at the MESH conferences are as follows:

- _ Procurement, Legal Issues and Insurance;
- _ Adoption of common BIM Guidelines and Information Exchange;
- _ Multi-disciplinary BIM Education;
- _ Product Information and BIM Libraries;
- _ Business Process Change; and
- _ Compliance and Certification.

These impediments form the basis of the stakeholder consultation undertaken for this report and are included in the accompanying National BIM Implementation Plan.

Box 2.1 Proven benefits of BIM on projects

“Coca Cola Place, 40 Mount St, North Sydney witnessed substantial time and cost benefits from the BIM technology that was integrated into the project design, delivery and management. The BIM modelling provided significant productivity gains for the project witnessed by time and cost savings. The coordination of the numerous trades assisted in fast tracking the project and meeting all leasing milestone dates”.

“The BIM model process also provided a collaborative approach to the project delivery and assisted in alignment of contractor, tenant and owner goals. This lead to an extremely successful built form”.

“When a national object library is established in Australia, and industry awareness and training implemented, the whole property sector, regardless of project size or type, will be in a position to capture these significant advantages that BIM offers”.

Mark Tait – General Manager
Commercial Development
– Investa Property Group

2.0 The Need for Action

2.2 Potentials of the New Technologies

New technologies, if implemented consistently, have been proven to generate productivity, performance, social and environmental gains. The Australian Government has commenced the roll out of the National Broadband Network to ensure future global competitiveness.

The construction industry, through the National BIM Initiative consultation process, has voiced an enthusiasm to see the Government extend its commitment to new technologies through the adoption of BIM as an enabler for a better performing built environment. The section below considers the potential for innovative change and turning barriers into opportunities.

2.2.1 The Digital Economy

A critical set of influences can be collected under the concept of the Digital Economy. The Australian Government's aim is that, by 2020, "Australia becomes a leading digital economy which will contribute to Australia's productivity, maintain our global competitiveness and improve our social wellbeing". The government's commitment to build the enabling infrastructure for the digital economy, the National Broadband Network (NBN), is a key step towards this vision.

The government has set 'Digital Economy Goals' that focus amongst others, on the areas of:

- _ Online participation by Australian households;
- _ Online engagement by Australian businesses and not-for-profit organisations;
- _ Smart management of our environment and infrastructure;
- _ Increased teleworking;
- _ Improved online government service delivery and engagement.

The Australian Government's roll-out of the NBN will transform access to high speed digital services; this will make possible advanced collaboration using all media modes such as video, and make web-based services practical and efficient.

The Seamless Economy initiative is focussed on creating a seamless national economy, reducing costs incurred by business in complying with unnecessary and inconsistent regulation across jurisdictions. These measures will enhance Australia's longer-term growth, and expand Australia's productive capacity.

Of specific interest to the Australian construction sector are projects for uniform occupational health and safety laws; environmental assessment and approvals; electronic conveyancing; development assessment; and a new National Construction Code. These present opportunities for smarter ways of working based on the integration of BIM and geospatial data, which could have a significant impact on the efficiencies for local government, and innovation through a move to performance based regulations.

2.0 The Need for Action

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The Workplace Network

TWN is a "... global community of senior executives in public-sector real estate". Members are leaders and decision makers from public-sector real estate organizations worldwide: from corporations, institutions and government agencies spanning 15 different countries.

A role played by TWN is the members who have committed to support the continuing development and implementation of open Building Information Modeling (open BIM). "...As clients of the (AEC/FM) sector, signing members strive toward achieving open standards in industry, specifically in BIM (i.e., planning, design and construction component) and in SBT (i.e., operations component), to foster innovation and the continuous advancement of productivity, efficiency, quality, and sustainability through energy use reduction in building construction and operations, leading to a better built environment for end users, clients, and stakeholders".

2.2.2 Innovation in the Built Environment Industry

The Built Environment Industry and Innovation Council (BEIIC), established by DIISRTE to examine ways of introducing innovation in the Built Environment identifies that increasing use of information technology, facilitated by the National Broadband Network, will have a profound effect on the way the Built Environment is planned, designed, procured, constructed and operated:

"Plans and designs can be conceived, tested and optimised in a virtual world before committing to construction. Such plans and design will benefit from access to data about usage, consumption and performance of the existing built environment."

Construction will tend towards a manufacturing process using "just in time" procurement allied to "mass customisation" and on-site assembly with all information flowing directly from digital databases and/or information rich models (Built Environment Models - BEM).

Assets can be managed and efficiently operated directly from BEM, reducing energy consumption, optimising operating costs and determining replacement plans".

2.3 Existing Industry Initiatives

During 2008-9 interest in BIM in Australia was sharply accelerated. While architectural BIM products were in use by larger design practices since the late 1990s it wasn't until engineering consultants started to use BIM that the opportunity for multi-disciplinary BIM –

integrating architecture, structure, mechanical, electrical and hydraulic services – became obvious. The CRC for Construction Innovation anticipated this change and incorporated many significant BIM focussed projects, but the industry was not then aware of the dramatic change in work-practice and industry impact that this new technology would bring.

2.3.1 Industry Progress

By the end of 2011, many organisations were realising that key resources were inadequate or missing. The first of the construction sector to take up the technology were the design professions, identifying four areas of importance– model building guidelines, shared BIM component libraries, procurement and education. Accompanying this expanding national awareness has been increasing understanding of the identical changes occurring in the global construction sector and leading international BIM developments.

2.3.2 BIM Guidelines

The CRC for Construction Innovation's National Guidelines were Australia's excellent first step and a good reference source. It has been followed by the NATSPEC National BIM Guide and BIM Management Plan, which has been well received and increasingly adopted across the industry, providing a sound basis for further work. This work has been based on adapting (with permission) the U.S. Veteran Affairs' BIM Guidelines and is a role model for international cooperation and alignment.

2.0 The Need for Action

In the UK, RICS has been working with industry and academia to develop *New Rules of Measurement* and extending this collaboration with the Australian Institute of Quantity Surveyors in Australia. This publication aims to establish greater consistency in the measurement of buildings.

A group of quantity surveyors in Queensland has been pioneering the adoption of models as the basis for estimating and scheduling buildings. The output from those initiatives has been reliable estimates produced in hours rather than days and schedules that are consistent with a bill of quantities that can be produced reliably, cheaply quickly and which have the potential to be used by tenderers as the vehicle for easily prepared bids.

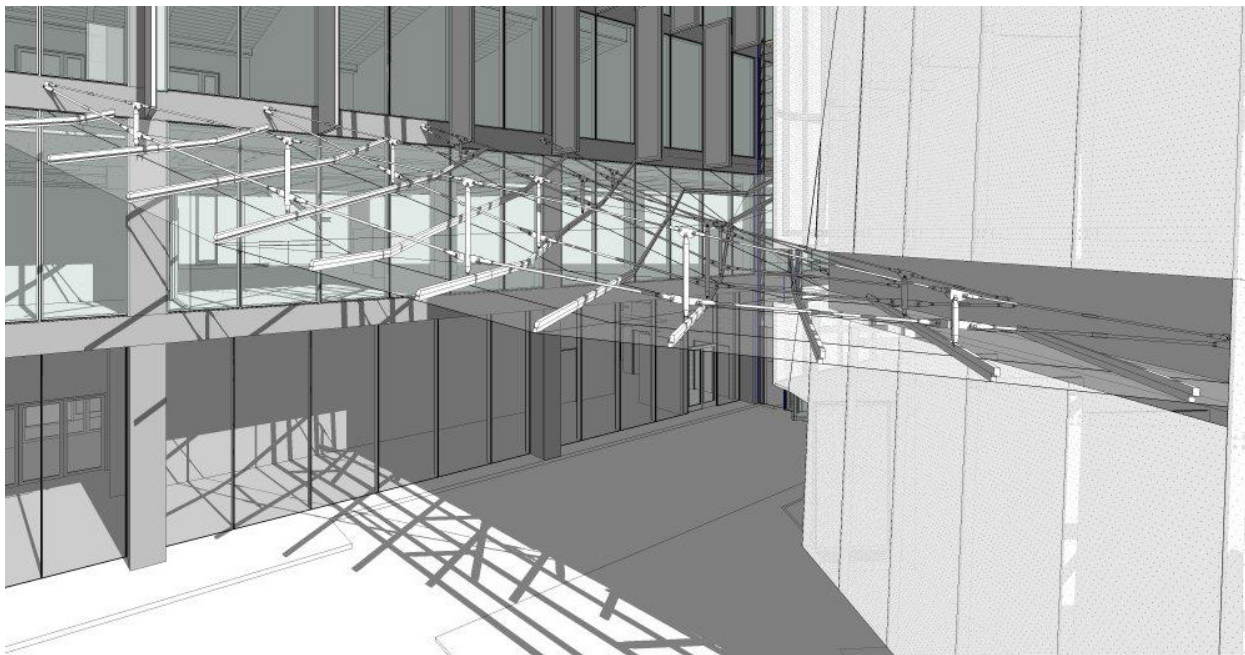
The American Institute of Architects' document AIA E202 - 2008 highlights the importance of "information" in BIM, integrated practice, the adoption of open standards and providing guidelines on BIM processes

Key national current projects in the health sector using various levels of BIM – Royal Hobart Hospital, Royal Adelaide Hospital, Princess Margaret Hospital for Children (Perth) are applying explicit project specific BIM Execution Plans to improve consistency in modelling, clear outputs and enhanced efficiency in the collaborative processes.

2.3.3 Product Information

As adoption of BIM has increased, users have been increasingly looking to improve the generic libraries of common building products and components (e.g. wall construction definitions, window and door types, steel sections, etc.) that vendors provide, in most cases derived from a United States or European industry context.

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3D modelling

2.0 The Need for Action

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- Representative activities are:
- _ The Sustainable Built Environments National Research Centre (SBEnrc) at the Queensland University of Technology has a current project on Interoperable Object Libraries that is developing a library of generic objects, accessible by the three major BIM tools in the Australian market intended to demonstrate a national solution for industry access to building product data.
 - _ User groups for proprietary software applications such as Revit have developed Australian and New Zealand Content Standards for developing 'Families' and best practice that are also in alignment with United Kingdom Revit Users Standards.
 - _ BIM MEP AUS, an initiative by the Air Conditioning and Mechanical Contractors' Association of Australia, has implemented proprietary product data for the mechanical services supply chain.

Internationally, Riba Enterprises Ltd (trading as NBS) in the United Kingdom has published a BIM Store providing free-to-use standard generic library BIM content to the construction industry.

In France, the Building product industry association is leading building product data development and is currently working towards quality, regulatory and voluntary efficiency of these systems. buildingSMART International has created a 'Product Room' providing support for worldwide integrated BIM processes, in line with the International Framework for Dictionaries (IFD). In the United States, the Construction Operations Building information exchange (COBie) and Specifier's Properties information exchange (SPie) undertaken by the U.S. Army Corps of Engineers are being developed as a standard framework of objects for information exchange to support facility management.

2.3.4 Procurement, Legal Issues & Insurance

Amongst other initiatives, The Australasian Procurement and Construction Council (APCC) together with the Australian Construction Industry Forum (Forum) has been working on the development of a proposal for the wider adoption of an Integrated Project Delivery (IPD) form of procurement in Australia. IPD is a critical initiative in the implementation of more effective, value based procurement in this country and needs to be supported.

A key activity has been the Consult Australia/Australian Institute of Architects - Legal and Procurement working group, developing guidelines for BIM teams, procedures, forms of agreement etc. to better inform clients, consultants, contractors and subcontractors. The Architects Professional Risk Services company is developing a collaborative agreement to support integrated practice contracts.

2.3.5 Multi-disciplinary BIM Education

Another activity being driven by the Australia Institute of Architects and Consult Australia is the BIM Education Working Group who are working to deliver a framework for BIM learning and a position paper for discussion. The Construction Industry Training Board in South Australia is offering awareness seminars on three different levels: basic (multi-disciplinary trade professions, intermediate and advanced. The University of South Australia, the University of Technology, Sydney and the University of Newcastle are working on Australian Learning and Teaching grant "Collaborative building design education using Building Information Modelling".

The Associated General Contractors of America are developing sector-based BIM certification, while in the United Kingdom industry groups are mobilising large scale re-training programs to educate current industry professionals and tradespersons.

2.0 The Need for Action

“We saved waste, we reduced time, we increased quality.”

Tony Gulliver, Head of Development, Dexu Property Group
Australian Financial Review 28 April 2011

The construction industry employs just under 1.3 million workers, or 12.8% of the total [Australian] job market. The industry is the nation’s largest – 11.5% of the total economy.

In 2010, property services and construction added \$147 billion to GDP directly. There’s also \$219 billion of flow-on demand not counted in the 11.5%.

