NATSPEC National BIM Guide

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NATSPEC National BIM Guide

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NATSPEC believes that digital information, including 3D Modelling and Building Information Modelling will provide improved methods of design, construction and communication for the Australian construction industry. Further, NATSPEC supports open global systems. This will result in improved efficiency and quality. Visit the NATSPEC BIM Portal bim.natspec.org.

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Webber Executive Architecture

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Xrev

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The 2011 NATSPEC National BIM Guide was an adaptation of the 2010 VA BIM Guide. It was an important contribution to improving BIM practice in Australia – NATSPEC thanks the United States Department of Veteran Affairs which gave permission for its use.

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Formatting conventions

In addition to the text formatting conventions used for Section headings, Clause titles, Table headings, etc, the table below shows other text formats used in this document:

Text type	Example	Indicates
Italicised text	*Project BIM Brief*	Name of a specific document or standard.
Violet text	Data Reuse	Cross reference to a Section, Clause, Table, Diagram, etc
Blue text on blue fill	See the *ABAB AIR Guide*	References to relevant sources of information.
Blue underlined text	www.natspec.com.au	Hyperlink/weblink

In this document:

- 'the Guide' should be taken to mean the *NATSPEC National BIM Guide*.
- Numbering of Tables, Diagrams and Figures is derived from the Clause in which they appear.

1 INTRODUCTION

1.1 Building Information Modelling (BIM)

> *BIM is a digital form of construction and asset operations. It brings together technology process improvements and digital information to radically improve client and project outcomes and asset operations. BIM is a strategic enabler for improving decision making for both buildings and public infrastructure assets across the whole lifecycle. It applies to new build projects and crucially, BIM supports the renovation, refurbishment and maintenance of the built environment – the largest share of the sector.*

EU BIM Task Group Handbook

BIM is not any single act or process, nor is it a 3D model in isolation, or computer- based fabrication. BIM is being aware of the information needs of others as you go about your work.

BIM is the sharing of structured information

Terminology

While BIM, Digital Engineering (DE) and Virtual Design and Construction (VDC) refer to different paradigms, they share many concepts and principles. In the interests of brevity, BIM is the term used throughout this document to refer to them collectively, regardless of whether processes are being applied to buildings, infrastructure or other built assets. Refer to *Appendix A - Glossary* for definitions.

For an introduction to BIM and Digital Engineering see
https://bim.natspec.org/resources/introduction-to-bim

1.2 The National BIM Guide

1.2.1 Purpose

The purpose of *National BIM Guide* (the Guide) is to:

- assist clients, consultants, contractors and stakeholders to clarify their BIM requirements in a nationally consistent manner to reduce confusion and duplication of effort and;
- create a common understanding of information requirements including language to facilitate best practice implementation of BIM over the asset lifecycle.

1.2.2 Scope

The focus of the Guide is primarily on building projects – large and small – although many of the methodologies and resources it includes could be readily applied to any built asset such as civil and small-scale infrastructure assets managed by local councils. See 2.6 Digital engineering / BIM for infrastructure for a brief examination of how the differences between building and infrastructure projects influence the application of digital modelling principles.

1.2.3 Audience

The Guide is addressed to all individuals and organisations implementing BIM processes or are interested in doing so. In recognition that many built environment stakeholders will have different perspectives, skill sets and information needs, the Guide has been structured to assist everyone find the information most relevant to them. See 1.2.4 National BIM Guide structure.

All industry stakeholders are encouraged to review their standards and procedures to see where they can be aligned with those documented in the Guide so they can realise the benefits of a more nationally consistent approach.

Please share standards and procedures you believe will benefit the wider industry with NATSPEC so they can be considered for inclusion in future editions of the Guide.

1.2.4 National BIM Guide structure

Document structure

The *National BIM Guide* comprises a suite of documents intended to be read in conjunction with each other. The parts are:

- *NATSPEC National BIM Guide*: The Guide (this document) provides an overview of BIM that is primarily directed at stakeholders in strategic and executive management roles or those new to the subject. It includes high-level guidance about implementation considerations.
- Appendices: Documents incorporating more detailed coverage of some topics in the Guide:
    - *Appendix A – Glossary*: Definitions of terms and abbreviations used in the Guide.
    - *Appendix B – AS ISO 19650 Resources Descriptions*: Brief descriptions of documents and resources that support the information management processes described in AS ISO 19650.
    - *Appendix C – BIM Use & Enabler Descriptions:* Descriptions of BIM uses and enablers including their potential value, scope considerations and useful references that can be used as a resource when selecting appropriate BIM uses on a project.
    - *Appendix D – Defining Information Requirements*: Guidance and resources for using the AIR, PIR and EIR Templates to document information requirements.
- Templates: Editable documents for implementing BIM on projects. They need to be selected, edited and compiled in a coordinated way to suit the requirements of the project.
    - *Asset Information Requirements (AIR) Template* (AS ISO 19650 aligned)
    - *Exchange Information Requirements (EIR) Template* (AS ISO 19650 aligned)
    - *Project Information Requirements (PIR) Template* (AS ISO 19650 aligned)
    - *Project BIM Brief Template* (serves a similar function to the PIR and EIR templates for simpler projects)

The intent of this structure is to enable the *National BIM Guide* to function as a core reference document and confine all editing to templates. This allows the *National BIM Guide* to be tailored to individual projects within a consistent, recognisable national framework.

Content structure

The first sections of the Guide provide a high-level overview of BIM and its implementation. They outline concepts and principles applicable to all phases of the asset lifecycle.

The later sections outline the processes for implementing these concepts and principles including the roles and responsibilities of those involved.

The appendices include content of a more detailed and technical nature.

The Guide is addressed to all industry stakeholders, but earlier sections are most relevant to those in executive roles and the later sections more relevant to those in management roles.

The appendices are generally intended for use by those in management and technical roles.

1.2.5 Normative and informative content

The Guide (this core document) now only includes informative content (information only, guidance and suggestions). Normative content (mandatory requirements) is now incorporated in the templates where it can be edited to suit the requirements of the project.

1.2.6 Policy and contractual status

In August 2019 the Board of Treasurers endorsed the *Australian Building Information Modelling (BIM) Strategic Framework* for proposed implementation by all State and Territory governments across Australia. Most State governments and agencies have policies and requirements supporting BIM for their projects. The Guide aims to provide a practical tool for clearly defining expectations for all project stakeholders regarding BIM implementation.

For the specific BIM requirements for a project to be contractually binding, the edited templates must be referenced by the contract in the same way as other contract documents, and should be consistently applied to all contracted parties across the project.

1.2.7 AS ISO 19650 and the Guide

This edition of the Guide incorporates many concepts and principles described in *AS ISO 19650 Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling*, the influential and widely adopted series of international standards on BIM.

The National BIM Guide and AS ISO 19650 share many related concepts and have complementary roles when implementing BIM on projects.

- AS ISO 19650* describes a framework for information management practice using BIM. As a high-level framework it outlines concepts, principles and management processes that can be applied to a wide range of projects in general but does not include detailed information about topics such as modelling practice or examples of the documents it describes.
- The National BIM Guide is a project-focused guide for implementing BIM which covers some of the more detailed aspects of implementation within the Australian market.

Benefits of aligning the Guide with AS ISO 19650 include:

- Consistency between them means readers do not have to re-interpret their content or adopt different approaches to similar tasks. This is particularly important with the growing international adoption of ISO 19650 and as Australian companies expand into international markets.
- It enables the Guide to build on the sound framework established by AS ISO 19650 and enables its users to benefit from the wealth of supporting resources such as guidance material and certification programs that are available.

*Australian experts actively participated in the development of all parts of ISO 19650 through Standards Australia committee BD-104 *BIM* since 2015 to ensure they were appropriate for local industry.

1.2.8 How to use the Guide

Customise to suit the project

The *National BIM Guide* is <u>not</u> intended as a one-size-fits-all document defining the use of BIM on all projects. This is not possible. The separate exchange information requirements (EIR), Project BIM Brief (PBB) and BIM Execution Plan (BEP) templates are used to specify project-specific requirements.

It is expected that project-specific requirements will be formulated by the client in consultation with the project team. The Guide can also be used as a planning tool by consultants to clarify the services they propose to provide when preparing tenders for projects.

Coordinate with client requirements

As a rule, where clients such as government agencies have documented BIM requirements and standards, they will take precedence over those of the Guide. Any conflicting or contradictory requirements should be identified, with project specific resolutions agreed and recorded in the contract documents.

Adopt AS ISO 19650 concepts and principles

To assist its wider adoption, the *National BIM Guide* incorporates AS ISO 19650 concepts and principles and is designed to be used in conjunction with it. Guide resources such as templates are aligned with the standard so they can be readily used on AS ISO 19650-conformant projects.

Resolve inconsistencies

If any inconsistencies or conflicts between the client's predefined BIM requirements, AS ISO 19650 requirements or the Guide's requirements come to light during the project, the information manager/BIM Manager should be notified immediately. In response, the information manager/BIM Manager should determine, in consultation with the project team (if necessary), which document's requirement will take precedence or whether amendments are required, and advise the project team of the ruling. Record amendments in the contract documents. Their application should be managed by the party responsible under the contract.

1.2.9 Supporting resources

The Guide cites many documents that provide more detailed information and guidance on topics it covers. References to these are generally included in panels of light blue fill at the end of clauses. They can be considered companion documents to the Guide.

The Guide also references tools and resources that will assist the BIM implementation process. Weblinks to them are provided throughout the Guide. Where applicable, they can be referenced in the exchange information requirements (EIR), Project BIM Brief (PBB) or BIM Execution Plan (BEP).

1.2.10 Changes since previous edition

Summary of the most significant changes:

- The *NATSPEC National BIM Guide* (this document) now provides a higher-level view of the topic aimed largely at those in executive and management roles. It introduces topics which are usually covered in more detail in the appendices or referenced documents.
- Concepts, principles and terms described in AS ISO 19650 have been incorporated.
- The first edition of the Guide included a detailed specification of the contents of a BIM Management Plan, now referred to as a BIM Execution Plan (BEP). As the BEP Template has been aligned with AS ISO 19650, the specification has been omitted.
- The *NATSPEC BIM Object/Element Matrix* that was formerly part of the National BIM Guide has been superseded by the NATSPEC BIM Properties Generator, an online tool designed to simplify the process of creating and sharing BIM content. It is based on buildingSMART's Industry Foundation Classes (IFC) and the *Open BIM Object Standard* (OBOS). It also includes classification data for BIM objects from major international classification systems. See https://bim.natspec.org/tools/properties-generator

2 CONSTRUCTION INDUSTRY CONTEXT

2.1 The construction industry and digital transformation

BIM is an example of the digital transformation taking place within the construction industry and reflects the digital transformation taking place in other industries and society more generally.

