Building and Construction Procurement Guide:
Project Team Integration and Building Information Modelling



Strategic Forum
for the Australasian Building and Construction Industry

acif
Australian Construction Industry Forum

Australasian Procurement and Construction Council

Building and Construction Procurement Guide: Project Team Integration and Building Information Modelling

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This Guide does not replace existing Government requirements or industry guidelines, and should only be used in conjunction with the statutory requirements for construction procurement of the relevant jurisdiction.

Contents

Contents

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About ACIF

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

About APCC

The Australasian Procurement and Construction Council Inc (APCC) is the peak council whose members are responsible for procurement, construction and asset management policy for Australian State and Territory Governments. Papua New Guinea is an associate member. The APCC is made up of 11 member agencies.

Over the past 48 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 APCC Council of Chief Executive Officers leads the direction of the APCC, while the Leadership Group drives the overall work program.

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

Strategic Forum for the Australasian Building and Construction Industry

An ACIF and APCC initiative

The Strategic Forum for Construction is a unique body that brings together key stakeholders in the Australasian construction industry. The Forum acts as an entry point and significant interface between government and the 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.

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

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1. Introduction

Background

Construction industry participants in Australia and New Zealand strive for efficient and effective project development, execution and completion.

This Guide 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.[1] Total spending in the building and construction industry reached $233 billion in 2013-14 - $128 billion on engineering construction, $75 billion on residential building and $30 billion on non-residential building. [2]

A study by the Allen Consulting Group found that accelerated adoption of Building Information Modelling (BIM) could increase productivity in the construction sector in Australia by up to 0.2 percent in 2011, by 2015 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) and by up to 0.36 percent by 2012. [3]

These statistics provide an indication of the potential benefits and productivity gains achievable through the adoption of the BIM process. However, much of the benefits of BIM accrue to owners, principals, builders, architects and engineers through cost avoidance via increased speed and ease of generation of shop drawings, building code reviews, forensic analysis of potential building issues, elimination of rework, enhancement of facilities management, improved cost estimation, improved construction sequencing and clash detection to name a few.

For example in the United States, Stanford University Centre for Integrated Facilities Engineering has studied 32 major projects using BIM and reported the following benefits: "up to 40% elimination of unbudgeted change; cost estimation accuracy within 3%; up to 80% reduction in time to generate a cost estimate; a savings of up to 10% of the contract value through clash detections; and up to 7% reduction in project time".[4] The level of the benefits depends on the project and the level of adoption of BIM.

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 and Project Team Integration (PTI) is still relatively immature. "The fragmented and sometimes adversarial nature of the commercial construction industry has been observed to be an impediment to full realisation of the benefits of BIM".[5]

Building Information Modelling (BIM) and Project Team Integration (PTI) Defined

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. BIM is a management and information tool which to be fully utilised and effective, requires cooperation and collaboration of all stakeholders. It is *not* a construction delivery method. "BIM is a term used to describe a myriad of computer software applications that can be utilised by design and construction professionals and increasingly facilities managers alike to plan, layout, estimate, detail and fabricate various components of a building". [6]

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1 Australian Bureau of Statistics (ABS).

2 Australian Construction Market Report (ACMR).

3 The Allen Consulting Group Pty Ltd, 2010. "Productivity in the Buildings Network: Assessing the Impacts of Building Information Models, Report to the Built Environment Innovation and Industry Council.

4 Center for Integrated Facilities Engineering (CIFE), 2007, in, Azhar, S., Hein, M., and Sketo, B. "Building Information Modelling (BIM): Benefits, Risks and Challenges, pp3.

5 Ilozor, B. D. and Kelly, D. J., 2012. "Building Information Modelling and Integrated Project Delivery in the Commercial Construction Industry: A Conceptual Study," in, Journal of Engineering, Project, and Production Management, 2012, 2(1), pp.23-36.

6 Ilozor, B. D. and Kelly, D. J., 2012. "Building Information Modelling and Integrated Project Delivery in the Commercial Construction Industry: A Conceptual Study," in, Journal of Engineering, Project, and Production Management, 2012, 2(1), pp.24.

1. Introduction

Project Team Integration (PTI) refers to the *process and level* of integration, cooperation and collaboration of the stakeholders in a construction project. The level of integration is substantially up to the Principal/ Client. 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.

Asset and Facilities Management (FM)

Asset and facilities management is often forgotten in early planning for building and construction projects. BIM facilitates consideration of maintenance issues prior to construction commencing. Adoption of BIM for asset and facilities management means that FM professionals become integral participants in the design and planning of all buildings.

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

Experience in asset delivery through capital investment projects varies greatly, from organisations that routinely deliver complex programmes to those that may deliver one project. However, a common factor that unites them is that capital projects represent a strategic investment for the Client, typically form part of a long term strategic plan to increase shareholder return, serve socioeconomic need, take market share, enter new markets or gain competitive advantage.

Capital works assets are procured and managed to serve long terms needs of clients which include knowing that:

- capital is being deployed effectively
- risks are being managed and appropriate trade-offs made
- returns are being optimised and commercial viability regularly tested
- business benefits will be delivered and aligned with end user requirements
- informed strategic decisions are taken at Board/Government agency and project level
- reporting is accurate, timely and can be relied upon by stakeholders

BIM is a key tool for procurers, designers and constructors, to ensure that these needs are met through the investment in new assets.

It is increasingly being used by asset and facility managers as a valuable tool to manage the efficient use of capital stored in those assets, through their management and operation.

Purpose

The purpose of the information contained in this Guide is to provide owner personnel and procurers of projects with an outline of potential procurement practices, processes and steps which might 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.

The Guide "*A Framework for the Adoption of Project Team Integration and Building Information*", which was released in late 2014, is the leading document in a series of guides to be developed throughout 2015 and beyond. These guides will provide the details for implementation in both government and the building and construction industry. [7]

7&8 A Framework for the Adoption of Project Team Integration and Building Information Modelling, 2014. (ACIF and APCC)

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1. Introduction

This Guide is also intended to promote consistency of approach 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.

While there are already a number of other documents in existence that deal with adoption of PTI and BIM, this Guide specifically addresses the procurement aspects of the use of BIM and PTI for specific projects.

This Guide does not replace existing Government requirements or industry guidelines, and should only be used in conjunction with the statutory requirements for construction procurement of the relevant jurisdiction. The guide explains how to use and navigate through the procurement process to adopt PTI and BIM. The Guide takes into consideration pre-existing material and defines a 'core' set of commonly used baseline processes for developing procurement strategies that can be used to consider the suitability of adopting BIM on a specific project.

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. APCC and ACIF 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.

It is assumed that readers of this Guide will have at least a basic understanding of BIM, gleaned from their own experience and or the Framework[8]. Whilst project team integration and the modelling functions of BIM are not necessarily new, it is the usage and integration of project data in this environment that is new to 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.

Although it is not impossible to implement elements of BIM technology using more traditional procurement delivery models other than collaborative models, these delivery models are not an ideal fit to reap the full benefits.

However, there are still advantages in requiring BIM for projects procured by these 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.

Projects using BIM which are procured through traditional methods may be handled by engaging a lead consultant to manage the design and documentation team output including management of the associated BIM Model. A BIM manager can also be engaged by the contractor during the construction stage. A process for transferring information to the Model and ensuring the accuracy of 'as-built' BIM models needs to be clearly defined so that all parties understand their obligations. The information management requirements to facilitate BIM can be substantial and specialised beyond the scope of a 'traditional' lead consultant or contractor.

As a lead consultant or a BIM Manager, 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.

'Fully Integrated'[9] BIM in design, documentation and construction requires 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 are different from 'traditional' methods and are based on a case by case basis and accommodate flexibility across the project lifecycle.

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. Asset managers or facility management professionals may also be involved in all stages of the project sign-off.

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9 Fully integrated is described as the hosting of a single integrated model on model servers.

1. Introduction

It is possible to define BIM information requirements (dependant on how BIM is used) such as BIM Management Plan proposals, precise Levels of Development (LODs) for various elements and 'as built' Models to facilitate future management and works, before the project commences.

A BIM management plan can be a project tool for defining requirements, and can include consideration of LOD and the model types needed. Intellectual property, risk sharing and insurance are also critical procurement and contractual matters for early consideration by the Client and project team.

How to use this Guide

This Guide is a companion document to the APCC and Austroads, *Building and Construction Procurement Guide – Principles and Options*.

This Guide is also a companion to the *Framework for Adoption of Project Team Integration and Building Information Modelling*, also published by ACIF and APCC. The *Framework* describes the necessary elements, their interconnected relationships, and what should occur to enable accelerated adoption of PTI and BIM.

This Guide has been designed as a reference document to complement rather than override existing policies and requirements and is to be read in conjunction with those to ensure that any additional national or local level requirements are met.

Additionally, the Guide also provides abstracts of corresponding guides, such as:

- *A Guide to Project Initiation - for Project Sponsors, Clients & Owners* (ACIF and APCC)
- *The Case for Project Team Integration* (ACIF and APCC)
- *Project Team Integration Workbook* (ACIF and APCC)
- *Guide to Successful Project & Asset Delivery - Getting it Right Up Front* (ACIF and APCC)

Scope

The key propositions behind this Guide are:

- the adoption and implementation of BIM and PTI will modify the typical procurement strategy process;
- BIM is no more than a tool to assist with design, construction, operation and management of an asset;
- the decision by a project sponsor to require BIM may call for specific procurement approaches to be considered and should support the procurement strategy; particularly when constructors are appointed to the project team before design is settled; and
- recognising that BIM is a factor in determining choice of a delivery model or procurement processes.

The Guide provides the procurer with the reference tools and templates necessary for planning to use BIM for a construction project.

Primarily, it is intended to apply to the procurement of commercial or multi-residential building or multi-unit residential infrastructure for projects of any scale and value, subject to BIM suitability.

However, the adoption of BIM and PTI may also be utilised in infrastructure areas such as roads, rail, ports and public utilities, as this Guide outlines generic processes in defining suitability of adoption in any given built project.

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1. Introduction

Who should use the Guide?

This Guide has been designed to assist project sponsors[10] that have been tasked with the responsibility of planning future building and construction procurement. This Guide is not meant to be prescriptive. Its intention is to alert project sponsor personnel to the main items that need to be taken into account, and to steer them through the analysis and decision making process.

Professional judgement is required to work through each of the nominated steps to ensure that all relevant items, together with any project-specific or jurisdictional specific matters not covered by this Guide are appropriately considered. It is therefore essential that procurement strategies are developed by personnel experienced in building and construction procurement and contracting.

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10 Project sponsors are the client, financiers, and end users who, individually or jointly, determine the risk allocations and terms of the head contract offered to the head contractor. Whilst during design and construction there will usually be only one organisation acting as the client under a contract with a head contractor, its ability to determine all relevant commercial and technical conditions may have been influenced or even controlled by providers of finance, or the requirements of end users.

2. To BIM or not to BIM: Matching Project Objectives with BIM Goals and Uses

Project Initiation: the Business Case and BIM

The project procurement strategy will define the process and management of the BIM model creation. It is imperative that the decision to use any delivery method such as Design-Bid-Build (DBB), Design and Construct (D&C) and Early Contractor Involvement (ECI), Integrated Project Delivery (IPD) be determined during project inception so that BIM can be properly structured and managed to support the procurement strategy. The procurement strategy will also determine the level of client involvement at each project stage. This should be made clear to the Client during the assessment of options[11].

The adoption and implementation of PTI and BIM will modify the typical procurement process. By exploring all available information and options, procurers can ensure that opportunities for achieving increased value-for-money and improved infrastructure investment outcomes are readily identified and capitalised on.

The utility of BIM as a design, construction, and asset and facility management tool is only maximised if it is addressed at the Project Initiation phase of a project, as one part of settling on a procurement strategy.