Peter Verwer,
Property Australia Magazine
April 2012

2.3.6 Asset Owners & Clients

The service delivery side of the construction industry has been key to the development of the above activities, however, the role of clients, owners and governments are now becoming more apparent as BIM-enabled facility management capabilities are better understood.

There is a maturing of understanding and management of BIM opportunities in the form of enhanced tools to manage building portfolios in the corporate national, state and local government agencies. Already, initiatives like the eDA / ePlanning project have identified the benefits of national consistency and improved automation, however several key resources are missing.

2.3.7 Regulatory Compliance and Certification

This topic has been a guiding vision in the adoption of BIM with the potential for an integrated set of building data that would support analysis by experts systems. The Design Check tool developed by the CRC for Construction Innovation, the Australian Building Codes Board and the CSIRO was a proof of concept, checking against Australian Standard AS1428 to assist designers, certifiers, consultants, authorities and design specification writers.

A leading exponent of Code Checking has been the Singapore E-Plan Check System, where a significant proportion of the nation’s Building regulations can be checked from Industry Foundation Class (IFC) models.

In New Zealand, the Department of Building and Housing has investigated the adoption of BIM for consenting (the New Zealand term for “code checking”) in their earthquake recovery program.

Global GreenTag provides BIM based product certification integrated into GreenStar and product ecoPoints for Green building professionals, clients, and consumers. A BASIX pilot from the UrbanIT project at the University of New South Wales demonstrated BIM data required to automate assessment of BASIX compliance on a residential project.

The Australia and New Zealand Virtual Australia and New Zealand (VANZ) Framework initiative aims to link independent data sets with access protocols, backed by legislation, that are tied to ownership and contractual rights in the real world to provide the comprehensive spatial context data needed by urban building developments.

2.3.8 Business Process Change & Information Exchange

This is an area where the industry has historically done little. Internationally, buildingSMART has focussed on process definition and set up a “Process Room” initiative to specify the key multi-disciplinary processes in collaborative projects. The Australian Mechanical Contractors Association (AMCA) is the first product specific sector to innovate through supply chain integration and process definition.

2.0 The Need for Action

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Benefits of accelerated adoption of BIM

Recommendation 10: Accelerating the adoption of building information modelling (BIM) in Australia could improve the productivity of those involved in the design, construction and operation of buildings by between six and nine percent.

Concerted government support for the use of BIM by the notoriously fragmented Buildings Network could increase usage at 2025 by six to sixteen percent according to conservative estimates from industry representatives. This accelerated rate of BIM adoption would produce an economic benefit equivalent to \$5 billion added to Australia's GDP.

Recommendations Report (BEIC, 2010)

2.4 Australian Industry Overview

The outline above identifies many activities underway by a variety of independent organisations. (See Appendix C for more details of these current activities). Successful execution of the National BIM Initiative will require involvement of all disciplines, eg. contractors in construction scheduling, to gain maximum productivity improvements and uptake across the entire supply chain.

The interdependency of many of the actions needed is obvious. For example, to achieve improved collaboration between an architect and sustainability analyst requires the product manufacturers to supply Life Cycle Inventory (LCI) and thermal performance attributes in their BIM compliant object data. Similarly, to automate building application approval requires comprehensive planning information derived from geospatial data to be accessible in BIM models. This interdependency also requires close collaboration between industry and government, for example, in terms of contracts, IP and insurances.

Some of these current activities are explicitly aimed for national adoption - such as the NATSPEC guidelines and the SBEnrc BIM libraries projects - but most have been "private" projects and at present there is no agreed consensus on what would be called the national scope.

Most projects need extension across all disciplines and sectors of the industry to ensure a coordinated and consistent approach for the entire construction industry.

The National BIM Initiative will provide a unique chance to drive the accelerated adoption of BIM in Australia and drive productivity benefits throughout the entire economy. Given its size, Australia needs a coordinated and consistent approach to the adoption BIM.

The need for national consistency across all levels of government and industry, including international alignment were affirmed to be of the highest priority at the National BIM Initiative stakeholder consultation workshops.

2.5 The Way Forward

This section seeks to position the National BIM Initiative into a strategic context where it builds on work already undertaken in Australia and in other jurisdictions. It also outlines the needs for a structured national approach through an implementation roadmap that is sufficiently flexible to respond to new opportunities for industry improvements though evidence based performance and integration with the geospatial context.

2.0 The Need for Action

A National BIM Program

Recommendation 2: Encourage industry-wide use of BIM, and support pilot projects that demonstrate the benefits of applying new technologies. Australia's uptake of digital modelling technologies in the built environment has been limited; however such technologies have the potential to significantly improve productivity in the sustainable design, integrated construction and improved performance and maintenance management of buildings and infrastructure.

Recommendations Report
(BEIIC, 2010)

How much is spent on Construction in Australia?

This year's construction spend will be about \$111 billion, 70% of which is slated for residential buildings. A further \$109 billion will be spent on civil infrastructure.

Peter Verwer
Property Australia
Magazine, April 2012

2.5.1 International Context

The United Kingdom (UK) Government has recently announced that "Government will require fully collaborative 3D BIM as a minimum by 2016". Their chief construction adviser, Paul Morrell, has identified BIM as one way his government can deliver better value for the UK taxpayer. In his view, using BIM will lead to significant innovation and integration across the supply chain. Furthermore, his guiding statement is that BIM is not about a specific technology or product, but a process to give clients all the data that is of use to manage the facility after hand over. The United Kingdom is expecting to achieve a 20% reduction in procurement costs for government buildings compared with traditional practice through the introduction of its requirement for full 3D collaborative BIM to be used on government building procurements.

Other government jurisdictions that already require the use of BIM for government building procurements include the United States, Norway, Finland and Denmark. In our region, China, South Korea and Singapore have taken steps to achieve BIM implementation through a planned approach. For example, the Singaporean Government is well into applying a mandate for BIM, offering incentives to those willing to be the early pathfinders towards a goal of increased industry adoption, and ultimately full BIM submissions by 2015.

See Appendix A for an extended discussion of International activity.

2.5.2 A National Approach to BIM

The Australian Government, through the Built Environment Industry Innovation Council (BEIIC) together with buildingSMART Australasia, commissioned a report Productivity in the buildings network (Allen Consulting Group, 2010) that puts forward a cogent economic case for the widespread adoption of BIM in the Australian built environment sector. The study states that "BIM has macroeconomic significance, that its accelerated widespread adoption would make a significant difference to national economic performance and that there is a compelling economic case for encouraging greater use of BIM in Australia."

The report further states, "the use of BIM has the potential to streamline processes throughout a building's lifecycle through the integration of design, engineering, construction, maintenance and decommissioning information" and, "the use of digital modelling tools can have wider benefits for the Australian community when the use of this technology is extended to, for instance, urban planning, infrastructure development and the designing and understanding of city environments."

A *Recommendations Report* (BEIIC, 2010) included two recommendations (2 and 10 respectively – see sidebars) that support and are consistent with the recommendations of the Allen Consulting Group report and the prospect of improved productivity and innovation in the sector.

2.0 The Need for Action

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2.5.3 A Move to Evidence Based Performance

Provided that object data in BIM has the necessary attributes, BIM's integration in a single database environment allows a wide range of analysis, performance and simulation.

buildingSMART's submission to the Energy Efficiency Working Group Select Council on Climate Change on the National Building Energy Standards-Setting, Assessment and Rating Framework buildingSMART, 2011) observed that the adoption of building information modelling can contribute significantly to the energy efficiency reforms of the National Building Energy (NBE) initiative:

"In summary it will bring the following benefits:

- _ Provide a unique contribution to the tasks of analysing and optimising energy performance of buildings;
- _ Deliver credible, repeatable evidence of energy performance, based on integrated model data;
- _ Give national, State and particularly local government agencies (in the context of the NBE) better and more efficient methods to undertake compliance of both energy and building codes;

- _ Offers solutions to the whole life cycle management of assets and infrastructure for owners and government;
- _ with the setting of an open BIM information sharing protocol, transform the currently wasteful processes and data losses that are endemic in the industry; and
- _ be a stimulus for innovation and productivity in the built environment sector."

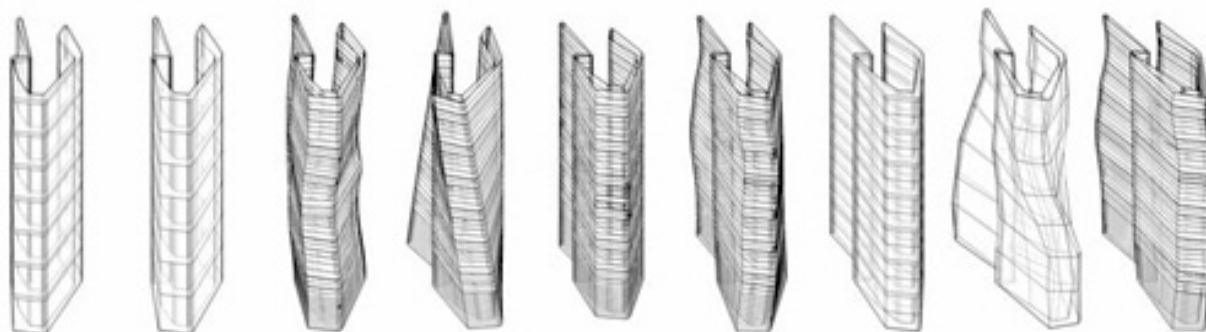
To enable this BIM based analysis to be used for building code & compliance checking requires a significant effort by the scientific community and product manufacturers. Work has been undertaken by the Australian Life Cycle Assessment Society and the Building Products Innovation Council on a Building Products Life Cycle Inventory but this is a single special part of more comprehensive data required for multi-disciplinary, life-cycle product data usage.

The National Research Centre, Queensland is undertaking a building product project which in our view should be supported by the building product manufacturing sector as a whole, and have strong links to Standards Australia, the Australian Building Codes Board and other relevant industry organisations and government agencies.

2.5.4 BIM Integration with the Geospatial Sector

What is required is a framework across Australia and New Zealand aimed at creating a set of laws, practices and web protocols to enable the creation of 'realistic' computer models of the natural and built environment (above and below ground, inside and out). Essentially, such a model will allow government, industry and the community to see each building model in its full 'spatial' context, resulting in a wide range of benefits that neither geospatial nor BIM alone can deliver.

Development of the Framework - VANZ (See Appendix B) in conjunction with the National Road Map for BIM will facilitate the adoption of laws and web services protocols to protect privacy and security. This is seen as key to encouraging asset owners to 'publish' their geospatial and BIM data on the 'net' for use by authorised third parties for planning, design, construction, operation, leasing and sale.



Modelling allows efficient review of options

3.0 Consultation

“On-site clashes have been dramatically reduced, leading to higher quality work, improved coordination between tradesmen and time savings.”

Bruce Jones, Grocon

“The high design performance, with its complex systems and geometry, required to achieve a six-star Green Star Rating could not have been achieved without the use of BIM. BIM enabled the simulation and analysis of 1 Bligh Street’s ecologically sustainable development performance of the various subsystems, before the design was finalised.”

Rodd Perey, Architectus,
Australian Financial
Review 28 April 2012

3.1 Stakeholder Engagement

This section outlines the methodology used to identify, analyse and engage with stakeholders who are impacted by or may impact the national program of BIM implementation. This was achieved by running a series of National BIM Initiative stakeholder consultation workshops across the country, one in each of the state capitals followed by a final workshop held in Canberra.

The collation of data captured from each workshop was documented (see Appendix C), representing an aggregated record of the discussions held) and re-distributed to each participant for comment and review. This was repeated with the final draft of the submission report, to ensure all of the key points expressed at each workshop were captured and expressed in the final report, whilst also providing consensus that the information represented was true and accurate.

The Canberra workshop agenda differed from the six states in that the group afternoon session focused on “roadmap prioritisation and confirmation” process, to align the “who and when” requirements for each of the actions and objectives identified by other states.

3.2 Workshop Methodology and Attendee Selection

The overarching aim of the BIM Roadmap Workshops was to canvass ideas and capture inputs from key participants across a wide variety of industry sector specialists in each state. Participation was by invitation only, ensuring an even mix of discipline representation.

The first task undertaken by the buildingSMART BIM Roadmap organising committee was to set and agree a “workshop agenda” along with the definitive list of 6 key initiatives formulated through the 2011 MESH conference. Each initiative formed a key topic for facilitated discussion and debate at each workshop. Workshops were held in Brisbane, Sydney, Canberra, Melbourne, Adelaide, Hobart and Perth. The organising committee identified a broad cross section of industry stakeholders to contribute to the BIM information gathering and analysis process, shortlisted to the following groups:

1. Architects
2. Consultants (architects, engineering services, quantity surveyors, building surveyors)
3. Clients and Owners (public and private)
4. Contractors – large, medium and small
5. Industry bodies and agencies
6. Educators and trainers

It was considered and agreed early in the process that no “software providers” would be invited to attend. This decision was to ensure the BIM information gathered reflected the views and needs of a cross section of affected practitioners, owners and clients rather than technology providers.

