





## About ACIF

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The Australian Construction Industry Forum (ACIF) is the meeting place for leaders of the construction industry in Australia. ACIF facilitates and supports an active dialogue between the key players in residential and non-residential building, engineering construction, other industry groups, and government agencies.

Our members are the most significant Associations in the industry, spanning the entire asset creation process from feasibility through design, cost planning, construction, building and management.

ACIF also provides a number of resources for the industry, including twice yearly release of the ACIF Forecasts, the industry's 'compass' to the demand for work over the next decade.

ACIF is focused on creating a competitive construction and property industry that is a leader in building Australia's prosperity. As well as facilitating communication between the different interests that make up the construction sector, ACIF provides governments and other agencies with a central and efficient industry liaison point.

ACIF harnesses the energies of its members to provide leadership and facilitate change within the industry, to increase productivity, efficiency, research and innovation. ACIF is governed by a Board of Directors comprising senior practitioners and chief executives of its member organisations. A secretariat supports the Board and the working groups tasked with developing policies and productivity tools.

ACIF seeks to develop a successful, strong and sustainable construction industry in Australia.

**For more information about ACIF,  
visit [www.acif.com.au](http://www.acif.com.au)**

## About APCC

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The Australasian Procurement and Construction Council Inc (APCC) is the peak council whose members are responsible for procurement, construction and asset management policy for the Australian, State and Territory Governments and the New Zealand Government. Papua New Guinea is an associate member. The APCC is made up of 15 member agencies.

Over the past 47 years, the APCC has established itself as a leader in government procurement, construction and asset management strategies and practice. The work of the APCC is committed to procurement innovation, solutions and efficiencies designed to create savings and maximise service delivery to the communities of Australia, New Zealand and Papua New Guinea.

The APCC promotes a cohesive government procurement environment and manages national projects for the Council of Australian Governments. It harnesses the benefits of nationally consistent approaches for its members.

The projects within the APCC are multi-faceted and collaborative. Each project has a dedicated Working Group, which progresses the aims, with support from the Directorate. The Working Groups meet regularly by teleconference, face-to-face and online.

The APCC community is made up of individuals with a wealth of skills and expertise. Collectively, it represents the hub for procurement excellence. Experts from each member jurisdiction collaborate on projects, creating a knowledge network.

**For more information about APCC,  
visit [www.apcc.gov.au](http://www.apcc.gov.au)**

**For a current list of ACIF and APCC Members, please see page 55**

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### Strategic Forum for the Australasian Building and Construction Industry

#### An ACIF and APCC initiative

The Strategic Forum is a unique body that brings together key stakeholders in the Australasian building and construction industry. The Forum acts as an entry point and significant interface between government and the building and construction sector. It facilitates positive change and encourages greater productivity. Above all, it acts as a national forum to network and discuss issues that affect the industry.

This Forum is an entry point to facilitate joint pathways for improving building and construction industry productivity in Australasia. By working together to do this, we engender and encourage trust between the government and industry sectors.

# Acknowledgements

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This Framework was developed by select members (or their representatives) of the Australian Construction Industry Forum (ACIF) and the Australasian Procurement and Construction Council (APCC). The Working Group comprised the following representatives:

- Teresa Scott and Jane Montgomery-Hribar, Australasian Procurement and Construction Council
- Peter Barda, Australian Construction Industry Forum
- Carolyn Marshall, Department of Finance, WA
- Chris Kane, Ministry of Business, Innovation and Employment, NZ
- David Eynon, Air Conditioning and Mechanical Contractors Association
- Robin Schuck, Consult Australia
- Nicholas Burt, Facility Management Association of Australia
- Chris Canham, Constructions & Infrastructure, Lend Lease, representing the Australian Institute of Building
- John Mitchell, BuildingSMART Australasia
- Sam Collard, BIM Academy, Northumbria University and representing Consult Australia
- Dan Jurgens, National BIM Manager, Cox Architecture, representing the Australian Institute of Architects

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## Thanks to ACIF Principal Sponsor

As one of Australia's largest industry super funds, Cbus is the proud Principal Sponsor of ACIF.

Established in 1984, Cbus is now one of Australia's leading industry superannuation funds for workers in the building, construction and allied industries.

Cbus' support makes it possible for ACIF to create sources of information, develop knowledge tools, and guides, to boost the productivity of the industry.



Construction & Building Industry Super

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## Recommended Further Reading

At the time of release of the Framework, recommended further reading was restricted to materials developed by the above people and organisations, and other material that was deemed current and relevant to the development of this Framework.

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# I. Executive Summary

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Construction industry participants in Australia and New Zealand strive for efficient and effective project development, execution and completion. *The Framework for the Adoption of Project Team Intergration and Building Information Modelling* (the Framework) has been prepared by a joint working group of the Australian Construction Industry Forum (ACIF) and the Australasian Construction and Procurement Council (APCC) who are acutely aware of the need for optimal delivery outcomes that eliminate waste, maximise end user benefits, enhance industry participants and also increase the productivity of the Australian and New Zealand economies.

Productivity in the construction industry is critical to Australia's growth and the economy. The building and construction industry accounts for 7.8% of Australia's gross domestic product (GDP), and employs 9.1% of the workforce. The industry contributed \$99.4 billion to the Australian economy in the 2011–12 financial year.

At the end of June 2012, the building and construction industry generated \$305 billion in total income, incurred \$275.4 billion in total expenditure, and employed 950,000 persons<sup>1</sup>.

A study by the Allen Consulting Group found that accelerated adoption of Building Information Modelling (BIM) would increase GDP growth in Australia by 0.2 basis points in 2011, by 2025, it was estimated that GDP growth would be 5 basis points higher. And also that the benefit cost ratio of early adoption of BIM would be around 10 (assuming a \$500 million adoption cost)<sup>2</sup>.

These statistics provide clear evidence of the benefits and productivity gains achievable through the adoption of BIM.

The construction sector is the fifth largest sector in the New Zealand economy. It employs over 170,000 people: 7.6% of the workforce. In 2010 it generated 6.3% of GDP (nominal)<sup>3</sup>. As yet, there are no hard facts available for benefits in New Zealand derived from BIM use, although several case studies are in progress at the time of printing. Indications are that benefits similar to those expected for Australia would also accrue in New Zealand.

In Australia and New Zealand the awareness of Building Information Modelling is high and the drive for productivity is facilitating increased integration and collaboration of project teams. However the commitment to and use of BIM with Project Team Integration (PTI) is still relatively immature compared to other countries.

There is a compelling reason for industry to encourage and support increased adoption of PTI and BIM. A 'whole of industry' commitment can be a powerful facilitator of change. Ongoing collaboration between government and industry could support the progress of BIM and generate substantial construction efficiencies and facilitate quality whole of life outcomes.

For Australia and New Zealand to achieve maximum benefits from the adoption of PTI and BIM, a number of activities need to be addressed.

The ACIF and APCC have identified seven key elements, underpinned by objectives and actions, that industry together with government could pursue to encourage and support increased adoption of PTI and BIM.

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<sup>1</sup> Australian Bureau of Statistics, 27 June 2013

<sup>2</sup> Allen Consulting Group, *Assessing the Impact of Building Information Models*, 2010

<sup>3</sup> MBIE Sectors Report: "Construction", November 2013, ISSN 2324-5077 (online)

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These are:

- People: Behaviour and Capability
- Procurement and contracting
- PTI/BIM protocols
- Asset management
- Information exchange and National Object Library
- Standards
- Technology

A summary of these objectives and tasks required for achievement is contained in the following table.

Elements and objectives	Proposed activities
<p><b>People: Behaviour and Capability</b></p> <p>To raise awareness of the organisational cultural, behavioural and capability changes needed to achieve the adoption and implementation of Project Team Integration (PTI) and Building Information Modelling (BIM) in the built environment.</p>	<ul style="list-style-type: none"> <li>■ Organisational culture, behaviour and capability change needs to be lead and driven from senior level.</li> <li>■ Organisations need the required cultural and personnel/skills - hire new staff and/or retrain existing staff - and a commitment to training and education of PTI and BIM.</li> <li>■ PTI/BIM industry champions need to be identified to inspire and lead industry.</li> <li>■ Experienced industry practitioners and trainers of PTI and BIM need to be targeted to share their knowledge and experiences within organisations and across the industry.</li> <li>■ Organisations need to be encouraged to establish mentoring programs and in house training from experienced and capable team members.</li> <li>■ Education and training needs to occur across the entire construction sector and targeted at different levels i.e. secondary study, undergraduate, practitioners' site and office personnel (including at the strategic level).</li> <li>■ Education and training courses on PTI and BIM need to be 'practical' with the skills being easily and readily applied on projects.</li> <li>■ The delivery of education and training programs need to facilitate a common understanding, consistent guidelines and work practice for the adoption of PTI and BIM.</li> <li>■ All PTI and BIM education, training and learning needs to result in transferrable skills and knowledge.</li> <li>■ Web based training needs to be accessible by all of the construction industry and supported by employers.</li> <li>■ Recognition that BIM education facilitates collaboration between project participants of all disciplines and across all project lifecycle phases.</li> <li>■ Skills in true Design Management in order to optimise available uses of BIM to leverage improved outcomes.</li> <li>■ Successful project outcomes require the selection of the 'right' project team members.</li> <li>■ Best practice methods and procedures of PTI and BIM on projects needs to be captured and integrated into learning and training courses.</li> <li>■ Professional bodies should refresh their accreditation criteria in line with the industry need for graduates to be skilled in the principles of PTI and BIM. The utilisation of accreditation criteria can facilitate an incentive for academic institutions to consider changes to their course curricula.</li> </ul>

# Executive Summary

Elements and objectives	Proposed activities
<p><b>Procurement and Contracting</b></p> <p>The adoption of procurement delivery models and contractual arrangements that removes ambiguity within the project team integration environment and takes advantage of the opportunities afforded by model based collaboration.</p>	<ul style="list-style-type: none"> <li>■ A well-informed client who knows what they want out of BIM.</li> <li>■ The dismantling of traditional barriers or silos of effort.</li> <li>■ Early engagement of facilities management professionals at the design and planning stage to minimise overall operational lifecycle costs of the asset/facility.</li> <li>■ Preparedness to lengthen contract negotiations and start them earlier giving greater consideration to risk, cost, time, management and roles and responsibilities. However this is likely to be a short term concern due to market immaturity.</li> <li>■ Comprehensive contractually binding BIM Management Plans including, where appropriate, client and asset/facility management obligations. This Plan should be completed jointly by a project owner representative, design team and contractor (depending on the procurement methodology adopted) to ensure necessity and achievability of requests.</li> <li>■ Undertake auditing of the deliverable at agreed milestones to ensure what is provided aligns with the BIM Management Plan.</li> <li>■ Include data ownership rights and responsibilities in contract documentation.</li> <li>■ Discuss and resolve indemnity and limited warranties and disclaimers of liability before BIM is used.</li> <li>■ Establish a consistent approach to contracts and protocols that is scalable (short version for small projects and a comprehensive contract for larger projects), and develop at the earliest project stage possible.</li> <li>■ Project owner to specify constructible BIM modelling and datasets with interoperability data exchange standards deliverable, for example Industry Foundation Classes (IFCs).</li> <li>■ Development of an Australian Standard Contract for PTI incorporating a BIM LOD authoring Framework.</li> <li>■ Understand the legal, intellectual property and insurance requirements required in a collaborative environment.</li> <li>■ Further develop national templates, content and standards. Refer to the Standards Chapter for further information.</li> <li>■ Review contractual framework developments from around the world to establish current best practice thinking and how it can be applied to the Australasian context.</li> <li>■ Development of a set of Conditions of Contract for Project Team Integration which incorporates the key BIM inputs to the BIM Management Plan.</li> </ul>



# Executive Summary

Elements and objectives	Proposed activities
<p><b>PTI/BIM Protocols</b></p> <p>To assist project sponsors and project team leaders to understand and address the cultural and behavioural change needed and the obligations required for optimal outcomes from the adoption of PTI and BIM.</p>	<ul style="list-style-type: none"> <li>■ Share responsibility for the successful delivery of a project including identifying the Building Information Models that are required to be produced.</li> <li>■ Commit to achieving the client’s project objectives and put into place specific obligations, liabilities and associated limitations on the use of the models.</li> <li>■ Clarify and manage commercial issues such as protection of Intellectual Property Rights (IPR) from infringement, legal issues and security concerns.</li> <li>■ Establish agreement for process and data exchange including security of the data model, data sovereignty, use of Cloud based services.</li> <li>■ Participate in data sharing - addressing confidentiality, data security; setting adequate user rights to prevent data loss or damage during file exchange, maintenance, and archiving; authorised uses of the data; identifying clear ownership of the model elements throughout the project life-cycle; transmission, use, storage and archiving the data.</li> <li>■ Integrate team members at the early design stages.</li> <li>■ Facilitate particular ways of working – such as the adoption of a common naming standard.</li> <li>■ Establish a collaborative project environment and culture (trusting relationships, strong leadership).</li> </ul>
<p><b>Asset/Facilities Management</b></p> <p>That asset/facilities management professionals become integral participants in the design and planning of all buildings.</p>	<ul style="list-style-type: none"> <li>■ A contractual obligation (clause) binding on all parties from initiation of a built project for the development, transfer and maintenance of an asset register across the asset life cycle. The clause also needs to define the roles and responsibilities of individual parties.</li> <li>■ The asset/facilities management industry must define data sets and information asset register outcome requirements to enable the transition from design and construction to operation in a BIM environment.</li> <li>■ Establishment of an Open Object Library to ensure ‘endurance’ of access, to information pertaining to the operating parameters which will potentially extend the asset life and allow for reuse and recycling of equipment at asset end of life.</li> <li>■ Develop an industry wide understanding of PTI and BIM asset/facilities management skill requirements and provide the necessary training.</li> </ul>