This is because adoption of project team integration and BIM introduces several new options for decision making and will require budget consideration as well as consideration in terms of business need. For example, the primary need may be the construction of a new school to meet increasing population growth; however, it may be that there is a problem in the current infrastructure for schools with lack of drawings and schematics to support maintenance and safety updates. This is a secondary issue which may be solved by the implementation of BIM (there may also be other ways; however, this is where these considerations commence). The question relates to importance of the secondary benefits.

This means that decisions around whether to utilise BIM and use an integrated project delivery method pushes the process back into consideration at the 'Business Needs stage".

11 NZ BIM Guide Handbook, A Guide to enabling BIM on building projects, July 2014

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3. Early Project Team Integration

The Importance of Integration

Delivery models that use greater collaboration amongst project team members and use BIM can drive out waste and avoid disputes to deliver outstanding project outcomes. Outstanding projects meet and deliver the service needs of end users and those that manage the assets on their behalf.

The collaboration required to deliver such outcomes requires alignment of goals across the project team, including key project sponsors. That alignment in turn is a product of the degree to which the team members are indeed a team – that is to say, the extent to which they are integrated. The goal of Project Team Integration and the opportunities that Project collaboration and BIM software can provide in terms of cross-Project Team (information and decision making) transparency will amplify the importance of high level managerial choices (for both State/Principal and Contractor) regarding a flat vs hierarchical organisational structure.

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

Planning for Integration

All procurers must decide how much integration or collaboration is appropriate or desired on their projects. There are straightforward approaches that can be used to enhance collaboration amongst project team members and identify issues to be addressed to increase effective team integration.

The aim is to create a common set of objectives for the project, that everyone is committed to achieving. How to do this? The procurement strategy chosen by the project sponsor can be a key enabler together with selecting the 'right' project team members. It is important to involve project team members in setting the objectives, and the strategies and actions that are included in the project management plans that describe them e.g. quality management plans, safety plans, material handling protocols, communication plans.

This initial involvement is critical to all members of the team feeling that they own those plans. Why? It is because involvement is necessary to achieve ownership. Ownership leads to commitment and achievement of the common project objectives.

The *Project Team Integration Workbook* published by ACIF and APCC in 2014 provides a checklist for clients, designers and constructors to assess the degree to which they are able to integrate a project team, and identifies issues that need to be addressed to deliver optimal project outcomes. The focus is on the behaviours needed to ensure the project team works collaboratively and efficiently, with each member respecting the contribution of other members.

The *Workbook* also provides a framework for the decision making required by the project team to enable the collaborative behaviour that needs to become the norm - "the way we do things here".

The critical challenge for project sponsors and project team leaders is to understand and address the cultural and behavioural change needed to do things differently.

In a project-based industry, every project creates and is dependent on, a unique team of people. The work involved is undertaken by a mix of project sponsors' staff, contractors, and consultants. Teamwork is harder to achieve than in a conventional business setting, because of the following challenges:

- the team is assembled for one project, and is then disbanded;
- it is made up of multiple organisations and bosses;
- on site staff owe primary allegiances/responsibilities to their bosses, not the project;
- contractors and consultants join the team when they have tasks to perform, and then leave it;
- teams are selected afresh for each project without regard to whether individual team members have worked together before; and
- by and large, teams are selected with more regard to price than the ability of individual team members to work collaboratively.

3. Early Project Team Integration

Identifying Shared Objectives

Who needs to do what and when depends, in part, on the stage of the project life cycle being considered. The earlier the stage, the greater the visionary involvement of project sponsors.

The later the stage, the greater the strategic or operational role for the main contractor/project manager, and leaders of project team members in facilitating collaborative behaviour.

The *Workbook* will inform project sponsors of the decisions needed to determine the degree to which they are able to integrate a project team. It also highlights the decision-making required by the project team to enable collaborative behaviour becoming "the way we do things here".

The *Workbook* identifies 18 separate decisions, listed in Table 1 below, that need to be made and that will influence *the* way in which project teams are created and managed. Each is capable of several possible outcomes ranging from "Red" or business-as-usual to "Blue" leading practice.

Table 1: Collaboration Decisions

Project sponsor decisions	Project delivery team decisions	
1. Environment & culture	7. Client business integration	13. Collaboration & communication
2. Trusting relationships	8. Scope management	14. Wasted effort
3. Project leadership	9. Team selection	15. On-the-job learning
4. Client risk tolerance	10. Team integration	16. Project control standards
5. Financial management	11. Project start up	17. Technical, OHS, environmental
6. Project delivery model	12. Stakeholder involvement	18. Continuous improvement

Source: The Case for Project Team Integration Team (ACIF and APCC)

The decisions are required at different stages of projects. The earliest and arguably most significant decisions are taken during the early stages of project initiation. By definition, these decisions are taken by project sponsors, and substantially determine the environment or culture within which the project team will operate. Ideally the project delivery team decisions will implement those taken by project sponsors.

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3. Early Project Team Integration

The Procurer's Role

The project sponsor decisions can be simulated as part of the project initiation process, using a facilitated workshop gap analysis to identify what actions are needed to bridge the gap between the likely outcome, given known commercial and technical constraints and assumptions, and the desired outcome for each decision.

The actions generated from this gap analysis help determine whether project sponsors are capable of appointing contractors early i.e. to be involved in design before it is concluded.

The project sponsor decisions will typically involve the staff and advisers. They have the capacity to determine the bounds within which project delivery team decisions are made. They need careful thought and discussion in a workshop during project initiation, to encourage integration and collaboration, and drive excellent project outcomes.

The decisions made by project sponsors substantially determine the manner in which the project delivery team is conditioned to behave whilst the team's own decisions will determine the mechanisms, through applied tools and techniques, which will reinforce these behaviours. These decisions are key to whether a collaborative approach to the project is actually achieved.

Collaboration by project team members creates a common set of objectives for the project, that everyone is committed to achieving. This is done by involving all team members in a series of briefings and facilitated workshops focused on identifying actions needed to deliver multiple project outcomes.

The outcomes include:

- formulating process tools (management plans, programs, etc), for determining how the project team will perform;
- highlighting the process choices available to minimise inefficiency, repetition and waste;
- reinforcing the roles and responsibilities for team members;
- identifying potential risks to integration and collaborative behaviour; and
- reinforcing the project culture.

Procurers have the opportunity to hold facilitated workshops during project initiation, to address the key decisions that set the scene for the project culture. They may also include provisions in selection documents requiring designers and constructors to hold collaborative workshops to achieve those outcomes. The *Project Team Integration Workbook* suggests outcomes ranging from "red" or business-as-usual to "blue" leading practice for each of the 18 decisions listed in Table 1. Briefings and workshops for the 12 project delivery team decisions are used to agree on how improved outcomes are achieved. The participants for briefings and workshops will vary from project to project. Importantly all those who could influence the outcomes need to participate. This is at three levels, each of them an opportunity to drive the elimination or minimisation of the "red" outcomes and achievement of "green" and "blue" outcomes.

Workshop participation levels:

Level 1: Brings together the proprietors or senior managers of the designers, the main contractor, and trade contractors. They are briefed on how the project is to be managed, and how the desired levels of integration are to be achieved. The briefing is given by senior management of the project sponsors involved in day to day management of the project.

Level 2: All senior site staff of the main contractor, designers, and trade contractors, work through the 12 project delivery team decisions (numbers 7 to 18 listed above) in workshops to agree on actions required to achieve target outcomes, and formulate the delivery mechanisms. The delivery mechanisms include the tools needed to plan for and manage all aspects of the project.

4. Incorporating PTI and BIM into the Four-Step Development Process

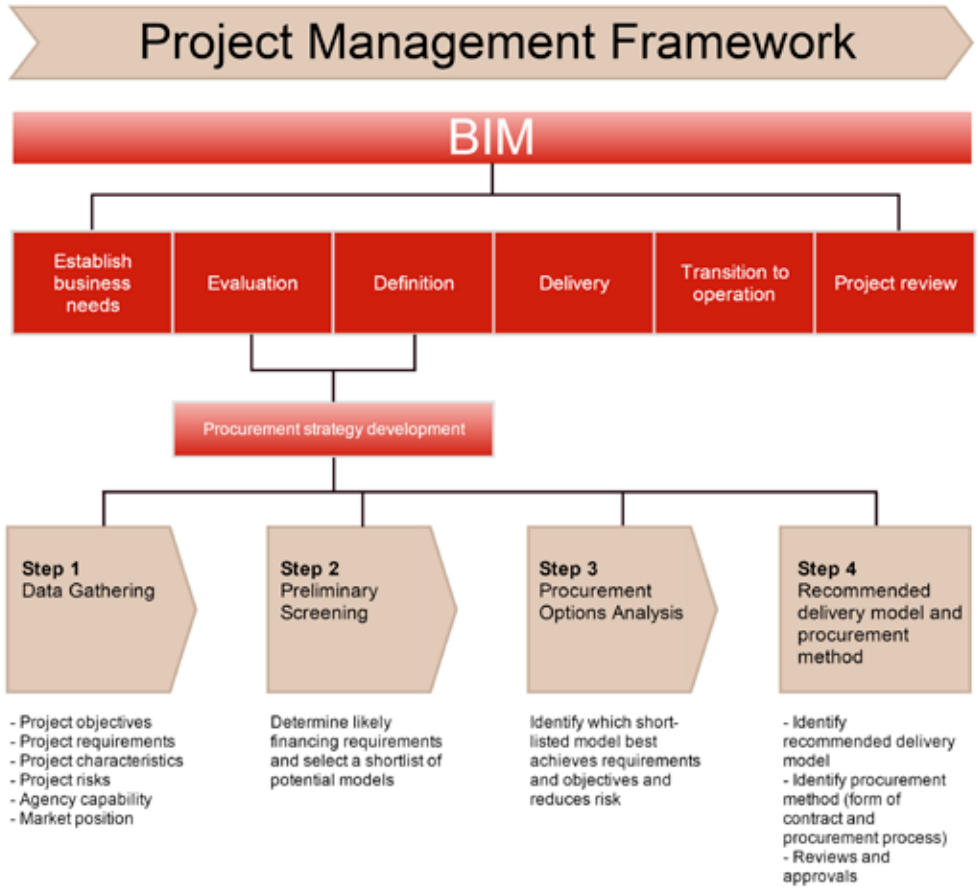
Each of the 12 project delivery decisions involves determining:

- which of the possible outcomes (from red to blue) is likely to be achieved on this project, given the background, experience and skills of those making the decisions;
- what is the target outcome that could be achieved;
- what actions are needed to enable the target outcome to be achieved; and
- how progress towards achieving the target outcome will be measured.

Level 3: The on-site job captains, foremen and supervisors, develop detailed tactics to deliver the target outcomes.

Figure 1 below (*Building and Construction Procurement Guide*, Austroads and APCC) shows the procurement strategy development commencing after consideration of business needs. The introduction of BIM/PTI needs to be taken into account earlier.

Figure 1: Incorporating PTI and BIM into the Four-Step Development Process



Source: Building and Construction Procurement Guide, Austroads and APCC

It should be noted that BIM may not be appropriate for all projects, neither is PTI appropriate or required for all construction projects.

When the choice has been made to use BIM on a project, the efficiencies gained are potentially greater than the cost of implementation of BIM at this current time depending on the size and value of the project. Full BIM implementation is currently costly, but as BIM becomes more common and standard practice in Australia, and as the technologies advance the benefit/cost ratios on any given project are likely to improve for using BIM.

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4. Incorporating PTI and BIM into the Four-Step Development Process

The procurer may choose a set of specific BIM requirements or uses or a minimum limit for which BIM is to be implemented based on size, scope, complexity and value of the project. Alternatively, BIM may be used as the whole of lifecycle model – which includes asset and facility management.