3.0 Consultation

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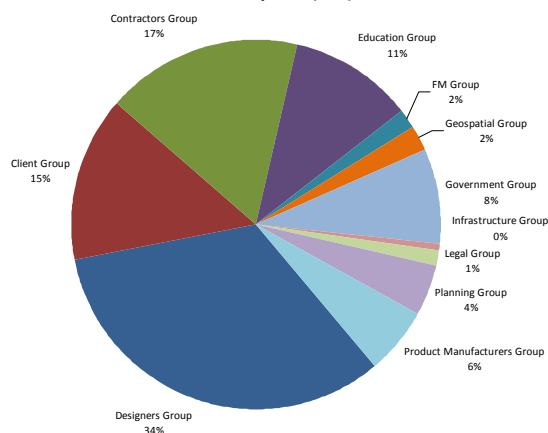
The following pie charts shows the breakdown of workshop participants across the professional sectors that attended the various stakeholder consultation workshops, along with the total number of respondents that participated in any way in responding to the National BIM Initiative stakeholder consultation process.

It was agreed that the optimum number of participants at each workshop was 30 (inclusive of the four facilitators/correspondents) to ensure each participants' contribution was able to be expressed and captured within the allocated timeframe of each workshop.

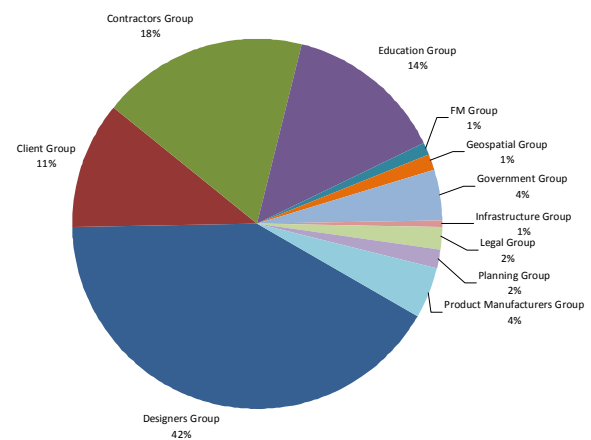
The invitation list for each workshop was developed jointly between the organising committee and selected State correspondents. The correspondents were selected on the basis of their interest/knowledge in BIM, local network and commitment to industry development. The correspondents assisted the organising committee with management of attendees, workshop materials, venue and information capturing based upon the committee's pre-determined and agreed format. The workshops were facilitated by at least two members of the organising committee to ensure consistency with each venue.

Appendix D lists the workshop attendees. To maintain a balanced group, the invitee target was set to a maximum of 5-6 professionals from any one professional group. This mix of representatives ensured a wide variety of experience and opinion in relation to the key initiatives, opportunities and actions required to identify the BIM roadmap.

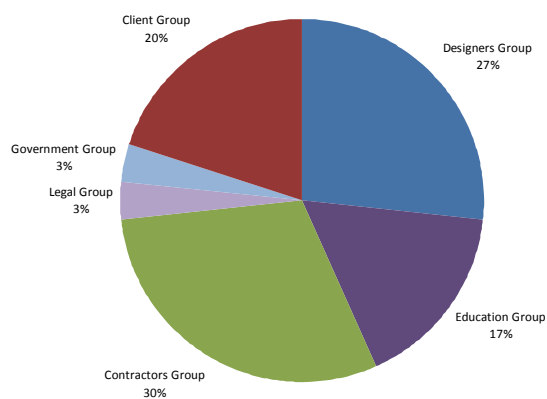
Total Participants (273)



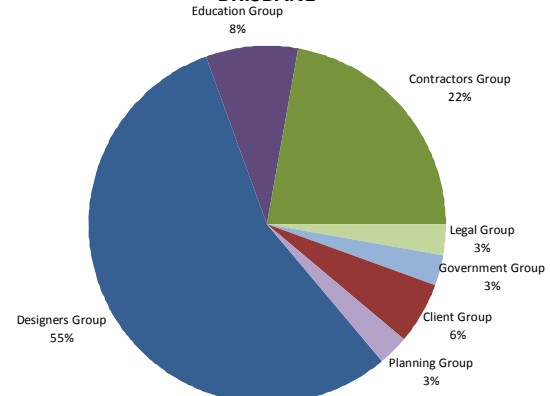
Total Attendees



ADELAIDE



BRISBANE

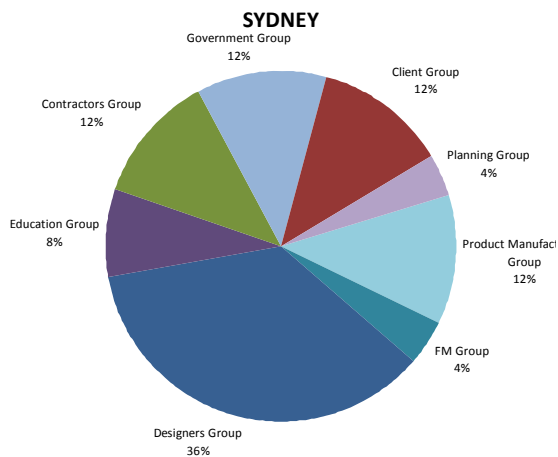
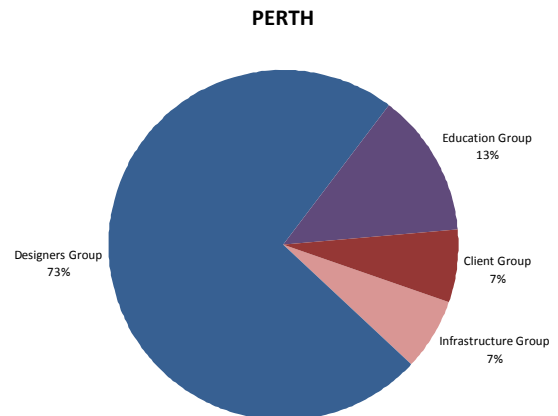
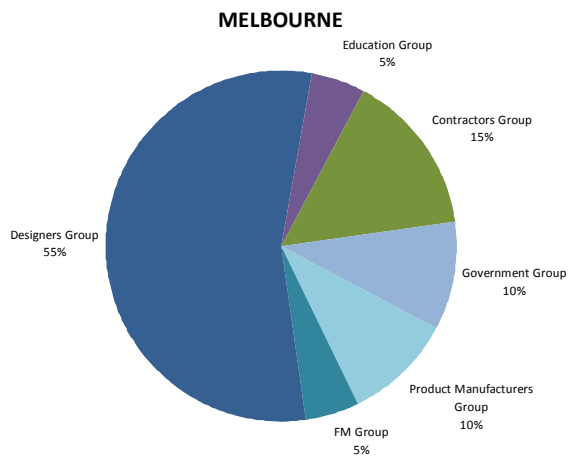
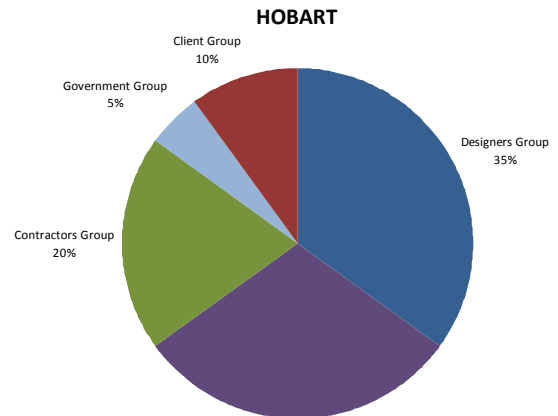
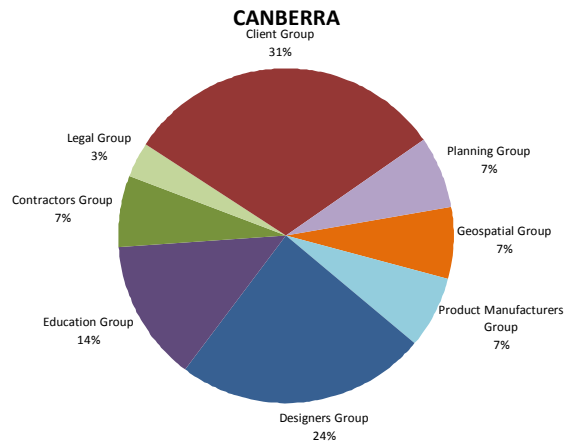


3.0 Consultation

“BIM cut out the rebuilding by cutting out the conflicts. The impact has been no variations”

Lyn Shaddock, Growthpoint Properties
Australian Financial Review 28 April 2011

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3.0 Consultation

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“We saw that accelerated coordination of disciplines and trades, and precision in set out and tolerance, was obvious.”

Bruce Jones, Grocon

“Many of the most complex areas in 1 Bligh Street, such as basements, plant rooms and the roof structure could not have been designed or constructed without the use of BIM.”

Tony Gulliver, Head of Development, Dexus Property Group, Australian Financial Review, 28 April 2011

This strategy was identified as the best chance of delivering the end goal: a BIM roadmap that delivers a unanimous plan and direction, resulting in standardised, coordinated and, most importantly, industry-adopted BIM practices, inclusive of a BIM library, tools, education and business processes.

Each Workshop was undertaken over a 5 hour session time, following a set agenda that involved:

1. Participant Introduction – covering background, roles, previous BIM project experience and involvement, whilst at the same time, establishing 6 groups to work across each of the initiatives.

2. Workshop Initiatives Debate and Discussion – capturing a collective statement of vision, outcomes/benefits, challenges/opportunities, key success factors with respect to each of the six initiatives.

3. Objectives, Actions, Leadership – identifying objectives and appropriate activities to achieve those, including the identification of the specific organisations/individuals best placed to deliver those objectives.

4. Prioritise Roadmap – establishing a timeframe and priority for each of the key actions

The information collection involved participants detailing their responses and thoughts for each of the items 2, 3, and 4 above on A1 template sheets. At the conclusion of each workshop the correspondents and facilitators from each workshop captured this data, aggregated it in to a single document (Appendix C) and transferred key ideas into a data base.

The information was then redistributed to the participants for their review and comment as appropriate. The final version of the collated responses was then used as the data source for this report.

Based on the priority rankings across all the Workshops, we can identify a set of key initiatives, observations or concerns that were generally seen to be critical for the BIM Roadmap. These are listed in priority order in Box 3.1 using the actual words used by the Participants.

Box 3.1 Priority Outcomes from the Stakeholder Consultation

1. Complete BIM Roadmap and itemise value at each stage;
2. Encourage government to introduce mandatory use of BIM;
3. Educate and lobby government departments on BIM;
4. Identify procurement champions;
5. Develop new forms of contract for consultants, contractors;
6. Government procurement and assistance packages;
7. Standards Australia and buildingSMART to coordinate stakeholders to develop BIM standards;
8. Council of Australian Governments accept BIM initiatives and work with States to resolve IP and standards issues;
9. Create Australian BIM standard / International BIM standard;
10. Implement collaborative framework;
11. Educate clients and operators – creating demand;
12. Determine minimum level of detail at each stage of the asset life cycle; and
13. Develop central regulated repository for BIM product information

3.0 Consultation

3.3 Consultation Output

The Allen report identified the vast potential of BIM technology. *“Building Information Models (BIM) are emerging as a transformative, enabling technology that has the potential to improve the buildings network productivity and raise the economic wellbeing and competitiveness of the Australian economy as a whole”.*

There was very strong endorsement, with alignment right across the sector, for the industry to drive the adoption of BIM as quickly as possible, rather than be led by timeframes set by other outside parties. There was unanimous agreement with the urgent need to set and deliver a BIM roadmap through an efficient and coordinated approach in order to capture the design, construction and economic benefit offered by BIM implementation. The other key message from the stakeholder group was the need to capture and implement the BIM roadmap activities across all scale of projects (\$1M - \$1BN+) and all end-to-end contributors and users. The six initiatives below summarises the key agreed BIM initiatives:

1. **Procurement** – resolution of current procurement, legal and insurance impediments to facilitate the use of BIM to deliver true Integrated Project Delivery across consulting services, management of risk, fee structures, responsibilities, intellectual property, legal liability and indemnity insurance.
2. **BIM Guidelines** – to move the industry to the use of world best practice BIM protocols in support of collaborative design practice (BIM can assist industry to move to integrated, whole of life cycle property solutions and away from the current silo mentality).
3. **Education and Pilot Projects** – since BIM is a new technology, the whole of industry (including both public and private clients to ensure projects are scoped as BIM), need various levels of training, ranging from BIM awareness, across the development of technical skills and knowledge, through to an understanding of BIM as a collaborative working tool. Lessons learned from the running of various pilot projects validating processes across the other initiatives also need to be disseminated to government, academia and industry.
4. **Product Data and Libraries** – access to BIM-compatible product information in an open format that is properly specified, fit for purpose and can be correctly integrated into the project model.
5. **Process and Data Exchange** – need for business process changes to facilitate integration of the briefing, design, construction, manufacturing and maintenance supply chain throughout the entire life of a built facility, achieved through effective exchange of BIM-based data and information.
6. **Regulatory Framework** – the development of automated building design performance assessment and compliance checking based on the object-based information models that are developed through BIM processes. In order to achieve maximum benefit, BIM needs to be extended in to the geospatial domain, so that models can be tested within a virtual urban and regulatory context.