# Executive Summary

Elements and objectives	Proposed activities
<p><b>Information Exchange and National Object Library</b></p> <p>Information about building and infrastructure asset elements, such as building fabric or building services or furniture and equipment, necessary for the design, construction, operation and management life cycles, is shared in a common format, across all participants in the asset/facility development and management sector.</p>	<ul style="list-style-type: none"> <li>■ Establishment of a National Object Library system to be stewarded by NATSPEC as the authoritative national Information Broker for product information. This vision is shared by New Zealand, however it is yet unclear who will host the library.</li> <li>■ Develop a business plan to implement an Australian National BIM Library with appropriate resourcing and funding, including evaluating collaboration with NBS UK to share potential use of the UK BIM Library, and technology development cooperation to enhance availability of digital product data.</li> <li>■ In Australia, liaise with CIL, NZ, to arrive at an aligned trans-Tasman business model.</li> <li>■ Engage product manufacturers (particularly in specialist domains) to work with BIM users developing supply chain sector specific object libraries.</li> <li>■ Engage the product manufacturing industry as part of the adoption of the BIM journey in the Australian and New Zealand construction industry.</li> <li>■ Engage globally on object library Standards developments (for example ISO, COBie, bsDD, SPie etc) where it suits our national interests and to exploit and expedite the potential of BIM.</li> </ul>
<p><b>Standards</b></p> <p>The establishment of a collaborative work environment where all participants operate in the same context; automation of supply chains to achieve greater industrialisation and productivity within the construction industry, and; to ensure the Australian and New Zealand construction industry is compatible and competitive in the global construction sector.</p>	<ul style="list-style-type: none"> <li>■ National adoption of ISO and related BIM Standards across the Commonwealth, and all States and Territories.</li> <li>■ In Australia, adoption of the NATSPEC guidelines as a national standard.</li> <li>■ Adoption of open formats to ensure data access for an owner over a building's life.</li> <li>■ Development of digital standards for key supply chains, e.g. AMCA BIM-MEPAUS.</li> <li>■ Development of a Standard for the asset/facilities management industry on data sets and information asset register outcome requirements to enable the handover from design and construction to operation in a BIM environment.</li> <li>■ Links to ISO and global BIM developments.</li> </ul>
<p><b>Technology</b></p> <p>Australia and New Zealand construction industry to be competitive on the international stage, particularly in the Asia-Pacific region.</p>	<ul style="list-style-type: none"> <li>■ Industry to demonstrate the potential and readiness of BIM technology and project teams by undertaking pilot projects to display the benefits of BIM. 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.</li> </ul>

## 2. Introduction

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### 2.1 Purpose

**“This document responds to the increasing need for new, more effective approaches to project delivery that will transform building and construction industry practices and greatly assist in optimising project outcomes for clients.”**

The ACIF and APCC identified a fundamental gap in the coordination and national focus on the adoption of PTI and BIM. Whilst pockets of valuable work are underway in Australia and New Zealand, it has, to date, been a fragmented approach.

This Framework is designed to guide and assist industry stakeholders in the adoption and implementation of PTI and BIM. Members of both the APCC and ACIF support the key design and process changes and the opportunities available to deliver greater value for money project outcomes offered by the uptake of PTI and BIM where appropriate.

As agencies in each jurisdiction are proceeding at their own pace, it is beyond the scope of this Framework to recommend or suggest uniform strategies for jurisdictions or private sector clients to adopt BIM more widely. What is apparent though, is that there is an increase in adoption. Due to its ultimate efficiencies and cost, reports on the use of BIM globally and in Australia point to its growing adoption by designers and constructors as a tool. It is likely that once the initial investment in systems and skills is made, BIM models and their use will be offered as a competitive advantage by early adopters, and eventually as a matter of course by all firms who wish to continue as suppliers.

**The Framework seeks to enhance awareness of the changes needed to achieve optimum benefits from the adoption and implementation of PTI and BIM in the built environment.**

It is acknowledged that this Framework is a subset of a broad and dynamic digital economy for the construction industry, providing the potential for significant change in the way in which the construction industry currently operates and performs. The use of technology to connect all aspects of the built environment as part of a digital economy is increasingly achievable with the rollout of the National Broadband Network (NBN) and the amplified use of Cloud technology. Similar activity is occurring in New Zealand with the Ultra Fast Broadband (UFB) rollout.

There are many elements to the successful adoption of PTI and BIM and to achieving optimal PTI and BIM enabled project outcomes. This document describes the necessary elements, their interconnected relationships, and what should occur to enable accelerated adoption of PTI and BIM.

ACIF and APCC believe that the powerful combination of modelling and analysis tools of BIM together with the integrated collaborative processes of PTI can be significant contributors to the achievement of excellent project outcomes. We envisage that as the adoption of PTI and BIM accelerates with time, it will inspire more advanced and innovative project adoption and outcomes. We trust this Framework will assist in this important journey.

# Introduction

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## 2.2 Agreed definition of PTI and BIM

PTI is a project delivery approach that encourages clients to engage a team (including design consultants and building contractors) at the earliest stages of a project to enhance the level of integration between them. PTI is a process to facilitate integration and encourage collaborative behaviour and harness the talents and insights of all participants, as well as to reduce waste and optimise project outcomes through all phases of design, fabrication, construction, project handover and facilities management. PTI principles can be applied to a variety of contractual arrangements.

In the context of this Framework the accepted definition of BIM is that described by BuildingSMART Australasia as “a digital representation of physical and functional characteristics of a building”. As such it serves as a shared knowledge resource for information about a building, forming a reliable basis for decisions during its life-cycle from inception onward. However it is acknowledged that civil and infrastructure projects will equally benefit from BIM adoption.

The other term commonly used is Integrated Project Delivery (IPD). IPD takes PTI a step further in advocating for a delivery strategy built around IPD. IPD is a contractual framework which works on the premise that all project participants share the risk and reward of the project outcomes, generally tied to financial performance metrics.

In summary, PTI is the **process**. IPD is one possible end state or **result** of work to integrate the project team.

## 2.3 Greater potential when PTI and BIM are twinned

The higher the level of integration of project team members at the early design stages the greater the opportunities to get maximum benefit from the use of BIM.

BIM is a very effective tool that promotes project collaboration through clearer, more accurate, up-to-date communication by consolidating currently disparate project information, allowing all team members to contribute to the establishment and population of the databases underpinning the planning, design, construction and operation of the asset<sup>1</sup>.

At the same time the use of BIM assists PTI by dissolving the barriers between project team members through the sharing of knowledge and closer collaboration throughout the project lifecycle.

The powerful combination of PTI and BIM can significantly reshape the way project teams work together to increase productivity and improve outcomes for all project participants. Utilised together, PTI and BIM are capable of driving the most transformative change the building and construction industry has ever experienced.

## 2.4 The journey

BIM is shaping the way the Architectural, Engineering and Construction (AEC) industry and its associated professions will work for years to come.

No one shape or size fits all. Some companies have been involved in the implementation of BIM for over ten years, others for much less.

Figure 1 below illustrates the stages in the implementation of BIM as companies move towards integration. The journey starts with the movement from 2D CAD to 3D modelling

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<sup>1</sup> ACIF and APCC *The Case for Project Team Integration 2014*

# Introduction

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with different disciplines increasingly working collaboratively. The initial stages take place in-house but then opportunities arise to integrate information from other consultants, contractors, sub-contractors and others who are working on the same project. The final stage is integration, with full information capture for the project. Many companies in Australia and New Zealand are currently in the 3D modelling and collaborative stages<sup>2</sup>.

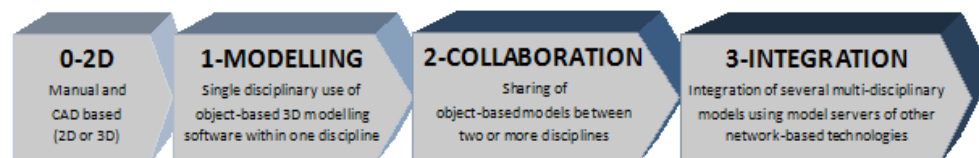


Figure 1 Towards Integration – extract from *Implementing BIM* Source: Australian Institute of Architects and CRC for Construction Innovation

Full integration maximises the potential benefits from PTI and BIM adoption and is a whole of industry journey.

## 2.5 Scale and shape of the market

**“Utilised together, PTI and BIM are capable of driving the most transformative change the building and construction industry has ever experienced.”**

Productivity in the construction industry is critical to Australia’s growth and economy. The building and construction industry accounts for 7.8% of Australia’s gross domestic product (GDP), and employs 9.1% of the workforce. The industry contributed \$99.4 billion to the Australian economy in the 2011–12 financial year.

At the end of June 2012, the building and construction industry generated \$305 billion in total income, incurred \$275.4 billion in total expenditure, and employed 950,000 persons.<sup>3</sup>

The construction sector is the fifth largest sector in the New Zealand economy. It employs over 170,000 people: 7.6% of the workforce. In 2010 it generated 6.3% of GDP (nominal)<sup>4</sup>. As yet, there are no hard facts available for benefits in New Zealand derived from BIM use, although several case studies are in progress at the time of printing. Indications are that benefits similar to those expected for Australia would also accrue in New Zealand.

In Australia and New Zealand the awareness of BIM is high and the drive for productivity is facilitating increased integration and collaboration of project teams. However the commitment to and use of BIM with PTI is still relatively immature compared to other countries.

Indications are that the construction industry in both Australia and New Zealand is recognising the value of BIM and are increasing their BIM investments. Recent research shows that by the end of 2015, 74% of firms report that they will be engaged in BIM on more than 30% of their projects<sup>5</sup>.

Currently the evidence also suggests that there are varying levels of BIM adoption among design professionals and leading contractors; however the gap is expected to close over the next two years.

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<sup>2</sup> Extracts from Consult Australia, AIA & Autodesk, *BIM in Australia – report of BIM/IPD forums 2010*

<sup>3</sup> Australian Bureau of Statistics, 27 June 2013

<sup>4</sup> MBIE Sectors Report: “Construction”, November 2013, ISSN 2324-5077 (online)

<sup>5</sup> McGraw Hill Construction *The Business Value of BIM in Australia and New Zealand: How Building Information Modelling is Transforming the Design and Construction Industry 2014*

# Introduction

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## 2.6 What are governments' proposing?

The members of the APCC are working towards the following:

- That Government agencies should consider adoption of BIM for major projects (noting that the definition of 'major' is at the discretion of each jurisdiction therefore variations are expected in regards to possible thresholds);
- When adopting BIM on the project, consideration should be given to the procurement strategy implemented for the project; and
- At completion of any BIM enabled government project, clients should be requiring a 3D view of the asset with embedded data and materials for use across the asset life cycle.

## 2.7 What is industry proposing?

The industry is committed to delivering assets efficiently, with required levels of quality and performance, and within cost limits set by its clients. It is prepared to consider, where appropriate, the needs of particular projects, adopt new ways of designing, constructing and commissioning assets. This is clear from the private sector's involvement in and drive of initiatives including BuildingSMART Australasia, and the development of this Framework and its related initiatives.

BIM and its innovation help meet Project Team Integration, offer considerable opportunities for reducing wasted effort, encouraging collaborative working, minimising disputes, and for aligning of the objectives of the many different organisations that typically make up project teams.

Different parts of the industry are working towards wider adoption of BIM software and practice in design, project site buildability, commissioning, and asset management. Design professionals are investing heavily in required technology and training. Trade contractors, particularly engineering services and structure trades, are doing likewise.

The industry's professional bodies are working towards setting agreed national competency standards for people working with BIM software and management systems. Others are working hard to populate object libraries to make design faster and more efficient.

However, industry is but a servant of those who commission new assets or decide to refurbish existing ones. It will adopt new technology and systems when its clients demand them. It will willingly explore innovation in procurement, including early appointment of contractors to project teams with the intention of better integrating those teams, when its clients require it.

Industry and individual firms of designers and other consultants, constructors, trade contractors and suppliers, are committed to working with representatives of clients and individual project sponsors to achieve wider and more effective adoption of BIM, of Project Team Integration, and to deliver better asset performance over the life of assets.

**The adoption of PTI and BIM is a journey. Both ACIF and APCC recognise this and we envisage that as it grows with time it will inspire more advanced and innovative use. We trust this Framework will assist in this important journey.**

## 3. Why are PTI and BIM important?

### 3.1 Benefits of using PTI and BIM

Optimal project outcomes are achievable and greatly assisted by the adoption of PTI and BIM. Numerous examples in the UK and the USA - as well as Australia - demonstrate the significant benefits and opportunities that BIM can provide in respect to innovation, productivity, cost and waste reduction.

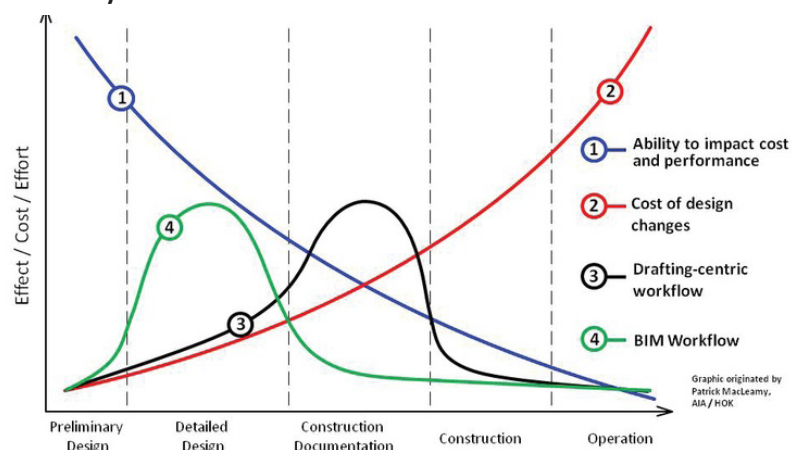
The more effectively a team is integrated the better it can perform to deliver project sponsors greater value for money outcomes together with end users expectations being met or exceeded. The full benefits of BIM will not be realised without a project delivery mechanism that facilitates integration of all project team members.