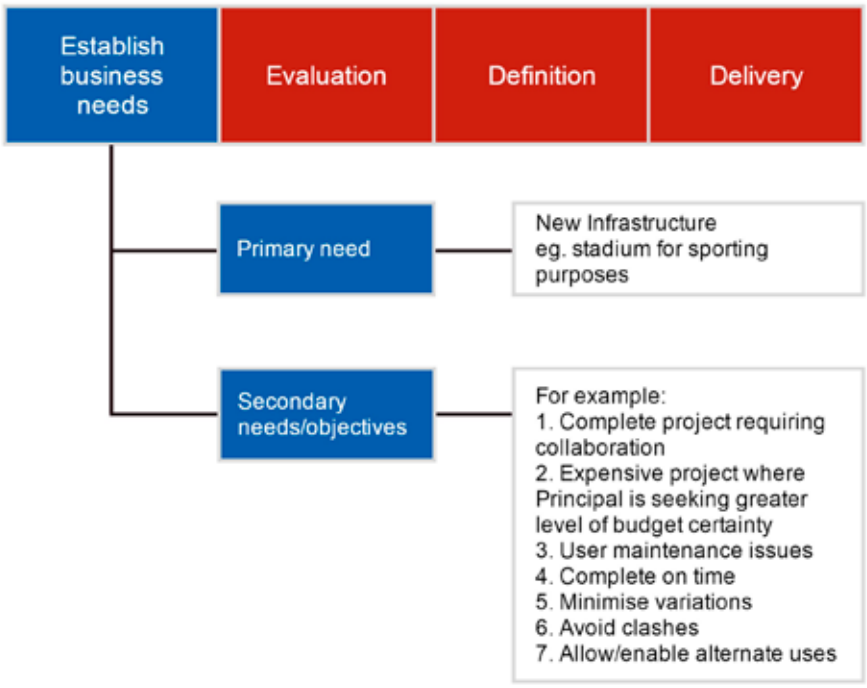
The Business Case will describe a range of options using and not using BIM, and using or not using integrated delivery models. In order to inform the decision makers, the Business Case will need to address the benefits and costs of these alternatives, and issues such as market readiness, staff capability and level of adoption to name some. However, first is the determination of the business needs.

Establishing Business Needs and the potential for PTI and BIM

Stakeholder/User workshops are a valuable method of developing and analysing primary and secondary needs and to develop the need requirement or User Brief. There are various tools and techniques for conducting these workshops and they are similar to those used for risk identification and value management.

Figure 2 demonstrates the difference between primary and secondary needs. Clients/Principals need to establish the relative importance and cost benefit of addressing secondary needs. A project scenario of the construction of a new sports stadium is assumed for illustration purposes.

Figure 2: Considering Business Needs and PTI/BIM



Source: Robyn Hardy Adjunct Professor, University of Canberra

Having established the primary and secondary needs, the task is now to match these with levels of BIM implementation.

4. Incorporating PTI and BIM into the Four-Step Development Process

Table 2 below is an example of *one possible decision making tool* that may assist in determining whether the use of BIM would aid in achieving project objectives at a cost that is warranted by the value of the added benefits over and above those offered by other design tools.

Table 2: Sample analysis method for Secondary Benefits of Project Implementation Delivered by BIM - Option: Full BIM utilisation.

Project Objectives from Project Initiation Value Management	Weight	Potential Contribution of BIM										
		Low 1	2	3	4	5	6	7	8	9	High 10	Total
Minimise variations	0.10								8			0.8
Complete on time	0.30							7				2.1
Budget certainty Complexity of Services	0.50							7				3.5
Enhanced early decision making	0.20								8			1.6
Risk and opportunity scan	0.50								8			4.0
Complexity of services	0.50									9		4.5
Total												

Source: Adapted from CRC for Construction Innovation

The project objectives will usually be drawn from the project initiation stages of the project, often from value management studies that both identify objectives and rank them. The potential contribution from using BIM could also be derived from value management studies or an assessment by the team undertaking project initiation.

Using "*a New Stadium Scenario*", in addition to Business Case considerations of Do Nothing, Build a new Stadium, Build a smaller stadium, Refurbish an old Stadium for example, each option would have the added consideration of BIM and delivery model (eg full BIM and full Alliance as opposed to limited BIM managed by a separate BIM Manager under a traditional Design-bid-build approach) and these would be analysed according to these secondary benefits.

The importance of consideration at this stage is due to the varying cost of the implementation of BIM (and the benefits) which needs to be a part of the Business Case. If the delivery options are turning toward a traditional method using BIM it may be that a BIM Consultant and/or project team is required to be engaged up front to work for the Principal for the duration of the project, rather than say a scenario of engaging a builder on a design and construct basis and requiring BIM usage or a fully integrated team utilising BIM. The costs would be markedly different.

The project objectives will vary from job to job including the complexity of services. Using this analysis method referenced in Table 2, the higher the total, the more likely it is that BIM would be a positive contributor to the project objectives being achieved. However, these would then be balanced with cost considerations.

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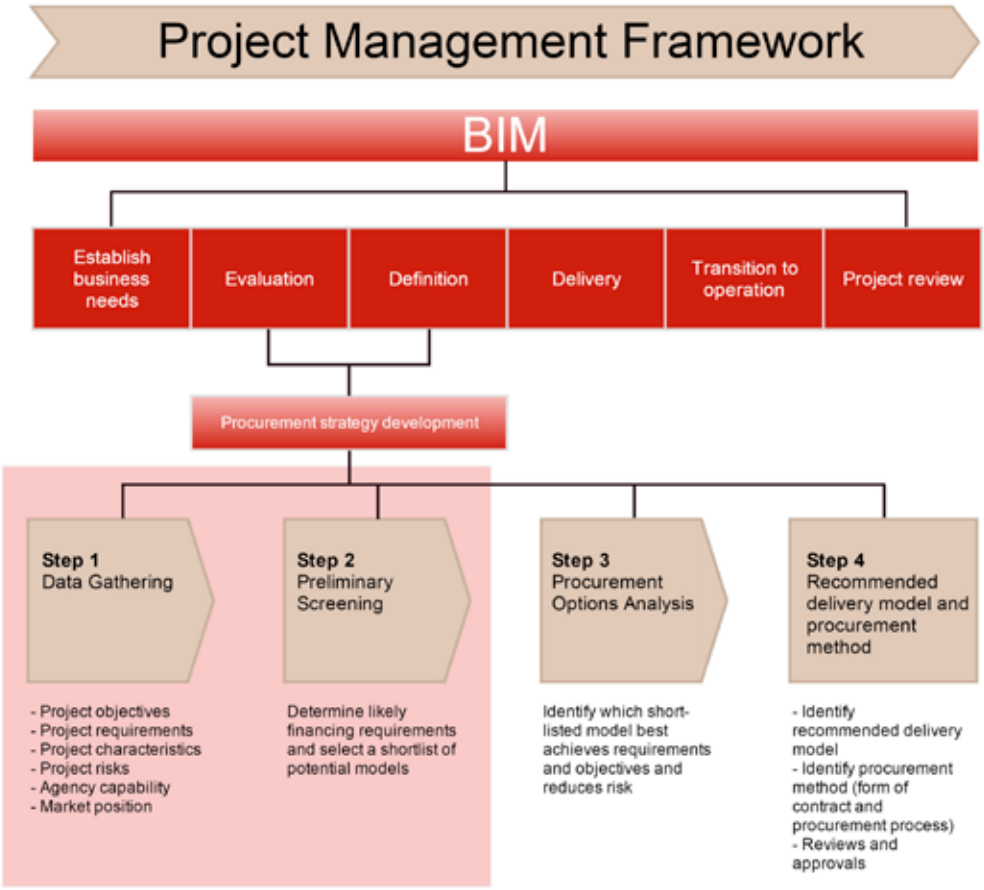
4. Incorporating PTI and BIM into the Four-Step Development Process

Procurement Strategy Development Steps 1 and 2: Data Gathering and Preliminary Screening

Each of the areas under Step 1 Data Gathering and Step 2 Preliminary Screening will require assessment in relation to the use of PTI/BIM.

Figure 3: Incorporating PTI and BIM into the first two steps of the Development Process



Source: Building and Construction Procurement Guide, Austroads and APCC

Of particular importance in this initial analysis is the Principal's capability and that of the market. Requiring fully integrated BIM in an immature market will be fraught with difficulty.

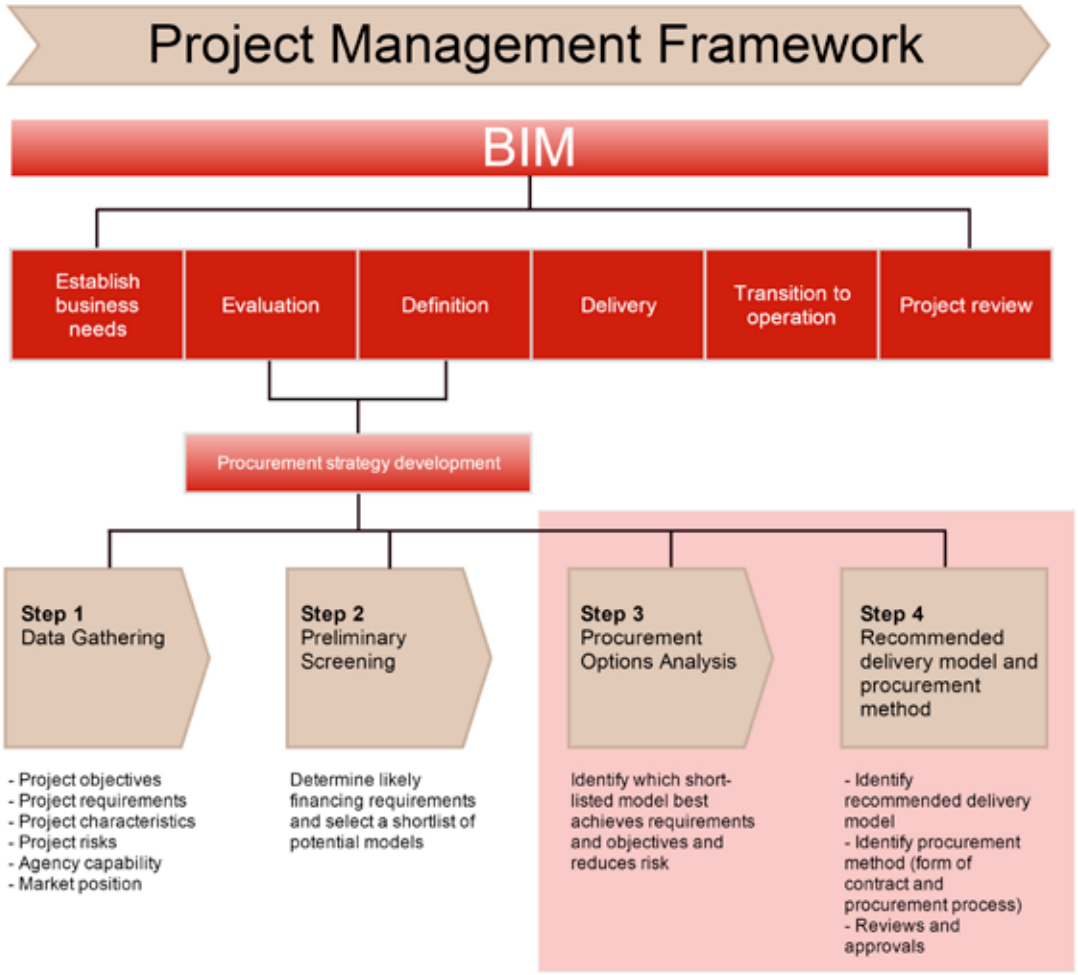
An example of choosing not to implement BIM on a project may include:

- the project is small in scope; or
- the construction and modelling of the building would add significant cost without providing an equal or greater benefit; or
- the contractor or project teams are not capable of implementing BIM; and or
- the scale of the project would prohibit smaller firms (SME's) from competing.