The construction industry has several unique characteristics which make digitalisation challenging. It involves the collaboration of many stakeholders over extended periods of time entailing very extended supply chains of materials, products, services and information. Its project-based nature means that team membership varies from project to project; making it difficult to establish the standardised practices that make the most of digital technologies.

While BIM has been used for quite some time, it is by no means yet 'business as usual'. Wide disparities still exist in understanding, adoption and capabilities.

The Guide recognises this and that the roles and responsibilities it describes may not be as clear-cut as implied. This is particularly the case with the client-consultant relationship or – using AS ISO 19650 terminology – appointing party-lead appointed party relationship.

For BIM implementation to deliver full benefits, a very collaborative relationship needs to be established between the client and consultants from the outset, even for clients who have well developed briefs and predefined BIM requirements. To properly elicit the client's requirements and for their consultants to formulate the most appropriate approach to delivering on them through BIM requires a cooperative spirit, commitment and an adequate investment of time and effort by all parties. Therefore, consistency in procurement requirements is key.

2.2 Benefits of adopting BIM processes

BIM supports feasibility, planning, design, construction, and operation stages of the project lifecycle. A strategic, whole-of-life approach to information management will optimise the benefits of BIM.

The benefits offered by BIM processes include:

- Improved coordination
- Improved communication
- Improved data management
- Better analysis and simulation
- Improved working methods during design
- Improved productivity during construction
- Better information for asset management
- Improved lifecycle management
- Reduced risk and uncertainty

2.3 BIM enablers/Enabled by BIM

Figure 2.3 shows the technologies and processes that enable more effective use of BIM, or that leverage the value of its core functionalities. Many of them regularly feature in articles on technological innovations in the construction industry. Most of them can be used in conjunction with the BIM uses described in 7 BIM uses.

The purpose of Figure 2.3 is to show how enablers relate to core BIM practices. It groups them into rough categories depending on whether they are largely technological, cultural, provide data inputs to the modelling process, or make use of data from models.

Many enablers can offer significant benefits that may not be immediately apparent. For example, photogrammetry-equipped drones can capture large amounts of highly accurate geometrical data in minutes that would take weeks by traditional methods. Likewise, GIS digital setout can have offer substantial improvements in accuracy and productivity. Nonetheless, a careful assessment of the business case for each should be undertaken when considering them for a specific project.

A short description of each enabler including how they can be used is provided in *Appendix C – BIM Use & Enabler descriptions*.

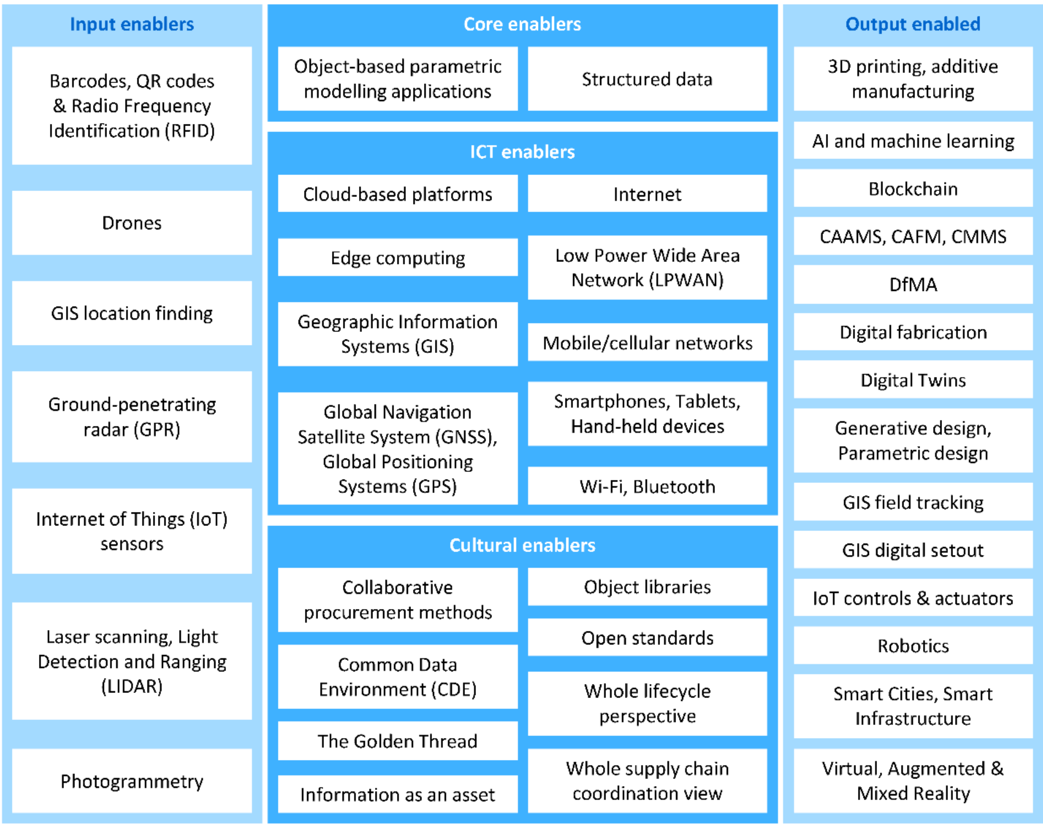


Figure 2.3: BIM enablers/Enabled by BIM

2.4 Relationship of BIM to broader management principles

Many of the BIM practices documented in the Guide are based on established good project and asset management practice. Many of the principles found in AS ISO 19650, such as establishing broad strategic goals and priorities before progressively defining more detailed requirements, can be found in other international standards for quality management, project management, asset management and facility management. AS ISO 19650 shares a structure and approach similar to *AS ISO 55000 Asset management - Overview, principles and terminology* which helps align BIM and asset management practices. See Figure 2.4 for other related standards sharing similar principles.

These shared principles also assist dialogue between stakeholders from different disciplines.

Figure 2.4: Related standards sharing similar principles

BIM and project management

Implementing BIM on a project is part of the overall project management process – it does not replace it. The BIM Execution Plan (BEP) should complement or supplement, rather than replace project management documentation. Therefore, project managers must have an input to the BEP, and then manage it accordingly. They should retain overall control of the project program, deliverables, and communication so that they are properly coordinated and integrated.

2.5 Relationship of BIM to asset management

Design and construction sectors were early adopters of BIM. The facilities and asset management (FM/AM) sectors are now also latching onto the benefits of using the information generated during design and construction phases. This trend is driven by the increasing recognition that operational costs typically represent 70% - 90% of the cost of an asset over its whole lifecycle; particularly significant for costly infrastructure. See Figure 2.5.

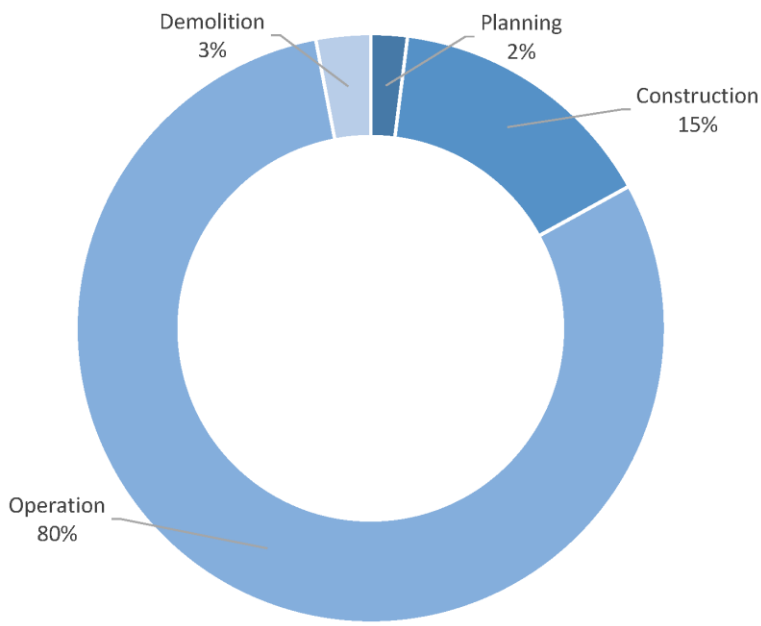


Figure 2.5: Typical lifecycle cost proportions

BIM provides many opportunities to streamline the transfer of construction information to asset and facility managers by providing a single source of truth, but this needs to be planned for from the outset, i.e. the asset information needed for the CAFM system is a specified requirement throughout the delivery process.

See 7.3 Modelling for asset management in this Guide and Asset management in *Appendix C – BIM use & enabler descriptions* and for fuller coverage of this topic.

For coverage of the relationship of digital twins to asset management, see 7.3.3 Digital twins.

For guidance on formulating asset information requirements (AIR) see the *ABAB AIR Guide*
https://www.abab.net.au/wp-content/uploads/2018/12/ABAB_AIR_Guide_FINAL_07-12-2018.pdf

2.6 Digital engineering (DE) / BIM for infrastructure

The differences between applying digital modelling processes to building projects and linear infrastructure (e.g. roadways, railways, utility services) projects are largely the result of differences in spatial distribution and complexity:

- Buildings are generally confined to sites owned by a single owner and less than 1 km x 1 km. The site usually abuts a limited number of similar properties.
- Linear infrastructure ranges across a wide geographical area and the corridors they use abut many individual properties.

2.6.1 Differences between BIM for buildings and infrastructure

Geometrical modelling

Software for building modelling purposes is based on cartesian geometry, i.e. three axis perpendicular to each other, with buildings set out from X, Y, Z orthogonal grids. Linear infrastructure elements such as roads and railways are usually set out using offsets from an alignment. This has traditionally been done using a manually set out chainage. Methodologies enabled by BIM/DE such as digital layout using total stations and machine-controlled equipment offer significant improvements in productivity and accuracy. It also provides asset managers with more accurate location data.

Buildings are also modelled as sitting on a virtual horizontal plane. This is not an issue when it is applied to a site of limited area. However, for an infrastructure project distributed across many kilometres, the divergence between a virtual horizontal plane and the curved surface of the earth becomes very large and has to be taken into account in the modelling process.

Compositional modelling

The software for modelling buildings and that for modelling infrastructure have their roots in different domains, each with different use cases. Building modelling applications model compositional or constructional relationships between the components, assemblies and elements that make up a building. The geospatial applications required for infrastructure projects have their roots in surveying, mapping and cadastre (property ownership and use) domains where the focus was primarily on modelling surfaces, not compositional relationships.