The Australian and New Zealand construction industry recognises that collaboration among project team members in the construction industry is a good thing – it drives team work. It is a vital input to efficiency and productivity gains, reduction in wasted effort, risk and minimisation of disputes on construction projects.

The adoption of BIM with PTI can produce excellent results and have far reaching and substantial benefits extending to every stakeholder involved in the design, construction, maintenance, management and use of the building.

**“The sophistication of the data provided by BIM is a powerful tool to enable facilities managers to more efficiently operate and maintain an asset and extend the life of an asset.”**

MacLeamy Curve



Graphic originated by Patrick MacLeamy AIA/HOK

The red line demonstrates the ease of making design changes versus the cost of making design changes over the project lifecycle.

The black line indicates that on traditional, non-BIM projects, the largest proportion of design, documentation and planning effort is usually expended during the late Design Development phase and the Construction Documentation phase when the cost of design change is greater.

The blue line represents the ability to control cost and performance. At the beginning of the project there is greater flexibility – at a lower cost – to facilitate design variations. As decisions are made, it progressively reduces the number of options available, thus increasing the cost of variations.

The higher the level of integration of team members at the early design stages, the greater the opportunities to gain maximum benefit from project team collaboration and cooperation.

BIM is also a key to driving greater productivity from the industry supply chain offering opportunities to improve productivity through efficient data exchange, standardisation and off site fabrication.

# Why are PTI and BIM important?

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The expected benefits from the use of BIM and PTI include:

- lower project cost;
- more streamlined project management;
- better quality outcomes; and
- more efficient lifecycle management due to access to more accurate data.

BIM provides predictability as essentially the building is constructed twice: first through the virtual build, second physically on site. Therefore BIM has the ability to proactively resolve design limitations before they impact upon construction. It also provides a level of 'comfort' for the supply chain in respect to design proofing, early detection and resolution of clashes between construction components and cost savings.

BIM also encourages innovative practices together with productivity, time and quality gains which can be harvested at every stage of the project delivery process without inhibiting competition or transparency. The full benefits of BIM are reaped when BIM is integrated into the day-to-day workflow from feasibility to asset/facility management. The sophistication of the data provided by BIM is a powerful tool to enable facilities managers to more efficiently operate and maintain an asset and extend the life of an asset.

International competitiveness is 'real' as we trade in a global economy. Increased adoption of BIM offers valuable opportunities for Australia and New Zealand including the potential to export our design and construction services to the developing world.

The future of the construction industry in Australia and New Zealand can be transformed through the adoption of BIM and PTI, which can drive substantial productivity improvements, expand business opportunities and encourage investment; in turn boosting both economies.

## 3.2 BIM – Return on Investment (ROI)

It is widely acknowledged that the advent of BIM is transforming the process by which buildings and infrastructure are designed and constructed. However the perceived high initial cost of implementing BIM has deterred many industry professionals from adopting the technology.

Contractors in nine of the world's top construction markets using BIM report BIM helps them to improve productivity, efficiency, quality and safety on their projects, as well as their own competitiveness<sup>1</sup>. Further, contractors in markets with well-established BIM, together with those markets that are still in the initial stages of BIM adoption, are experiencing a positive return on their investments in BIM.

The Australian Government Productivity Commission Inquiry Report into Public Infrastructure released in July 2014 suggests: *Given the potential savings from BIM, government clients should consider provision of initial designs in a BIM format when the project is of sufficient complexity to provide for lower construction costs and the selection of the lowest 'whole of life' design option.*

The data available to date suggest that the adoption of BIM is a sound investment and that the ROI metrics are principally financial, to reduce cost, to produce higher profitability and higher productivity. Furthermore, these are supported by other ROI metrics including fewer Requests for Information (RFI's), less unplanned changes, reduced

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<sup>1</sup> McGraw Hill Construction *The Business Value of BIM for Construction in Major Global Markets Smart Market Report 2014*



# Why are PTI and BIM important?

errors and omissions, reduced project delays, reduced rework and increased collaboration by project sponsor and project teams.

It is suggested that BIM Performance Metrics can assist both the new and experienced BIM users to track their ROI and measurement of the benefits derived from BIM to enhance an organisation’s BIM processes and productivity and efficiency over time.

The data shows a positive differential or a net gain from BIM projects.

## Returns from Non-BIM to BIM

Metric	Unit	Non-BIM	BIM	Non-BIM vs. BIM
RFIs	Quantity/tool	6	3	3
Change orders	% of standard project costs	12%	7%	42%
Schedule	% behind standard schedule	15%	5%	67%

Source: *Automation in Construction Volume 24, How to measure the benefits of BIM – A case study approach*, Barlish & Sullivan, 2012

### 3.3 BIM Performance Metrics

While acknowledging the benefits of BIM as a means of increasing productivity, its use needs to be assessable if the improvements are to become apparent. The development of BIM performance metrics is a critical requirement for BIM performance improvement. For example, an overriding measure needs to be total cost of ownership across the life of the building.

Also, BIM performance metrics will enable teams and organisations to assess their own competencies in using BIM and/or compare them against an industry benchmark.

It is important to develop metrics and benchmarks for BIM performance assessment that are consistently accurate and adaptable to the different sectors of the building and construction industry.

The following five components have been suggested as those required to enable accurate and consistent BIM performance measurement<sup>2</sup>.

1. BIM capability stages representing transformational milestones along the implementation continuum;
2. BIM maturity levels representing the quality, predictability and variability within the BIM stages;
3. BIM competency sets representing incremental progressions towards improvements within BIM stages;
4. Organisational Scales representing the diversity of markets, disciplines and company sizes; and
5. Granularity Levels enabling highly targeted yet flexible performance analyses ranging from informal self-assessment to high-detail, formal organisational audits.

The five BIM components allow performance assessments to be conducted involving

**“BIM performance metrics will enable teams and organisations to assess their own competencies in using BIM, and/or compare them against an industry benchmark”**

<sup>2</sup> *The Five Components of BIM Performance Measurement*, Bilal Succar, University of Newcastle, 2010

## Why are PTI and BIM important?

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combinations of these components. They complement each other and enable highly targeted yet flexible performance analyses to be conducted. If adopted these components could form the basis of a consistent assessment system for BIM implementation and performance.

ACIF and APCC suggest that further consideration and exploration is given to the development of an agreed set of consistent, accurate and adaptable BIM performance metrics.

## 4. Australasian Landscape

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### 4.1 Current levels of PTI and BIM adoption

As the adoption of BIM increases so does the adoption of PTI. Early adoptors of BIM appreciate the positive changes in the interaction between design consultants, building contractors and/or sub-contractors. The construction industry recognises the potential productivity gains achievable through greater collaboration.

According to the McGraw Hill Construction Report<sup>1</sup>, the uptake of BIM across Australia and New Zealand is rising. Design consultants lead building contractors as users, with 6 out of 10 currently using BIM on 30% or more of their work, versus only one-third of contractors.

BIM as expertise is reported highest in larger firms such as architectural/engineering, mechanical/sheet metal/plumbing contractors, steel fabricators and civil contractors.

Together, Australia and New Zealand rank the third highest adoptors of BIM in the world. They also demonstrate global leadership in the frequency with which they leverage BIM to visualise design intent. Design consultants, building contractors and subcontractors are sharing models<sup>2</sup>. While there is a growth in BIM adoption it is - and will remain - largely driven by the design consultants.

Currently trade contractors (mechanical, hydraulic, fabricators, fire and structural) proficiency in BIM is higher than other construction sectors<sup>3</sup> with the direct benefits, for example reduced rework and ability to accurately prefabricate, are becoming increasingly apparent. In addition, trade contractors with BIM expertise are reporting positive impacts on winning new work.

The BIM process has been leveraged very successfully in the resources sector with the digital engineering models leading to more holistic design and safer solutions on major industrial and infrastructure projects.

Model-driven layout in the field (BIM to field) and model-driven prefabrication are both highly rated construction phase BIM activities in Australia and New Zealand and create improved production opportunities.

The types of projects that most frequently use BIM include:

- commercial buildings and precincts;
- healthcare;
- education;
- residential;
- buildings and building services;
- retail/shopping centres;
- infrastructure;
- mining; and
- urban design.

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<sup>1</sup> McGraw Hill Construction, *SmartMarket Report, The Business Value of BIM in Australia and New Zealand*

<sup>2</sup> Green Building Council Australia, *BIM Industry Research, October 2012*

<sup>3</sup> *The Five Components of BIM Performance Measurement, Bilal Succar, University of Newcastle, 2010*

# Australasian Landscape

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In adopting BIM and PTI the 'traditional' Procurement Methods are becoming more 'innovative'. For example, the most common Procurement Methods are:

- Design-Bid-Build (DBB);
- Design-Build (DB);
- Construction Management (CM);
- Design-Build-Operate (DBO);
- Design-Build-Finance-Operate (DBFO);
- Design-Build-Manage (DBM); and
- Public-Private-Partnership (PPP).

Nowadays, other approaches are evolving such as:

- Integrated Project Delivery (IPD);
- Project Alliancing (PA);
- Early BIM Partnering (EBP); and
- Early Contractor Involvement.

In the public sector, jurisdictions (and their agencies) are moving at their own pace to adopt BIM as a tool to design and construct assets, including ongoing management after they are commissioned. Some agencies are more advanced than others: those that regularly commission projects to deliver new or refurbished assets, and have significant asset portfolios to manage (including Defence, health and education agencies), are more advanced in their thinking and development of internal policies and processes.

## 4.2 Perceived challenges

The collective membership of ACIF and APCC identified perceived challenges and, whilst the list is not exhaustive, the key elements are addressed below.

A lack of demand by client and project owners is reported to be the main reason some contractors have not yet invested in BIM.

The Australian and New Zealand construction industry remains a local industry of many small firms with regional differences. Access to BIM investment funds for BIM implementation is a challenge where there is no guarantee of consistent BIM work. However these smaller firms are working with models generated (authored) by design consultants.

Currently across the Australian and New Zealand construction industry, BIM skill levels directly correlate with the level of BIM adoption. Where BIM is adopted on a large percentage of projects within the organisation, skill levels are considered to be high. Conversely, skill levels are low in those organisations that do not use BIM. The importance of BIM skills will increase in line with the expected increase in BIM adoption.

Other challenges include:

### Communication

- Realisation that BIM should not only be driven by technical staff within design and construction, but also by 'top' management
- Lack of unbiased case studies on how BIM has been realised on projects
- Explaining the benefits of PTI and BIM to stakeholders (both internal and external), including value for money for project sponsors

# Australasian Landscape

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- Changing the perception that BIM is too complex/expensive
- Facilitating widespread adoption of PTI and BIM

## Investment

- Promoting efficiencies for smaller builders
- Upfront and ongoing cost of hardware, software and training

## Methodology

- Developing a national object library
- Formulating agreed standards for modelling practice and collaborative workflows
- Challenges of interoperability utilising application agnostic formats that can require a substantial amount of effort to validate
- Enabling internal cultural changes to adapt to a BIM methodology
- Clarity in responsibilities, obligations and deliveries
- Developing industry Standard contractual documents

## Policy

- Development of government rules and policies that support the adoption of PTI and BIM

## Skills

- Encouraging consistent national training and education
- Ensuring sufficient staff with BIM experience are available

Being aware of the challenges to BIM adoption will help determine what steps the industry needs to take to advance the new technology. The “big four” issues in NZ are:

1. lack of expertise (54%);
2. lack of standardised tools (39%);
3. lack of collaboration (37%); and
4. cost (34%) - always a concern for those facing a significant technological challenge, until the real advantages of the change are realised.

In Australia, key issues for public sector agencies include:

- assessing whether the costs of requiring the delivery and use of BIM models are outweighed by the asset whole of life benefits;
- exploring the minimum threshold values of projects on which BIM may be beneficial to design, construct or manage assets;
- assessing whether local suppliers (designers and constructors and asset managers) have the skills and resources to build and use BIM models;
- ensuring smaller firms – whether designers or other consultants, or constructors – that are slower than others in using BIM are not disadvantaged;
- determining whether existing legislation, policies, or procedures, are flexible enough to allow the early appointment of constructors to project teams to be part of the design process; and
- exploring which internal BIM capability or other project management capability is appropriate when pursuing the delivery and use of BIM models by suppliers.

# Australasian Landscape

It is clear that the main roadblocks to the successful implementation of BIM-based technology continue to be lack of expertise (i.e. the need for training and support) and a lack of standardised tools and protocols, leading to difficulties in achieving full collaboration through the design and construction chain.

## 4.3 Australia and New Zealand BIM adoption compared internationally

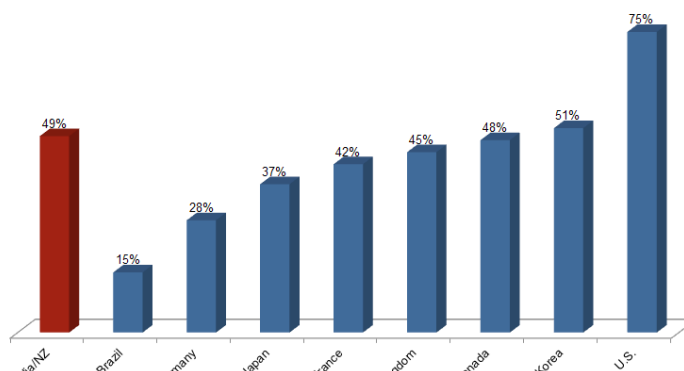
In respect to BIM leadership, Australasia should not be underrated. Where designers are contracted to provide one, it is common for models to be passed forward to a construction team. While this is 'simple' BIM it is a demonstration and introduction of PTI and recognition of the value and benefit of using BIM.

"Australia and New Zealand are among the world's leading regions for building information modelling, with firms planning to deepen their involvement."<sup>4</sup>

The McGraw Hill Construction, SmartMarket Report, presents the following charts derived from their online survey conducted with 435 respondents across the construction industry in Australia and New Zealand.