4. Incorporating PTI and BIM into the Four-Step Development Process

Procurement Strategy Development Steps 3 and 4: Procurement Options, Analysis and Recommendations

Figure 4: Procurement Development Steps 3 and 4 Procurement Options, Analysis and Recommendations



Source: Building and Construction Procurement Guide, Austroads and APCC

In a traditional delivery model, a BIM service or BIM information may be required by a separate consultant BIM team contracted by the Principal to give advice. In this case the designer is separately contracted and required to provide input to the BIM model as is the Builder and other contractors.

The engagement of an independent auditor or a third party auditor may be required to review the consultants or BIM team contracted work.

Another example is a Financed or Public Private Partnership. Here the Principal is interested in reported progress (but arguably lacks control of the build as this is a service model) but has a stake in the final asset (assuming a Build-own-operate-transfer (BOOT) model) when the asset is finally transferred back 20 years later. This implies BIM for facilities management. These management considerations also need to be taken into account at the initial stages.

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4. Incorporating PTI and BIM into the Four-Step Development Process

Delivery Models

Traditional or Construct Only: The Principal engages a designer to design or a construction manager to specify a project and calls for tender for the Construction (or implementation).

Note: Contractor takes on Design risk.

- Construction management;
- Construct only.

Design & Construct: The Principal/Client contracts to an entity (company or consortium) that is responsible for both the design and construction (or implementation) of the project.

- Design Development & Construct;
- Design, Novate and Construct;
- Design and Construct (D&C);
- Design, Construct & Maintain (DCM).

Managing Contractor: This method of delivery/procurement model is normally used for large complex buildings.

This relationship-style delivery model, based on collaborative principles, involves head contractor being engaged as the 'managing contractor'.

The managing contractor manages the development of the design, coordinates production of construction documentation, enters into contracts and manages the delivery of the works on behalf of the project sponsors.

Construction Management: The Principal/Client enters the services of a manager of the construction process but accepts some risk and reward on the cost outcomes.

- Project Management;
- Engineer, Procure & Construction Management (EPCM);
- Cost Plus;
- Cost Reimbursement;
- Performance Incentive.

Direct Manage: The delivery model involves the project owner directly managing the full delivery of the project works.

PPP/Financed: This method of delivery model involves the project being wholly or partly financed by someone other than the Principal/Client.

- Construction Finance;
- Private Public Partnership (PPP);
- Build, Own, Operate (BOO);
- Building, Own, Transfer (BOT);
- Build, Own, Operate, Transfer (BOOT);
- Design, Construct, Maintain and Operate (DCMO);
- Design, Build and Operate (DBO) ;
- Design, Construct, Finance and Operate (DCFO).

4. Incorporating PTI and BIM into the Four-Step Development Process

Relationship Contracting: These methods of procurement attempt to align the goals of the Principal/Client and contractor (and other relevant parties) so that all decisions are made for the benefit of the project.

- Alliance
- Early BIM Partnering (EBP).
- Early Contractor Involvement (ECI).
- Partnering.

Table 3 (overleaf) summarises the differences between these delivery models with respect to BIM Implementation

Source:
1. Building and Construction Procurement Guide Principles and Options. Austroads and APCC.
2. Consult Australia.

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4. Incorporating PTI and BIM into the Four-Step Development Process

Table 3: Summary of Differences between Models of Construction Delivery with respect to BIM Implementation

Implications/Issues	Delivery Model		
	Traditional, Design and Construct and Management Models	Relationship or Partnering models	Financing Models
Point of engagement of BIM service provider	Depends on the Principal/Client. Conceivably a BIM consultant could be employed from the outset to work alongside the Designer/Architect and then go on to work with the contractor. However, as the designer's role falls away to a large degree during the construction phase, there is an issue with any need for further input to the model from this stakeholder. If the designer is engaged as the Superintendent (which often occurs) then this causes a conflict of interest or difficulty if they must then input into the model during construction from the design perspective.	At the same time of forming the partnership/ alliance	Likely to be engaged by the consortium once it is established. In a sense similar to Relationship model except that the Client is not included as a partner here. The Client would be a recipient of information.
Principal Client level of control/ownership of BIM model	Very High	Medium. One of the partners only	Low. A recipient of data and information.
Level of integration of project team	Low unless forced through individual agreements.	Very High	Could be very high but controlled by the Consortia not the Principal
Consideration of SME's	Would need to be enforced through procurement and agreements	Would depend upon the partners and whether they agree to this kind of support.	Would have to form part of the Principal's original requirements to be enforced.

4. Incorporating PTI and BIM into the Four-Step Development Process

Implications/Issues	Delivery Model		
	Traditional, Design and Construct and Management Models	Relationship or Partnering models	Financing Models
Contractual relationships	Multiple between the Principal and other stakeholders requiring cascading and complementary clauses to ensure cooperation and provision of information to the Model.	Single integrated agreement if Alliancing. With lesser model of Partnering may have other side agreements.	Depends on the model, but could be a single contract between BIM provider and Consortia. May also be more complex.
Communication relationships	Very complex with multiple strands and stakeholders are required to be coordinated and managed.	Optimal coordination and communication in an Alliancing model where all information is open and shared.	Likely to be high amongst the members of the Consortia. This depends upon their level of agreement.
Level of capability and management required by the Principal	Very High dependence on in-house resources and BIM provider to manage the Model and ensure input from parties.	Shared responsibility. All parties in an Alliancing model contribute to the management and open information sharing.	Low as long as there is capability to specify end data and information requirements.

Source: Robyn Hardy Adjunct Professor, University of Canberra

Delivery Models and BIM-Benefits

BIM can benefit all of these delivery models referred to in Table 4 below. However, the issue is the degree. It is not exact to say that Construct only and Construction management etc. would not have the same benefits at every stage. It is just the degree due to scheduling of contribution.

For example, if a Construction Manager had a BIM consultant the benefits would be almost equal to Relationship contracting – just not as easy.

Table 4 summarises the generic potential benefits of BIM under different delivery models. It should be used as a general guide only. Each project will have particular complexity and characteristics for determining procurement methodology and the delivery model the procurer will take. Additionally, the procurer should take into consideration risk and any distinctive aspects of the applicable delivery model including how the teams will integrate and adopt with the appropriate delivery model.

Note to Table 4: In identifying who receives the benefit on different models of use will drive who acquires the benefit.

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4. Incorporating PTI and BIM into the Four-Step Development Process

Table 4: Delivery Models and BIM-Benefits

Potential BIM Benefits	Traditional or construct	Design & construct	Construction Management	PPP/Finance	Relationship Contracting
Site utilisation planning	✓	✓		✓	
Modelling to existing conditions	✓	✓		✓	
Design visualisation & review	✓	✓		✓	
Promotes innovation		✓		✓	✓
Increase co-operation between the parties – collaboration	✓	✓		✓	
Clash detection/coordination	✓	✓	✓	✓	✓
Quantity take-off & Cost planning	✓	✓	✓	✓	✓
Costs are transparent – open book		✓		✓	✓
Procurement/Supply	✓	✓		✓	✓
Manufacturing	✓	✓		✓	
Planning construction scheduling & sequencing		✓	✓		
Reduce disputations	✓	✓		✓	✓
Share the benefits or costs that might affect any of the parties during the project.		✓	✓	✓	✓
Share significant risk	✓	✓		✓	✓
Reduce significant risk	✓	✓	✓	✓	✓
Project is governed by a BIM Team with representatives from all parties	✓	✓	✓	✓	✓
Decisions by the team unanimous	✓	✓		✓	✓
Maintenance scheduling		✓		✓	
Building syst. perf. Analysis		✓		✓	
Space management/tracking		✓		✓	
Asset management		✓		✓	
Disaster planning		✓		✓	
Workforce Planning	✓				
As Built Model	✓				

Source: Australian Construction Industry Forum and Australasian Procurement and Construction Council

5. Specifying BIM Requirements

Procurers need to be clear about the deliverables they need from designers, and constructors, when they decide to require BIM to be implemented. A client attempting to define specific BIM requirements without the right capability to do so can obscure, rather than clarify, important patterns and relationships, reducing their effectiveness for their intended use.

The Client's focus is better spent on developing a clear Project Brief articulating BIM deliverables and their purpose which can be interpreted by those planning to author the BIM.

Demystifying the most common acronyms

To articulate BIM deliverables, "*LODs*", "*BIM Dimensions*", and "*Authorised Uses*" are frequently referred to, but are also widely misunderstood.

Level of Development (LOD)

LOD – originally Level of Detail – which was repurposed as Level of Development by the American Institute of Architects (AIA), has become an industry recognised acronym. Level of Development describes the "*minimum dimensional, spatial, quantitative, qualitative, and other data included in a Model Element to support the Authorised Uses associated with such LOD*." [12]

BIM Dimensions

Another approach widely referenced to articulate the required uses of BIM is the concept of stating additional "dimensions" required beyond 3D. The definition of these dimensions is often debated, however the typically accepted definitions are:

- 4D – Time sequencing information;
- 5D – Cost, rates and quantities associated with the model, and;
- 6D – Facilities Management, asset management and lifecycle management.

It is recommended not to use dimension numbers beyond these. It is clearer to just describe the BIM use, e.g. thermal simulation.

Authorised Uses

The concept of authorised (or warranted) use is linked to the collaborative use of models and LOD. The premise of this is to specify who is allowed to do what with the BIM being authored. If this is not specified there is a risk that problems may result from someone trying to use a model or model elements for purposes not intended by the author. Therefore in addition to the degree of certainty of the elements within the BIM as implied by the LOD definitions a model author can also agree to an authorised use of the BIM, categorically stating the elements they author are suitable for that intended purpose.

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12 AIA Document G202–2013, Project Building Information Modelling Protocol Form: AIA Document G202™–2013 is a form that is coordinated for use with AIA Document E203™–2013, Building Information Modelling and Digital Data Protocol Exhibit. Its purpose is to document the agreed upon protocols and procedures that will govern the development, transmission, use and exchange of building information models on a project. It establishes the requirements for model content at five levels of development, and the authorized uses of the model content at each level of development. Through a table completed for each project, AIA Document G202–2013 assigns authorship of each model element by project milestone. G202 defines the extent to which model users may rely on model content, clarifies model ownership, and sets forth building information modelling standards and file formats AIA Document G202 – 2013 Building Information Modelling and Digital Data Exhibit.

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5. Specifying BIM Requirements

The LOD Table

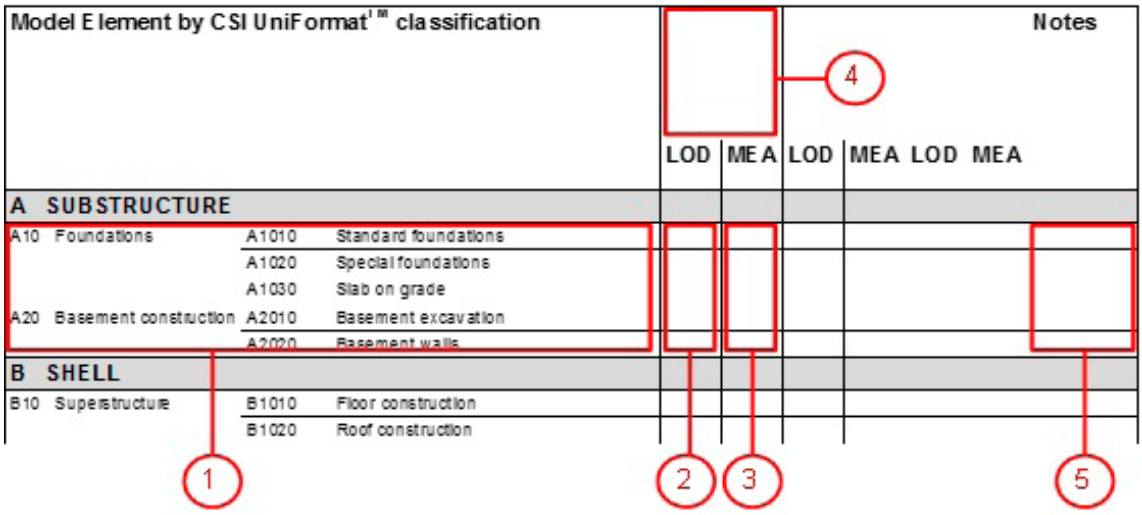
While the aspects raised previously are some of the means available to quantify the deliverable they do not define who is responsible for authoring them or by when. In essence, LOD represents the extent to which information about an element can be relied on and a LOD Table (also known as a Model Element Table, Model Progression Specification or Model Collaboration Matrix) represents who has authored which LOD at a particular point in time.