The key outcomes from the National BIM Initiative stakeholder consultation workshops resulted in a unanimous position from the design, construction and property sector. The key initiatives discussed above if actioned and delivered upon in a timely manner will deliver the following key sector benefits including, but not limited to:

- _ Industry collaboration and information sharing;
- _ Productivity gains – time and cost;
- _ Improved project quality ;
- _ Transparency and accountability in decision making across whole of project lifecycle;
- _ Increased sustainability; and
- _ Labour market improvements – including safety.

4.0 Implementation Strategy

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International experience has been that industry has been galvanised to action when Government has demonstrated leadership in the adoption of BIM. buildingSMART believes that the actions recommended below need to be a joint collaborative effort by government and industry.

In the first instance, the Australian Government needs to act decisively on the two actions set out below. This will be enabled by a set of work programs set out further below that will be carried out by industry to address the barriers to widespread adoption of BIM and informed by a suite of pilot projects aimed at testing and validating the outputs from the respective work programs.

4.1 Government Action Required

Action 1: Require BIM for Australian Government procurement for built environment projects by 1 July 2016.

The Australian Government Agencies could leave its Agencies to move to BIM processes on timeframes that they find most beneficial. However, it would send a clearer signal to industry if all Australian Government Agencies were to require BIM in their procurement processes from a defined date.

Other developed countries are requiring BIM as part of their building procurement processes. The UK is implementing a requirement for full 3D collaborative BIM for its building procurements by 2016.

Action 2: Encourage State and Territory Governments and the private sector to require BIM for procurement for built environment projects by 1 July 2016.

The Australian States and Territories could be left to implement BIM at their own rate according to their own needs and timeframes. However, it would send a clearer signal to industry if the Australian Government were to encourage the States and Territories (through the Council of Australian Governments) and the property industry to require BIM in their building procurements a similar time frame to the Australian Government. A nationally agreed consistent approach to BIM adoption by all other levels of government and industry would lead to maximum benefit to the Australian economy.

4.2 National BIM Initiative Work Programs

The target outcomes for each of the Work Programs are set out below. The projects required for delivery of these outcomes are developed further in the National BIM Initiative Implementation Plan.

Work Program 1 – Procurement

Deliverable 1.1: Develop Australian BIM contracts for adoption by 1 July 2014

Develop BIM contracts for standard Australian application, focussing on integrated project delivery to maximise the value from the deployment of BIM technologies. Develop initially as addenda that can be used in conjunction with current building and construction and design and construct standards.

When tested, embed directly within such standards. This would facilitate collaboration required for Integrated Project Delivery type contracting that will maximise benefits from the use of BIM, lowering risk, costs, disputation and better encouraging use of off site digital fabrication, just-in-time manufacture. The contracts prepared will need to be scalable, with at least a short version for small projects and a comprehensive contract for larger projects.

The use of ad hoc contracts does not provide sufficient incentive for Australian industry participants generally to invest in the provision of BIM services. Differing contracts and lack of Australian standard contracts increases the perception of risk for market participants, increasing costs for clients.

Work Program 2 – BIM Guidelines

Deliverable 2.1: Develop Australian technical codes and standards for BIM for adoption by 1 July 2015.

Develop Australian BIM standards for consistent application. Consistent application of standards will be essential for interoperability and collaboration between BIM model authors. There is a need to ensure minimum deliverables including models at the end of building construction, with data exchange protocols to allow maximum benefit of building information over building life.

4.0 Implementation Strategy

Proprietary standards for use of best-of-breed software will have a place in the planning, design and construction of buildings, but it will be critical for these to be supplemented with open standard, vendor neutral standards to ensure proper data access for an owner over a building's life span. The standards prepared should be scalable with a short version for small projects and a comprehensive standard for large projects.

Development of consistent Australian BIM standards will facilitate a market for BIM services, and accommodate improve briefing systems, offering significant savings in construction. The standards should be developed sufficient to facilitate a properly functioning market for BIM services, and allow the market to determine further function specific standards for higher order simulation and analysis applications.

Deliverable 2.2: Align Australian BIM codes and standards with international equivalents by 1 July 2015.

Australian Government signing of the commitment to open standard BIM (Open BIM) would provide significant confidence to owners for data fidelity and availability over a building's life and provide impetus for improvement in the suite of open standard technical instruments. Australia would be joining a growing number of its trading partners by making a commitment to openBIM. Other benefits also realised through open standard, vendor neutral BIM information for post construction building management, operation and maintenance.

There is a healthy international market for BIM authoring tools and a growing process for ensuring interoperability of such tools, but the open standard suite requires support to ensure maximum post construction benefits for building owners.

Work Program 3 – Education

Deliverable 3.1: Develop and deliver a BIM awareness and promotion program for key government and broader industry participants by 1 July 2013

Design and deliver training packages to increase overall understanding of key stakeholders of BIM technology, processes and building whole-of-life benefits.

Many understand BIM as a simple replacement for 2D CAD, without realising the significant benefits of collaborative processes and resulting long term benefits to building owners.

Software vendors have an incentive to sell their products into a technology market, but not to provide a sufficient whole-of-life perspective for an owner to realise maximum value from BIM. Delivering targeted training from a building whole-of-life perspective will provide an incentive for industry participants to invest in BIM service delivery capability, increase the desire of owners for BIM to be used on their projects, and lead to an increase in industry collaboration and competitiveness, delivering improved building sustainability and related outcomes and ultimately provide improved social and economic benefits to the Australian community.

Deliverable 3.2: Develop and start delivery of BIM training packages to industry practitioners by 1 July 2013

Industry needs to work with Government to ensure delivery of training to facilitate a consistent approach to BIM service delivery.

Consistent baseline training for existing industry participants will build a shared understanding across industry of the benefits of BIM processes, lowering the perception of risk, facilitation orderly change management. Leaving the market to deliver training without guidance is likely to lead to a fragmented approach unable to maximise gains for the Australian community. Some Government involvement may be required to ensure the training market delivers as required for a properly function BIM market in Australia.

Deliverable 3.3: Encourage the inclusion of BIM as a collaborative technology for both professional education and vocational training in the tertiary sector by 1 July 2014.

Engage with tertiary institutions to the extent required for tertiary education to properly support a properly functioning market for BIM services across the Australian economy.

Some Australian Government involvement may be necessary to ensure consistent baseline BIM education for future graduates to enable them to function in a seamless Australian digital economy including integrated BIM and geospatial elements.

4.0 Implementation Strategy

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Work Program 4 – Product Data and BIM Libraries

Deliverable 4.1: Enable progressive access to an Australian library of generic BIM objects and information for manufactured products that comply with Australian BIM standards from 1 July 2013

The United Kingdom has recently provided free universal access to its National BIM Library. The objects in the Library are available in open standard and common proprietary software formats. They are generic objects able to be used for design modelling and would ultimately be substituted for digital representations of actual manufactured products in a construction-oriented BIM. The objects are designed to suit UK construction practice so will not necessarily be fully sufficient to suit Australian construction practice.

Australia will need to build its own BIM Library that enables access to generic Australian BIM objects and information for manufactured products that comply with Australian BIM standards from 1 July 2014. This will require collaboration with Australia's trading partners for development of a shared international BIM Library with Australian extensions to suit Australian construction practice. The library could extend to the conversion of existing 2D CAD briefing systems (for example the health facilities briefing system) to BIM models to facilitate lower cost design of health and other facilities.

International consistency of BIM objects would be preferable. Until such can be realised, it will be critical to the success of BIM that the Australian Government support the development of Australia-specific objects to maximise growth in the Australian BIM services market. In any case, there will be benefit in Australia further developing generic product information to include data required to facilitate simulation and analysis of energy efficiency, adverse weather event resilience and like issues required to optimise sustainability of Australian buildings. A market failure means that social investment of a generic product creator cannot be realised. There is hence a role for government in establishing a base library of objects that can maximise the utility of BIM processes for the Australian economy.

Work Program 5 – Process and Data Exchange

Deliverable 5.1: Develop industry protocols for information exchange to underpin BIM and collaborative practice by 1 July 2014.

Identify information exchange requirements and develop and incorporate them into industry protocols in collaboration with all affected sectors to ensure reliable communication between industry practitioners across the entire built environment lifecycle. Participate in development of international best practices through existing international forums, particularly through buildingSMART International.

This will be essential to ensure that building owners are delivered open standard information that will remain accessible and useable throughout the entire building life.

The current lack of standardisation does not provide the required incentive for industry participants to invest in the collaborative processes that will maximise the benefit of the use of BIM technologies. Process alignment will be necessary for Australia's international competitiveness.

Work Program 6 – Regulatory Framework

Deliverable 6.1: Coordinate activity between relevant sectors of the Australian economy to enable integrated access to land, geospatial and building information by 1 July 2014

Encourage an orderly transition to a digital economy in which industry participants are able to transparently access land, geospatial and building information from respective sources according to their needs. This will require agreement to ensure effort is not duplicated for building-related information and on protocols for BIM and geographic information systems (GIS) and respective information delivery mechanisms (for example, web services and related technologies)

4.0 Implementation Strategy

Facilitating ready integrated access to diverse land, geospatial and building information will deliver a major benefit to the Australian economy, significantly reducing current the administrative burden on developers who presently need to access information from many sources acting as silos – with much of the information transferred in manual form.

Australian Government involvement may be required to the minimum to encourage and/or regulate as required the information management approaches of the various information managers to ensure efficient interoperability approaches are followed to enable universal nationwide access to land, geospatial and building information.

Deliverable 6.2: Develop a model-based building regulatory compliance process demonstrator by 1 July 2015

A move to model-based consenting systems will be required if Australia is to realise its objective of becoming a world-leading digital economy by 2020.

There would be benefit in collaboration with New Zealand in preparing for this transition. New Zealand has set a nearer term target for achieving model based consenting systems.

Deliverable 6.3: Develop an implementation plan by 1 July 2015 for the transition of Australian regulatory codes and compliance mechanisms to model-based performance based systems

A priority would be to develop a strategic plan in collaboration with all affected Australian sectors for the eventual move to model based approval systems in support of the Australian Government's strategy to become a world-leading digital economy by 2020. This would be best undertaken in collaboration with ePlanning Australia.

4.3 National BIM Initiative Pilots

Source a number of pilots to demonstrate and validate the above identified deliverables. This would benefit the community through regular dissemination of lessons learned. There will need to be some support provided for clients to encourage their involvement.

Exposure of industry professionals and others to results of exemplar projects will accelerate take up of well designed collaborative BIM processes. Some Government support to assist with rapid uptake to drive innovation and performance improvement in the building and construction sector may be required.

5.0 Conclusions

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Whilst a significant sector of the economy employing over one million people and with annual GDP of 147 billion, the construction sector has historically and continues to have low levels of productivity. The construction industry - the built-environment - is the last sector to fully exploit the advantages of information technology.

The Mesh Conferences posed this challenge: **what barriers are preventing a greater use of BIM technologies in our support of a sustainable built environment?**

Rather than assuming the technology will percolate unguided through the industry, what must be done to accelerate the uptake of BIM technology in the national interest? The lessons from the current technology 2D CAD are clear: after 20 years there are no common guidelines, a decline has occurred in documentation quality, there is no consensus in either industry or government on standards and no process improvement.

This report highlights the need for industry and Australian Government to take a lead position in implementing a standard approach to BIM implementation on asset portfolios. While industry is working on a variety of BIM initiatives to address specific immediate needs, a co-ordinated approach with industry and Government collaborating to accelerate adoption of BIM would provide productivity benefits flowing to the entire economy.

BIM provides a vehicle for addressing the fragmentation of the industry and a platform for greater collaboration and information sharing across the entire construction supply chain.