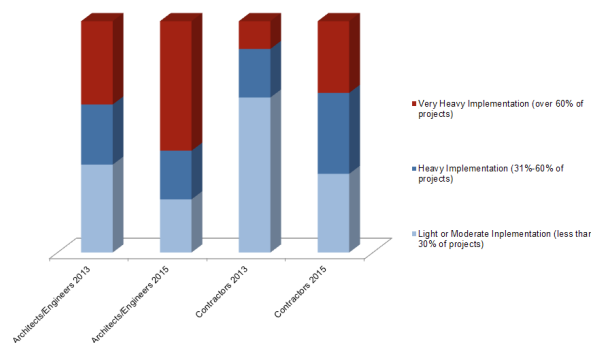
**"Australia and New Zealand are among the world's leading regions for building information modelling, with firms planning to deepen their involvement."**

Percentage of BIM Users with More than Three Years' Experience<sup>5</sup>



According to the chart, Australia and New Zealand rank third in regards to BIM longer than three years, behind the United States and narrowly behind Korea. This indicates that BIM is not new in the Australia and New Zealand construction industry. Furthermore, survey respondents predict a strong increase in BIM implementation.

Current and Future BIM Implementation Levels<sup>6</sup>



74% of respondents report that they will be in the heavy or very heavy implementation categories within the next two years. This represents an increase of 69% against current heavy or very heavy BIM implementation.

4 McGraw Hill Construction, SmartMarket Report, 2014

5 Source: McGraw Hill Construction, The Business Value of BIM in Australia and New Zealand, 2014

6 Source: McGraw Hill Construction, The Business Value of BIM in Australia and New Zealand, 2014

## 5. People: Behaviour and Capability

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### Objective

**To raise awareness of the organisational cultural, behavioural and capability changes needed to achieve the adoption and implementation of Project Team Integration (PTI) and Building Information Modelling (BIM) in the built environment.**

### 5.1 The cultural and process change required

Developing the right environment to foster effective implementation of PTI and BIM including people, processes, technology and governance factors requires a significant change initiative for people and organisations. It requires leadership and direction from the most senior level.

Project delivery using PTI and BIM needs to be driven from the strategic level of the organisation. Collaborative working using PTI and BIM requires not only the learning of new approaches and technologies/software but also the learning of a new way of working.

Recognition is needed by senior leaders that BIM is a collaborative tool which is the main communication method to facilitate technology enabled advances in design, construction and facilities management.

Importantly PTI and BIM can empower current and future generations of industry practitioners to achieve increased productivity, waste reduction and a viable aesthetic and sustainable future. Therefore building capability is one of the most important aspects of PTI and BIM adoption.

Organisational process change is central to achieving integration and collaboration of project teams. Project sponsors and project team leaders need to understand and address the cultural and behavioural change required to do things differently. Senior management need to be aware and convinced of the benefits of PTI and BIM so that they can convey the benefits to various stakeholders, including their own employees who may need reassurance and convincing of the need for change and training.

The higher the level of integration of project team members at the early design stages, the increased opportunities to obtain maximum benefit from the use of PTI and BIM. This requires new skills together with different ways of working and new roles such as the Model/Information Manager. Managing the relationships to optimise PTI and BIM require a new operating environment.

### 5.2 How can this be achieved (at the organisational level)?

Senior leaders should guide and sustain their organisation towards PTI and BIM adoption, where it is deemed appropriate. PTI and BIM vision and goals for the organisation should be developed and communicated, demonstrated and reinforced to employees and stakeholders.

The uptake of PTI and BIM can be facilitated by adopting different procurement approaches which encourage project innovation and more cost effective solutions. Procurement strategies that encourage the use of PTI and BIM have the potential to offer increased value-for-money outcomes in a transparent process. Procurement guidelines can incorporate or provide reference to detailed advice to government agencies and their agents on the efficient use of BIM.

Organisational change requires a management framework for creating and managing change. This requires recognition by senior leaders that the organisation needs the

# People: Behaviour and Capability

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required culture and personnel/skills: hire new staff and/or retrain existing staff. Preparedness for investment in training, learning and education from senior leaders in organisations is critical to the successful implementation of PTI and BIM.

The establishment of mentoring programs within organisations is a practical and valuable method to advise, encourage, develop and support staff learning the skills of PTI and BIM adoption and experiencing organisational change.

The necessary resources should be invested to progress and monitor the PTI and BIM adoption program which includes the change management plan. Creating the climate for change assists the organisation to migrate from current to future states with less disruption and resistance.

Project sponsors must select a procurement strategy that will enable the selection of the 'right' project team members who have accepted a common set of project objectives that everyone is committed to achieving. This is a key enabler to integration and collaboration and project success.

Integration and collaboration is driven by teamwork and this can be difficult to achieve at the project level. It is important to involve all team members at the initial stages in setting the project objectives, strategies and actions that are included in the project management plans.

This initial involvement is critical to achieve ownership by all team members. This then leads to commitment. Project sponsors need to understand and address the cultural and behavioural changes needed to do things differently in order to achieve PTI.

Industry 'champions' need to be identified and encouraged to share their knowledge, experiences and lessons learnt. These champions can assist to facilitate, expedite and drive the adoption and implementation of PTI and BIM.

The cross exchange of sharing knowledge, experience, best practice methods and case studies in an open and collaborative environment is extremely valuable and the industry champions would be well placed to establish an appropriate medium to facilitate this.

## 5.3 What educational needs are required at all levels?

Importantly, PTI and BIM learning can be delivered in various forms however consistency is essential to broad industry adoption.

Fundamentally there is a need for education and training designed to increase the understanding of PTI and BIM technology and processes. Interoperability is central to being productive using BIM.

The focus for education needs to include the benefits of PTI and the pathways to achieving integration together with BIM awareness, technical skills, knowledge and understanding BIM as a collaborative working tool. It is important to highlight that BIM is more than technology changes; it provides significant collaboration and competitiveness benefits.

PTI and BIM education and training is being integrated into education courses with universal adoption, secondary, trades, universities, TAFE's, polytechs, vocational etc. Consistent baseline training is required to build a shared understanding across the industry with learning outcomes resulting in transferrable skills.

Universities and other educators need to incorporate consistent BIM education and training into degrees and coursework (more than the basic principles of BIM technology). Web based training is an important option that needs to be accessible and available.



# People: Behaviour and Capability

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The traditional silos of architecture, engineering and building and construction schools may not be conducive to the delivery of education and training programs that facilitate a consistent approach to BIM service delivery. Integrating the principles of PTI and BIM into existing course curriculum can reduce the need for developing new courses and drive consistency of delivery.

PTI and BIM training is ongoing and all industry stakeholders need to acknowledge that those who are skilled and trained require continuing support and a thorough understanding of the PTI and BIM process.

Regular induction programs provide solid learning support and the Perth Children's Hospital Project as follows is a good example.

**“It is important to highlight that BIM is more than technology changes; it provides significant collaboration and competitiveness benefits.”**

*“BIM introduction sessions are held weekly on the Perth Children's Hospital Project with invitations being sent to all project staff, new or current to explain what BIM is, how we are using it and why we are using it to deliver the project. The 30 min session provides an introduction to BIM, examples of its use on the project and hands on demonstrations on how to open and navigate the models. These sessions are limited to 10 attendees to maximise knowledge transfer and individual tuition time. Straight after this introduction a BIM question session is held, a BIM manager is on hand to answer any queries, define possible BIM solutions for your project problems and assist with any Navisworks queries. These sessions allow consolidation of the information obtained in the introduction session and are aimed at ensuring project staff realise the potential of BIM and use the tools/workflows at their disposal.” - Alastair Brook, BIM Manager: Construction, PDC Western Australia.*

The Perth Children's Hospital provides an excellent example of how PTI and BIM training can be seamlessly and effectively facilitated at the project level with minimum effort and disruption for all project stakeholders.

## Proposed activities to deliver on Objective

There are numerous risks and challenges that impact on the culture, behaviours, management and systems necessary to support effective PTI and BIM implementation and management. These risks and challenges can also provide opportunities for organisational change.

- Organisational culture, behaviour and capability change needs to be lead and driven from a senior level. Project sponsors and senior leaders are drivers.
- Organisations need the required cultural and personnel/skills - hire new staff and/or retrain existing staff - and a commitment to training and education of PTI and BIM.
- PTI/BIM industry champions need to be identified to inspire and lead industry.
- Experienced industry practitioners and trainers of PTI and BIM need to be targeted to share their knowledge and experiences within organisations and across the industry.
- Organisations need to be encouraged to establish mentoring programs and in-house training from experienced and capable team members.
- Education and training needs to occur across the entire construction sector and be targeted at different levels i.e. secondary study, undergraduate, practitioners' site and office personnel (including at the strategic level).
- Education and training courses on PTI and BIM need to be 'practical' with the skills being easily and readily applied on projects.

## People: Behaviour and Capability

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- The delivery of education and training programs need to facilitate a common understanding, consistent guidelines and work practice for the adoption of PTI and BIM.
- All PTI and BIM education, training and learning needs to result in transferrable skills and knowledge.
- Web-based training needs to be accessible by all of the construction industry and supported by employers.
- Recognition that BIM education facilitates collaboration between project participants of all disciplines and across all project lifecycle phases.
- Skills in true Design Management in order to optimise available uses of BIM to leverage improved outcomes.
- Successful project outcomes require the selection of the 'right' project team members.
- Best practice methods and procedures of PTI and BIM on projects needs to be captured and integrated into learning and training courses.
- Professional bodies should refresh their accreditation criteria in line with the industry need for graduates to be skilled in the principles of PTI and BIM. The utilisation of accreditation criteria can facilitate an incentive for academic institutions to consider changes to their course curricula.

## 6. Procurement and Contracting

### Objective

**The adoption of procurement delivery models and contractual arrangements that remove ambiguity within the project team integration environment and takes advantage of the opportunities afforded by model based collaboration.**

Whilst project team integration and the 3D modelling functions of BIM are not necessarily new, it is the usage and integration of project data in this environment that is new to the design and construction industry practices. New practices call for the development of more collaborative and integrated procurement and contractual arrangements to facilitate the use of BIM.

There are also advantages in requiring BIM for projects procured by more traditional methods; asset owners should carefully consider current and future BIM benefits. Early engagement with owners and users in the design process can increase efficiency through enhanced visualisation and reduce changes later in the process.

To best enable PTI, the role of the procurer and client requires extension to include establishing project teams in a manner that helps to maximise the possibility of information-sharing across designers, contractors and the asset/facility managers. This will also support easier use of BIM.

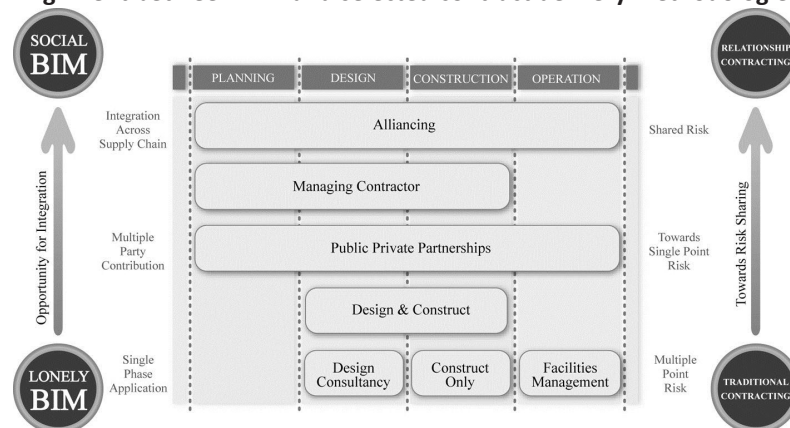
There are a few contractual features that underpin the key differences between adopting PTI and BIM compared with traditional construction practices that should be addressed by project owners. Namely:

- Early engagement of the entire team which includes the contractor and in some cases key subcontractors
- PTI that enables maximisation of potential benefits
- BIM can deliver a geometrically accurate 3D model and data set that supports the building through its lifecycle.

The necessity for new or customised procurement or contractual arrangements is subject to how BIM is integrated into the project delivery and the allocation of roles and responsibilities. The engagement early at the design and planning stages by facilities and asset management professionals also needs to be considered in the procurement and contracting arrangements.

There is no definitive practice that encompasses BIM. This is further exemplified by the fact that BIM can be used in a myriad of ways, as is the case in 2D.

#### Alignment between BIM and selected contract delivery methodologies<sup>1</sup>



<sup>1</sup> Kuiper, I., & Holzer, D. (2013). Rethinking the contractual context for Building Information Modelling (BIM) in the Australian built environment industry. *Australasian Journal of Construction Economics and Building*, 13(4), 1-17. <http://eprints.lib.uts.edu.au/journals/index.php/AJCEB/article/view/3630>

# Procurement and Contracting

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The above graphic illustrates the relationship between the possible uses of BIM, including potential parties who may contribute and be involved in the development of BIM, and existing procurement and contractual delivery methodologies.

‘Fully Integrated’<sup>2</sup> BIM would require changes in the way projects are procured, and the way contractual and liability issues are managed. The formation of project teams and the engagement of the various disciplines is different to ‘traditional’ methods and is undertaken on a case by case basis and accommodates flexibility across the project life.

Projects using BIM which are procured through traditional methods may be handled by engaging a lead consultant to manage the team output including management of the associated Model. However, the role of the project BIM manager needs to be clearly delineated from that of the lead consultant and/or contractor. One can cover both but not as a matter of course, as the information management requirements to facilitate BIM can be substantial and well above and beyond the scope of a ‘traditional’ lead consultant. Information management processes may also be dictated by BIM related Standards adopted for the project e.g. PAS1192 series.

Whilst it is acknowledged that information management is a sub-set of Project Management – whether BIM is adopted or not – the information management requirements are considerably more sophisticated when BIM is adopted and need to be integrated within the BIM process. Sign-off by all parties, including asset and/or facilities management professionals, at each of the BIM/design milestones should be part of the overall information management process.