Although there are a number of LOD Table templates available, there is currently no industry accepted standard. Practitioners are faced with different LOD Table formats from project to project, making their interpretation more difficult.

The purpose of a LOD Table is to define the desired deliverables or outcomes, not the means of achieving them. Therefore only the critical milestones and corresponding model element content (or data) should be articulated in the Table. If the LOD Tables are made too complex or attempts are made to define every aspect of model collaboration before this is realistically possible, they can absorb a disproportionate amount of energy and be counterproductive.

Components of LOD Tables

Figure 6: Model Element - LOD Table - example



Source: NATSPEC BIM Paper NBP 001: BIM and LOD – Building Information Modelling and Level of Development. First published 2013.

1. Model Element list: A list of model elements, usually ordered by an established element classification system, e.g. UniFormat™. The amount of detail required for a project can be adjusted by selecting the desired level of a classification system or pre-selecting a set of elements. Items not required to be modelled can be indicated by an abbreviation such as 'NM' (non-modelled) or 'NR' (not required).

2. LOD value cells: Cells for entering LOD values for each Model Element are cross-referenced to nominated project milestones. Sometimes this arrangement is reversed, with project milestones listed in columns for each LOD value.

3. Model Element Authors (MEA) cells: Cells for indicating the MEA responsible for developing each model element to the required LOD. Some tables, like the *AIA G202-2012* shown here, show the MEA for every model element at each LOD. On the basis that many model elements have the same MEA for most phases of a project; some tables consolidate this information in a single column. In this instance, if a model element is shared between more than one MEA, all are listed in the one cell. Where responsibility shifts from one MEA to another, the row for the element is duplicated and the MEA responsible for each LOD value entered against that value.

4. Project milestones headings: Cells for entering nominated project milestones. Cross-references the LOD for each Model Element to each nominated project milestone. Sometimes this arrangement is reversed, with LOD values shown in the heading cells and project milestones entered in the cells below.

5. Notes: Cells for explanatory comments or qualifying remarks.

LOD Tables represent a detailed aspect of project planning. They are the end product of team decision-making based on strategic project planning, not it's starting point[13].

BIM Management Plan

It is suggested that as it is unlikely that the granularity of the LOD will be nominated efficiently in the contractual agreement, that the BIM Management Plan must be referenced within the contract. This then places an emphasis on the management of the LOD for the projects life and encourages all stakeholder agreement.

During the project start-up the BIM Management Plan should always further expand on the granularity of the LOD. This is often further developed in an Object Element Matrix, by nominating responsible parties for creating elements at/or during particular phases, noted as the Model Element Author (MEA). It is understood that the element author will not always be a particular discipline authoring an element throughout the projects life. Often elements are contextually suggested by one discipline – such as architecture and then further defined by another discipline such as structures. This planning determines the Object Element Matrix which informs the suppliers of their responsibilities for elements over the projects life.

Collaborate[14] believe the LOD definition is required or referred to in a contractual context. The LOD should only be used to define the Level of Development for individual elements within 3D models and not an entire model; with specific granularity supporting the information and contextual use. This is supported with a Model Element Author as the responsibilities for an element may shift from one consultant to another to the contractor during the course of a project. It is also agreed to and signed off within the BIM Management Plan and ultimately the BIM Management Plan should form part of the agreement, with all parties.

13 *NATSPEC BIM Paper, BIM and LOD, November 2013*

14 *Collaborate is a group of thought leaders from the ANZ construction industry. http://collaborate-anz.com/main/*

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6. Tendering: Selecting BIM Consultants, Project Teams and Head Contractor

Selecting Consultants, Project Team and Head Contractor

Following a thorough project initiation process, including the choice of a delivery model, the Project Sponsor and or procurer will know whether, and if so, how BIM is to be used on a project.

Specifically, the precise scope of a project, showing key uses and requirements, ownership and development of the information (LOD) to be generated by the BIM workflow and processes, are all very important.

Depending on the delivery model, there may be two selection processes to consider- appointment of consultants and the requirement that they produce a model, and appointment of constructors to, in part, use the model for construction using a BIM Management Plan.

For example, if the Alliance delivery model is proposed, then expressions of interest would be called for that as a whole.

However, in situations of less than full Project Team Integration (PTI), the first process will involve consideration of the capability of sub-consultants as well as lead consultant, and the second will ideally involve consideration of the capability of trade contractors in the head contractors' team.

The degree to which the consultant and contractor teams are able to integrate to create and then use the BIM model will be a key consideration for the procurer when evaluating proposals, whether submitted competitively or negotiated.

If required, support may be considered in engaging a specialist organisation in BIM consultancy and or a 'BIM Champion' in relation to project/tender scoping and management, and may include the review of tender submissions, proposals, and BIM Management Plans.

Development of BIM Management/Project Team

Table 5 on the following page shows the responsibilities assigned to each role during the development of the BIM Management Plan and throughout the project. These are subject to contractual agreements and any variations agreed. The BIM Team should define the working relationships between roles (e.g. request, reporting and approval protocols) so that lines of authority are clear, and to facilitate the efficient resolution of issues as they arise. See also Project Team Integration.

6. Tendering: Selecting BIM Consultants, Project Teams and Head Contractor

BIM Roles and Responsibilities

Table 5: BIM Roles and Responsibilities

Note: may be modified to suit project

Defined Role	Responsibility in BIM Management Plan (BMP) Development	BIM Responsibility
Project Manager	Manages and coordinates project execution and BIM to meet procurement strategy and cost containment.	Oversight.
Design Team Project Manager	Team manager and coordinator, BMP.	Coordination & Review.
BIM Manager		
(Design Team or Construction)	Coordinate BIM use on project, determine schedule of use, sharing activities, quality control, modelling responsibilities and documentation in BMP.	Oversight, Management Execution and Model Exchange.
Lead BIM Coordinator	Assist BIM Manager.	Implementing BIM Manager instructions with (Design or Construction) Team. Representing BIM Manager.
Architecture Team	Design Execution – formulate with BIM Manager. Map BIM use for architectural design.	Modelling and Review.
Structural Team	Engineering – formulate with BIM Manager. Map BIM use for structural design – determine BIM use for structural simulations, analysis and documentation. Identify tools.	Modelling and Review, Model Exchange.
MEP Team	Engineering – formulate with BIM Manager.	
Map BIM use for MEP design – determine BIM use for simulations, analysis and documentation. Identify tools.	Data Development. Modelling and Model Exchange.	
Interior Design Team	Interior Design Execution – formulate with BIM Manager and architect. Map BIM use for interior design.	Data Development, Modelling and Model Exchange.
Sustainability and Energy Team	Engineering – formulate with BIM Manager.	
Map BIM use for Sustainability, 3rd Party Rating Systems – determine BIM use for simulations, analysis and documentation. Identify tools.	Data Development Review and use of model.	

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6. Tendering: Selecting BIM Consultants, Project Teams and Head Contractor

Defined Role	Responsibility in BIM Management Plan (BMP) Development	BIM Responsibility
Building Users Group	Determine facility functionally issues to be modelled and tested.	Development of critical building use issues and inputs for testing, and their review.
Commissioning Agent	Support. Provide architectural, engineering, equipment compliance reports produced in the specified exchange format.	Data Development Review and use of model.
BIM Modelling Application Expert	Support BIM Manager on application specific content, issues.	Modelling and Data Integration.
Quantity Surveyor/Cost Planner	Support alignment of project procurement to BIM development and cost containment strategies.	Data development and integration. Use of model.
Contractor	Receive or help create BIM for constructability and handover for field use. Determine Interference checking responsibility.	Use of model, Review, Model Exchange.
Subcontractor and/or Fabricator (as appropriate)	Off-Site Fabrication – formulate with BIM Manager and designer. Map BIM use for fabrication and shop drawing design. Determine BIM use for simulations of maintenance space analysis and documentation. Identify tools.	Use of model, Modelling and Integration.

Source: BIM Roles and responsibilities NATSPEC National BIM Guide

Development of Tender Proposals

A tender proposal will usually require a full capability description of the BIM Consultant and or project team including their qualifications and prior BIM experience and skills.

Prior capability is very critical in delivery of BIM management and outcomes.

Whether BIM Project Teams are in-house staff or consultants and or the head contractor, the following functions are usually undertaken:

- the development of a LOD Model indicating owner's requirements for information required in the model at specified project stages;
- the process for managing, updating and producing 'as-built' Model to achieve the specified deliverables (refer to BIM Management Plan Template); and
- Project Team Integration (PTI).

6. Tendering: Selecting BIM Consultants, Project Teams and Head Contractor

Capability may include experience in development and description of the proposed BIM uses, collaborative procedures and deliverables.

The selection of a BIM consultant and or a project team by means of a tender proposal may be through:

- a principal tender for a head contractor with BIM capability; or
- a request specifically for a BIM consultant and or project team to provide advice and or BIM management directly to the Project Sponsor to benefit the head contractor procurement and selected Delivery Model processes; and or
- a head contractor tender for a BIM Consultant and or Project Team.

Selection methods in engaging a BIM Consultant and or Project Team, head contractor may include:

Stage 1 of the tender process is to engage a BIM Manager/Project Team and/or Consultant (if the delivery model selected determines) through:

- Expressions of Interest (EOI); or
- Request for Proposals (RFP); or
- Request for Quote (RFQ); or
- Request for Tender (RFT).

With the demonstrated ability:

- in the management and or assisting in the development of a BIM brief, scope, specification model for the project, which may also involve supply chain partners,
- to detail BIM Management Plans, scopes of work and or statement of requirement and draft project programme for developing the tender bid model to be generated.

Stage 2 of a tender proposal process may include:

Staging or increasing project team integration (PTI) on a competitive basis;

- key head contractors, design consultants and specialist trade contractors.
- Securing the involvement of a contractor for pre-contract services on a competitive basis, to obtain input on buildability, sequencing and subcontractor selection.

In addition to stating the project requirements, it is important that the Project Sponsor and procurer has the information needed to understand the BIM project team (structure), and make a decision about its ability to work collaboratively to develop and then use the BIM model.

Proposal Pricing Schedule

A tendered price for BIM services may be in the form of Lump Sum and or Schedule of Rates for the BIM Model and or management and as with other contractual elements should include pricing for services which may be additional or outside the scope.

An example is:

- What is the total price for the scope and statement of requirements of the BIM deliverables?
- Additional requirements for BIM – how will these be scoped and priced.

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6. Tendering: Selecting BIM Consultants, Project Teams and Head Contractor

Statement of Requirements

An example of stating requirements and evaluating a suitable BIM Consultant and or Project team will also be dependent on the BIM role and may include initially demonstrated BIM skills and experience in:

- the management; and/or
- assistance in the development of a BIM brief, scope, specification model for the project, which may also involve;
- manufacturing and supply chain partners.

Including the demonstrated capability by:

- specifically detailing skills and experience of the BIM Consultant/Manager/Project Team roles for the proposed project;
  - nominating BIM projects they have been involved in the last 4 – 5 years; including the specific roles in those projects with referees.
  - what were the budgets for the projects?
  - detail of what BIM Uses has the BIM Consultant/Manager/Project Team implemented?
  - the technical capabilities of the BIM Consultant/Manager/Project Team?
  - how much experience and success has the proposed BIM Consultant/Manager/Project Team had?
  - what were the final BIM deliverables?