Another consequence of modelling the large-scale complex surfaces associated with civil engineering elements for infrastructure projects is that they usually generate much larger file sizes than for building projects.

GIS/BIM software interoperability

Interoperability issues arise from the differences between the data schema required to support the different types of modelling for buildings and infrastructure noted above. In practical terms this means a file generated by one type of application cannot always be opened or read by the other. Users of these applications have found workarounds and vendors are working on addressing the issue, but there is still some way to go before this is satisfactorily resolved.

buildingSMART's IFC 4x3 addresses some of the interoperability issues. IFC 4x3 extends the data schema originally developed to model building elements – walls, floors, roofs, building services – to model infrastructure elements such as roadways, railways, bridges, wharves and associated utility services.

Data structures

The spatial breakdown structures used to organise information on building projects are generally based on the hierarchical subdivision of buildings into storeys and spaces. The approach for linear infrastructure is different: their branching or net-like morphology is broken down into a series of links, nodes and ports georeferenced to map coordinates.

Project execution complexity

Building projects are largely confined to a single site and even when they involve work on an existing building, they usually only affect its occupants, visitors and neighbours. Most infrastructure projects involve alterations to existing networks servicing many users and have to be kept operational while the work takes place. This requires more attention to project management and communication.

2.6.2 Shared concepts and principles

While there are differences between the information and modelling processes required for building and infrastructure projects, they share many concepts and principles when it comes to defining requirements and structuring data for the effective collaborative production of information and project delivery.

2.7 Industry BIM requirements

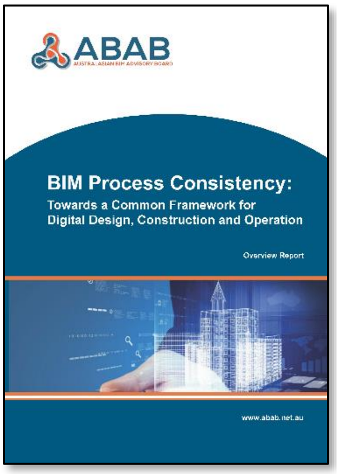
The Australian Building Information Modelling (BIM) Strategic Framework was endorsed by the Board of Treasurers in 2019. The Strategic Framework was developed by the Australasian BIM Advisory Board which is tasked with promoting best practice and consistent approaches to BIM practices, standards and requirements. National consistency can significantly reduce duplication of effort and the time wasted adjusting approaches on each project for processes common to all. It also provides the certainty organisations and individuations need for education, training, accreditation and establishing management systems. The *NATSPEC National BIM Guide* was an early initiative to address these issues.

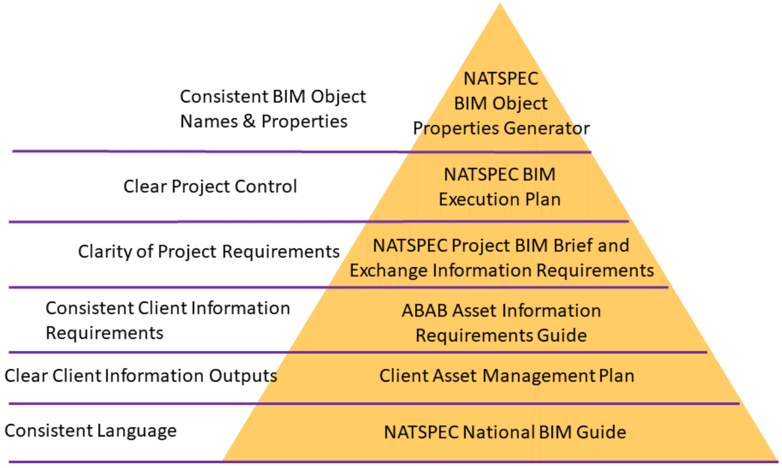
The Framework outlines a series of objectives, reiterates National Digital Engineering Policy Principles endorsed by the Council of Australian Governments' (COAG) Transport Infrastructure Council in 2016, describes four strategic action areas, and identifies past and existing initiatives that support the objectives of the Framework.

2.7.1 Australasian BIM Advisory Board (ABAB)

The Australasian BIM Advisory Board (ABAB) was established in 2016 by the Australasian Procurement and Construction Council (APCC) and the Australian Construction Industry Forum (ACIF), together with NATSPEC, buildingSMART and Standards Australia. ABAB's membership consists of organisations who are well-placed to influence and lead the adoption of BIM. Its members include experts from government construction policy agencies, peak construction associations, and standard setting bodies.

ABAB has produced a range of documents including the *ABAB BIM Process Consistency Report* which outlines the benefits of BIM process consistency, the requirements for achieving this, and cites existing Australian BIM document suites and standards that support it including many from NATSPEC.





ABAB BIM Consistency Report **ABAB BIM consistency documents**

For more details about ABAB and to download their BIM documents, visit https://www.abab.net.au/

Several organisations and government agencies have BIM requirements for their projects. Where they are applicable to a project, any requirements that differ from the Guide's should be identified and the agreed resolution of any conflicts or ambiguities documented in the contract documents.

2.8 Organisational capabilities

BIM offers an opportunity for organisations willing to make the change to lift efficiency and productivity and improve the quality of project outcomes.

Adopting BIM processes necessitates a shift in the approach to practice. The digitalisation of processes demands a strategic and disciplined approach, and often a different mindset. This requires an understanding of BIM processes, close attention to management, and the adoption of quality assurance measures such as data standards, file naming conventions and standardised procedures.

A common way of representing the elements of digital transformation is people, processes and technology. In the context of BIM, a couple of other aspects – structured data and governance – have been added to Figure 2.8. The key to success is maintaining the right balance between each.

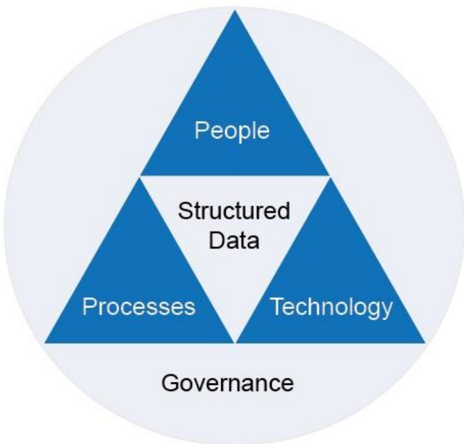


Figure 2.8: People, processes and technology

The cultural issues associated with making the transition from established practices are often more challenging than technological issues, and should not be underestimated. Awareness of this and considered attention to how the transition process is communicated and implemented is critical to success.

2.8.1 Progressive implementation roadmaps

Successful transition to BIM-based methodologies requires buy-in from the organisation as a whole and on-going support from the top down. The best approach is a planned, strategic one: incremental, managed improvements in capabilities over time. The development of a roadmap is a worthwhile first step.

> For information on getting started with BIM and tools and resources to assist the transition to BIM methodologies see https://bim.natspec.org/resources/getting-started-with-bim

The NATSPEC *BIM Execution Plan template* that can be used to provide a consistent framework for evaluating the prospective delivery team's capability, capacity, and competence to meet the client's requirements.

2.8.2 Organisational capability accreditation

Although BIM capability accreditation is not yet mandatory, compliance with the AS ISO 19650 series is more and more mandated by appointing parties as part of their request for tender (RFT) documents, and becoming the norm for any organisation willing to be considered for large project delivery.

There are broadly two types of BIM capability accreditation available:

- Organisational capability accreditation, where companies are audited for alignment to certain BIM standards or protocols such as AS ISO 19650.2. Having an independent third party assess the prospective lead appointed party's systems as part of their accreditation process provides an additional level of confidence to an appointing party.
- Individual BIM capability accreditation. See following clauses.

2.9 Individual capabilities

Individuals assigned to BIM or information management roles should have sufficient BIM qualifications and experience for the size and complexity of the project, and be proficient in the use of any software or platforms associated with their roles.

The qualifications, experience, and previous success in BIM or information management will form part of the evaluation criteria for the selection of architecture and engineering (AE) consultants.

The qualifications, experience, and previous success in BIM or information management, coordination and fabrication will form part of the evaluation criteria for contractor and subcontractor selection.

2.9.1 Individual capability accreditation

Individual BIM capability accreditation is aimed at individuals who want to be educated and trained to an assured level of BIM competence. It is critical to ensure that individuals working on a project have the BIM knowledge and skills to do so. An appointing party should have confidence that the individuals they have contracted understand how to approach and carry out the project according to AS ISO 19650 standards.

buildingSMART Professional Certification (PCERT) is an education program that has been built on an international learning outcome framework, designed to educate and certify individuals to a recognised level of competence, consistent with international standards and best practises. See Figure 2.9.1.

PCERT offers two defined two levels of Professional Certification:

- **Foundation level** addresses knowledge and comprehension around openBIM principles (knowledge-based learning). It is divided into specific learning curricula; each comprising a separate course catering to a specific domain. There are currently nine curricula offered or in development: Basic, Owner/Operator, Contractor, Designer, Facility Manager, Project Information Manager, Manufacturer, Building Performance and COBie. Basic provides the foundation for the other eight and is a prerequisite for commencing any of them.
- **Practitioner level** (currently in development), addresses practical expertise through the individual's ability to apply, analyse and evaluate activities at work. This level of training encompasses a more comprehensive approach that is aligned with ISO 17024 and AS ISO 19650. The Practitioner level is aimed at a much higher competency threshold, where applicants are challenged to apply their knowledge in a project environment.

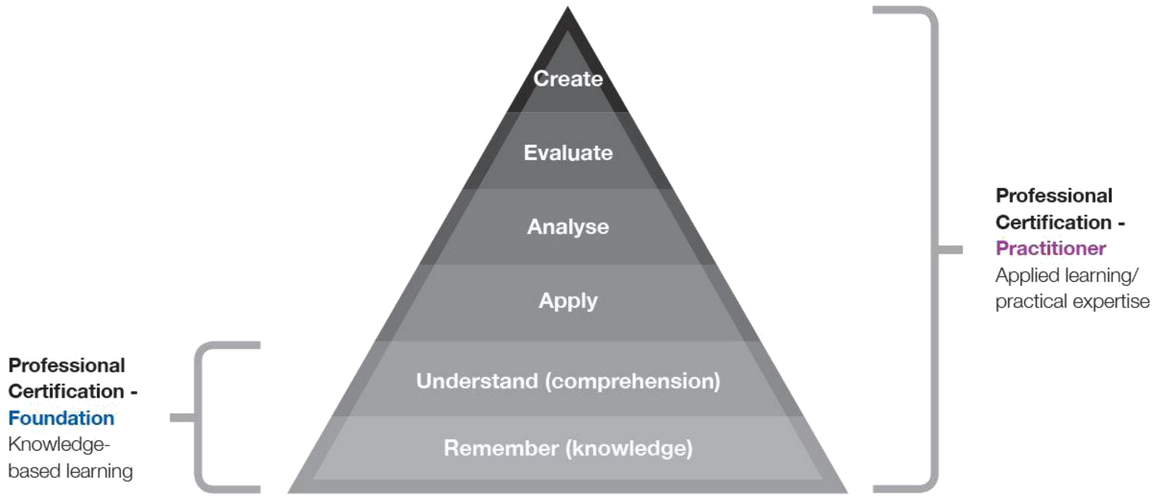


Figure 2.9.1: PCERT knowledge and comprehension learning levels (after Bloom's Taxonomy)

It is not the intention of buildingSMART to deliver individual training, but rather to provide a framework for course development, against which training providers can be accredited and individuals who participate in the PCERT program can be assessed and certified.