It will be important to ensure that technologies and processes deployed throughout the built environment supply chain are able to deliver information in an open standard format so that an owner can be assured it will remain available throughout the life of a building. Participation in international activities focussed on the development of such technologies and processes will minimise the cost for Australia to successfully accelerate the adoption of BIM across the national economy.

6.0 References

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A International BIM Activity

The National Building Information Modelling Initiative (NBI) will represent a significant program of work for Australian industry and government that can build on extensive work already undertaken internationally by buildingSMART International and its many partner organisations. This work will require collaboration with the building and construction industry and the co-ordination of a number of initiatives currently being undertaken through a number of industry bodies and research organisations, both within Australia and internationally.

buildingSMART Australasia, established as an incorporated association under the laws of New South Wales, has access to each of the chapters of buildingSMART throughout the world and the work that each of them is undertaking in similar and related areas. buildingSMART Australasia is the only independent Australian body focused on the advancement of the technologies associated with digital modelling and the promotion of interoperable technologies through the adoption, promotion and development of Industry Foundation Classes as a universal language for electronic data exchange. It seeks to improve communication, productivity, delivery time, cost and quality throughout the planning, design, construction, operation and maintenance life cycle of buildings and infrastructure. buildingSMART represents the interests of all of the stakeholders in the Australian built environment industry - including clients, design disciplines, constructors and facility managers. It is well placed to co-ordinate the implementation of the step change required for the Australian built environment sector that includes a complex integration (nationally and internationally) of technology, process and skills through the supply chain and the life cycle of buildings and infrastructure.

A number of the key international BIM-related activities are set out below.

United Kingdom

The UK *Government Construction Strategy* was published in May 2011 and sets out goals for government works and the use of BIM by 2016, using a “Push Pull” strategy. The Pull by Government aims to be good at buying data (as well as assets and services), to do it consistently, yet leave the “How” to the Supply Chain. The Push by Industry or Supply Chain is informed by early warning to mobilise, time for re-training and is responsible for defining methods & documentation.

The Government has defined its specific needs in terms of an end-of-project deliverable in terms of asset management data, a Construction Operations Building information exchange (COBie) format spreadsheet (COBie-UK 2012), through the use of a Level 2 BIM model. The United Kingdom’s BIM Maturity Levels are set out below in Box A.1. A comparison between the Australian Institute of Architects BIM Maturity Model and the United Kingdom’s BIM Maturity Model is set out at Figure A.1.

A International BIM Activity

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An increasingly more detailed asset handover is projected as industry, software, and clients' asset operations mature.

In the United Kingdom, the Royal Institute of British Architects, BuildingSMART United Kingdom and Ireland's Chapter and the Knowledge Transfer Networks for the Modern Built Environment, a government initiative funded under the Technology Strategy Board, have come together to develop initiatives for promoting BIM in the construction industry.

NBS, similar to Australia's NATSPEC, have published a generic BIM Objects library (see Appendix C for more details) as a first step to improving object information in models.

Box A.1. United Kingdom BIM Maturity Levels

Level 0: Unmanaged CAD probably 2D with paper (or electronic paper) as the most likely data exchange mechanism

Level 1: Managed CAD in 2 or 3D format using BS1192:2007 with collaboration tool providing a common data environment, possibly some standard data structures and formats. Commercial data management by stand-alone finance and cost management packages with no integration.

Level 2: Managed 3D environment held in separate discipline building information modelling tools with attached data. Commercial data managed by enterprise resource planning software. Integration on the basis of proprietary interfaces or bespoke middleware could be regarded as 'pBIM' (proprietary). The approach may utilise 4D program data and 5D cost elements as well as feed operational systems.

Level 3: Fully open process and data integration enabled by 'web services' compliant with the emerging IFC/IFD standards, managed by a collaborative model server. (Could be regarded as integrated BIM potentially employing concurrent engineering processes.)

A International BIM Activity

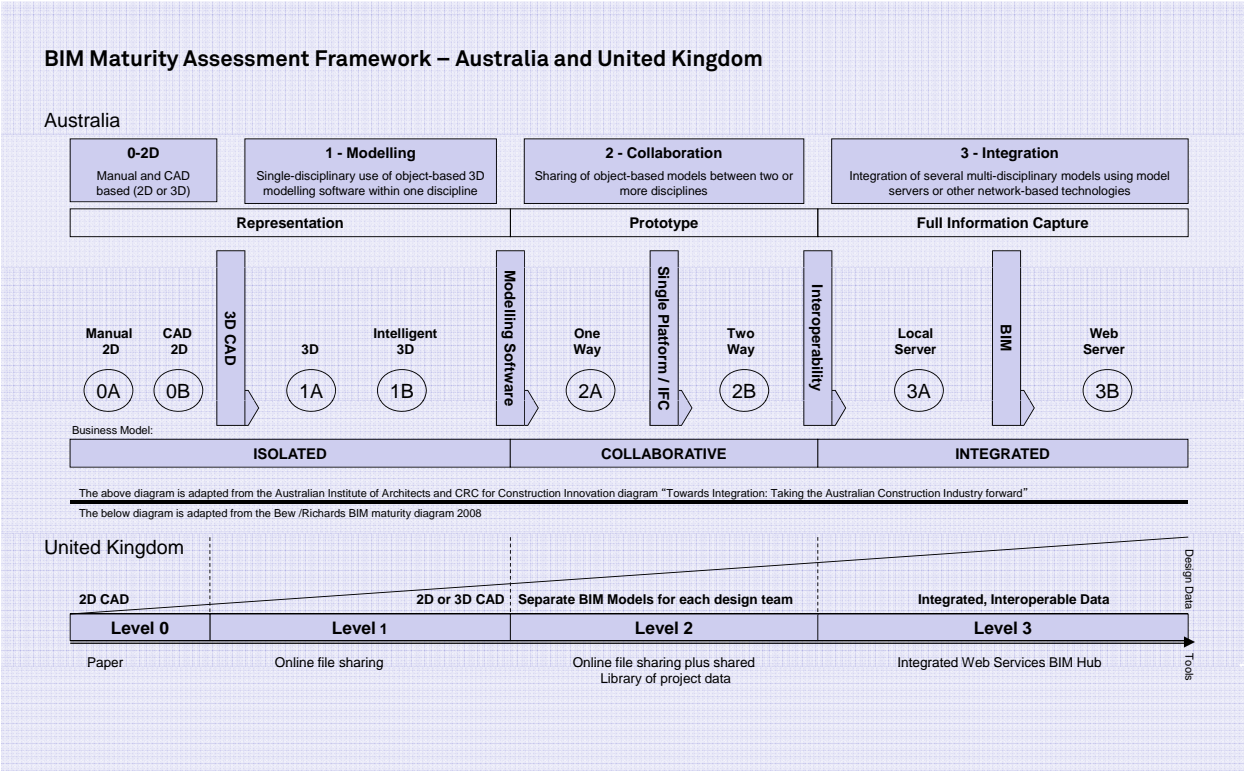


Figure 2: Comparison of UK and Australian BIM maturity levels

A International BIM Activity

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Singapore

The Singapore Government has established a Construction Productivity and Capability Fund (CPCF) of S\$250m, where BIM is a key component to the enhancement of the country's construction sector services.

Singapore in 2000, established the Construction and Real Estate Network (CORENET) program, a strategic initiative of the Ministry of National Development that aimed to drive transformation in the construction industry through the use of information technology. CORENET provides the necessary infrastructure for exchange of information among all parties in building projects, as well as the regulatory authorities.

The CORENET e-Plan Check system is a program that aims to encourage the construction industry in Singapore to use BIM. The program is fully funded by the government and is designed to move the construction industry from 2D design to building information models that are data rich and are used throughout the life cycle of the building from design through to construction and demolition. The system allows registered architects and professional engineers to check their BIM designed buildings for regulatory compliance through an internet gateway. Regulatory officers are also able to conduct audits on the building submissions. Using the e-Plan system via the internet a report is generated to highlight non-compliances; designers can also see their non-compliances graphically using the viewer. The system uses IFC specifications as the core model for e-Plan. Singapore has adopted the IFC as the standard for BIM implementation in the construction industry.

Finland

Senate Properties is a Government owned enterprise under the guidance of the Finnish Ministry of Finance and is responsible for managing the Finnish state's property assets and for letting premises. Senate Properties provides services related to premises, primarily to customers, which form part of the state administration. The building stock comprises university, office, research, cultural and other buildings with a total portfolio asset of 5.6 billion Euros. In 2001, Senate Properties carried out a number of pilot projects to develop and study the use of BIMs. Based on feedback, Senate Properties has decided to require models meeting the IFC standard in its projects as of 1 October 2007. The level of modelling required from 1 October 2007 is just the first step in going over to the broader use of models. The aim is to go over to all-embracing, integrated model-based operations in designing, building, and property servicing and maintenance in the next few years.

This year the Government published a Universal BIM Guide for industry which is being promoted across all parts of the facility development community.

A International BIM Activity

Denmark

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In 2007, Denmark's Government agencies; The Palaces and Properties Agency, The Danish University and Property Agency and Defence Construction Service have implemented the Digital Construction Program.³³ Combined total of assets managed through these agencies is approximately 5.5 million square metres.³⁴ The Danish Enterprise and Construction Authority established the program to increase and improved knowledge sharing between the parties of the construction sector, from the initial idea to the operation and maintenance of the finished construction project. The program requires that for projects above 5.5 million Euros, models need to contain various information levels that are exchanged using the IFC format. Within the program, a number of reports and guidelines have been developed in order to make it easier for the industry to fulfil the requirements and in general adopt the technology.

5.

Norway

Statsbygg acts on behalf of the Norwegian Government and is responsible for the construction, management and development of state owned property. Statsbygg manages approximately. 2.6 million square metres of floor space, in Norway and abroad. The portfolio consists of government and cultural buildings, colleges and public administration buildings, royal properties, embassies and diplomatic residences abroad.

In 2007, Statsbygg decided to use BIM for the whole life-cycle of their building and have mandated that by 2010 all the properties will use IFC/IFD based BIM.

United States of America

In 2003 the General Services Administration (GSA), through its Public Buildings Service (PBS) Office of Chief Architect (OCA), established the National 3D-4D-BIM Program. GSA owns, operates and manages more than 340 million square feet of space in approximately 8,700 owned and leased buildings across the United States. OCA has led over 30 projects in its capital program, and is assessing and supporting a further 35 ongoing projects across the nation.

GSA is committed to a strategic and incremental adoption of 3D, 4D, and BIM technologies. The next stage for GSA in BIM implementation is exploring the use of BIM technology throughout a project's lifecycle in the following areas: spatial program validation, 4D phasing, laser scanning, energy and sustainability, circulation and security validation, and building elements.

A International BIM Activity

36 For all major projects at the prospectus-level, receiving design funding in Fiscal Year 2007 and beyond, GSA requires spatial program BIMs be the minimum requirements for submission to OCA for Final Concept approvals by the PBS Commissioner and the Chief Architect. For architects and engineers working on these projects, this means that their concept design must be submitted to the GSA in both the native format of the BIM authoring application and as an IFC file. GSA is also encouraging projects to use more advance BIM technologies—spatial program validation and beyond—at strategic project phases in support of specific project challenges.

The GSA's current focus is to acquire open source Model Server technology to develop capability to store BIM models of assets owned by the Agency. This development is already established in Norway and is seen as the next logical step to holding and managing building asset data, becoming the base for more pro-active and evidence based strategic management of built facilities.

B

B BIM in the Geospatial Context

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1. BIM links with GIS through the VANZ Framework

During the buildingSMART forums conducted in Canberra and Melbourne representatives from the geospatial sector spoke about the work being undertaken to develop a Framework across Australia and New Zealand aimed at creating a set of laws, practices and web protocols to enable the creation of a 'realistic' computer model of the natural and built environment (above and below ground and inside and out), including all structures at 'engineering scale'.

Essentially, such a model will allow Government, industry and the community to see each building BIM in its full 'spatial' context, resulting a wide range of benefits that neither geospatial nor BIM alone can deliver.

Since the forums, building SMART has worked with VANZI Ltd and a range of key stakeholders to outline the Framework. The aim is to have a draft completed for consideration by Government and Industry in the latter part of 2012, with extensive consultation taking place through 2013. Stakeholders include the Property Council of Australia, Dial Before You Dig and ePlanning, amongst a range of others.

The work required to achieve a National Policy in regard to the VANZ Framework will complement that required to Implement BIM and, on the geospatial side, the proposed 'Australia and New Zealand Spatial Market Place'. Each supports the other.

VANZI Ltd is a 'not-for-profit' company set up by the CRC for Spatial Information (CRC-SI), the Victorian Partnership for Advanced Computing (VPAC), National Information and Communications Technologies of Australia (NICTA) and the Municipal Association of Victoria (MAV) for the express purpose of facilitating the development of the VANZ Framework across all jurisdictions within Australia and New Zealand. BuildingSMART has been invited to become a member of VANZI Ltd and to join the board.