Other Considerations within Tender Proposals

A Tender proposal may include consideration of:

- A greater detail of the BIM process and involvement in the formation of the “BIM Strategy” and “BIM Management Plan”.
- Level of Development (LOD) - scope of work and specification.
- Price by way of Lump Sum or Schedule of Rates.
- An alternative solution to BIM management not being integrated on the project.
- BIM implementation to reduce the number of clashes and defects.
- A detailed plan of roll-out (implementation times) across design, contractor and sub-contractors to be generated.
- Key BIM software applications that will be used.
- Method of enabling of design information capture and reuse by all parties of the project team.
- Collaboration method and process enabling the Principal/Client and or procurer, the design team and the sub-contractors to comment on the design during the construction phase.
- Demonstration of data management and organisation of data between the BIM management team, design team, contractor and Client/owner/procurer.
- How will the design team, contractor, BIM Management /project team record model information and transmit (circulate) the information generated by the related discipline ie. the design team.
- How is record model information captured?
- Has the contractor a Records manager or Design manager?
- How could the model be used in other ways or projects that would benefit the owner/client?
- Consideration of new software and hardware requirements to fulfil its objectives.
- IT infrastructure requirements.

6. Tendering: Selecting BIM Consultants, Project Teams and Head Contractor

Consideration of Small Medium Enterprises (SMEs)

BIM expertise is not limited to large consultancy and building firms.

Many small and medium enterprises (SMEs) are rapidly developing expertise in BIM and see this expertise as a competitive advantage in the market. The experience in the United Kingdom is that lack of demand from clients is the highest barrier to the adoption of BIM by smaller firms – not lack of capital or desire to invest in BIM by the SME firm. The National Building Specifications (NBS) 2014, National BIM Report also highlights that SMEs are often better placed than larger firms to quickly adopt BIM than their larger competitors.

When selecting consultants and contractors, the procurer can encourage the adoption of BIM by SMEs. This will not only introduce a competitive tension to the procurement process, but will also over time spread BIM expertise across industry. [15]

Legal considerations and issues

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

- 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 copyright laws and other 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.

Legal and contract language as related to BIM:

Contract language and document hierarchy

Prior to developing the BIM Management Plan and complementary procurement documentation, it is beneficial to become familiar with existing industry BIM requirements, including how organisations procurement or delivery models method(s) affect the contract delivery. In addition it is important to include the BIM Annexures/Schedules when determining the appropriate hierarchy of contractual documents.

Legal status of the Design Model to Construction[16]

Binding: Imposing a legal (contractual) obligation between the author/s and recipient/s. Used in this context to mean a Design Model that represents what has to be constructed under the terms of the contract.

Informational: A Design Model that conveys non-binding information relevant to the project that may be useful to its recipient/s. No formal claims are made about its accuracy and it is provided on an 'as is' basis.

15 *Reference: http://www.buildingsmart.no/sites/buildingsmart.no/files/nbs-national-bim-report-2014.pdf*

16 *Reference: Legal status of the Design Model to Construction. Source: buildingSmart*

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Reference: A Design Model that is intended to be used for 'read-only' purposes such as recording model development at different stages of the project or clash detection. Once Design Models are designated 'Reference', they shall not be edited further. Reference Design Models can be used as the basis for bid preparation but cannot form part of the contract documents. A model has to be designated 'Binding' for this purpose. Reference models shall be sufficiently accurate for their intended purpose.

Reuse: A Design Model authorised by its authors for modification or further development by its recipients.

Information sharing

The project team shares information throughout the duration of the project. This usually means all parties have access to the BIM models, reports, facility data, and any other necessary information as appropriate which will be defined in the BIM Management Plan.

Note: This often requires setting up a file exchange website or other collaboration software designed specifically for file sharing.

For this strategy to be successful it needs to be recognised as a PTI and BIM 'foundational requirement' and driven at Project Director level.

This strategy will also require adequate recognition of how collaboration software can increase transparency as mentioned below.

Errors

Any project team participant discovering an error must notify the creating party in a pre-defined method to fix the error. Responsibility for errors needs to be addressed in the contractual documentation as is the case now; however, with BIM this becomes even more important.

Outsourcing

Outsourcing of technical engineering solutions are 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 flow 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 outsourcing companies become dependent and reliant on the service, 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[17].

17 *A Framework for the Adoption of Project Team Integration and Building Information Modelling, ACIF & APCC.*

7. BIM Management

The key to successful use of a model is the BIM Management Plan (BMP). It will help guide the framing of selection documents for designers and contractors to ensure that there is clarity on what is included in the plan, including description of roles and responsibilities of designers and constructors, and team collaboration and communication protocols around development and use of the BIM model.

The level of input from various parties to the BIM model will change during the project life cycle. It will start with the design team then transfer to the contractor and finally to the Client (or their FM provider). However, the "ownership" of the model refers to the party that has primary contractual responsibility for the model or ownership from an Intellectual Property perspective. This needs to be determined. See above.

Whilst each discipline/trade model is owned by the organisation producing it, the federated model is owned by whomever the Principal/Client originally determines/negotiates in the contract.

NATSPEC has produced a valuable collection of documents which project sponsors should consider in preparing briefs and management plans for use of BIM.

They are available at:

Resource: http://bim.natspec.org/index.php/natspec-bim-documents/bim-management-plan-template

The documents include a template for a BMP. The following sections of this part of this Guide are extracts from the NATSPEC BMP template.

A BMP is a formal document that defines how a project will be executed, monitored and controlled with regard to BIM. One of its main purposes is to make clear what members of the project team can expect from each other.

The BMP should provide a master information/data management plan and to assign roles and responsibilities for model creation and data integration at project initiation.

The template can be used to document either a Design BMP or a Construction BMP in conformance with *NATSPEC's National BIM Guide* clause 3.2 or 3.3 respectively. It is formatted to produce a Design BMP as the default.

The template can be customised to suit the specific requirements of the project and respond to the requirements recorded in the *Project BIM Brief* that accompanies the *National BIM Guide*.

BIM Management Plan: Scope and relationship to other documents

The NATSPEC BMP addresses the BIM management of a project only. It does not specifically address issues surrounding the competency and capacity of project team members to implement it. It is taken as understood that team members will only include provisions in the BMP that they know they can adequately address. Issues of competency and capacity should be addressed during the team member selection process and documented separately.

An important principle to keep in mind during the development of a BMP is that anything that alters original contractual agreements should be addressed in the Project BIM Brief and/or Contract, not the BMP. Apart from being more appropriate, recording amendments in these locations makes them easier to track. Any amendments should be agreed after notification and consultation with all parties.

Notes on using the BIM Management Plan (BMP) Template (NATSPEC):

A record of agreement: The BMP is a record of agreement between members of the project team rather than a prescriptive specification by any one party. Its contents should reflect the outcome of issues discussed and negotiated before completing the Template.

A living document: The BMP is required to be reviewed and updated throughout the project. There are some things that cannot be defined in any meaningful way when formulating the initial BMP. Agree what is sensible at that time and note items that need to be reviewed or resolved in more detail in a later BMP.

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7. BIM Management

A framework – not a straightjacket: The BMP Template provides a framework for documenting team agreements about the execution of the project, and is an aid to the management of a project, not an end in itself. Do not feel compelled to fill in every schedule or prompt. Use professional experience and judgement to modify and edit it to suit the requirements of the project.

Create and maintain an office master: The first time you complete the BMP Template is likely to be the most time-consuming – it will become quicker with practice. One approach to streamlining the process is to create an office master from a completed BMP. This avoids starting from scratch each time and provides a vehicle for refining the document in response to your experiences and preferences.

Edit to suit the project: To make it useful for a wide range of projects the BMP Template includes extensive content. Delete any content that is not applicable to your specific project or simplify it to suit. Not doing so only leads to a bulky document and confusion for its readers. Extensive material that interferes with the flow of the document or detailed guidelines, more likely to be referred to on a regular basis during the project, may be better located in appendices. An outline list of project guidelines is included in Appendix A to the BMP.

Project Team Integration and BIM Protocols

PTI/BIM Protocols determine:

- the sharing of responsibility for the successful delivery of the project; the identification of the Building Information Model(s) that is required;
- provides for commitment in achieving the project objectives;
- allows for the identification of specific obligations, liabilities and associated limitations on the use of the models;
- clarity in the management of commercial issues such as protection of Intellectual Property Rights (IPR) from infringement, legal issues and security concerns;
- establishment of agreement for process and data exchange including security of the data model, data sovereignty, use of Cloud;
- the adoption of a common naming standard (language); and
- addresses data sharing, 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.

Those protocols are documented within a BIM Project Management Plan, this plan provides for the language, definitions, responsibilities, processes, collaboration and deliverables of the project.

This plan is to be documented and finalised as a schedule/addendum during the contractual stage for all project participants.

Right from the start of a project, the expectation from each project participant and the collaboration between all the project parties must be understood and agreed to in the contract delivery model, schedules/addendums and BIM Project Management Plan.

Examining the conditions and circumstances with a Project Team Integration (PTI) as part of the procurement strategy development process will also assist in identifying the suitability of contract delivery models.

8. Resource Documentation

Australia:

NATSPEC: National BIM Guide documents
Source: NATSPEC
Reference: http://bim.natspec.org/

buildingSMART / ISO Standards
Source: buildingSMART
Reference: http://buildingsmart.org.au

- ISO 12006-3:2007 – Building construction -- Organisation of information about construction works -- Part 3: Framework for object-oriented information
- ISO 29841-1:2010 – Building information modelling -- Information delivery manual --

Part 1: Methodology and format

- ISO 29841-2:2012 Building information models -- Information delivery manual --

Part 2: Interaction framework

- ISO 12911:2012 – Framework for building information modelling (BIM) guidance
- ISO 16739:2013 – Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries
- ISO 16757-1 Product data for building services systems models – Concepts, architecture and model
- ISO 16757-2 Product data for building services systems models – Geometry
- Other ISO standards relevant to BIM include:
- ISO 12006-2:2001 Organisation of information about construction works - Framework for classification of information
- ISO 15686-4 – Building Construction -- Service Life Planning -- Part 4: Service Life Planning using Building Information Modelling

Source: International Standards
Reference: http://www.iso.org/iso/home/standards.htm

New Zealand:

Building Value – BIM in NZB
Reference: http://www.buildingvalue.co.nz/BIM-in-NZ

New Zealand BIM Handbook July 2014: A Guide to enabling BIM on building projects. Source: Building Value New Zealand
Reference: http://www.buildingvalue.co.nz/sites/default/files/New-Zealand-BIM-Handbook.pdf

Collaborate
Working Group papers
Source: Collaborate – Working Group – Level of Development
Reference: http://collaborate-anz.com/main/?page_id=429

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8. Resource Documentation

Other International references

These documents were created as a means of providing BIM users with contract language to reference in creating their own documents.

Each document takes a different approach to implementing BIM and many procurers find it beneficial to include elements from both into their customised BIM contracts. There are also numerous procurer created documents which are available for reference:

United States:

American Institute of Architects (AIA):
E203 Building information Modelling and Digital Data Exhibit.
Source: AIA. Reference: http://www.aia.org/

ConsensusDOCS 301 BIM Addendum
Source: Consensus
Reference: https://www.consensusdocs.org/Catalog/collaborative

Standards - AIA:

- AIA-CA BIM, Legal & Procurement Report
- E202-2013, Building Information Modelling and Digital Data Exhibit G201-2013,
- Project Digital Data Protocol Form G202-2013,
- Project Building Information Modelling Protocol FormConsensus Docs 301
- Building Information Modelling (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)

Source: AIA
Reference: http://www.aia.org/contractdocs/referencematerial/AIAB099128

OmniClass™
As strategy for classifying the Built Environment US.
Source: OmniclassTM.
Reference: http://www.omniclass.org/tables.asp

UniFormat™:
Source: CSI net.
Reference: http://www.csinet.org/uniformat

United Kingdom:

The National Building Specification (NBS)
Source: NBS
Reference: http://www.thenbs.com

The National BIM Library (NBL)

- BIM Object Library;
- BIM tools and guides.