For more details see https://www.buildingsmart.org.au/pcert

2.10 BIM education

BIM is a rapidly evolving practice requiring new skills. In response, education and training institutions around the globe have developed courses on the subject. However, there is significant variation in the scope and content of the curricula offered, making the assessment of graduates' competence by prospective employers difficult.

2.10.1 International BIM education activities

NATSPEC, on behalf of the International Construction Information Society (I.C.I.S.), produces an annual report that summarises the status of BIM education in several countries including coverage of courses and qualifications offered in Australia.

Download the report from https://www.icis.org/publications/papers/

2.10.2 BIM competency frameworks

The Australian Construction Industry Forum (ACIF) and Australasian Procurement and Construction Council (APCC) developed a BIM Knowledge and Skills Framework that provides guidance about the required skills and education relevant to BIM for a broad range of industry stakeholders. The intention of mapping the Framework in this wide-ranging manner is to encourage a consistent approach to the upskilling of the construction market sector.

Download the Framework and explanatory notes from https://www.apcc.gov.au/publications

The Australian BIM Academic Forum (ABAF) has sought to address the issue of inconsistent curricula content by developing a *BIM Competency Framework for Australian Universities* which sets minimum requirements for BIM education across Australian universities with the aim of "*creating a sustainable pipeline of graduates in AECO-related courses, who possess the knowledge, skills and abilities required by the Australian AECO industry*".

Download a copy of the Framework from https://nla.gov.au/nla.obj-3024188324/view

3 INTRODUCTION TO AS ISO 19650

As noted in 1.2.7 AS ISO 19650 and the Guide, the Guide incorporates many concepts and principles described in the standard. Those new to AS ISO 19650 can find its terminology confusing because it uses terms different to those in common use for familiar items. This section provides a brief overview of key AS ISO 19650 concepts and terminology.

3.1 Information management appointments, parties and teams

The terms for roles and relationships in AS ISO 19650 were adopted partly to achieve international consensus by avoiding terms unique to any one country, but mainly to provide generic functional descriptions of information management roles independent of contractual relationships. In fact, the standard uses the term function instead of role to differentiate the two.

3.1.1 Appointments

Appointment is a broader term than contract. It is an agreed instruction for the provision of information concerning works, goods or services, and is used whether or not a formal appointment between two parties is in place.

3.1.2 Parties

AS ISO 19650 clearly spells out the responsibilities of each party involved in the information management process. The following terms are specific to information management functions.

Appointing party

The recipient of information, e.g. the client, asset owner or operator. Apart from taking ownership or responsibility for the works, goods and services delivered by the project, they are the ultimate recipient of the information provided by the lead appointed party. There is only one appointing party per project.

Note: the client is the person or entity responsible for initiating a project and approving the brief. The client or their agent is usually – but not always – the appointing party.

Lead appointed party

A party (individual or organisation) directly appointed by the appointing party to provide works, goods or services, e.g. project manager, architect, contractor. They are the party responsible for providing information to the appointing party in response to their information requirements. They coordinate the production of information by any appointed parties or task teams for which they are responsible. There can be multiple lead appointed parties per project.

Appointed party

A party appointed by the lead appointed party to provide works, goods or services, e.g. consultants, subcontractors, suppliers. They provide information to their lead appointed party in response to the relevant exchange information requirements (EIR) associated with their appointment. They do not provide information directly to the appointing party.

Figure 3.1.2 shows the relationship between parties.

Figure 3.1.2: AS ISO 19650 appointment relationships

AS ISO 19650.2 Annex A includes an Information management responsibility matrix template that can be used to document the specific allocation of responsibilities to each function on a project.

3.1.3 Teams

The following terms are defined in AS ISO 19650 to describe groupings of appointments and their hierarchical relationships. See Figure 3.1.3.

Project team

Includes all parties described above: appointing party, lead appointed party and appointed parties. There is only one project team per project.

Delivery team

Includes all parties responsible for the production and delivery of information to the appointing party: the lead appointed parties and appointed parties. There can be multiple delivery teams for a project.

Task team

A team – or an individual – responsible for the production and delivery of information to a lead appointed party. As the name suggests, they are formed to complete specific sets of tasks and are typically discipline-based, e.g. cost management, surveying, engineering design. There can be multiple task teams in a delivery team.

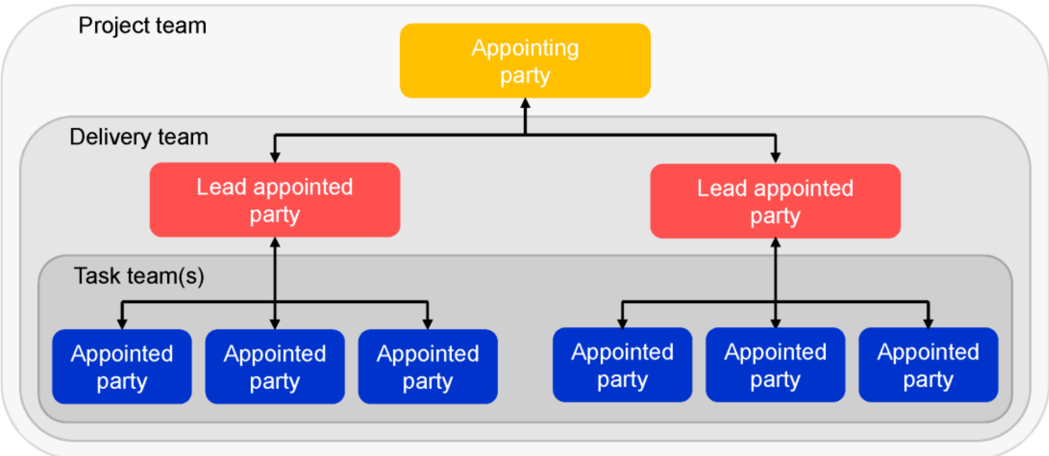


Figure 3.1.3: AS ISO 19650 parties and teams

3.1.4 Information management functions, contractual roles, BIM role descriptions

The relationship of AS ISO 19650 information management functions to contractual roles differs on each project. On some projects the lead appointed party may be a consultant; on others, a contractor. Also, at different stages on the same project one party's responsibilities for information management may change. Adopting AS ISO 19650 terminology makes it clear what each project team member's responsibilities for information management are according to the standard. Terms for each party's contractual roles and their relationships should be defined in the contract.

Information manager

Rather than defining information management responsibilities under specific roles, the AS ISO 19650 series moves away from this approach and intends that the information management function is embedded into existing roles. Therefore, AS ISO 19650.2 never uses the term 'Information Manager' but instead always refers to an "*individual or individuals nominated by the appointing party to undertake the information management function*" for a project. This is done to emphasise the point that this function is independent of an individual's contractual role. However, in the interests of brevity, the Guide uses the description information manager for this function. They can be from within the appointing party's organisation or a third party appointed by them, e.g. a prospective lead appointed party.

The crucial role of the information manager is indicated by the fact that the first requirement of AS ISO 19650.1 is the appointment of individuals to undertake the information management function. In the interests of continuity, it is preferable – wherever possible - for at least one information manager to be retained for the duration of the project.

BIM Manager and other titles

Just as information management functions do not always correlate with contractual roles, there is no direct correlation between AS ISO 19650 information management functions and common BIM role descriptions. A BIM Manager, for example, may be act as the information manager on a project but not all BIM Managers will necessarily be equipped for the role.

Common role descriptions such as Project BIM Manager, Design BIM Manager, Construction BIM Manager, Digital Engineer, VDC Manager, Discipline BIM Lead, BIM coordinator, are unreliable indicators of role responsibilities or individual capabilities. For this reason, AS ISO 19650.2 requires the appointing party to consider the competency of prospective individuals undertaking the information management function on behalf of the delivery team as part of establishing the tender response requirements and evaluation criteria.

See 2.8 Organisational capabilities and 2.9 Individual capabilities.

The BIM execution plan should define the responsibilities associated with each role description, and the description/title used consistently throughout the project.

NOTE: The Guide uses both common role descriptions and AS ISO 19650 information management function descriptions, depending on the context.

3.2 AS ISO 19650 documents and resources

AS ISO 19650 information management processes are supported by many documents and resources. Many of them have precedents in established design, documentation and construction management practice, but have different names, e.g. a master information delivery plan (MIDP) is similar to a documentation schedule or plan. *Appendix B Descriptions of AS ISO 19650 resources* is to assist interpretation of AS ISO 19650 terminology for these resources.

For an overview of AS ISO 19650 and links to guidance resources, see https://bim.natspec.org/documents/iso-19650-documents

4 GENERAL IMPLEMENTATION CONSIDERATIONS

This section covers general aspects of BIM implementation that should be kept in mind when applying the more specific aspects covered in following sections.

4.1 Appropriate implementation of BIM

A clear brief and an understanding of the constraints associated with a project have always been essential prerequisites for a successful project. The same principles apply to formulating requirements for the use of BIM:

- Taking the time to understand what is required.
- A realistic assessment of capabilities and capacities.
- Defining the scope of service.
- Managing expectations and risk.
- Effectively communicating agreed requirements to everyone responsible for satisfying them.
- Apportioning reward commensurate with effort and responsibility.

This is the reason that legal disclaimers are included in this document – it is the responsibility of its users to apply their professional judgment to determine what is appropriate in a particular situation.

If the client's requirements regarding BIM have not been spelt out, discuss how BIM could facilitate project goals, and how it can influence the procurement strategy. Discuss the benefits, limitations and implications of potential BIM uses for the project, and the availability and capability of suitable consultants. The client's understandings and expectations regarding BIM should also be gauged. Areas likely to cause an issue should be addressed with relevant information, such as that included in this Guide. Depending on various factors, it may be appropriate not to recommend a formal requirement for BIM on the project at all.