Development of the VANZ Framework in conjunction with the National Road Map for BIM will facilitate the adoption of laws and web services protocols to protect privacy and security. This is seen as key to encouraging asset owners to 'publish' their geospatial and BIM data on the 'net' for use by authorised third parties for planning, design, construction, operation, leasing and sale. It is also vital to protecting the interests of all parties who want to rely on the data for 'transactional' purposes, such as briefing consultants, etc.

B BIM in the Geospatial Context

2. Benefits of Integrating BIM and GIS

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- _ Planners, owners, designers and engineers can see buildings in their full spatial and regulatory context - improving design outcomes.
- _ Infrastructure usage (power, water, transport, etc) can be simulated within a 'real-world' context – enhancing understanding by allowing all key stakeholders (government and private) to participate in the development process from concept through rapid prototyping, design, engineering, and construction – to achieve better quicker outcomes.
- _ First responders can easily locate the source of an emergency within a building (victim, fire, criminal incident, etc) - by having it precisely geo-referenced within the model by the person reporting the incident
- _ Transport/Courier companies can trace routes direct to load/unload points inside a building (warehouse, or office tower, etc)
- _ Enhanced Privacy and Security - by ensuring access to data is linked to title and contractual rights of access that flow from ownership (e.g. via delegation to lessee, or architect, or contractor, etc) – ensuring a secure environment for all property related transactions.
- _ Storm, Flood, Fire and Earthquake Risks can be modelled with greater assurance, enabling authorities to better plan and regulate development (including specific building construction) and later using dynamic models to assess performance against regulation.
- _ Insurers are better able to assess risks in their 'spatial' context, leading to reduced premiums and faster claims processing
- _ By establishing the principles of one data set for each asset and access based on rights in the real world, each asset owner can reduce their costs by keeping only their own data up to date. All the other data they need to construct a full model of the land, building and services that surround their own assets can then be lawfully accessed from other asset owners through the VANZ Framework – saving the costs of data duplication and greatly reducing errors.
- _ With a single 'statutory' data set, utilities can ensure the quality of their data is continuously improved through feedback from any third party who discovers a discrepancy between the 3D model and the actual location of their assets (such as underground pipes, ducts, conduit etc) reducing errors and costs over time in maintaining and managing their assets.
- _ Architects, Engineers, Builders and Trades can more easily and more reliably locate underground services – with improving accuracy over time (as the data quality is improved through built-in correction processes) – avoiding design errors, data duplication and lost time
- _ Financiers are better able to understand developments in their spatial context speeding approval and reducing costs
- _ Approval processes can be increasingly automated where each building is geo-referenced to a 3D cadastre and related regulatory overlays.
- _ Objections and Disputes can be more easily resolved where the proposed building can be viewed in its 'real world' spatial context.
- _ Real Estate Agents can also use the BIM in its spatial context for leasing and sale



C Stakeholder Consultation

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This appendix contains a record of the key ideas and inputs that came out of the stakeholder consultation workshops run in Sydney, Melbourne, Brisbane, Hobart, Adelaide, Perth and Canberra in March and April 2012. As such, it represents the collective input from over 260 key industry and government participants across all the major jurisdictions in Australia.

The record has been grouped into the six initiatives that were identified by buildingSMART at the MESH Conferences held in 2010. These were used at the Workshops to focus the discussion.

The information has been aggregated under three headings for each initiative: identified advantages should the initiative be pursued; issues and questions that were raised in the workshops; and current activities that were identified by workshop participants. Each initiative is introduced by a summary statement that seeks to capture the key idea that lies behind it.

Apart from its clear reporting purpose, this record serves as a primary resource that identifies all the matters that must be considered when undertaking the work programs proposed as part of the National BIM Initiative.

This record was distributed both in its original form and in a refined form (in response to some initial feedback) to all workshop participants for clarification and further input. As such, the record in this appendix captures all that feedback and will continue to evolve as a record of the views of key industry stakeholders across Australia. A key element of the stakeholder consultation workshops was the identification (by participants) of activities to be undertaken in pursuit of each initiative. These activities were identified as required Work Programs in the first two distributed drafts, but have now been taken out of this appendix and are separately developed in the National BIM Implementation Plan.

It is important to note that there were no dissenting voices in the feedback, but rather a range of clarifying statements and additional ideas.

1. Procurement

It was widely recognised that BIM-based collaboration requires a cultural shift both within and outside an organisation, and that the key to achieving that change is recognition that risk can be mitigated through better provision of information prior to construction and that significant speed and cost advantages can be achieved through contracts that are based on mutual trust and shared risk.

There is a recognised need for government and other major clients to take the lead in this, promoting the development of new forms of contract that support collaborative, model-based procurement processes (sometimes collectively referred to as IPD, integrated project delivery) and provide appropriate mechanisms to manage risk, IP, insurance and warranty requirements.

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1.1 Advantages

- _ Measurable improvements in time and cost
- _ Shared risks and reward (no blame)
- _ Single project insurance policies ... reduced insurance premiums
- _ Getting the right partners to collaborate ... early engagement of all stakeholders ... encouragement of innovation
- _ Integrated project delivery operating ... collaborative environment encouraged by properly structured contract arrangements
- _ Reduction in rework and variation ... more certainty in cost of buildings to clients
- _ Reduced litigation in the building industry

1.2 Issues & Questions

- _ Who leads procurement change? Government + 'big end of town' to collaborate ... role of APCC (Australian Procurement and Construction Council)
- _ Recognise and value the cost of productivity shift / investment
- _ Educating clients about 'model-based' deliverables and how they can better define their procurement requirements – a client 'Bill of BIM Rights'
- _ Identify and managing uninsurable risks ... insurers overcoming fear of covering other design team members ... identifying insurance risks profile changes (What is insured; projects or individuals. Sharing risks – bigger client responsibility & government)
- _ Government participation in managing and subsidising risk – leading to early adoption
- _ Building trust – changing attitudes - persuading stakeholders to shift current thinking/processes
- _ Existing legal framework – copyright laws – ownership of intellectual property - standard IP / copyright licence agreements to facilitate BIM
- _ Existing legal framework – representing data appropriately to avoid “passing off” infractions for proprietary data, eg COLORBOND® steel vs generic pre-painted steel has significantly different sustainability credentials in some areas.
- _ Team with pertinent knowledge available... managing responsibilities of each discipline ... each consultant must take ownership of their design – and paid accordingly for efforts
- _ Contractual environment – 'line in sand' needs to be blurred to promote more collaboration
- _ Traceable review process required of the model
- _ BIM model should capture design intent/philosophy
- _ Develop working principle guidelines to raise practitioners' awareness of issues ... support this with suggested standard clauses for items such as defining the allowed/legal uses of different types of models, disclaimers, statements of limitation, etc.
- _ Life cycle benefits need to be recognized in procurement/tender metrics: lowered environmental impact of buildings; more cost effective buildings
- _ Integrated practice - a form of engagement for the consultant team with specific deliverables for the substance and quality of the model: requirement for the contractor to use the documentation model as the basis of a construction model which will be used to

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- 44 create an 'as built' model; terms of engagement for the consultant team that precisely defines the outputs required and the collaborative behaviours needed to enable the development of a useful model for asset management
- _ Formalise verifiable information exchange requirements
 - _ New construction method – more manufacturing & assembly than on-site construction
 - _ Ownership of the model ... identify and manage copyright contribution >> acknowledgement - who owns the BIM and the data that goes into it?
 - _ Reverse brief: i.e. design begins at demolition stage

1.3 Current Activities

- _ Consult Australia, Australian Institute of Architects - BIM Group (National BIM Steering Committee) - Legal and Procurement working group
- _ Who: AIA, Consult Aust, Arup, WB, Lend Lease, RLB, Corrs Chambers, Planned Professional Risk Services, Hassell
- _ Deliverable: guidelines for BIM teams, possibly procedures, forms of agreement etc.
- _ Beneficiaries: clients, consultants, contractors, subcontractors
<http://www.consultaustralia.com.au/Home/Advocacy/PracticeProcurement.aspx>
http://www.consultaustralia.com.au/Libraries/Contracts_Liability/Forum_Report_Alliance_Contracting.sflb.ashx
http://www.consultaustralia.com.au/Libraries/Contracts_Liability/Submission-VIC_Alliancing_Guidelines_-_13_Dec_2010.sflb.ashx
- _ Architects Professional Risk Services (national company) – developing a collaborative agreement (Multi-Party)
<http://www.architecture.com.au/i-cms?page=1.13262.165.4429.12515>
http://www.architecture.com.au/emailnews/Policy&corporate/Guiding_Principles.pdf
- _ Mitchell Brandtman (Quantity Surveying and Construction Risk Management Services) and Holding Redlich Lawyers – collaboration to develop Australia's first BIM contracts
<http://www.mitbrand.com/assets/documents/PDF/Presentations/MB%20Position%20Yourself%20for%20the%20Recovery.pdf>
- _ Vanzi Ltd (plus government & industry partners): project to develop VANZ legal framework and web services architecture (combining BIM and geospatial) to support 'true to life' computer model of natural and built environment with virtual 'Capital City' as pilot
<http://www.vanzi.com.au/node/3>
<http://www.slideshare.net/cybera/cloud-lessons-learned-case-studies-bill-appelbe-victorian-partnership-in-advanced-computing>
- _ Hindmarsh – SAMHRI (South Australian Health and Medical Research Institute). This is an ecologically sustainable development currently on target for a gold rating in Leadership in Energy and Environmental Design (LEED)/

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- <http://www.hindmarsh.com.au/construction/index.php?type=1&state=SA&project=100>
- <http://www.sahmri.com/upload/2011%20Annual%20Report.pdf>
- _ HYLC Joint Venture – The current collaboration between Hansen Yuncken & Leighton Contractors to design and construct the new Royal Adelaide Hospital – A Green Initiative; that focuses on water conservation, energy efficiency and indoor environment quality. It will be one of the most technologically advanced hospitals in Australia.
http://www.sahp.com.au/index.php?option=com_content&view=frontpage&Itemid=1
- _ Kerry London, RMIT, Melbourne – Organising virtual conferences exploring and re-developing legal and regulatory aspects for BIM. Currently working on a book based on Legal and Construction practices.
<http://www.tg80.org/>
<http://www.tg80.org/20120109minutes.pdf>
- _ ACIF/APCC – Integrated Project Teams
www.acif.com.au

2. BIM Guidelines

It is widely accepted that we need to have standards and guidelines that facilitate the adoption and application of BIM across the AEC sector in support of integrated practice. This will ensure a smooth transition to a collaborative approach to the design, documentation, delivery, construction and maintenance of built facilities.

A key to this is the adoption of open BIM information exchange standards and IFC is clearly the most advanced option available, as long as BIM software vendors across the sector provide consistent compliance with that standard in all model imports and exports.