Source: NBS
Reference: http://www.nationalbimlibrary.com/

8. Resource Documentation

BIM Task Group Project
CIC BIM Protocol

- Employers Information Requirement (EIR)
- Scope of Services for Information Management

Source: The BIM Task Group
Reference: http://www.bimtaskgroup.org/

RIBA (Royal Institute of British Architects)
RIBA: Plan of Work 2013
Organises the process of briefing, designing, constructing, maintaining, operating and using building projects into a number of key stages. The content of stages may vary or overlap to suit specific project requirements. The RIBA Plan of Work 2013 should be used solely as guidance for the preparation of detailed professional services contracts and building contracts.
First developed in 1963, the RIBA Plan of Work is the definitive UK model for the building design and construction process. The Plan of Work now includes a online resource enabling professionals to browse, customise and download a plan of work. It is intuitive to use with on-screen help at each stage.
Source: RIBA
Reference: http://www.ribaplanofwork.com/

British Standards (BSI):

PAS 1192-2:2013: Specification for information management for the capital/delivery phase of construction projects using Building Information Modelling. This standard was developed to support Government early-adopter clients and the supply chain in achieving Level 2 BIM. PAS 1192-2 builds on BS 1192:2007.

BS 1192:2007: Collaborative production of architectural, engineering and construction information – Code of practice.

PAS 1192-3: Specification for information management for the operational phase of assets using building information modelling. Guidance on the use and maintenance of the asset information model (AIM) to support the planned preventative maintenance programme and the portfolio management activity for the life of the asset.

It is supported by:

"Building Information Management – A Standard Framework and Guide to BS 1192" – a jointly published guide with CPI.

For further information on the BIM deliverables:

BS 8541: Library Objects series; and

BS 7000-4: 2013: Design management systems: Guide to managing design in construction.

Source: BSI
Reference: http://www.bsigroup.com/en-GB/global-contact-details/

Uniclass™
Uniclass™ (Unified Classification for the Construction Industry), published in 1997 in UK by the Construction Project Information Committee (CPIC). And, Uniclass2, 2013.
Source: The National BIM Standard (NBS)
Reference: http://www.thenbs.com/uniclass/

Reference: http://www.thenbs.com/topics/PracticeManagement/articles/newDraftOfUniclass2.asp

Source: Construction Project Information Committee.
Reference: http://www.cpic.org.uk

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9. Further Reading

Successful project team integration and BIM management, and related planning, are based on known standards, precise project language, and project collaboration. There are a number of useful tools and guides currently available.

Standard plans and tools

National BIM Guide

The NATSPEC National BIM Guide works with a number of supporting documents that can be compiled in a coordinated way and read in conjunction with each other to define how BIM is to be implemented on a project.

NATSPEC National BIM Guide:

- NATSPEC Project BIM Brief template
- NATSPEC BIM Reference Schedule
- NATSPEC BIM Object/Element Matrix
- NATSPEC BIM Management Plan Template

NATSPEC BIM Papers (informative):

- NBP001: BIM and LOD
- NBP002: getting started with BIM
- NBP003: BIM Project Inception Guide

Source: NATSPEC
Reference: http://bim.natspec.org/

NATSPEC National BIM Guide: The Guide's core document is a reference document that defines roles and responsibilities, collaboration procedures, approved software, modelling requirements, digital deliverables and documentation standards. It documents a range of possible uses for BIM on projects. To download a copy, see the button below.

NATSPEC Project BIM Brief template: A Project BIM Brief documents the specific requirements of a project. It can be developed using the NATSPEC Project BIM Brief template. In addition to identifying the project and members of the project team, it provides places to specify what BIM is to be used for on the project. It is also used to record what standards from the NATSPEC BIM Reference Schedule will apply. This arrangement allows the necessary flexibility for selecting references to suit the particulars of the project.

NATSPEC BIM Reference Schedule: A list of documents and standards provided for consideration as references that can be cited in the National BIM Guide. The specific documents chosen to be applicable to a project are recorded in the Project BIM Brief.

NATSPEC BIM Object/Element Matrix: A series of Microsoft Excel (.xls) worksheets that defines a large number of objects and elements and their properties by UniformatTM/OmniClassTM classification and Level of Development (LOD) at different stages in the building's lifecycle.

National BIM Guide Structure

The intent of the Guide's structure is to allow each edition of the National BIM Guide to function as a core reference document and to confine all editing to the Project BIM Brief. This allows the National BIM Guide to be tailored to individual projects while allowing it to be progressively upgraded in response to users' needs from edition to edition within a consistent, recognisable framework.

NATSPEC BIM Management Plan Template, a companion document to the National BIM Guide. Together, the documents represent a substantial resource for anyone planning a project based on BIM and collaborative work practices such as Integrated Project Delivery (IPD).

9. Further Reading

BIM Management and Implementation Planning

Computer Integrated Construction (CIC) Research Program's BIM Planning. Penn State University:

Strategic BIM Plan is a tool for assisting in the development of a strategic planning document.

- Assessment of the organisations current internal and external level of BIM integration.
- Alignment of BIM goals by identifying desired levels of maturity for BIM Uses. Development of defined advancement strategy.

Strategic BIM Plan Template (Penn State)
Source: CIC Penn State.
Reference: http://www.bim.psu.edu/

Organisation Execution Plan Template Tool for assisting in the development of an organisation execution planning document.
Source: CIC Penn State University.
Reference: http://www.bim.psu.edu/

Business Case for Organisation BIM Integration provides concise overview of the proposed BIM implementation and answers the question of why BIM should be supported.

- The tool aids decision makers; and includes
- Risk Management Planning.

Business Case for Organisation BIM Integration Template
Source: CIC Penn State University.
Reference: http://www.bim.psu.edu/

NBS BIM Tool Kit
The free-to-use NBS BIM Toolkit provides step-by-step help to define, manage and validate responsibility for information development and delivery at each stage of the asset lifecycle.
Source: NBS
Reference: http://www.thenbs.com/bimtoolkit/index.asp

BIM Protocols / Schedule Template Tool for assisting in the development of a BIM specific schedule for BIM delivery to be attached to the prime delivery model in planning delivery.
Source: BIM Task Group (UK)
Reference: http://www.bimtaskgroup.org/bim-protocol/

New Zealand BIM Handbook: July 2014:
A Guide to enabling BIM on building projects
Source: Building Value.
Reference: http://www.buildingvalue.co.nz/sites/default/files/New-Zealand-BIM-Handbook.pdf

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9. Further Reading

Project Team Integration (PTI) and BIM

The following documents provide further guidance on the topic of BIM and Project Team Integration:

A Framework for the Adoption of Project Team Integration and Building Information Modelling, 2014 (ACIF & APCC): The *Framework* is designed to guide and assist industry stakeholders in the adoption and implementation of project team integration and Building Information Modelling (BIM).

This is the first time that government and industry have come together to collaborate and coordinate on a cohesive national approach to the effective adoption of BIM.

The release of the *Framework* signals a 'whole of industry' approach to what will be 'business as usual' in the very near future.

A Guide to Project Initiation – for Project Sponsors, Clients & Owners (ACIF& APCC): the Australian Construction Industry Forum (ACIF) and the Australasian Procurement and Construction Council (APCC) have produced two important and valuable guides to help the construction industry improve productivity.

The Case for Project Team Integration and The Project Team Integration Workbook (ACIF & APCC) contain straightforward ways to improve project team collaboration and performance. They make a strong case for early integration of project team members, to get the best from all disciplines that can contribute to good project outcomes and, where it is used, from Building Information Modelling (BIM).

Source: Australasian Procurement and Construction Council (APCC)
Reference: http://www.apcc.gov.au

Source: Australian Construction Industry Forum (ACIF)
Reference: https://www.acif.com.au/

10. Glossary

Alliance	Alliances are defined in the *National alliance contracting policy and guidelines (Department of Infrastructure and Transport 2011)* as follows: Alliance contracting is delivering major capital assets, where a public sector agency (the Owner) works collaboratively with private sector parties (Non-Owner Participants or NOPs). 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 structure capitalises on the relationships between the Participants, removes organisational barriers and encourages effective integration with the Owner.
Asset Management	The process of managing and maintaining the efficient operation of asset/facilities including buildings, properties and infrastructure. The term is also applied to the discipline concerned with this process.
Attribute	Attribute Data element for the computer-sensible description of a property, a relation or a class. Note: An attribute describes only one single detail of a property, of a class or of a relation. Example: The names of a property, the code of a class, the measure unit in which values of a property are provided are examples of an attribute. [ISO/IEC Guide 77:2008]
Authorised Uses	In addition to LODs, authorised (or warranted) use is often referred to. The premise of this is to specify who is allowed to do what with the BIM being authored. So that in addition to the degree of certainty of the BIM as implied by the LOD definitions there is a separate statement to quantify if the associated information is fit for the various purposes stated. i.e. construction documentation only, or including other uses like cost estimation, scheduling etc. Fundamental LOD definitions by themselves are not enough to define minimum requirements of the resulting BIM.
Building Information Management (Data Definition)	Building Information Management supports the data standards and data requirements for BIM use. Data continuity allows for the reliable exchange of information in a context where both sender and receiver understand the information.
Building Information Model (BIM) - Product	An *object-based* digital representation of the physical and functional characteristics of a facility. The Building Information Model serves as a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its lifecycle from inception onward.
Building Information Modelling (BIM)	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.
Building Information Modelling (BIM) Addendum	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)*
Building Information Modelling (BIM) -Coordinator	A person who performs an intermediary role between the BIM Manager and the modelling team. He/she implements the BIM Manager's modelling standards and protocols and deals with the day-to-day coordination of team members to achieve project goals.

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10. Glossary

Building Information Modelling (BIM) -Manager	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 sponsor. 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.
Building Information Modelling (BIM) - Management Plan (BMP)	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. BMP is used in preference to BIM Execution Plan in the Guide because it conveys a broader scope. Note: In some regions, a BMP is referred to as a BIM Execution Plan.
Building Information Modelling (BIM) - Process	A collection of defined model uses, workflows, and modelling methods used to achieve specific, repeatable, and reliable information results from the model. Modelling methods affect the quality of the information generated from the model. When and why a model is used and shared impacts the effective and efficient use of BIM for desired project outcomes and decision support.
Building Information Modelling (BIM) - Uses	Project specific outcomes arising through from the use of BIM processes.
Build–Own–Operate–Transfer (BOOT)	A project delivery model, where the contractor assumes the risk of financing till the end of the contract period. For example a private sector entity builds a project, operates it and eventually transfers ownership of the project to the government.
buildingSMART	The name given to the International Alliance for Interoperability (IAI), the pre-eminent organisation promoting interoperability in the construction industry. Promotion of IFC, IFD and IDM.
CAD*	Computer Aided Design. A geometric/symbol based computer drawing system that replicates hand drawing techniques.
2D CAD	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.
3D CAD	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.
Capability	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.
Code Validation	A process in which code validation software is utilised to check the compliance of model parameters against design codes.
Collaborate	“Collaborate” is a group of thought leaders from the Australian and New Zealand construction industry.
Conceptual Design	The phase of the design process in which the overall scope and nature of the project is determined in response to the site, planning considerations and the client’s brief, budget and program.