It is possible to define BIM information requirements (dependant on how BIM is used) such as BIM management plan proposals, precise (on a project by project basis) Levels of Development (LODs) for various elements and ‘As Constructed’ Models to facilitate future management and works, before the project commences. A BIM management plan can be a project tool to achieve and define requirements and can include consideration of LOD model types.

Intellectual property, risk sharing and insurance are critical procurement and contractual matters for early consideration by the project team.

## 6.1 Contractual

Integrated approaches to project delivery involve contractual relationships that are typically quite different from traditional contract models.

**“The necessity for new or customised procurement or contractual arrangements is subject to how BIM is integrated into the project delivery”**

It is vital to correctly scope and define the deliverables. The contractual matters that are likely to arise, and be considered and explicitly addressed in a project specific BIM Management Plan include:

- provisions dealing with IP - It is important that these apply to all members of the project team involved in producing the model. However this can be addressed through the BIM Management Plan, where rights are explicitly specified;
- professional Indemnity Insurance (Reliance) - Does the PI insurance explicitly cover these new deliverables? That is, a digital model deliverable that is to be reused by someone else: is it fit for that purpose? If the deliverables/outcomes are the same as in 2D, then there is no issue. If asking for asset/facilities management capable models, then this would impact PI;
- priority of contract documents (order of precedence), including the relative status of the BIM Project Protocol;

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<sup>2</sup> Fully integrated is described as the hosting of a single integrated model on model servers.

# Procurement and Contracting

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- changes to participants' roles and responsibilities, including consultants engaged to support the virtual build process with the scope to be carefully considered as this can be exponentially more work;
- model (data) management and access, particularly if you have geographically dispersed teams;
- authorised use of BIM; and
- expected information output and format.

While a number of entities are developing Integrated Project Delivery contracts, contractual provisions have not yet caught up with BIM practices or the innovative procurement strategies that these practices enable, such as Project Team Integration. Although, no standard Australasian contract or addendums have been developed through industry consensus let alone tested in practice, New Zealand is moving towards the use of standard contracts and the current use of NZS3910 provides the flexibility to cover use of BIM.

International contractual Standards available include:

## United States

- E203-2013 Building Information Modelling and Digital Data Exhibit
- G201-2013 Project Digital Data Protocol Form
- G202-2013 Project Building Information Modelling Protocol Form
- ConsensusDOCS 301 BIM Addendum
- C106-2013 Digital Licencing Agreement
- Guide, Instructions and Commentary to the 2013 AIA Digital Practice Documents (E203-2013, G201-2013 and G202-2013)
- ConsensusDoc 301 BIM Addendum

## United Kingdom

- CIC BIM Protocol
- PAS1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using Building Information Modelling

## New Zealand

- NZS3910:2013 Conditions of contract for building and civil engineering construction
- NZS3916:2013 Conditions of contract for building and civil engineering – Design and construct
- NZS3917:2013 Conditions of contract for building and civil engineering – Fixed term

## 6.2 Management of risk sharing

The very nature of PTI and BIM can introduce new risks that need to be considered and managed among project team members. Risks unique - and subject to BIM use/s - to a BIM based project include:

- project participants assuming contributions of another project participant as accurate and authorised to be used in a manner that the original author did not agree to;
- software interoperability and ongoing legacy maintenance of file formats;

# Procurement and Contracting

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- unintended assumption for responsibility of authorship;
- design programs where trades are out of sync when they author their respective models;
- the amount of work required to embed or associate additional information requirements into the BIMs;
- a misunderstanding on what is modelled and what is supplementary 2D documentation or information in a different format;
- not having a clear methodology as to how design models are provided in an application agnostic format like \*ifc and how much of the data is accurately translated from the authoring application;
- who is responsible for updating building information model data and ensuring its accuracy;
- sharing of BIM when a party is not a discipline which requires professional indemnity insurance;
- reliance on project specific policies;
- operating outside the insured profession; and
- potential increasing duty of care.

Generally, the above issues can be managed through a clear and concise BIM Management Plan.

## 6.3 Legal

The relative importance of intellectual property, risk sharing and insurance matters depends on the level of maturity of BIM use within a project.

Legal considerations include:

- Whether the completed model is a product and hence subject to the laws that govern goods, warranty and liability;
- Whether the data/model should be afforded proprietary recognition or clarity whether being personal or real;
- Licensing e.g. IP, copyright, software use and access to data;
- BIM data and the need to protect it through legal channels;
- Procurers may need to seek advice about whether their services, work, involvement in a PTI context warrants IP consideration;
- Insurance forms suitable for Level 2 (and beyond) that recognises the risk sharing framework of PTI (refer to chapter 8, Level 2 BIM); and
- Share of costs for inputting and reviewing BIM data. However, in practice these considerations are not significant.

# Procurement and Contracting

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## 6.4 Tendering

The current approach to tendering can result in wasted effort by ‘pushing’ designs onto contractors and specialist trade contractors contributing to 10-15% of unnecessary costs<sup>3</sup>. Unnecessary waste is still present in ‘design and construction’ tenders when typically the core design is locked away with clients and design consultants reluctant to re-open design and incur additional fees.

Some form of competitive tendering will remain, particularly in public sector projects, to achieve value and cost certainty. However, alternative tendering approaches should be considered, for example:

- achieving early competitive appointment of the main contractor ahead of the completion of design, and potentially a quicker start on site;
- increasing integration on a competitive basis of the key specialist trade contractors, head contractors and design consultants;
- securing the involvement of a contractor for pre-contract services on a competitive basis, to obtain input on buildability, sequencing and subcontractor selection; and
- transferring a greater degree of design to the contractor.

## 6.5 Offshoring

Outsourcing of technical engineering solutions is usually undertaken to provide a technical solution at a lower cost structure, or to meet the temporary need of a skills shortage, and or peak lopping of resource demands beyond a company’s normal sustained support and delivery infrastructure.

Outsourcing based on “rate” alone can be a false economy if utilisation and reworks means that the efficiencies and economies of the work are not realised as planned. It is also imperative that the project management of the work assigned is clearly, fairly and equitably managed to ensure any issues and therefore opportunities to improve outsourcing are improved by both parties. It is critical to ensure that project information is issued and received as planned by both parties.

The potential downside of outsourcing in BIM is that the skills level and knowledge will remain substantially with the company producing the work, which could become an issue should the frequency and magnitude of outsourcing increase to an extent where the companies become dependent and reliant on the outsourced service provider, producing a skills shortage and potential lower cost market threat. It is unlikely that any national construction industry will derive long term benefits from extensive and sustained BIM outsourcing.

However there are design organisations that have established offices in lower cost centre areas providing a competitive advantage and a viable commercial business.

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<sup>3</sup> *Institution of Engineers Australia, Getting It Right the First Time, October 2005*

# Procurement and Contracting

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## Proposed activities to deliver on Objective

There are a range of tools, templates and literature to assist project teams deliver using PTI and BIM.

Changes required both from a PTI and BIM perspective include:

- a well-informed client who knows what they want out of BIM;
- the dismantling of traditional barriers or silos of effort;
- early engagement of asset/facilities management professionals at the design and planning stage to minimise overall operational lifecycle costs of the asset/facility;
- preparedness to lengthen contract negotiations and start them earlier giving greater consideration to risk, cost, time, management and roles and responsibilities. However this is likely to be a short term concern due to market immaturity;
- comprehensive contractually binding BIM Management Plans including, where appropriate, client and asset/facility management obligations. This Plan should be completed jointly by a project owner representative, design team and contractor (depending on the procurement methodology adopted) to ensure necessity and achievability of requests;
- a commitment to undertake auditing of the deliverable at agreed milestones to ensure what is provided aligns with the BIM Management Plan;
- the inclusion of data ownership rights and responsibilities in contract documentation;
- discuss and resolve indemnity and limited warranties and disclaimers of liability before BIM is used;
- establish a consistent approach to contracts and protocols that are scalable (short version for small projects and a comprehensive contract for larger projects), and develop at the earliest project stage possible;
- project owner to specify constructible BIM modelling and datasets with interoperability data exchange Standards deliverable, for example Industry Foundation Classes (IFCs);
- development of an Australian Standard Contract for PTI incorporating a BIM LOD authoring Framework;
- an understand the legal, intellectual property and insurance requirements required in a collaborative environment;
- further development of national templates, content and Standards. Refer to the Standards Chapter for further information;
- the review of contractual framework developments from around the world to establish current best practice thinking and how it can be applied to the Australasian context; and
- development of a set of Conditions of Contract for Project Team Integration which incorporates the key BIM inputs to the BIM Management Plan.



## 7. PTI and BIM Protocols

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### Objective

**To assist project sponsors and project team leaders to understand and address the cultural and behavioural change needed and the obligations required for optimal outcomes from the adoption of PTI and BIM.**

The powerful combination of PTI and BIM has the potential to reshape the building and construction industry to increase efficiency and productivity leading to improvement in the Australian and New Zealand economies.

PTI and BIM Protocols are needed to articulate and formalise the behaviour that is expected of all project team members and also to identify the BIMs that are required to be produced by the project team.

PTI and BIM Protocols also imbed the specific obligations, liabilities and associated limitations on the use of the models. The PTI and BIM Protocols are intended to be incorporated into all contracts and sub-contracts.

Importantly there are differences between legal and guideline documents in respect to PTI and BIM protocols and their legality. For example, the NATSPEC guidelines are intended for guidance and not for contractual obligation.

### 7.1 Purpose of Protocols and Proposed Activities

PTI and BIM Protocols assist project teams to:

- share responsibility for the successful delivery of a project including identifying the Building Information Models that are required to be produced;
- commit to achieving the client's project objectives and put into place specific obligations, liabilities and associated limitations on the use of the models;
- clarify and manage commercial issues such as protection of Intellectual Property Rights (IPRs) from infringement, legal issues and security concerns;
- establish agreement for process and data exchange including security of the data model, data sovereignty, and use of Cloud based services;
- participate in data sharing - addressing confidentiality, data security; setting adequate user rights to prevent data loss or damage during file exchange, maintenance, and archiving; authorised uses of the data; identifying clear ownership of the model elements throughout the project life-cycle; transmission, use, storage and archiving of the data;
- integrate team members at the early design stages;
- facilitate particular ways of working – such as the adoption of a common naming Standard; and
- establish a collaborative project environment and culture (trusting relationships, strong leadership).

### 7.2 Why are they important?

PTI and BIM Protocols can provide a 'foundation' for change to assist:

- clients to achieve better value for money and successful outcomes;
- clients to achieve or exceed expectations in respect to needs and objectives;
- in the delivery of a common set of BIMs;

## PTI/BIM Protocols

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- in facilitating better performing project teams due to clear lines of responsibility for action and deliverables;
- in enabling the production of BIMs at defined stages of a project;
- in waste reduction - recognition that PTI and BIM can reduce waste, wasted effort and the avoidance of disputes;
- integration of team members at the early design stage and support the adoption of effective collaborative working practices;
- in influencing the way in which project teams are created and managed;
- by supporting explicit contractual requirements under the Protocols;
- maximisation of the uptake of BIM for better project outcomes; and
- in the identification of 'champions' for PTI and BIM.

## 8. Asset Management

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### Objective

**That asset/facilities management professionals become integral participants in the design and planning of all buildings, thereby ensuring:**

- **design principles are mindful of, and do not adversely affect, the practicalities inherent in ongoing building operations;**
- **optimum data is collated and available at handover as part of the transition from the construction phase to the operational phase of the building;**
- **irrelevant data is removed from the models such that only applicable data is passed onto the asset/facility management professional.**

### 8.1 Strategic Asset Management

<sup>1</sup>Asset management is the process of organising, planning, designing and controlling the acquisition, care, refurbishment and disposal of infrastructure and engineering assets to support the delivery of services. It is a systematic, structured process covering the whole life of physical assets.

The objective of asset management is to optimise the service delivery potential of assets and to minimise related risks and costs and ensure positive enhancement of natural and social capital over an asset lifecycle. Good governance and the intelligent deployment of business systems, processes and human resources are key aspects of this endeavour.

Integrated Strategic Asset Management (ISAM) brings together economics, engineering, information technology, sustainability and human elements to form a holistic approach to the delivery of built assets. This approach recognises the combination of these elements into a greater whole as well as their interrelationships and interdependencies. It focuses on the long term direction for overall management of infrastructure and engineering assets, while considering the immediate operational matters.

The following principles guide how Strategic Asset Management integrates with broader government and organisational planning.

- Assets exist to support service delivery. Therefore non-asset solutions should be considered.
- Government agencies should manage assets consistent with whole-of-government policy frameworks.
- Private and public sector owners should take into account whole of life costing, future service demands and balance between capital expenditure and maintenance requirements.
- Asset management should be integrated with the owner's strategic and corporate planning.
- Asset management decisions should holistically consider sustainability outcomes: environmental, social, economic and governance.
- Governance arrangements should clearly establish responsibility for functional performance of, and accountability for, the asset and service delivery.

The framework in the following diagram "Integrated Strategic Asset Management Framework" reflects the increasingly complex and interconnected processes which government and its agencies need to take into account when delivering services.