2.1 Advantages

- _ Encourage the industry to change from litigation / fragmentation to a culture of open sharing of information and multi-skilled collaborative working practices
- _ Consistent, codified means of creating building models ... roles, responsibilities and processes defined
- _ Accessibility of information – integration of info – one point of contact – freedom of data – ease of use
- _ Improved design process ... managing information from cradle to grave
- _ Improved building performance – life cycle sustainability and a quality built environment
- _ Improved productivity across the AEC sector .. vertically integrate product supply chain
- _ “Plug & play” models for clients ... client confidence in the model ... BIM becomes a valid and authoritative representation of the product

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2.2 Issues & Questions

- _ Definition of what BIM is – what do we actually want when requiring BIM
- _ Guidelines for (1) project setup, (2) protocol & procedures
- _ A single guideline document is not feasible because of the diversity of project circumstances and users' needs. A more realist structure would be a series of 'modules' that could be assembled as appropriate. A consistent, coordinated approach to terminology, style, format and organisation, and careful definition of the scope of each would facilitate this.
- _ Need for open standard for data exchange (not rely on proprietary solutions) ... technology barriers to achieving seamless interfaces.
- _ Need for continuous monitoring and updating of guidelines / standards (ongoing funding / overseeing committee of experts)
- _ Change should be gradual ("crawl before you walk") ... begin with minimum and evolve from there.
- _ An Australian-focused model progression specification (MPS): model content plan; consistent terminology but not overly prescriptive
- _ Guidelines & standards must be consistent with global equivalents (to support international practice)
- _ Need for scalable guidelines so small jobs don't get bogged down
- _ Issue of scope: national / state / local ... national coordinating role to facilitate a common approach
- _ Essential that guidelines and standards do not stifle or restrict innovation
- _ Need coordinating body that is comfortable with managing an information business - would need input from key stakeholders
- _ Need for Government to lead the way by mandating BIM for all government-owned properties – all buildings to be procured and maintained / operated using BIM (what level of BIM?) ... other clients need to follow.
- _ Pace of industry versus pace of standards
- _ Resolving IP issues when sharing information ... copyright and warranty laws take in to account BIM
- _ Vendor restriction due to market dominance ... need co-operation of competing platforms
- _ Modelling with a view to supporting downstream processes ... the impact of that information not existing or being incorrect
- _ Adopt a classification protocol (e.g. Uniformat, Natspec, etc) to ensure building model quality

2.3 Current Activities

- _ NATSPEC guidelines (BIM Guide & BIM Management Plan) have been well-received and adopted across the industry, providing a sound basis for further work
<http://www.natspec.com.au/index.asp>
- _ Efforts by CITB to educate and support industry standards, as well as adaptability to current industry changes including the recent 'Introduction to BIM' course.
<http://www.citb.org.au/>
- _ CRC CI National Guidelines – was an excellent first step and a good reference source

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http://www.construction-innovation.info/images/pdfs/BIM_Guidelines_Book_191109_lores.pdf

- _ Australian Steel Institute is encouraging industry to implement integrative data transfer procedures to assist construction processes and ultimately improve steel documentation for buildings. Focus on “buildability” to establish better detailing of designs to enable more efficient quoting ... generally referred to as “construction BIM”
<http://steel.org.au/key-issues/building-information-flow>
- _ ANZRS – Revit User Group – proprietary standards and guidelines; alignment with UK BIM (Revit) Standard; building information structured in a virtual format
<http://www.anzrs.org/blog/>
- _ RICS (UK) – Developing with industry / academia NRM (New Rules of Measurement) --- collaboration with AIQS in Australia. This publication aims to establish greater consistency in the measurement of buildings.
<http://www.rics.org/nrm>
- _ AMCA Australia initiative – BIM-MEP AUS proposes smarter IPD workflows and promotes collaborative BIM projects
<http://buildingsmart.org.au/Warwick%20Stannus.pdf>
- _ US AIA E2 American Institute of Architects - working to highlight the importance of “information” in BIM, integrated practice, the adoption of open standards and providing guidelines on BIM processes
<http://www.aia.org/index.htm>
<http://network.aia.org/centerforintegratedpractice/home/>
- _ Mitchell Brandtman (Quantity Surveying and Construction Risk Management Services) – web site provides list of recommended local and international guidelines:
http://www.mitbrand.com/advocacy/guides_specs/
- _ Key national current projects in the health sector using various levels of BIM – Royal Hobart Hospital, Royal Adelaide Hospital, Princess Margaret Hospital for Children (Perth)

3. Education and Pilot Projects

There was universal support for the development of BIM education across the entire construction sector, at both the tertiary level (university undergraduates and TAFE colleges) as well as among practitioners ranging from tradespeople on the work site through to professional consultants and clients. Furthermore, the focus of that education should range from BIM awareness, across the development of technical skills and knowledge, through to an understanding of BIM as a collaborative working tool.

3.1 Advantages

- _ Learning silos demolished across AEC disciplines in professional courses, placing BIM at the core of multidisciplinary learning and practice, leading to integration across the learning disciplines – same for TAFE and universities
- _ Graduates with a clear understanding of multi-disciplinary practice and team working ... graduates BIM ready ... including non design

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- 48 students (PM, FM, BM) ... integrated units required in all construction industry courses that bring IPD into later stages of programs
- _ All levels of business / industries understanding what BIM can deliver ... BIM is not just a technology but a process and a tool
 - _ Common understandings (no need to hold these workshops!) ... uniform adoption and consistent guidelines and work practice ... teams who understand project goals
 - _ Innovation resulting from sophisticated virtual model – move away from craft-based practice – mirrors technology cf. iPad impact

3.2 Issues & Questions

- _ BIM must be integrated into education courses, not standalone, across all disciplines ... disciplinary education delivered in a collaborative BIM context (potential to sit in others roles) ... introduce BIM 101 at every course in the industry sector
- _ We should also aim to foster collaboration between geospatial and BIM professions within each organization – particularly for ‘planning’ courses.
- _ Requires universal adoption – high school / trades / universities / TAFE’s / vocational education & training ... all involved in the building industry – down to the trades on site ... educate the end users and the instigators ... education of regulatory bodies
- _ Should be treated as another competency - need a framework for professional capabilities to feed into curriculum and PD programs ... different levels of understanding / confusion as to what it means to be ‘doing BIM’ ... need for a register of accredited practitioners – consistency, QA, regulation, required by industry bodies
- _ Need to recognise the new roles that are emerging in industry which will require new qualifications with accreditation and certification, e.g. BIM Modeller: by discipline or expertise, BIM model project co-ordinator, BIM manager, visualisation modeller, design modeller, construction modeller, FM modeller, model maintainer, fabrication modeller
- _ Need to address the range of related generic and specific software knowledge and skills, knowledge management, network and model server data management
- _ Global working – need same work practices
- _ Decision makers are embedded in the past compared to the young graduates ... dealing with 2 tiers - older decision makers versus the younger technology users ... young users don’t have the content knowledge to put into BIM
- _ Question around who provides assurance of education outcomes (challenge: should this be an international accredited body?)
- _ Mid-career training – don’t lose existing resources ... cost of re-education, including time ... investment is recognised - drop in productivity upfront for longer term gain
- _ Take up of new technologies - youngest sector - identify a young person to be champion
- _ International acceptance so Australia can sell their BIM services
- _ ‘BIM Storm’ competitions ... design competition for integrated BIM project including supply chain

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- _ Good trainers – are they out there? Capacity in the disciplines
 - enough people to educate? Retraining the educators – CPD for educators
- _ Resourcing – Government in its culture change management program
- _ BIM has been “research” now needs to move to current practice
- _ Develop a vendor neutral curriculum framework - adopt framework (IMAC-Illustration:Manipulation:Application:Collaboration) for collaborative education using BIM (based on an ALTC funded project at UniSA) ... different software may confuse training curriculum
- _ Need to drive cultural change through education - resistance to change ... revolution not evolution in roles ... promotional opportunity: still lack of awareness
- _ Need to get everyone to same level of BIM understanding ... overcome ignorance and fear ... expanded training needs to include more than just BIM documentation
- _ Threat to those who have BIM skills as a ‘competitive advantage’
- _ Articulate the full range of BIM potential and benefits (clients, end-user, government)... BIM accepted as the common method and not just a choice
- _ Need to ensure commitment to sub-contractor early
- _ Challenge of keeping up to date with rapid changes in technology and processes ... mobile applications
- _ University faculty structure as an impediment to implementation ... inflexible courses and structures
- _ Professional bodies must include BIM / collaborative working criteria in accreditation of university courses

3.3 Current Activities

- _ BIM Education Working Group of AIA / Consult Australia: a framework for BIM learning and a position paper for discussion
http://www.consultaaustralia.com.au/Libraries/Media_Releases/BIM.sflb.ashx
<http://www.architecture.com.au/i-cms?page=1.13262.13289.13527.14980>
- _ CITB Awareness Seminars – three different levels – Basic (multi-disciplinary trade professions) – already developed and are being run. Intermediate / Advanced to be developed
<http://www.citb.org.au/Employer/WorkPlacementRegistration/tabid/272/Default.aspx>
- _ UNISA, UTS and Newcastle universities are working on an Australian Learning and Teaching grant “Collaborative building design education using Building Information Modelling.” 2011-2012.
<http://www.olt.gov.au/project-collaborative-building-design-education-using-building-information-modelling-2010>
- _ University of Newcastle research papers >> Conference ARCOM Edinburgh (UK) September 2011 >> 2 papers looking at potential for BIM in regional context: focussing on Tasmania as case study, Associate Professor Graham Brewer presenting AGC (US) BIM Certification
http://www.buildingsmartusa.com/AGC_BIM_Certification.html
- _ Constructing Excellence (UK) - Construction Industry Council (CIC)
<http://www.constructingexcellence.org.uk/>

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- _ FMA Aust - NFEE (COAG)+industry stakeholders - matrix of competencies and training for everyone involved with management, operation and maintenance
 - _ CFMEU – Providing training for the industry by the industry
<http://www.cfmeuvic.com.au/training>
 - _ Plumbing industry
http://www.ppigroup.com.au/documents/PC-3-2010_BIM_Cover%20story.pdf
<http://www.plumbingregulators.org/resources/Oberoi.pdf>
 - _ Department of defence (US)
<http://www.facilitiesnet.com/software/article/BIM-A-Wealth-of-information--5389#>
http://www.tricare.mil/ocfo/_docs/BIM-UFC-RequirementDetails.pdf
 - _ AMCA – Intermediate specialist contractor – upgrade from technical drafting to use of BIM models – BIM Webinar “BIM – Taking the initial steps”
<http://www.amca.com.au/>
 - _ Alliancing Association - Seminar series
<http://www.a3c3.org/>
 - _ WoL BIM LCA of products and buildings; Who: Ecospecific global GreenTag; Deliverable: Seminars; Beneficiary: Industry – specifiers, procurement, FM
<http://www.ecollect.com.au/>

4. Product Data and BIM Libraries

It is widely recognised that a major impediment to the widespread adoption of BIM is the lack of access to BIM-compatible product information in an open format that is properly specified, fit for purpose and can be correctly integrated into the project model. This creates the need for a universally-accessible library of BIM objects, complete with embedded performance and specification data that is warranted by the manufacturer, and provided in a neutral format compatible with all proprietary BIM software. This is a critical enabler for full lifecycle performance analysis, effective supply chain integration and facilities management.

4.1 Advantages

- _ Consistent access to product properties & performance
- _ Increase accuracy of BIM models throughout life cycle
- _ Potential reduction in risk & RFI's ... increased productivity
- _ Ready access to diverse range of specifiable products
- _ Opportunity to streamline the supply chain, allowing sub-contractors to build relationships with suppliers that facilitate smoother construction processes
- _ All new products brought to the market are BIM ready (i.e. any content created should conform to a National Standard) and better able to be incorporated in to the procurement process ... encourages innovation
- _ More reliable performance analysis...including life cycle assessment
- _ Design for manufacture .. better integration of products in to designs
- _ Product information will be internationally compatible

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4.2 Identified Issues & Questions

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- _ Who will take ownership of the library and host it? Options are: individual manufacturers; Government (National, State or Local undecided); and not for profit organisation(s).
- _ Do we need to use a creative commons licence?
- _ Take advantage of existing work in this area, both local and international
- _ Need to work towards a common international solution, aligning our work with international efforts in this area
- _ Need to persuade product manufacturers of advantages ... product manufacturers need assurance that their data will be appropriately represented and utilised – they need to see the advantages for their products.
- _ Providing technical content versus marketing content ... a suggested approach would be that manufacturers be left to market as they please outside the BIM library and that they direct prospective customers to the library, but that the library itself contain only technical information.
- _ Environmental product declaration (EPD) for all products – LCA (life cycle assessment) and LCI (life cycle inventory)
- _ Must be able to handle parametric models
- _ Concept should be extended to integrate land parcel data, survey and planning information
- _ Need for automated update sync of product data and error control to maintain the integrity of the data
- _ Identify appropriate server technology to host library
- _ Establish 'Google-style' library structure – semantic Web ... requires agreed defined terms, controlled language and thesauri.
- _ Must handle life cycle of building: representations for briefing, specification, manufacture, installation and maintenance (vary the level of detail and provide support for supply chain integration) ... need to support performance based and proprietary methods of specification.
- _ Accommodate change in product throughout usage life of building, even if supplier goes out of business
- _ Cost implications for small product manufacturers and suppliers
- _ IP and legal liability issues (royalties?) ... “passing off” legal concerns for proprietary data associated with branded products from manufacturers.
- _ Adopt iterative development approach ... work with stakeholders to identify 80/20 opportunities, where 80% benefit can be achieved for 20% of the time or effort
- _ Need to get local and international BIM vendors on board ... a significant issue for imported products is likely to be compliance with local industry standards.
- _ Manufacturer's Perspective ... need to ensure that the following issues are addressed:
 - _ Consistent, agreed format of data required
 - _ Types of data to be included in libraries – define mandatory and optional information to be included
 - _ Governance process around data:
 - _ Engineering validation of data, eg for BCA requirements

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- _ Industry-specific validation of data, eg peer-review by accredited organisations for green claims such as LCI, solar reflectance, etc. This will become of increasing importance as BIM is used for energy modelling. The market competition in this space is growing rapidly.
 - _ Ensuring that minimum data requirements and standards are upheld. Companies should be required to offer full disclosure to an agreed set of categories, not just the ones that they look good in.
 - _ Legal governance around use of data. Legal requirement not to “pass off” data for one product as representative for another. BIM should encourage innovation for sustainability, but this can only be done if products are differentiated and not allocated a “one size fits all” approach.
 - _ Initiative 3 talks about “reliable (certified) product data embedded in open BIM libraries” – the concepts of reliability and certification are critical to success in this area.
 - _ For manufacturers to release branded (generally higher performing) product data, generic data must also be available for commodity items in the market so that designers aren’t encouraged into illegal acts of “passing off”.
 - _ A manufacturer’s forum should be held to clarify these issues and determine a way forward to gain consensus
 - _ It will be difficult to get buy-in from manufacturers until a clearer representation of the data requirements/possibilities is given. Currently we do not have this information.
 - _ In addition, it is difficult for manufacturers and fabricators to buy into BIM fully unless there is a very good link between the design of a building and construction / fabrication. Currently designs often do not facilitate accurate quotation by fabricators, which results in them pricing themselves out of the market due to risk. The Australian Steel Institute (ASI) is working in this area (see reference current activities for Initiative 2).