10. Glossary

Construct only	A 'traditional' delivery model under which a designer develops the detailed design and other documentation for the project owner. Once the project owner is satisfied with the design and documentation, it will separately call for competitive bids from construction contractors to construct the project works. Following completion of the construction works, the project owner assumes responsibility for the ongoing maintenance and/or operation of the asset.
Construction Management (CM)	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 sponsor to deliver a specific construction project.
Construction Operations Building Information Exchange (COBie)	A system for capturing information during the design and construction of projects that can be used for 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 after construction has been completed. COBie eliminates the need for as-built data capture after building handover and helps to reduce operational costs.
Deliverables	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.
Delivery Model[18]	An approach to the delivery of a construction works or services project.
Design-Build (DB)	A project delivery model 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.
Design-Build-Operate (DBO)	A project delivery model is a system used by an agency or owner for organizing and financing design, construction, operations, and maintenance services for a structure or facility by entering into legal agreements with one or more entities or parties.
Design–Build–Finance–Operate (DBFO)	Is a project delivery model 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.
Design and Construct (D&C)	A delivery model (which includes variants such as novated design and construct, and design development and construct) under which a project owner selects a single contractor to deliver both the design services and construction works for a specific project. Following completion of the construction works, the project owner assumes responsibility for the ongoing maintenance and/or operation of the asset, except in cases where such responsibilities are appended to the D&C model under such variants as design, construct and maintain; design, construct and operate; or design, construct, maintain and operate.
Design-Bid-Build (DBB)	A delivery model 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.

18 Building and Construction Procurement Guide Principals and Options, (Austroads & APCC)

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10. Glossary

<table>
<tr><td>Design Development</td><td>The phase of the design process in which the general relationships represented in the schematic design phase are resolved in more detail. During this phase the dimensions of all major elements are defined and forms of construction finalised.</td></tr>
<tr><td>Dimension</td><td>Information in a model or the properties about the objects beyond the graphical representation.</td></tr>
<tr><td>Direct managed</td><td>A delivery model which involves the project owner managing the full delivery of the project, which includes directly providing the plant and resources or obtaining these by subcontracting activities. The project owner is responsible for administering the subcontracts and accepts all of the delivery and interface risk.</td></tr>
<tr><td>Discipline Models</td><td>Individual design discipline or trade sub-contractor models – aggregate models.</td></tr>
<tr><td>Early Contractor Involvement (ECI)</td><td>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.</td></tr>
<tr><td>Facilities Management (FM)</td><td>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.</td></tr>
<tr><td>Federated Model</td><td>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.</td></tr>
<tr><td>Federated IFC Model</td><td>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.</td></tr>
<tr><td>Federated Open Standard Model</td><td>Refer Federated IFC Model.</td></tr>
<tr><td>Federated VC Review Model</td><td>One or more aggregate models brought together in non-authoring software for the purposes of virtual construction review.</td></tr>
<tr><td>FF&E</td><td>Furniture, Fixtures & Equipment.</td></tr>
<tr><td>File Transfer Protocol (FTP)</td><td>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).</td></tr>
<tr><td>Grade</td><td>Additional metric description, for example:
<table>
<tr><th>Grade</th><th>Description</th></tr>
<tr><td>A</td><td>3D + Facility Data</td></tr>
<tr><td>B</td><td>2D + Facility Data</td></tr>
<tr><td>C</td><td>2D Only (Drafting, linework, text, and or part of an assembly)</td></tr>
<tr><td>+</td><td>Original Grade (A, B or C) adjusted for contract changes and field conditions</td></tr>
<tr><td>-</td><td>Notincluded in or tied to the model (however is still required in teh deliverable)</td></tr>
<tr><td>*</td><td>Refer to the specific child element for appropriate Grade. (used for categories that have multiple sub-elements for which varying Grades apply)</td></tr>
</table></td></tr>
<tr><td>IFC (Industry Foundation Classes)</td><td>A specification for a neutral data format to describe, exchange and share information typically used within the building and 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.</td></tr>
</table>

10. Glossary

IFD (International Framework for Dictionaries)	Library. An object terminology library for the building construction industry. The name is used both for the IFD Library and for the organisation running and maintaining it. The simplest description of IFD Library is that it is a kind of dictionary of construction industry terms that must be used consistently in multiple languages to achieve consistent results – this will enable reliable automated communications between applications. The structure of IFD is given in ISO/PAS 12006-3, which is an EXPRESS model with a short explanation of its purpose and use.
Informational	See Legal status of the Design Model to construction.
Integrated Project Delivery (IPD)	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.
Level of Development (LOD)	The American Institute of Architects Document *E202 – 2008 Building Information Modelling protocol Exhibit* 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. Each subsequent level builds on the previous level and includes all the characteristics of the previous levels.
Managing Contractor	A delivery model which involves a head or 'managing' contractor being appointed by the project owner to provide advisory and management services; create work packages; source and enter into contracts with designers and subcontractors; and coordinate, supervise and potentially directly undertake some elements of the work pertaining to a specific construction project.
Master Format®	Master Format® is a master list of numbers and titles classified by work results or construction practices, used throughout the North American construction industry to organise project manuals, detailed cost information, and relate drawing notations to specifications. [19]
Model▲	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.
Model-based Deliverables	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.
Model Collaboration Matrix	See Model Progression Specification. The difference in title simply reflects an emphasis on the collaborative nature of managing the modelling process.
Model Element▽	A portion of the Building Information Model, representing a component, system or assembly within the building or building site.
Model Element Author	The authorised person who inputs data into a Building Information Model.

19 http://csc-dcc.ca/Document+Store/MasterFormat/

▲ *Source: ConsensusDocs 301 BIM Addendum, 2008*

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

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10. Glossary

Model Progression Specification	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.
Mechanical Electrical Plumbing (MEP)	Referring to this group of building services or the engineering disciplines associated with them.
Mechanical Electrical Plumbing Fire (MEPF)	Referring to these building services or the engineering disciplines.
Model View Definition (MVD)	An IFC View Definition, or Model View Definition, defines a subset of the IFC schema that is needed to satisfy one or many Exchange Requirements of the AEC industry. A MVD defines a subset of the IFC Schema providing implementation guidance for all IFC concepts (classes, attributes, relationships, property sets, quantity definitions, etc.) used within this subset. It thereby represents the software requirement specification for the implementation of an IFC interface to satisfy the exchange requirements.
NATSPEC	The Australian National Building Specification system. Used in this document to describe the work section classification system used to organise it, or the name of the organisation that produces it.
OmniClass™	The OmniClass™ Construction Classification System is a classification system for the construction industry, developed by the Construction Standards Institute (CSI) and is used as a classification structure for electronic databases. As the basis of its tables, OmniClass™ incorporates other existing systems currently in use, including Master Format® for work results, UniFormat™ for elements, and EPIC (Electronic Product Information Cooperation) for structuring products.
Open Standard Specification	An open standard specification describing the data needed to support operational management, building and system alterations or additions, and asset maintenance scheduling.
Operational Management	A process in which the data outlined in the open standard specification is used to allocate, manage, and monitor assigned workspaces and related resources.
Project Alliancing (PA)	Alliance contracting is delivering major capital assets, where a public sector agency (the Owner) works collaboratively with private 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.◣
Project ManagerΩ	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.
Procurement method	The form of contract and procurement process to be used with respect to the selected delivery model, as documented in the procurement strategy.

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

Ω Source: Standards Australia, SAA HB 50, 2004

10. Glossary

Procurement Strategy	A document that represents the outcome of the procurement options analysis process and identifies the recommended delivery model and procurement method for a project, based on the project's individual characteristics and circumstances.
Project Team Integration (PTI) [20]	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.
Product	Thing or substance produced by a natural or artificial process. Note: In ISO/IEC Guide 77, the term "product" is taken in its broadest sense to include devices, systems and installations, as well as material, software and services. [ISO/IEC Guide 77:2008]
Program for Design (PFD)	A formal quantitative schedule of spaces and fixtures, furniture and equipment that informs the design process. A detailed development of the design brief. Derived from analysis of the client's brief, design guidelines and design assessment criteria. It can be manually compiled or generated with the assistance of purpose designed Architectural Programming Software.
Progress BIMs	BIM models other than those specified in Final BIM Deliverables to be provided at specified milestones in the project program to demonstrate or record progress. They can be used as a design tool by the design or construction teams only or form part of the deliverables for the client. If Progress BIMs are required, they shall be specified in the BIM Management Plan (BMP) and the following details for each included: ■ Program milestone ■ Level of Development ■ Features to be modelled ■ Recipient, e.g. Design Team only, client. The same delivery requirements for 3D Geometric Deliverables specified in Final BIM Deliverables apply to Progress BIMs unless otherwise noted in the BMP.
Project Sponsors	Project sponsors are the client, financiers, and end users who, individually or jointly, determine the risk allocations and terms of the head contract offered to the head contractor. Whilst during design and construction there will usually be only one organisation acting as the client under a contract with a head contractor, its ability to determine all relevant commercial and technical conditions may have been influenced or even controlled by providers of finance, or the requirements of end users.
Property	A quality, trait or characteristic belonging to a thing. See Parameter. A defined parameter suitable for the description and differentiation of products. Note 1: A property describes one aspect of a given object. Note 2: A property is defined by the totality of its associated attributes. [ISO/IEC Guide 77:2008]
Public Private Partnership (PPP)	A delivery model under which the project owner selects a private sector partner to finance, design and construct the project works, and assume responsibility for operations and/or maintenance over a long-term period.
Reference	See Legal status of the Design Model to construction

20 A Framework for the Adoption of Project Team Integration and Building Information Modelling, ACIF & APCC

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10. Glossary

Request for Expression of Interest (REI)	A documented request for information on a matter from one party to another. They are usually managed through formal procedures agreed by members of the project team.
Request for Information (RFI)	A documented request for information on a matter from one party to another. They are usually managed through formal procedures agreed by members of the project team.
Request for Tender (RFT)	A documented request for tender on a matter from one party to another. They are managed through formal procedures.
Schematic Design	The phase of the design process in which the general arrangement of the project, including indicative room sizes and layout, overall form of the building/s and its/their relationship to the site, is determined.
Statement of Requirement	The Statement of Requirement is a detailed description of the Goods and or Services to be provided by the successful tenderer including technical specification, service levels and performance framework. Taken together with the accepted parts of the tenderer's response, it will form part of the Agreement.
UniClass™	A UK classification system. Uniclass™ is a classification scheme for the construction industry. It is intended for organising library materials and for structuring product literature and project information. Uniclass™ comprises 15 tables, each of which represents a different broad facet of construction information. Each table can be used as a "stand alone" table for the classification of a particular type of information, but, in addition, terms from different tables can be combined to classify complex subjects.
UniFormat™	Is a common elemental classification for the description, economic analysis and management of a building for its life-cycle. Elements often referred to as systems or assemblies, are major components common to most buildings that are identified as performing a given function regardless of the design specification, construction method, or materials used. UniFormat™ is most often used by estimators and design teams, who use it as a cost analysis format or arrangement for early project design documentation. Because it breaks a facility into the systems that perform distinct functions – shell, foundation, interiors, etc. The elements are major components common to most buildings. The system can be used to provide consistency in the economic evaluation of building projects. It was developed through an industry and government consensus and has been widely accepted as an ASTM standard.[21]
Value-for-money[22]	Value-for-money is an essential determinant in the procurement of goods, services and works by Government agencies. It does not necessarily represent lowest cost; rather the achievement of the best available outcome for money spent on the procurement, taking into account whole-of-life considerations such as: ■ fitness-for-purpose and other considerations of quality ■ performance ■ price ■ delivery ■ accessories and consumables ■ service support ■ disposal.

21 http://csc-dcc.ca/Document+Store/UniFormat/

22 The definition of value-for-money differs marginally in all the Australian states and territories; however, the broad concepts are the same. This particular definition is derived from the Australia and New Zealand Government Procurement Agreement (September 2007), which is substantially consistent with the various state and territory definitions. Source: Building and Construction Procurement Guide Principals and Options, (Austroads & APCC)

10. Glossary

VC – Virtual Construction	The interrogation of federated models to test geometrical and spatial fit in a rehearsal of the physical construction process.
View	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.

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