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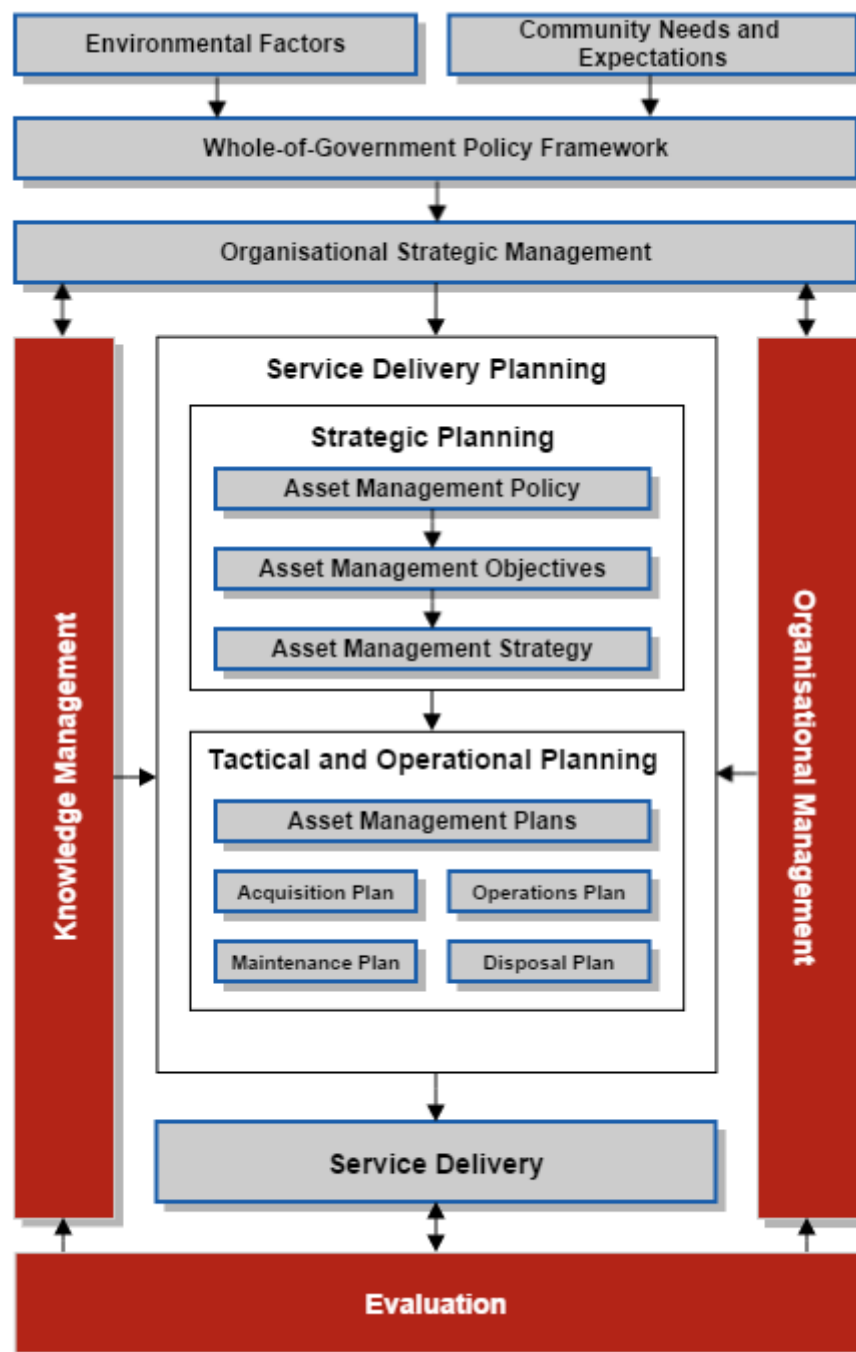
<sup>1</sup> Section 8.1 is an extract from ACIF-APCC Guide to Successful Asset and Project Delivery - Getting it Right Up Front, 2014

# Asset Management

The framework demonstrates that ISAM is cumulative and each component is interdependent. A logical progression through each component is required for maximum service delivery outcomes.

Whilst this ISAM framework focuses on the public sector, it is equally applicable to any organisation or sector.

## Integrated Strategic Asset Management Framework



# Asset Management

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## 8.2 Facilities Management

BIM is an electronic technology that to date has been utilised in the design of facilities and components within facilities. As such, it is becoming an increasingly important tool in the development and maintenance of the built environment.

The PTI and BIM capability to identify and target cost efficiencies through the standardisation of asset and component records is starting to deliver tangible benefits that will continue throughout the entire lifecycle of an asset/facility.

The early engagement of asset/facilities management professionals at the design and planning stage will ensure relevant data is available at handover and establish a framework for the ongoing collection of information critical to minimising overall operational lifecycle costs of the asset/facility, currently in the order of 70%.

The aspiration is to create a dimensionally accurate model that is handed over with a full asset register. This will allow the facilities management professional to strategically plan works, understand the interoperability of the building components and to better manage all aspects of the asset/facility to meet occupant objectives and designer intent.

## 8.3 What are the lifecycle benefits?

Asset/facilities management professionals struggle with a lack of reliable 'as-built' and contemporary data on all aspects of asset/facilities under management. PTI and BIM provides a platform that can ensure 'as-built' drawings, 3D Model and information are available and can be kept up to date.

By providing a single point of convergent datasets, PTI and BIM has the potential to be an extremely powerful tool that will allow asset/facilities managers to achieve their objective to provide an asset/facility that is safe, compliant and productive for users. This is a key benefit for both the occupier and the owner.

The sophistication of PTI and BIM data makes it possible to upload a dynamic operational information model to building management systems (BMS), thereby streamlining the process of hand over and the transition to the operational phase in the life of the building.

The value of this information as a 'tool' ensuring ongoing improvements in building operational efficiencies, needs to be understood and appreciated by all involved in the management and operation of the facility from the point of handover. A dynamic model provides a continuum of historic and current information beyond that normally available to those who undertake building operations, including service contractors. Such a tool offers clear benefits in the ongoing maintenance of unseen fixtures and fittings, replacement of end of life equipment and in the design and construction phases of retrofits and building alterations.

A facility that has BIM at the core of the operations will reduce the cost of management, improve asset life, deliver more strategic and proactive maintenance regimes and facilitate replacement of fixtures and fittings proactively. A dynamic asset register that is field-verified will provide an opportunity to understand the parameters of original equipment specifications and allow this to be taken into account when specifying a replacement.

PTI and BIM will also allow for more efficient use of energy, through model-based simulation and analysis. It allows for comparisons between energy use models, therefore allowing optimum energy levels to be utilised.

# Asset Management

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In summary, the lifecycle benefits include:

- more targeted maintenance specification;
- improved asset management records;
- longer asset life and condition;
- reduced cost of change management; and
- greater control over compliance and safety.

## 8.4 Potential of the technology

The benefits of PTI and BIM in the operational phases of the lifecycle of a building have the potential to be extensive. This is highly dependent on the value placed on accessible, up-to-date information. These benefits include:

- maintenance of data;
- ongoing accuracy of data;
- ongoing use of the data;
- input of the data directly into the BMS; and
- data customisation to meet the client needs.

## Proposed activities to deliver on Objective

**“PTI/BIM has the potential to be an extremely powerful tool that will allow asset/facilities managers to achieve their objective to provide an asset/facility that is safe, compliant and productive for users”**

- **A contractual obligation (clause) binding on all parties from initiation of a built project for the development, transfer and maintenance of an asset register across the asset life cycle. The clause also needs to define the roles and responsibilities of individual parties.**

Establishing contractual parameters for an asset/facility to determine and make binding the transfer of required dynamic information from the design and construction phase to the operator. This will enable the full operational and strategic benefits of BIM to be achieved. The mandated inclusion of a full asset register, complete with operational and design modelling data, will optimise ongoing asset operations and maximise its potential over its lifecycle.

This will require interface with ultimate clients to understand and confirm the costs and benefits for the additional effort required to capture full data within the model for their project.

- **The asset/facilities management industry must define data sets and information asset register outcome requirements to enable the transition from design and construction to operation in a BIM environment.**

A staged approach to defining these requirements would be the most effective way to achieve cross-industry consistency. This needs to commence with common practice being documented against industry ‘good practice’ guidelines and then tested in the operational phase of a project to ensure requirements are met. Following a period of revision and alteration, the refined optimum data sets and information requirements would have the resilience to lay the foundation for an industry-based Standard. As a catalyst for undertaking an industry based review, this process could expedite a portion of the process utilised to develop an Australian Standard.

# Asset Management

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The development and adoption of an Australian Standard would provide the ultimate reassurance of achieving a consistent approach when transitioning building information from design and construction through to its operational life cycle phases.

- **Establishment of an Open Object Library to ensure ‘endurance’ of access, to information pertaining to the operating parameters which will potentially extend the asset life and allow for reuse and recycling of equipment at asset end of life.**

Having access to an object library that is updated beyond the manufacturer’s warranty and manufacturing period will ensure the maximum life cycle of assets can be achieved. In addition, understanding the extended capability of equipment will provide the opportunity to utilise this equipment past its end of life within a specific asset/facility.

- **Develop an industry-wide understanding of PTI and BIM asset/facilities management skill requirements and provide the necessary training.**

The asset/facilities management industry is the key to gaining full value from BIM. The objective of enabling the capability BIM offers can only be achieved when asset/facilities managers are provided with the tools and the training to utilise technology to deliver optimum building performance across the entire lifecycle of their assets/facilities.

# 9. Information Exchange and National Object Library

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## Objective

Information about building and infrastructure asset elements, such as building fabric or building services or furniture and equipment, necessary for the design, construction, operation and management life cycles, is shared in a common format, across all participants in the asset/facility development and management sector.

### 9.1 What is Information Exchange as it applies to BIM?

Information exchange - as it applies to BIM and building and infrastructure developments entailing the sharing of models between project partners - has several aspects:

- the purpose of the exchange - for regulatory approval, for design coordination, for manufacturing or for operations and maintenance
- the discipline-specific type (e.g. architecture, structure or building services etc.)
- the object classes contained in the models (e.g. ceiling tile, column or a VAV box)

Depending on the specific context there will be several factors influencing the scope and level of detail of information exchange, all comprising a purposeful selection of objects with property data. Accordingly an exchange may comprise the whole of a disciplinary model such as the structure, or a partial model of masonry walls for pricing by a sub-contractor, or a defined set of diverse objects and specific property data to enable a thermal analysis calculation.

### 9.2 What is an Object and an Object Library as it applies to BIM?

As adoption of BIM has increased, users - mainly from the design professions - have been increasingly looking to improve the generic libraries of common building products and components that vendors provide, in most cases derived from a United States or European industry context.

The National Object library will provide both a subset of generic objects for design development, extended with proprietary specific versions from Australian and international product manufacturers. This vision is shared by New Zealand, however it is yet unclear who will host the library in New Zealand.

Library objects cover a very large range of building and infrastructure products and components (e.g. wall construction types, windows and doors, steel sections, furniture, basins, VAV AC boxes etc.) that go into the construction of the final asset.

### 9.3 Why is it important?

Objects contained in a Library should be available in open and common proprietary software formats, therefore allowing generic objects to be used for design modelling and transformation for digital representations of actual manufactured products in a construction and asset management oriented BIM.

Current best practice usage in industry shares high quality geometry models, but with limited or uncoordinated property data to support analysis, costing, construction processes and asset/facility management.

This requires a shared contribution from clients and owners, domain experts, product manufacturers, and BIM vendors, a substantial industry challenge but vital for continuing productivity.



# Information Exchange and National Object Library

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It is important that Australian and New Zealand manufactured products that comply with Australian and/or New Zealand BIM Standards are accessible in a BIM Library. It is desirable that Australia and New Zealand share compatible systems, and international consistency of BIM objects for international services and trading competitiveness.

The development of Australia and New Zealand-specific objects will maximise growth in the Australian and New Zealand BIM services markets. Development of a shared international BIM Library with Australian and New Zealand extensions to suit Australian and New Zealand construction practice is currently being undertaken.

The library could extend to the conversion of existing 2D CAD briefing systems (for example the Australian Health Facilities briefing system) to BIM models to facilitate lower cost design of health and other facilities.

Further development of generic product information can include data required to facilitate simulation and analysis of energy efficiency, embodied carbon, adverse weather event resilience and like issues required to optimise sustainability of Australian buildings.

## 9.4 Current Object Library Developments

Locally and worldwide, work is progressing on developing Object Library protocols to improve the quality of models for the many uses during the asset development lifecycle.

Current related activities:

**“The development of Australia-specific objects will maximise growth in the Australian BIM services market”**

- The Sustainable Built Environments National Research Centre (SBEnrc) has developed a pilot on Interoperable Object Libraries that establishes 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 Revit Standards (ANZRS) for developing ‘Families’ and best practice.
- BIM-MEPAUS, an initiative by the Air Conditioning and Mechanical Contractors’ Association of Australia, has implemented product data for the building services supply chain.
- The National Building Specification (NBS) in the United Kingdom provides free universal access to its National BIM Library and is a leader in the UK, and globally, of product information management & BIM technology development.
- BuildingSMART Australasia’s National BIM Initiative Working Group 3 – Object Libraries, has developed a more detailed version of the QUT Interoperable Object Libraries prototype and joined an international pilot of the BuildingSMART Australasia Data Dictionary creating both Australian and New Zealand versions of a ceiling tile system property definitions.

## Proposed activities to deliver on Objective

Whilst these individual industry efforts have demonstrated good practice and improved productivity, they lack holistic industry adoption. Accordingly, actions are:

- establishment of a National Object Library system to be stewarded by NATSPEC as the authoritative national Information Broker for product information (this may be via a Memorandum of Understanding between NATSPEC and NBS);

# Information Exchange and National Object Library

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- development of a business plan to implement an Australian National BIM Library with appropriate resourcing and funding, including evaluating collaboration with NBS UK to share potential use of the UK BIM Library, and technology development cooperation to enhance availability of digital product data;
- in Australia, liaison with CIL, NZ, to arrive at an aligned trans-Tasman business model;
- engagement of product manufacturers (particularly in specialist domains) to work with BIM users developing supply chain sector specific object libraries;
- engage the product manufacturing industry as part of the adoption of the BIM journey in the Australian and New Zealand construction industry; and
- engagement globally on object library Standards developments (for example ISO, COBie, bsDD, SPie etc) where it suits our national interests and to exploit and expedite the potential of BIM.

# 10. Standards

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## Objectives

- The establishment of a collaborative work environment where all participants operate in the same context: that is, there are Standards for modelling, terminology, and process.
- Automation of supply chains to achieve greater industrialisation and productivity within the construction industry.
- To ensure the Australian and New Zealand construction industry is compatible and competitive in the global construction sector.