It is strongly recommended that the information manager function is assigned to a suitably qualified person and a structured process to define the requirements for using BIM on the project, involving the client and project team, is instigated as early as possible.

> The SBEnrc BIM Value Tool can assist the process of selecting BIM uses which offer the most potential value for a project, see https://bim.natspec.org/tools/bim-value-tool

4.2 Project phases

Agree a project phase framework as early as possible in the project planning process. Government agencies often have their own frameworks based on internal funding and approval policies including gates with well-defined criteria for determining whether the project should proceed to the next phase. Understanding the information required for decision making at each gate is essential. The Guide adopts standard building industry phases including Conceptual Design, Schematic Design, Design Development, Contract Documentation, Construction and Operation.

4.3 Procurement strategy

The project procurement strategy will define the overarching structure of relationships on a project. It is imperative that the procurement strategy be determined at the outset of the project so that BIM can be properly structured and consistently implemented to support it.

BIM's benefits are more likely to be realised when the procurement strategy promotes a collaborative approach.

Design, bid, build (DBB): Contracts should be drafted to assist designers to take a more collaborative approach. It is important for everyone to agree who models what, and when. Contractors tendering for work should understand the nature and completeness of the models they will receive.

Design and construct (D&C), or early contractor involvement (ECI): These strategies present designers and constructors with the opportunity to work together to enable things to be modelled only once. Including specific elements in design stage models rather than generic elements will make the design process more efficient.

Collaborative contracting or integrated project delivery (IPD): Linking the client, designers and constructors to common objectives can maximise the benefits of BIM processes. However, this approach demands a high level of trust between all parties.

The contracts will define the integration or separation of risk and responsibilities for the design and construction contracting entities, and therefore, the level of information need and division of responsibilities. For example, there may be only one BIM Manager throughout the project if IPD or D&C is used, or potentially two. A separate Design BIM Manager and Construction BIM Manager will usually be required if DBB is used. Similarly, contractually defined risk will also determine whether there are separate design intent and construction BIM models, or whether they can be combined into one model.

Where building information modelling is to be used for design/documentation and construction, the BIM Execution Plan (BEP) should address how model(s) and other information can be migrated between stages efficiently while preserving their integrity.

Likewise, the procurement strategy will influence decision making about information requirements. For example, the client will not require a cost estimate derived from BIM processes during the construction phase under a D&C contract in which the contractor is responsible for the project budget during that phase.

> *NATSPEC TECHreport TR 06 Procurement: Past and present* outlines the major procurement systems used in the construction industry today including the advantages and disadvantages of each. Download a copy from https://www.natspec.com.au/resources/techreport

4.4 Roles and responsibilities

4.4.1 AS ISO 19650 information management functions

As noted in 3.1.4 Information management functions, contractual roles, BIM role descriptions AS ISO 19650 deliberately separates the information management functions it describes from common BIM role descriptions as they can vary from project to project, or even throughout a project. Figure 4.4.1 shows the distribution of information management functions across teams.

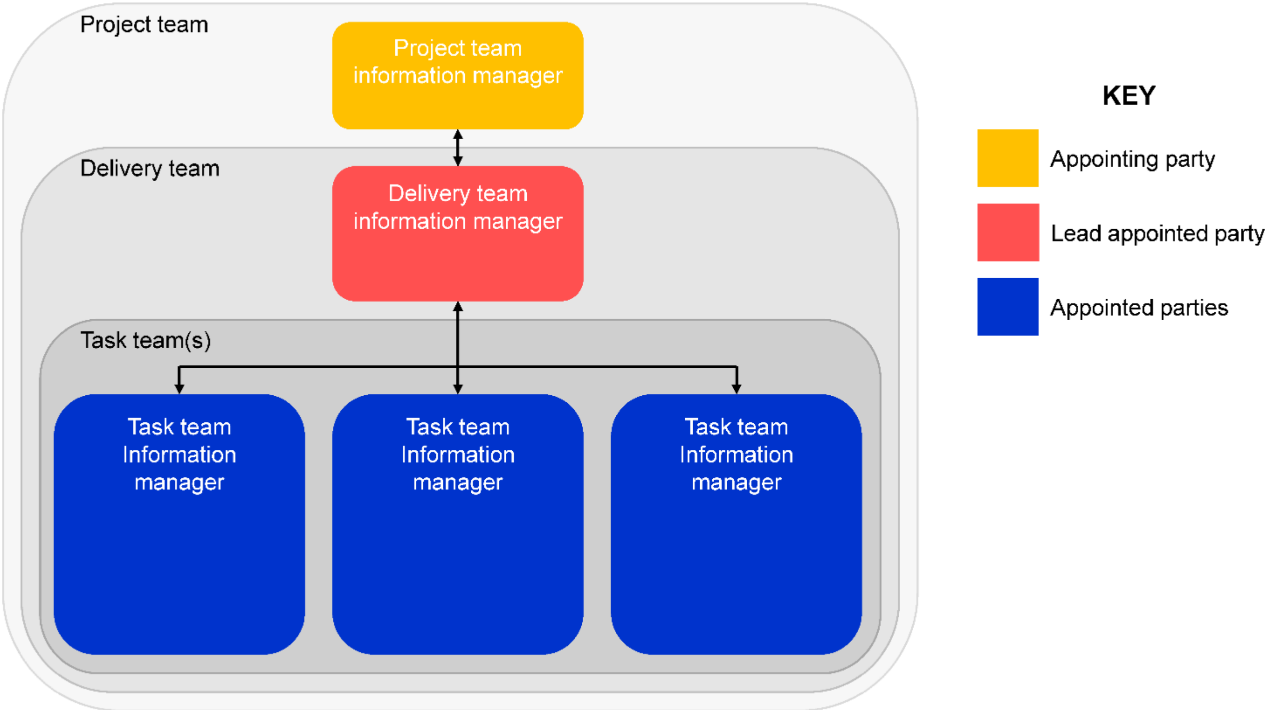


Figure 4.4.1: Typical organisational structure of information management functions on BIM projects

4.4.2 Common BIM role descriptions

There is no reliable correlation between the information management functions described in AS ISO 19650 and common BIM role descriptions. This section examines some of the common role descriptions in use and their typical responsibilities.

There are many permutations of BIM role descriptions. BIM Manager is the most generic but more specific titles include Project BIM Manager, Design BIM Manager and Construction BIM Manager. Other role descriptions encountered include BIM Consultant, BIM Specialist, Discipline BIM Lead, BIM Coordinator, BIM Auditor, BIM Technician and BIM Modellers.

The following role descriptions are provided to illustrate the range of responsibilities commonly assigned to individuals.

Typical BIM Role descriptions

Project BIM Manager

BIM Managers are responsible for satisfying project objectives as they relate to BIM.

They are the primary link between BIM management activities and broader project management activities.

Discipline BIM Lead

Each discipline, e.g. architect, structural engineer, services engineer, should appoint a BIM Lead to coordinate BIM-related activities between their team and the Project BIM Manager.

BIM Modellers

These are BIM software users responsible for satisfying information requirements and facilitating BIM uses by developing the building information model during the project.

Figure 4.4.2 shows one example of an organisational structure including common discipline and BIM role descriptions. They will vary from project to project, so titles, BIM role descriptions, their responsibilities and relationships should be defined in the BIM Execution Plan (BEP) to avoid any ambiguities or misinterpretation.

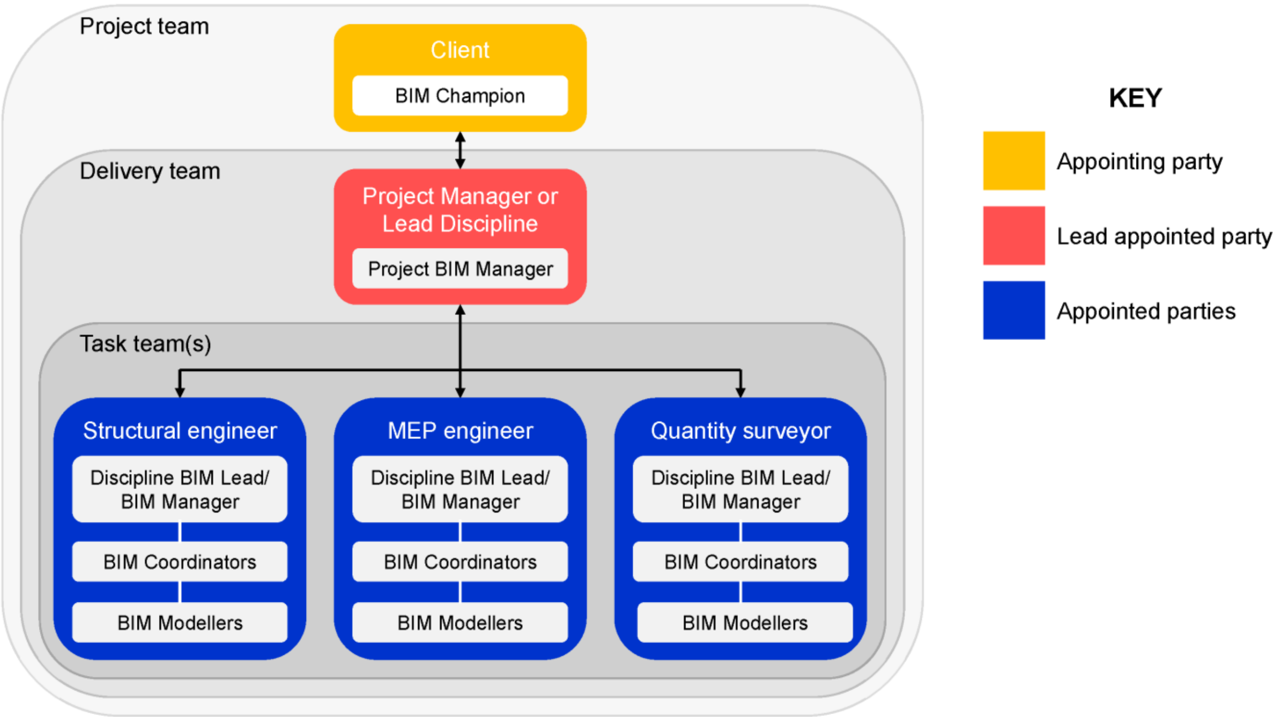


Figure 4.4.2: Example of BIM role organisational relationships

Authority

The project team should define the working relationships between roles (e.g. request, reporting and approval protocols) in the BEP so that lines of authority are clear, and to facilitate the efficient resolution of issues as they arise.

4.5 Legal and contractual aspects

Information contained in this section is guidance only. Seek legal advice when developing and executing contracts.