4.3. Current Activities

- _ Sustainable Built Environments National Research Centre (SbeNRC) at QUT – current project on Interoperable Object Libraries
<http://www.sbenrc.com.au/research/driving-productivity-through-procurement/collaborative-object-libraries-supporting-the-facility-lifecycle>
- _ ANZRS (Australia New Zealand Revit Standards) - ANZ Content Standards for developing ‘Families’ and best practice. Alignment with UK BIM (Revit) Standard
<http://www.anzrs.org/blog/>
- _ BIM MEP AUS – initiative by AMCA Australia (Air Conditioning and Mechanical Contractors’ Association of Australia)
http://www.bimmepaus.com.au/home_page.html
- _ Google/Microsoft data server internationally set up: all–industry and product supplied
<http://www.microsoft.com/en-au/server-cloud/readynow/default.aspx>
<http://www.google.com/about/datacenters/inside/index.html>

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- _ NBS UK generic library project – BIM Store providing free-to-use standard BIM content to the construction industry
<http://www.nationalbimlibrary.com/>
- _ FR AIMCC (Building product industry association) is leading Building Product Data and is currently working towards quality, regulatory & voluntary efficiency of these building products
<http://www.aimcc.org/>
- _ BuildingSMART International – ‘Product Room’ provides support for worldwide integrated BIM processes, in line with the International Framework for Dictionaries (IFD)
<http://iug.buildingsmart.com/product-room>
- _ COBIE / SPIE – US Army Corps and the Specifier’s Properties Information Exchange are developing a standard framework of objects for information exchange. This framework requires objects to adhere to specification, codes and standards including the National Building Information Modelling Standard (NBIMS)
<http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA491932%26amp;Location=U2%26amp;doc=GetTRDoc.pdf>
<http://www.nibs.org/client/assets/files/fmoc/2008-01-18-SpecifiersPropertyProject.pdf>
- _ ACCEL – James Hardie – on-line product information portal with downloadable content for Revit & ArchiCAD
http://www.accel.com.au/about_accel_home.php

5. Process and Data Exchange

There is widespread recognition of the need for business process changes to facilitate integration of the briefing, design, construction, manufacturing and maintenance supply chain throughout the entire life of a built facility, achieved through effective exchange of BIM-based data and information. A methodology is required to achieve collaboration and communication between client, designers, consultants, constructors, product suppliers/manufacturers and facility operators.

5.1 Advantages

- _ Better able to articulate value proposition by linking projects and programs of work to clients/users business drivers. Client driven early engagement in projects enables business needs to be integrated into better management of supply chain from inception to completion/handover and operations of the facility.
- _ Collaboration within AND across organisations (leading to more innovation) ... cooperation supported by structures that support sharing
- _ Use of collaborative lean process to increase productivity and reduce waste (current process: 95-98% Lead time = “waste”)
- _ Smarter, faster and more efficient .. right first time ... harmonious contracting
- _ Consolidated process (one database in real time) ... BIM will drive process / management change
- _ Implement on all sizes of project, not just large multi-million \$ projects

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5.2 Issues & Questions

- _ Requires a universal acceptance of BIM ... thoughtful integrated BIM strategy and lifecycle understanding of all aspects and stakeholders in the building supply chain and the impact of all decisions on those stakeholders
- _ Need for high level of engagement by management, not just by technicians ... internal high level motivation and commitment leadership
- _ Need to develop collaboration models (communication, standard template, understanding of terminology) ... identifying specific information content ... development of information exchange protocols ... live data collaboration / transparency through whole process
- _ Improve model quality to facilitate use of BIM in other business applications such as whole of life operations and maintenance of facilities.
- _ Break down barriers between disciplines by encouraging trust and collaboration
- _ Strong, strategic, BIM Execution Plans ... step by step change manual with assessment at the start and measurement at the end
- _ Examine new technology/processes to optimize gains both within firm & among project consortia
- _ Need for legal framework to recognise 'statutory' data that represents each object, with the rights and obligations that attach to it essentially mirroring those that relate to the object itself.
- _ Need for common data standards, e.g. COBie2 & IFC ... standards must be in place before government will adopt
- _ Need software vendors to support effective information transfer between proprietary applications
- _ Who is responsible for managing change process and how is that risk managed?
- _ Recognition of up-front cost loadings delivering project long benefits
- _ Cultural change will be critical within business – e.g. flatter reporting structures
- _ Need good Industry examples – case studies
- _ Challenge: achieving recognition, at all levels of industry, of the time / cost associated with implementing BIM on project
- _ Opportunity: recognising that BIM will result in savings throughout the life of a project
- _ Respect for each discipline domain knowledge – integration of the building industry
- _ What happens to the 'gatekeepers'? Local government, planning agencies – where do they enter and exit? and community?

5.3 Current Activities

- _ BuildingSMART International – process definition: “Process Room” initiative
<http://iug.buildingsmart.com/process>
- _ Seganto and Stacey (Air Conditioning Engineers and Contractors, Qld) – identified as using 100% digital information flow using BIM – automation and accuracy, minimise double handling of info, improved delivery times, reduce error costs
<http://www.sigstac.com.au/>

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- _ AMCA – supply chain integration and process definition
<http://www.amca.com.au/>
- _ Change Agents (Melbourne based company): BIM Excellence tool to assess capacity to do BIM – applied to individuals, organisations, projects and project teams. It aids in facilitating collaborative BIM processes.
<http://www.changeagents.com.au/Services.htm>
- _ Vanzi Ltd (plus government & industry partners): project to develop VANZ legal framework and web services architecture to support ‘true to life’ computer model of natural and built environment (combining BIM and geospatial) for use in all property related processes
<http://www.vanzi.com.au/node/3>
<http://www.slideshare.net/cybera/cloud-lessons-learned-case-studies-bill-appelbe-victorian-partnership-in-advanced-computing>

6. Regulatory Framework

It is widely agreed that a key benefit of BIM, as well a strong force for its accelerated adoption, is the development of automated building design performance assessment and compliance checking based on the object-based information models that are developed through BIM processes. In order to achieve maximum benefit, BIM needs to be extended in to the geospatial domain, so that models can be tested within a virtual urban and regulatory context.

This initiative is heavily connected to and dependent on all the other initiatives: the need for BIM standards and guidelines, including BIM model and data exchange certification procedures; reliable (certified) product data embedded in open BIM libraries; resolution of various legal & procurement issues; and education and training to ensure building models are appropriately constructed to support automated assessment.

6.1 Advantages

- _ 3D BIM model (including all ‘properties’) could be legally relied upon in design process (as an accurate representation of the design), much as the physical object is relied on during facilities procurement
- _ Buildings more fit for purpose through transparent view of project requirements (shared through the BIM) and confirmed satisfaction of code and standards requirements (measured using the BIM)
- _ More cost effective buildings in terms of both design and operation: decrease downtime due to re-works; decrease cost/compliance utilisation
- _ Acceleration of design/approval/compliance process ... more compliant buildings, more widespread compliance
- _ Independent, third party peer review/auditing - no vested interest, product substitutions ... transparency of processes
- _ Development of a suit of “Deemed to Comply” BIM solutions that could be certified by relevant authorities within the BCA performance based framework.

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- _ Rule-based checking of models against codes for compliance (BCA, NABERS, Greenstar, SAA, Codes), cf. Singapore BCA
 - _ Automated building certification – BIM model tested in virtual space ... better information will lead to targeted policy (based on accumulated evidence)
 - _ Quicker understanding of impacts of one set of requirements on another ... achieve a higher level of compliance with less compromises of the desired outcome
 - _ Opportunity to simulate serviceability and safety aspects of infrastructure maintenance for risk management purposes - e.g. Plumbing regulations

6.2 Issues & Questions

- _ Designs are traditionally certified for regulatory compliance on the basis of design drawings and specifications – as we move to a BIM-based certification regime, there may need to be procedures in place to ensure that the BIM properly represents the design ... some kind of security 'lock' on the BIM, as well as the individual product components within it ... essentially like "warranty"
- _ Building codes and cited standards are regularly being updated. Operation and maintenance costs of these systems can be a significant issue. It is essential that the platform for this type of system can be readily and reliably updated in response to changing regulations without its custodians (e.g. ABCB) requiring highly specialised programming skills.
- _ If process is automated, someone must review all aspects and provide final approval of the model ... may need a BIM certification scheme to confirm the quality of the model or the person who created it – similar to TNO BOUW system
- _ Liability - who is responsible for accuracy of data? Who is ultimately responsible for the model?
- _ National standards need to account for regional differences (e.g. climate) ... products are often international and no easy way to get legal compliance across national/states ... various certifications, depending on circumstances
- _ Linking of data that may not be in BIM environment
- _ Authorities have to be certain that data in model is 'trusted' ... legally defensible ... opportunity to exploit (rich) BIM models
- _ Integration with GIS / planning constraints and also servicing ... Councils must have all information accurately in their systems ... Intelligence based on location & building type
- _ Different BIM capabilities of stakeholders ... number of different people involved
- _ Compliance standards for different stages of the project & applications
- _ Crossover of issues, leading to conflicting performance requirements ... how to incorporate design approval into the process?
- _ Need to harmonise data and methods across software vendors in terms of capabilities and processes
- _ Allow for future processes & improvement on current processes
- _ Need for a common data classification – such as COBie2 – to ensure a complete nomenclature that includes interiors and components

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6.3 Current Activities

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- _ Design Check (completed 2005): CRC CI, ABCB, CSIRO - proof of concept, checking against AS1428. For designers, certifiers, consultants, authorities and design specification writers. It is a tool used for compliance checking against building codes
<http://eprints.qut.edu.au/27224/1/27224.pdf>
- _ Global GreenTag product certification: Ecospecifier P/L and Global GreenTag P/L - BIM based WoL product certification integrated into GreenStar and product rating bronze, silver, gold, platinum and ecopoints, Green building professionals, clients, consumers
<http://www.ecospecifier.com.au/our-services/greentag-certification.aspx>
- _ NZ Department of Building & Housing – have investigated adoption of BIM for consenting (NZ term for “code checking”) in their earthquake recovery program
<http://www.dbh.govt.nz/UserFiles/File/Reports/quake-dbh-cti-final-report.pdf>
- _ BASIX pilot (deliverable from the UrbanIT project at UNSW) – demonstrating BIM data required to automate assessment of BAIX compliance on a residential project.
http://buildingsmart.org.au/national-conference-sep09-presentations/PlumeBartonMitchell_UrbanModelling.pdf
https://www.basix.nsw.gov.au/docs/thermal_comfort/tc_pilot_procedures.PDF
<http://buildingsmart.org.au/John%20Mitchell-%20NTIP%20conclusion.pdf>
- _ Emerging tools such as Solibri Model Checker: commercial product - model checking software – define own rule sets. For designers, contractors, FM, code compliance checking
<http://www.solibri.com/>
- _ Emerging VANZ Framework to link the unique data sets (that each specify an object in the real world) via a web services architecture - with access protocols backed by legislation that are tied to ownership and contractual rights in the real world. This will allow authorised users to download all the data they require to model their property in its ‘spatial’ context – while protecting privacy and security.
<http://www.vanzi.com.au/>
- _ Qld Government (Project Services, Queensland) – TAFE Summer School BIM Course - Multi-discipline
<http://www.projectservices.qld.gov.au/home/home.asp>
<http://training.qld.gov.au/resources/information/pdf/skills-plan-evaluation-report.pdf>



D List of Workshop Participants

60 The National BIM Initiative Project Team thanks all those persons listed below who have contributed to the National BIM Initiative either through participation at the workshops held in March and April 2012 in Adelaide, Brisbane, Canberra, Hobart, Melbourne, Perth and Sydney, or through the development of the work programs.

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