## 10.1 Why are standards necessary and how do they assist us in our development of buildings and infrastructure?

As in any computer-based technology, information Standards are the instruments for universal usage and understanding, just as the standard railway gauge unlocked transport in the Industrial Revolution, and email protocols became universally adopted in the 20th century.

It is clear “that significant improvements in cost, value and carbon performance can be achieved through the use of open sharable asset information in the creation and operation of our civil infrastructure and buildings worldwide. We know that open sharable asset information will help the supply chain unlock more efficient and collaborative ways of work throughout the entire project and asset life cycle end to end.”<sup>1</sup>

## 10.2 International Standards and Standards Australia Work

ISO Standards originated for the global use of BIM technologies are:

- ISO 16739-12:2012 Building Information Modelling IFC4
- ISO 12006-2:2001 Building construction - Organization of information about construction works - Part 2: Framework for classification of information
- ISO 12006-3:2007 Building construction - Organization of information about construction works - Part 3: Framework for object-oriented information
- ISO/POS 29481-1:2014 Building information modelling - Information Delivery Manual - Methodology and format
- ISO 29481-2:2012 Building information modelling - Information Delivery Manual - Interaction Framework
- ISO 29481-3:2012 Building information modelling - Information Delivery Manual - Model View Definitions
- ISO TS 12911-2012 Framework for building information modelling (BIM) guidance
- ISO/FDIS 16354 Guidelines for knowledge libraries and object libraries
- ISO/CD 16757-1 Product Data for Building Services System Models -- Part 1: Concepts, architecture and model
- ISO/CD 16757-2 product data for building services system models - Geometry
- ISO 81346-12 Industrial systems, installations and equipment and industrial products – Structuring principles and reference designation

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<sup>1</sup> *buildingSMART International Vision ([www.buildingsmart.org/organization/copy\\_of\\_new-page](http://www.buildingsmart.org/organization/copy_of_new-page))*

# Standards

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- ISO/AWI 19650 Specification for information management for the capital/delivery phase of construction project using building information modelling
- COBie MVD (see [http://docs.buildingsmartalliance.org/MVD\\_COBIE/](http://docs.buildingsmartalliance.org/MVD_COBIE/))

Australian building Standard activities are managed by the SA Committee BD-104 Building Information Modelling (Australian Mirror Committee to ISO TC 59/SC 13 Organisation of information about construction works).

These are technical protocols for the formatting and management of model-based information. In addition the industry requires guidelines and reference methodologies to create, manage and deliver BIM based projects.

## 10.3 Why consistent application of Standards is important

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

## 10.4 Australian and NZ Standards

Development of consistent Australian and NZ BIM standards will:

- ensure a consistent definition and format of model data;
- provide significant confidence to owners for data fidelity and availability over a building's life;
- offer significant savings in construction;
- facilitate a market for BIM services;
- accommodate improved briefing systems;
- demonstrate a commitment to open format BIM (Open BIM); and
- provide impetus for improvement in the suite of open protocols for technical instruments.

Other benefits may be realised for post construction building management, operation and maintenance using the COBie Standard (or others such as ISO, bsDD, SPie etc) that helps organise information about new and existing facilities. It is general enough that it can be used to document both buildings and infrastructure assets. It is simple enough that it can be transmitted using a spreadsheet.

It is essential that a greater understanding be sought as to why many practitioners are reluctant to use the COBie Standard.

## 10.5 Current related activities

In the UK the government through their UK BIM Task Force has facilitated the development of Guidelines working with industry in their formulation:

- PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling
- PAS 1192-3:2014 Specification for information management for the operational phase of assets using building information modelling

# Standards

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## Proposed activities to deliver on Objective

### “Information standards are the instruments for universal usage and understanding”

- National adoption of ISO and related BIM standards across the Commonwealth, and all States and Territories;
- in Australia, adoption of the NATSPEC guidelines as a national standard;
- adoption of open formats to ensure data access for an owner over a building’s life;
- development of digital Standards for key supply chains, e.g. AMCA BIM-MEPAUS;
- development of a standard for the asset/facilities management industry on data sets and information asset register outcome requirements to enable the handover from design and construction to operation in a BIM environment; and
- links to ISO and global BIM developments.

Standards and other recognised protocols that are prepared should be scalable with a short version for small projects and a comprehensive Standard for large projects.

# 11. Technology

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## Objectives

**Australia and New Zealand construction industry to be competitive on the international stage, particularly in the Asia-Pacific region.**

BIM is not a mature technology - its origins have arisen from the design professions' evolution of 2D CAD into building information modelling. That move to 3D intelligent object models has taken at least 15 years to become a global trend, which still has a long way to go before widespread adoption occurs.

Increasingly, owners and service providers are needing an integration with land or spatial data, in an extended context of infrastructure development in transport – roads, railways etc., and larger elements of the built environment such as precinct or city urban modelling.

### 11.1 Infrastructure and geo-spatial integration

Facilitating ready integrated access to diverse land, geospatial and building information will deliver a major benefit to the Australian economy, significantly reducing the current 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.

This will entail 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.

The asset/facility and infrastructure development industry should seek to collaborate with government. This will encourage information management methods to deliver efficient interoperability approaches that will enable universal nationwide access to land, geospatial and building information.

Other IT developments are also influencing the use of BIM such as Cloud based services and increasingly more vigilant security systems to protect rich public and private data. Ongoing understanding of the impact of such systems needs to be maintained, so that Australian and New Zealand clients and users exploit the new advantages and compete internationally.

### Proposed activities to deliver on Objective

- Industry to demonstrate the potential and readiness of BIM technology and project teams by undertaking pilot projects to display the benefits of BIM. 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.

## 12. Summary

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This concludes the seven key elements which look to support a whole of industry commitment between government and industry and will provide guidance to an agency or jurisdiction when developing their own PTI and BIM strategies.

This foundation document will mark the cornerstone of future pathways for the industry to achieve efficient and effective project development, execution and completion.

# Appendix A.

## Current Joint ACIF and APCC Projects

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In conjunction with this Framework, the ACIF and APCC are involved with the release of accompanying documentation to support the growth of PTI and BIM knowledge and implementation.

### PTI and BIM - Procurement Models and Application Guide

#### Objective

**To develop a Guide (the how to) for integration of PTI and BIM into each procurement model which will assist in promoting a consistent approach to tendering and contracting across Australia and New Zealand.**

#### Project Description

The purpose of this Guide is to provide member agencies, procurers and project procurers with an outline of potential procurement practices, processes and steps to be followed in developing effective procurement strategies for implementation of Building Information Modelling (BIM) and Project Team Integration (PTI) on specific projects within the built environment.

By ensuring that personnel follow these steps, project procurers can be confident that the recommended BIM strategy for a project – which includes the delivery model (e.g. construct only, alliance etc.) and procurement method – is appropriate, taking all of the relevant circumstances into account.

This Guide will enable consistency on a national basis in examining the relevant tools, Standards, strategies and development processes when identifying a model that best suits delivery using Building Information Modelling.

#### Timeframe

It is expected that an advance draft of the Guide will be ready by December 2014, for release in late December 2014.

### PTI and BIM Education and Skills Framework

#### Objective

**Develop a business proposition for education and training providers to provide building and construction industry clients, designers, contractors, trades and manufacturers with access to PTI and BIM education and training customised to the target audience and delivered at a defined level of difficulty.**

#### Project Description

The ACIF and the APCC believe that a collaborative and coordinated approach in response to the need for Project Team Integration (PTI) and Building Information Modelling (BIM) education and training is required to further maximise the benefits of the emerging processes and technologies in the building and construction industry.

BIM education and training in this context is about crystallizing PTI and BIM knowledge and skills required by project participants of all disciplines and across all project lifecycle phases. To maximise the benefits of BIM industry practitioners need to also be educated about collaborative work practices and processes that make use of BIM technologies.

PTI and BIM education and training is foundational to the Australian and New Zealand (ANZ) building and construction industry improving productivity and remaining



# Current Joint ACIF and APCC Projects

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competitive on the global stage therefore considered by ACIF and APCC as a priority due to the skill shortage in this sector in ANZ.

To deliver on the Objective, a series of five phases will be undertaken as follows:

1. Scan of current PTI and BIM education and training programs and courses available in Australia and New Zealand.
2. Needs Analysis for both construction industry participants and government procurers.
3. Demand and Supply Gap Analysis.
4. PTI & BIM Competencies Blue Print.
5. Promotion of PTI and BIM education and training demand to Tertiary and TAFE sectors

#### **Timeframe**

It is expected to be completed by mid to late 2015.

## **ACIF and APCC members' support for the National BIM Portal hosted by NATSPEC**

#### **Objective**

**A one-stop-shop knowledge hub for Australia and New Zealand, containing relevant and current PTI and BIM material.**

#### **Project Description**

The National BIM Portal website is home to materials deemed current and relevant to the Australian and New Zealand PTI and BIM environment and the NATSPEC National BIM Guide and other documents. It is also a repository of documents and tools that will assist the implementation of BIM in the construction industry.

The NATSPEC BIM Portal also acts as the ACIF and APCC Knowledge Hub.

ACIF and APCC members are responsible for providing relevant material to ensure the Portal remains current, and to promote the Portal to respective stakeholders as the one-stop-shop for relevant and current PTI and BIM material.

In New Zealand, the main BIM information source is: <http://www.buildingvalue.co.nz/BIM-in-NZ>

#### **Timeframe**

The National BIM Portal was launched by NATSPEC in mid-2014. As owners of the Portal, NATSPEC has sole editorial control and vetting rights.

## Appendix B. Definitions

<b>2D</b>	An overarching term for 2D CAD, 2D drawings (hand or software generated), or the process of producing 2D drawings.
<b>3D</b>	An overarching term for 3D CAD, or a 3D model, or the process of producing a 3D model.
<b>4D BIM•</b>	A 3D model linked to time or scheduling data. Model objects and elements with this data attached can be used for construction scheduling analysis and management. It can also be used to create animations of project construction processes.
<b>5D BIM•</b>	A 4D BIM linked to cost data. The time data adds another dimension to cost data, allowing expenditure to be mapped against the project program for cash flow analysis, etc.
<b>6D, 7D</b>	There is currently no consensus on the meaning of these terms. Some say 6D is for Facilities management, some sustainability assessments.
<b>Aggregate Models</b>	Individual design discipline or trade sub-contractor models.
<b>Asset Management</b>	A process that can aid in the scheduled maintenance and operation of an asset/facility.
<b>Best of Breed</b>	An overarching term for the supply chains' preferred BIM enabled aggregate model authoring software or virtual construction (VC) review and coordination software.
<b>Best for Project</b>	In relational contracts, decisions are made 'best for project' and not 'best for individual', since the team either wins or loses as a group.
<b>Building Information Modelling (BIM)</b>	BuildingSMART Australasia defines BIM as: a digital representation of physical and functional characteristics of a building. As such it serves as a shared knowledge resource for information about a building forming a reliable basis for decisions during its life-cycle from inception onward.
<b>BIM Addendum</b>	A contractual arrangement to modify the terms of a standard form agreement to which it is attached to addresses BIM-related issues that were beyond the original scope of the standard form agreement. Two forms exist : AIA E202 – 2008, and ConsensusDOCS C301 BEP (Or PXP)
<b>BIM (Project) Management Plan•</b>	A formal document that defines how the project will be executed, monitored and controlled with regard to BIM. A BMP is developed at project initiation to provide a master information/data management plan and assignment of roles and responsibilities for model creation and data integration throughout the project. In some regions, a BMP is referred to as a BIM Execution Plan.
<b>BIM Goals</b>	Project specific outcomes arising from the use of BIM processes.
<b>BIM Manager</b>	An individual responsible for the administration and management of processes associated with Building Information Modelling on a project. The appointment process may vary but the BIM Manager is still effectively an agent of the project owner. While the scope of management may vary, to include activities such as organising, planning, scheduling, directing, controlling, monitoring and evaluating BIM processes, the objective is to ensure that those processes are aligned with the project objectives.
<b>BIM Relationship Charter</b>	A mantra and reminder that the execution of the chosen BIM Goals are to work for the project.
<b>CAD•</b>	Computer Aided Design. A geometric/symbol based computer drawing system that replicates hand drawing techniques.
<b>2D CAD</b>	The use of CAD software to prepare 2D lines suitable for presentation on hard copy plots of drawings and/or as background data to other 2D lines.
<b>3D CAD</b>	The use of CAD software to prepare 3D lines, surfaces or solids which are suitable for presentation on hard copy plots of drawings, and/or as background data for other 3D data or BIM
<b>Capability</b>	The ability to perform a task or deliver a service or product. In this context it is generally taken to mean capability with regard to BIM.