4.5.1 BIM protocols

A BIM Protocol identifies building information models required to be produced by the project team and puts in place specific responsibilities, liabilities and associated limitations on the use of those models. It defines the expected deliverables for each project stage. A BIM Protocol is a supplementary legal agreement that is incorporated into professional services appointments and construction contracts by means of an amendment.

BIM protocols address many of the issues covered in this section. Standard BIM Protocols have not yet been specifically developed or endorsed for the Australian or New Zealand markets. The lack of alignment between the terminology used in AS ISO 19650 and Australian contracts also represents a potential source of risk.

For more information on legal and contractual aspects of BIM including BIM Protocols see https://bim.natspec.org/resources/bim-topics/36-protocols-contracts-addenda/214-protocols-contracts-addenda

4.5.2 Appointed party selection

Prospective appointed parties review the EIR and other project information during the tender period. The invitation to tender/request for tender should clearly outline the appointing party's BIM-related expectations including specific BIM goals and benefits they have identified.

After the appointing party has reviewed the assessment of the delivery team's capability and capacity provided by the prospective lead appointed party, they are in a better position to select a team with the critical skills and experience required for the project.

The prospective BEP should detail the responsibilities of individual parties for information management. The roles of information and BIM Managers should be specifically detailed rather than combined with general role descriptions.

> The EIR and the tender response requirements and evaluation criteria are vital elements of the invitation to tender. Coordinate them with the proposed contract to avoid conflicts, contradictions or omissions. Provide a clear order of precedence between contract documents.

Appointed parties' responsibilities for timeliness, completeness, and quality of deliverables are no different under BIM delivery methods than non-BIM methods. However, BIM processes involve more interdependencies which must be factored into the delivery program. Formal delivery points, i.e. information delivery milestones should be defined to enable verification of program and deliverables requirements.

The deliverables and delivery dates documented in the BEP are contractually binding when referenced by the contract. If the scope or responsibilities of an organisation for information management change during the development of the delivery team's BEP after they have been engaged, they should be treated in the same way as other scope changes under the contract.

Contractor-specific considerations

The invitation to tender documentation should clearly outline the appointing party's expectations of the contractor. Issuing design information and models to the contractor at the time of tender and, subsequently, as a part of the contract can greatly improve information delivery, which will lead to improved project outcomes.

The invitation to tender information should cover the following items relevant to the contractor:

- Information models including their format and level of information need to be provided by the design team to the contractor.
- Design BEP.
- Whether the design information manager will be retained during the construction phase, or the contractor will be required to provide another individual for this function.
- Handover process from design to construction information manager.
- The format and level of information need required for project information models (PIM) at handover to the appointing party.
- The format and content required for asset information models (AIM) at handover to the appointing party.

4.5.3 Intellectual property

Models can contain far more information than traditional electronic deliverables. To maximise the benefits of BIM, this information should be available to others as appropriate. To facilitate this, clauses addressing ownership of intellectual property (IP) should be included in the conditions of contracts.

For BIM this can be interpreted as:

- Models created for the project are 'new IP' and jointly owned by the client and consultant. Each party grants the other an unrestricted royalty-free license to use them for the project. The client can make the complete models available to the project team for any project-related use. The client's rights with respect to new IP are conditional on the client paying all amounts due to the consultant.

- Specific modelled element details and libraries are 'pre-existing IP'. Ownership remains with the consultant. The consultant grants the client an unrestricted royalty-free license to use the specific element details and libraries to the extent reasonably required to enable the client to make use of the service or to adapt, update, or amend the works.
- The client can use the models created for whatever purpose they want but can only use the specific element details to complete the specific project.

Whatever IP arrangements are agreed to, they should be clearly documented in contractual documents.

4.5.4 Information status and its use

The exchange of models and other information is the very basis of the BIM process. Users need to understand the degree to which they can rely on the information they receive. In the interests of fostering true collaboration across the life cycle of an asset, avoid using blanket "for information only" disclaimers. (Though some agencies are obliged to do this due to legislation.)

The issuer of information should clearly define what it can (and cannot) be used for. For example:

- Work in progress – issued for ongoing coordination
- Developed design issue
- Detailed design issue for consent and contractor pricing
- Issued for construction – for production of shop drawings, not for fabrication
- Issued for construction – suitable for fabrication.
- As-built/as-constructed.

These classifications should be defined in the BEP.

Information status in common data environments (CDE)

The permitted uses of information managed in a CDE are designated by status codes embedded in the metadata attached to the information containers/files it includes. See 5.5 Common data environment. This is a more reliable way of describing the status of information because the meaning of these codes and the process of changing information status can be clearly defined in a National Annex to AS ISO 19650.2.

4.6 Information security

The increasing use of, and dependence on, information and communication technologies make it critical to identify potential vulnerabilities to the risk of unauthorised access to sensitive information or malicious disruption of services. Some projects may require national security clearance.

Typical risks that need to be considered include potential breaches of privacy laws due to the unauthorised access to data, and the loss or corruption of key data on critical assets.

A structured approach to assessing information security risks and developing appropriate risk mitigation measures is recommended. *AS ISO 19650 Information management using BIM – Part 5: Security-minded approach to information management* describes "*a framework to assist organizations in understanding the key vulnerability issues and the nature of the controls required to manage the resultant security risks to a level that is tolerable to the relevant parties*." It includes topics such as developing a security strategy, a security management plan and a security breach/incident management plan.

Note that AS ISO 19650.5 provides a framework for developing security management plans, not a ready-made plan or measures. Therefore, it is not appropriate to specify information security using statements such as "*Information security shall conform to AS ISO 19650.5*"

4.7 Value of asset data to the appointing party

The ability to own, reuse, and properly manage building data throughout the facility lifecycle accrues significant advantages for the appointing party. Consequently, the accurate creation, management and stewardship of information during project creation are of utmost importance. Data created during planning and refined during the project execution process can provide a valuable resource for asset and facility management, so its quality and reliability are paramount.

4.8 Quality assurance

Construction projects warrant a structured approach to quality assurance (QA). The Guide's sections 5 Information management practice and 6 Modelling practice include details of QA measures applicable to those practices. To ensure the appointing party's requirements are delivered accurately, reliably, and efficiently, QA measures need to be supported with adequate human and information resources including standards and induction procedures for new project team members.

5 INFORMATION MANAGEMENT PRACTICE

The first part of this section provides a conceptual overview of the information management process covered in more detail in the following parts. The concepts and terminology are based on those found in AS ISO 19650.

Refer to 4.4 Roles and responsibilities for an explanation of the terms used for information management functions.

Overview of information management using BIM

In addition to materials and resources, the construction of built assets relies on the collaboration of many individuals including for the creation and sharing of significant amounts of information.

Information requirements, deliverables and BIM processes are inextricably linked:

- Information requirements represent a request, or a call, for information.
- Information deliverables represent the response to the requirements.
- BIM processes represent the means of delivering information in response to information requirements.

Information requirements should be clearly defined to enable deliverables to be validated and verified, i.e. so you can tell if you got what you asked for. Validation and verification of deliverables should be carried out as each deliverable is received throughout the project.

Processes for delivering information assets parallel the process for delivering a physical asset.

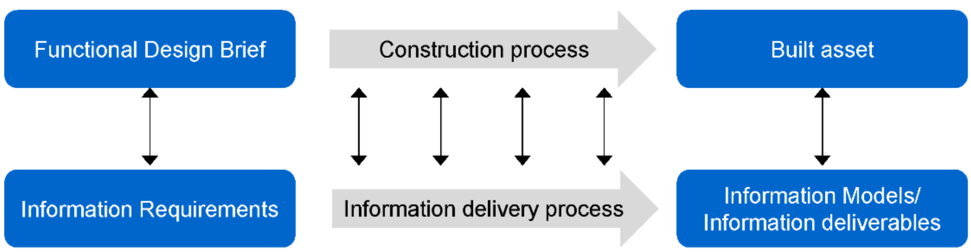


Figure 5: Parallel delivery of a built asset and asset data

5.1 Information requirements

AS ISO 19650 categorises information requirements into the following groups:

Organisational information requirements (OIR)

OIR set out the information needed by an organisation to inform decision-making about high-level strategic objectives. OIR inform the asset information requirements (AIR) and the project information requirements (PIR) but are generally not issued as part of tender documentation.

Project information requirements (PIR)

PIR set out the information required by the appointing party for decision-making at key decision points during its delivery.

These requirements can include the information needed to construct the built asset and project management documents such as cost and progress reports. Organisational policies such as financial reporting procedures and formats also influence PIR. PIR define the information content, form and structure that needs to be included in the project information model (PIM). Experienced clients usually have generic PIR that they adopt or customise for each of their projects. PIR contribute to the exchange information requirements (EIR) but are generally not issued as a separate document in the invitation to tender.

Asset information requirements (AIR)

AIR set out the information needed to operate and maintain a built asset throughout its lifecycle. Informed by the OIR, they define the information content, form and structure that needs to be included in the asset information model (AIM). They contribute to the EIR but are generally not issued as a separate document in the invitation to tender.

Exchange information requirements (EIR)

The EIR collate the AIR and PIR and express them in a way they can be readily assigned to project appointments. While the AIR and PIR are primarily concerned with **what** information needs to be delivered – its content, form and structure – the EIR outlines **which** sets of information need to be delivered **when**.

EIR are included in the invitation to tender and inform the development of the pre-appointment BIM Execution Plan (BEP) by the prospective lead appointed party. Grouping EIR by appointment type, e.g. discipline, and delivery milestone can facilitate a more consistent response by tenderers and make their submissions easier to assess.

Following appointment, the lead appointed party creates individual EIRs – derived from the initial EIR – for each appointment. These EIRs only include the parts of the AIR and PIR relevant to each appointed party.

Figure 5.1 shows the relationship between information requirements and information models.

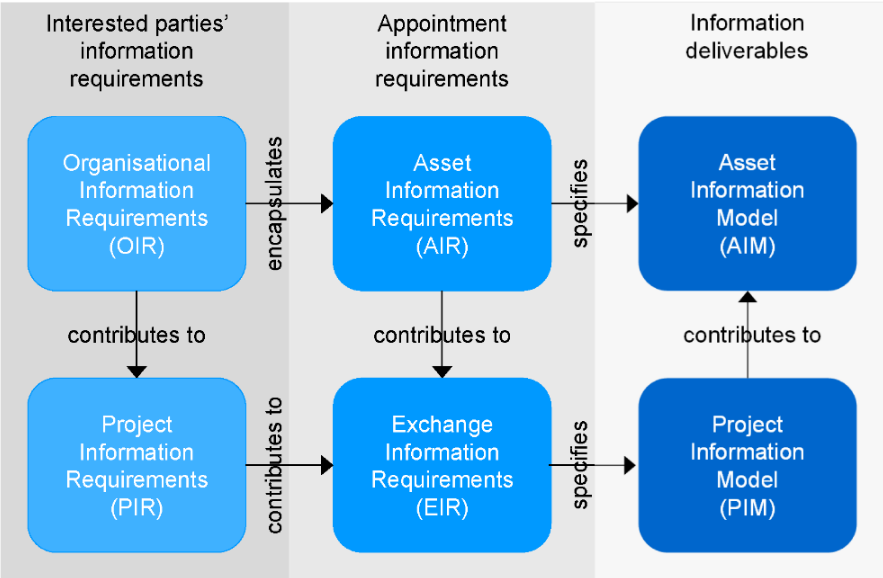


Figure 5.1: Information requirements and information models

5.2 Deliverables - Information models

Note that AS ISO 19650 uses the term 'model' in the broader sense when referring to information models, i.e. a representation of something. It describes not just a virtual 3D model but all the information that needs to be delivered to fully describe a project/asset including documents, drawings, models and structured data.

AS ISO 19650 describes two types of information models:

Project information model (PIM)

The PIM supports the delivery of the project and contributes to the AIM. As not everything added to the PIM during the project is relevant to the AIM, part of the project planning process should include how the AIM will be derived from the PIM, and which parties will be responsible. A PIM should be stored for auditing purposes and to provide a long-term archive of the project.

Asset information model (AIM)

The AIM is the deliverable provided by the delivery team in response to the client's AIR. It supports the client's strategic and day-to-day AM/FM processes. It can also provide information at the start of a refurbishment or an extension of an existing asset.

5.3 Level of information need

AS ISO 19650.1 incorporates the concept of level of information need, a framework for specifying the extent and granularity of information needed at key information exchanges during a built asset's lifecycle. Its purpose is to guard against delivery team members producing too much information or information that is too detailed. If everyone understands the purpose for which other members of the delivery team require information and their level of information need at each stage of the project, they can plan its production with greater confidence.

Similar concepts such as level of detail (LoD), level of information (LoI) and level of development (LOD) exist but the level of information need concept has been developed to address some of the issues encountered with them. These include their confinement to one type of deliverable, e.g. LOD for the geometrical resolution of model objects, and their excessive granularity for most purposes.

Level of information need encompasses all information deliverables, e.g. models, drawings, documents, model objects, data, and applies metrics appropriate to each (a broader metric is required for describing a whole model than its individual constituent object).

The key point to note about level of information need is that it is explicitly designed for *specifying* the maturity of information required by the appointing party throughout the project.

See *EN 17412-1:2020 Building Information Modelling - Level of Information Need — Part 1: Concepts and principles* for more details. An international standard, ISO 7817, with the same title is currently being developed.

Note: Level of information need does not completely replace LOD in the Guide, but the use of the LOD framework is confined to describing the geometrical resolution of model objects through LOD tables included in the *BIM Execution Plan Template*.

5.4 Information management process stages

Figure 5.4 summarises the eight stages of the information management process during the delivery phase of assets described in AS ISO 19650.2. (AS ISO 19650.3 deals with the information delivery process during the operational phase of assets.)

The *ANZ Guide to ISO 19650* provides guidance on this process.

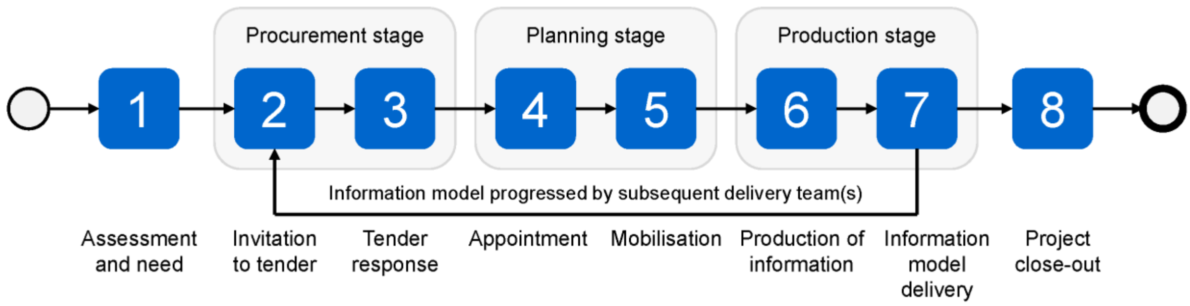


Figure 5.4: Information management process during the delivery phase of assets

5.5 Common data environment

This section covers the management requirements for the common data environment (CDE) which supports the collaborative production and delivery of information described in the previous section.

As part of developing the invitation to tender resources AS ISO 19650.2 clause 5.1.7 requires the appointing party to establish (implement, configure and support) the project's CDE to serve the overall requirements of the project and to support the collaborative production of information.

Establishing the CDE prior to tender enables the advantages of the CDE to be realised from the start. The large volumes of information often associated with tenders can be centralised and curated effectively, and in a way that provides all tenderers with equal access to current information. This includes addendum and clarifications issued in response to queries by all tenderers.

The CDE is fundamental for the effective handover of asset information to facility management (FM). Without the single source of truth between models, documents and data it provides, this information becomes fragmented very quickly.

Description

A CDE is defined as a single source of information for any given project. It functions as a digital hub for project stakeholders to collect, manage, and disseminate relevant approved project information in a managed environment. Information includes building information models, drawings, reports, and other project-related information.

Structure and management

The CDE manages the flow of information through four distinct states:

- **Work in progress:** Each member of the project team can carry out their own tasks before issuing information to other members of the project team.
- **Shared:** Information from project team members is stored in the CDE when it is ready to be shared with other team members to support on-going design development.
- **Published documentation:** Documentation based on information in the shared location is published at key milestones. This information is reviewed and approved by nominated approvers within each discipline.
- **Archive:** Historic versions of information are stored in the archive location and remain available for future reference.

Rules for reviewing and authorising the transition of information from one state to another maintain the integrity of the system. See Figure 5.5.

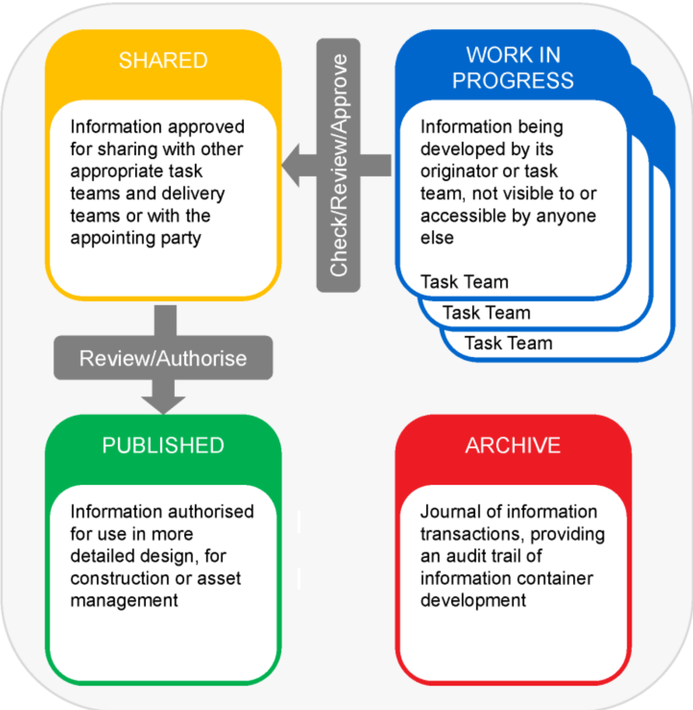


Figure 5.5: Common data environment information workflows

Information identification

Naming conventions are used to identify information containers/files within the CDE. These conventions encode information such as the originating organisation, the discipline responsible, the location of the item to which the information relates and its form, e.g. text document, drawing, model.

Information status

It is essential for all members of the project team to understand the status of information (as distinct from the state) provided by others, i.e. its intended purpose and permitted uses. Status and revision codes embodied in the metadata of the information containers/files are used to designate this. Embodying revision and status in metadata means the identification (ID) or name of information containers/files remain unchanged, which facilitates more reliable searching and reporting.

Implementation

The ICT implementation of CDEs can take many forms. Likewise, their structural implementation. The conceptual ideal of a single CDE used by everyone: appointing party, lead appointed party, appointed parties, is rare. In practice, they are more likely to be an ecosystem of CDEs. A common arrangement is to have two types of CDE: one for company-based information and another for project-based information:

- A company-based CDE is managed on each appointed party's network and hosts information in the work in progress (WIP) state.
- A project-based (CDE) is managed by the information manager on behalf of all members of the project team. It hosts information in the shared, published, and archived state.

After the project has been delivered, the project CDE should be archived. If it is hosted or managed by a third party on behalf of the appointing party, its content and/or management should be formally handed back to them at project close-off.

For further information on CDEs, see:

- DIN SPEC 91391-1:2019 *Common Data Environments (CDE) for BIM projects – Function sets and open data exchange between platforms of different vendors – Part 1: Components and function sets of a CDE; with digital attachment* https://www.en-standard.eu/din-spec-91391-1
- DIN SPEC 91391-2:2019 *Common Data Environments (CDE) for BIM projects – Function sets and open data exchange between platforms of different vendors – Part 2: Open data exchange with Common Data Environments* https://www.en-standard.eu/din-spec-91391-2

5.6 Information management documents and resources

The items described in the remainder of this section represent the core documents and resources used to support the information management process. Most, but not all of them are from AS ISO 19650.2. See *Appendix B – Descriptions of AS ISO 19650 resources* for details.

To assist implementation, the Guide includes templates for the key documents described below.

5.7 Exchange information requirements

Refer to AS ISO 19650.2 clause 5.2.1.

Establishing the appointing party's exchange information requirements (EIR) is an important first step in preparing an invitation to tender, as they define the information the prospective lead appointed party is expected to deliver. Defining the asset information requirements (AIR) and project information requirements (PIR) beforehand helps break the process into more manageable steps and enables tasks to be allocated to the most appropriate stakeholders, e.g. AIR to asset or facility managers.

Once information requirements have been established, they are collated in the EIR. As EIR are appointment-based, this collation helps avoid duplication of effort. Specifying the level of information need at each information delivery milestone enables the prospective lead appointed party to respond more effectively. Likewise, aligning requirements to project-related appointments, e.g. by grouping them by discipline, will assist development and assessment of the prospective BEP.

In addition to information requirements, an EIR provides the prospective lead appointed party with broader contextual information about a project including a project description, project goals, priorities and procurement strategy.