• Source: NATSPEC – BIM Glossary. Retrieved August 2014, <http://bim.natspec.org/index.php/resources/glossary>

# Definitions

<b>Cloud Computing</b> ••	A type of computing that relies on sharing computing resources rather than having local servers or personal devices to handle applications. In cloud computing, the word “cloud” (also phrased as “the cloud”) is used as a metaphor for “the Internet,” so the phrase cloud computing is used to mean a type of Internet-based computing, where different services - such as servers, storage and applications - are delivered to an organisation’s computers and devices through the Internet.
<b>Cloud-based Services</b>	Services based on cloud computing.
<b>Code Validation</b>	A process in which code validation software is utilised to check the compliance of model parameters against design codes.
<b>Construction Management (CM)</b>	A delivery model that involves the appointment of a construction manager to oversee and coordinate the work of a range of individual trade contractors and designers engaged directly by the project owner to deliver a specific construction project.
<b>Construction Operations Building Information Exchange (COBie)</b> •	A system for capturing information during the design and construction of projects that can be used for Asset/Facility Management purposes including operation and maintenance. A key element of the system is a preformatted Excel spreadsheet used for recording this information. COBie eliminates the current process of transferring massive amounts of paper documents to facility operators/asset managers after construction has been completed. COBie eliminates the need for as-built data capture after building handover and helps to reduce operational costs.
<b>Deliverables</b> •	The product of engineering and design efforts to be delivered to the client as digital files and/or printed documents. Typically, this would be the concept submittal and the corrected final design. A deliverable may have multiple phases.
<b>Design-Build (DB)</b>	A project delivery system used in the construction industry and a method to deliver a project in which the design and construction services are contracted by a single entity. Design-Build with its single point responsibility carries the clearest contractual remedies for the clients because the Design-Build contractor will typically be responsible for all of the work on the project.
<b>Design-Build-Operate (DBO)</b>	A project delivery method is a system used by an agency or owner for organising and financing design, construction, operations, and maintenance services for an asset or facility by entering into legal agreements with one or more entities or parties.
<b>Design-build-finance-operate (DBFO)</b>	Design-build-finance-operate is a project delivery method very similar to build-own-operate-transfer (BOOT) except that there is no actual ownership transfer. Moreover, the contractor assumes the risk of financing till the end of the contract period. The owner then assumes the responsibility for maintenance and operation. This model is extensively used in specific infrastructure projects such as toll roads. The private construction company is responsible for the design and construction of a piece of infrastructure for the government, which is the true owner. Moreover the private entity has the responsibility to raise finance during the construction and the exploitation period.
<b>Design and Construct (D&amp;C)</b> •	The project procurement method in which the client enters into one contract for the design and construction of a building or project with an organisation, generally based on a building company which provides all project management, design, construction and project delivery services.
<b>Design-Bid-Build (DBB)</b> •	The project procurement method in which the client enters into separate contracts for the design and construction of a building or project. Design and documentation services are generally provided by a professional design consultancy, the documents are used for bidding (tendering) purposes and the successful bidder, generally a building company, enters into a contract with the client to build the project. Often referred to as the ‘traditional’ method of procurement.
<b>Discipline Models</b>	Individual design discipline or trade sub-contractor models – aggregate models.

• Source: NATSPEC – BIM Glossary. Retrieved August 2014, <http://bim.natspec.org/index.php/resources/glossary>

•• Source: Webopedia. Retrieved August 2014, [www.webopedia.com](http://www.webopedia.com)

# Definitions

<b>Early Contractor Involvement</b>	A two-stage relationship-style delivery model, generally structured to resemble a project alliance model during the first stage and a D&C model during the second. This delivery model is specifically designed to achieve good relationship, cost and constructability outcomes by fostering the involvement of construction contractors during the preliminary (design and development) stages of project delivery.
<b>Federated Model*</b>	A model consisting of linked but distinct component Models, drawings derived from the Models, texts, and other data sources that do not lose their identity or integrity by being so linked, so that a change to one component Model in a Federated Model does not create a change in another component Model in that federated Model.
<b>FM</b>	Facilities Management - the process of managing and maintaining the efficient operation of facilities including buildings, properties and infrastructure. The term is also applied to the discipline concerned with this process.
<b>Federated IFC Model</b>	One or more aggregate models brought together in non-authoring software Industry Foundation Class (IFC) reading for the purposes of virtual construction and data manipulation.
<b>Federated Open Standard Model</b>	Refer <i>Federated IFC Model</i>
<b>Federated VC Review Model</b>	One or more aggregate models brought together in non-authoring software for the purposes of virtual construction review.
<b>File Transfer Protocol (FTP)**</b>	The protocol for exchanging files over the Internet. FTP is most commonly used to download a file from a server using the Internet or to upload a file to a server (e.g., uploading a Web page file to a server).
<b>GIS•</b>	Geographical Information System. A system that integrates hardware, software, and data for capturing, managing, analysing, and displaying all forms of geographically referenced information.
<b>Industry Foundation Class (IFC) •</b>	A specification for a neutral data format to describe, exchange and share information typically used within the building and asset/facility management industry sectors. The IFC data model consists of definitions, rules, and protocols that uniquely define data sets which describe capital facilities throughout their lifecycles. IFC is the only non-proprietary, open global data model specification available.
<b>Integrated Project Delivery (IPD)•</b>	The project procurement method in which the client enters into a contract with a number of organisations including design consultants and building contractors at the earliest stages of the project to create an integrated team. It is characterised by an expectation that the team will work collaboratively to deliver a product that meets the client's requirements.
<b>Integrated</b>	Project Delivery principles can be applied to a variety of contractual arrangements and Integrated Project Delivery teams will usually include members well beyond the basic triad of owner, designer and contractor. At a minimum, though, an integrated project includes tight collaboration between the owner, architect/engineers, and builders ultimately responsible for construction of the project, from early design through project handover. <i>Source: American Institute of Architects – California Council, Integrated Project Delivery – A Working Definition, 2007.</i>
<b>Just In Time (JIT)</b>	An approach to design and manufacturing processes, focusing on how milestones and material should be executed in order to arrive 'just in time'.
<b>Lean construction</b>	A way to design production systems to minimise waste of materials, time, and effort in order to generate the maximum possible amount of value. <i>Source: Koskela et al., The Foundations of Lean Construction." Design and Construction: Building in Value, R. Best, and G. de Valence, eds., Butterworth-Heinemann, Elsevier, Oxford, UK 2002.</i>

\* *Source: ConsensusDocs 301 BIM Addendum, 2008*

•• *Source: Webopedia. Retrieved August 2014, www.webopedia.com*

# Definitions

<b>Level of Development (LOD)</b>	The American Institute of Architects <i>Document E202 – 2008 Building Information Modeling protocol Exhibit</i> defines Level of Development as follows: “The level(s) of Development (LOD) describes the level of completeness to which a Model Element is developed”. It describes the steps through which a BIM element can logically progress from the lowest level of conceptual approximation to the highest level of representational precision The document defines 5 LODs as described below. Each subsequent level builds on the previous level and includes all the characteristics of the previous levels.
<b>Model*</b>	A three-dimensional representation in electronic format of building elements representing solid objects with true-to-scale spatial relationships and dimensions. A Model may include additional information or data.
<b>Model-based Deliverables</b>	Model-based Deliverables (also known as Model Uses or BIM Uses) are the deliverables expected from generating, collaborating on and linking object-based models to external databases. Model-based deliverables include those specific to the Design Phase (e.g. Immersive Environments), Construction Phase (e.g. Construction Logistics and Flow) and Operation Modelling The process of creating a model or using a model to predict the behaviour of the thing represented by the model.
<b>Model Collaboration Matrix</b>	See <i>Model Progression Specification</i> . The difference in title simply reflects an emphasis on the collaborative nature of managing the modelling process.
<b>Model Element~</b>	A portion of the Building Information Model, representing a component, system or assembly within the building or building site.
<b>Model Progression Specification</b>	A document, usually a drawn matrix, which summarises how the significant Model Elements that comprise a model are to be progressively developed by reference to the Level of Development required for each element at different phases of the project. It also shows who is responsible for this development (the Model Element Author) at each phase. For project team members, whose ability to fulfil their roles is interdependent, it provides a framework for coordinating their activities.
<b>Naming Conventions</b>	A convention for naming things based on a standardised approach to semantics, syntax and formatting. O&M - Operations and Maintenance The process of linking external data relating specifications and manufacturers’ data of as-installed equipment to the objects within the aggregate models, for the purposes of asset maintenance and planning.
<b>Open Standard Specification</b>	An open Standard specification describing the data needed to support operational management, building and system alterations or additions, and asset maintenance scheduling.
<b>Operational Management</b>	A process in which the data outlined in the open Standard specification is used to allocate, manage, and monitor assigned workspaces and related resources.
<b>Parameter</b>	A numerical or other measurable factor forming one of a set that defines a system or sets the conditions of its operation. In this context it is applied to Model Elements or objects and has effectively the same meaning as the broader term Property.
<b>Project Alliancing (PA)</b>	Alliance contracting is delivering major capital assets, where a public sector agency (the Owner) works collaboratively with privat sector parties (Non-Owner Participants). All Participants are required to work together in good faith, acting with integrity and making best-for-project decisions. Working as an integrated, collaborative team, they make unanimous decisions on all key project delivery issues. The alliance encourages effective integration with the Owner.**

~ Source: American Institute of Architects, Document E202 – 2008, Building Information Modelling protocol Exhibit, 2008

\*\* Department of Infrastructure and Transport, National alliance contracting policy and guidelines 2011

Ω Source: Standards Australia, SAA HB 50, 2004

## Definitions

<b>Project Manager<math>\Omega</math></b>	An individual or organisation contracted to administer and manage a project on behalf of the owner. While the scope of project management may vary, to include activities such as organising, planning, scheduling, directing, controlling, monitoring and evaluating, the objective is to ensure that the objectives of the project, manufactured product, or service, are achieved.
<b>Project Procurement Strategy<math>\pm</math></b>	Method of project delivery detailing the participant's methods and outcomes necessary to complete the project.
<b>Project Server<math>\bullet\bullet</math></b>	A computer or device on a network that manages network resources for a project. There are many different types of servers but in this context it usually refers to one or both of the following: <ul style="list-style-type: none"> <li>■ File server: a computer and storage device dedicated to storing files. Any user on the network can store files on the server.</li> <li>■ Database server: a computer system that processes database queries.</li> </ul>
<b>Project Team Integration (ACIF/APCC version)</b>	PTI is a project delivery approach that encourages all project team members (including design consultants and building contractors) at the earliest stages of a project to enhance the level of integration between them. This is to encourage collaborative behaviour and harness the talents and insights of all participants. And also to reduce waste and optimise project outcomes through all phases of design, fabrication, construction and project handover.
<b>Property</b>	A quality, trait or characteristic belonging to a thing. See <i>Parameter</i> .
<b>QTO – Quantity Take Off</b>	The process of creating a bill or schedule of quantities from data held by objects within the aggregate models.
<b>SCI – Supply Chain Interaction</b>	A process that engages with the supply chain to explore and understand the potential for data transfer, best of breed software, just in time delivery, optimisation of materials, material pre-ordering and NC data specification.
<b>Teaming Agreement</b>	A document that sets out the basis on which individually contracted parties will work together for the purposes of meeting their joint obligations.
<b>VC – Virtual Construction</b>	The interrogation of federated models to test geometrical and spatial fit in a rehearsal of the physical construction process.
<b>View</b>	A representation of model from a defined vantage point. This can be outside or inside the model, or when seen from one side of a cutting plane intersecting the model.

$\pm$  Source: Australasian Procurement and Construction Council (APCC) *A Guide to Project Initiation*, 2010

$\bullet\bullet$  Source: *Webopedia*. Retrieved August 2014, [www.webopedia.com](http://www.webopedia.com)

## Appendix C. Further Reading

### By Chapter headings

<b>Australian Landscape</b>	Masterspec New Zealand National BIM survey 2013 (approx 500 qualified respondents) which provides specific insight on the barriers to BIM adoption. The full survey report is available free-of-charge from <a href="http://www.masterspec.co.nz/news/reports-1243.htm">http://www.masterspec.co.nz/news/reports-1243.htm</a> McGraw Hill Construction, SmartMarket Report, 2014
<b>People: Behaviour and Capability</b>	ACIF-APCC Project Team Integration Workbook AIA – BIM Survey CITB (SA) – BIM Initiative, A Practical Guide to BIM ICIS – International BIM Education Report NATSPEC BIM Paper: Getting Started with BIM
<b>Procurement and Contracting</b>	Department of Planning, Transport and Infrastructure (SA) – BIM Requirements and Procedures Department of Health and Human Services (TAS) – Strategic Implementation of BIM NATSPEC – National BIM Guide NATSPEC BIM Management Plan Template SBEnrc – Integrated Project Environments
<b>PTI/BIM Protocols</b>	BuildingSMART Australasia – NBI WG 1: Integrated Project Delivery SBEnrc – Integrated Project Environments
<b>Asset Management</b>	Facilities Management Association of Australia (FMA) Good Practice Guide for Building Information AIA-Consult Australia, BIM Outreach: Facilities Managers – What benefits are there for me engaging with a BIM process?
<b>Information Exchange and National Object Library</b>	AMCA – BIM-MEP AUS BuildingSMART Australasia – NBI WG 3: Object Libraries SBEnrc – Collaborative Object Libraries Supporting the Facility Lifecycle

## Further Reading

Standards	<p>AMCA – BIM-MEP AUS</p> <p>BuildingSMART International – Global BIM Guide Wiki</p> <p>BuildingSMART International – Data Dictionary (bSDD)</p> <p>BuildingSMART Australasia – NBI WG 2: BIM Guidelines</p> <p>CR-CI – National Guidelines for Digital Modelling</p> <p>Department of Planning, Transport and Infrastructure (SA) – BIM Requirements and Procedures</p> <p>Facilities Management Association of Australia (FMA) – Good Practice Guide for Building Information</p> <p>ICIS – Project 03: Classification and BIM</p> <p>ISO/TC 59/SC 13 – Organization of information about construction works</p> <p>National BIM Standard – United States™ Version 3</p> <p>NATSPEC – Australian National BIM Guide</p> <p>Productivity Partnership – New Zealand BIM Handbook</p> <p>Standards Australia – BD-104: Mirror committee of ISO TC59/SC 13project 03: Classification and BIM</p>
Technology	<p>CRC-CI – SpecNotes and Viewer</p> <p>ICIS – Project 02: Specifications and BIM</p> <p>QUT-ARC – Linking BIM, Specifications and BOQs</p>



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Department of Treasury and Finance

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### Victoria

Department of Treasury and Finance

### Queensland

Department of Housing and Public Works

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Department of Defence

### Northern Territory

Department of Business

Department of Infrastructure

### Australian Capital Territory

Chief Minister, Treasury and Economic Development Directorate

### Papua New Guinea

Central Supply and Tenders Board

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# Strategic Forum for the Australasian Building and Construction Industry

**Building and Construction Industry Leadership Collective -  
Bringing the Public and Private Sectors Together**