Content

In summary, AS ISO 19650 requires the following items to be taken into consideration when establishing EIR:

- AIR
- PIR
- Level of information need required to meet each information requirement
- Acceptance criteria for each information requirement (based on the project's information standards, methods and procedures, etc)
- Supporting material that can assist the prospective lead appointed party fully understand requirements, e.g. existing asset information, planning and construction conditions of consent.
- Dates, relative to the project's information delivery milestones that each requirement has to be met.

The Guide's *Exchange Information Requirements (EIR) Template* is a useful tool for prompting discussions about requirements and providing a framework for capturing decisions about them.

Ancillary items

Other information forming part of the invitation to tender includes:

- Project reference information such as information standards, e.g. naming conventions, classification systems, information production methods and procedures and other reference information, e.g. site surveys, existing asset data.
- Shared resources such as templates, style libraries and object libraries.
- Tender response requirements and evaluation criteria.

This information is best stored in a CDE where it can be effectively managed and readily accessed by tenderers.

5.7.1 Project BIM Brief

Project BIM Briefs (PBB) are not described in AS ISO 19650 but can serve a similar function to the project information requirements (PIR) and exchange information requirements (EIR) documents. Like them, they are created by the appointing party as part of developing the invitation to tender resources.

The Guide retains a PBB template. Potential uses include:

- Specifying BIM requirements on simple projects.
- As a framework for discussion and consideration of BIM requirements during early client meetings.
- Creating a preliminary draft or executive summary of requirements as a starting point for the more detailed definition of requirements in the AIR, PIR and EIR templates.

5.8 (Pre-appointment) BIM Execution Plan

Refer to AS ISO 19650.2 clause 5.3.2.

The pre-appointment BIM Execution Plan (BEP) is prepared by prospective lead appointed party in response to the appointing party's EIR and supporting invitation to tender information. It is the plan proposed by the prospective lead appointed party that describes how the information the appointing party requires will be delivered and how the project will be executed, monitored and controlled with regard to BIM – who does what, when and how. It is crucial to the success of a project.

The prospective lead appointed party is responsible for providing prospective task team members with the relevant (appointment-specific) EIR they need to provide an informed response. The prospective lead appointed party should, in turn, coordinate and collate all responses to ensure the effective delivery of information back to the appointing party.

To assist evaluation, the responses documented in the BEP should explicitly reference the requirements specified in the invitation to tender.

The BEP should be considered a living document and updated throughout the project as required to ensure it remains on schedule and meets briefed requirements. The proposed method for facilitating this, e.g. scheduled review meetings, should be included in the pre-appointment BEP.

Alignment with procurement strategy

The BEP should align with the project procurement strategy by addressing requirements for design, construction and operational phases as appropriate. The ideal is for it to cover all phases in an integrated way because this enables more comprehensive planning and reduces the risk of issues with the handover of information models between phases. However, where the procurement strategy dictates otherwise, particular attention needs to be paid to defining the information development required by the recipients of information at handovers and assigning responsibilities for ensuring a smooth handover from one party to the other.

Content

AS ISO 19650 requires the following items to be taken into consideration when developing the prospective BEP:

- The names and résumés individuals undertaking the information management function on behalf of the delivery team.
- The delivery team’s information delivery strategy.
- The proposed federation strategy to be adopted.
- The high-level responsibility matrix which allocates responsibilities for key elements of the information model.
- Any proposed additions or amendments to the project’s information delivery methods and procedures.
- A schedule of software, hardware and ICT infrastructure proposed to be used.

Ancillary items

Other information forming part of the delivery team’s tender includes:

- A mobilisation plan.
- An assessment of the risks associated with the timely delivery of information and how they intend to manage them.
- A summary of the delivery team’s capability and capacity as described in the following clause.

5.8.1 Summary of the delivery team’s capability and capacity

Refer to AS ISO 19650.2 clauses 5.3.3 and 5.3.4.

To assist the appointing party assess the tenders they receive, AS ISO 19650 requires the prospective lead appointed party to include a summary of the delivery team’s capability and capacity to deliver information in accordance with the EIR and the pre-appointment BEP in a timely manner. It is developed by the prospective lead appointed party by aggregating each tasks team’s assessment of their own capability and capacity.

AS ISO 19650 requires the following items to be taken into consideration when task teams are undertaking these assessments of their capability and capacity to manage and produce information:

- The relevant experience and number of members.
- The relevant education and training available to members.
- The availability of information technology (IT) within the task team based on the specification and quantity of hardware, the available capacity of ICT infrastructure, and ICT support available to the task team.

Requiring all task teams to use the same template will make it easier to collate and summarise their responses.

5.9 Delivery team's BIM Execution Plan

Refer to AS ISO 19650.2 clauses 5.4.1 to 5.4.7.

Following the appointment of the successful tenderer, the lead appointed party – in agreement with appointed parties – should update and confirm any changes required to the BEP. It should be a requirement for this to be completed within an agreed period following the appointment.

AS ISO 19650.2 requires many of the items previously only required to be considered for inclusion in the (pre-appointment) BEP to be formally included. It requires the high-level responsibility matrix to be further refined into a detailed responsibility matrix and the development of additional resources including task information delivery plans (TIDP) and a master information delivery plan (MIDP).

The BEP should be updated throughout the project as required to reflect the delivery team's response to changing circumstances and new insights gained during execution.

6 MODELLING PRACTICE

This section outlines modelling and documentation practices that facilitate collaborative workflows and quality outcomes. Inevitably, there is some overlap between the information management processes described in 5 Information management practice and this section, e.g. Federation strategy/breakdown structures.

6.1 Key principles

6.1.1 Open standards

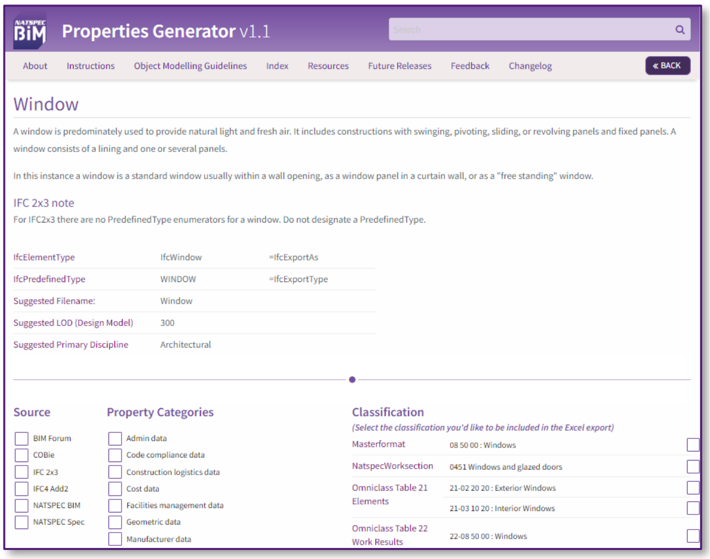
Not everyone uses the same modelling software and no single software application can do everything required to deliver projects – open standards address these fundamental barriers to collaboration.

Successful collaborative modelling and the on-going reusability of information relies on open BIM standards such as Industry Foundation Classes (IFC) and Construction Operations Building Information Exchange (COBie). Many BIM software applications are IFC-compliant to enable interoperability with other applications. However, for these advantages to be properly realised, it is essential for model objects to be correctly modelled and IFC parameters incorporated from the outset. Resources designed to assist this process include:

- Open BIM Object Standard (OBOS). Download a copy from https://bim.natspec.org/documents/open-bim-object-standard
- NATSPEC BIM Properties Generator. Visit https://www.propgen.bim.natspec.com.au/

Both of these resources are aligned to be complementary and mutually supportive tools.

For the most reliable exchange of information, the latest IFC export/import tools should be used.



Open BIM Object Standard cover

NATSPEC BIM Properties Generator screenshot

For contract deliverables whose open standard formats have not been finalised, they should be provided in agreed formats which allow the re-use of information without specialised proprietary software. The formats to be used are best specified in the EIR and BEP.

6.1.2 Well-structured data

To leverage the power of BIM applications, the data entered into them needs to be well structured. It is critical that available national standards, classification systems and protocols such as OmniClass, Uniclass 2015 and NATSPEC are used when modelling so that information can be machine-processed and normalised for the appointing party's management purposes. Global Unique Identifiers (GUIDs) should be assigned to model objects in BIM applications and carefully managed to support effective data management.

6.2 Model federation

Very few projects make use of a single model that includes all live project information and that is accessible to all. This may take place within a single organisation, but rarely across a whole project team.

In most cases, each discipline will develop their own models from a base model provided by the lead designer. Individual models can then be combined, or federated, to create a composite model. Federated models are the embodiment of interdisciplinary coordination in BIM. Figure 6.2 shows a typical federation structure.

File format compatibility and interoperability needed to support this process should be documented in the BIM execution plan. This will ensure geometry and/or information can be managed in compatible file formats to support smooth model sharing workflows.

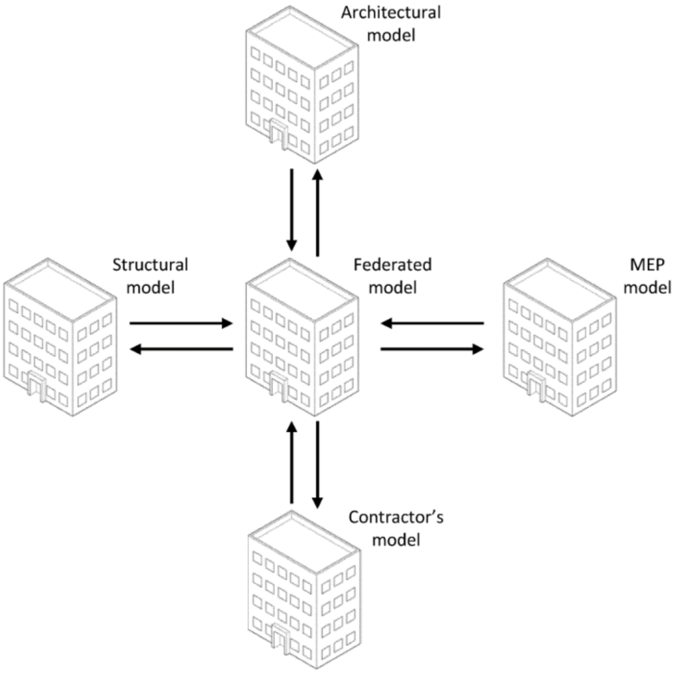


Figure 6.2: Model federation

6.3 Managing the modelling process

The EIR and BEP will define the appointing party's information requirements and/or required BIM uses for a project, determining the scope of modelling required to deliver the specified information models, i.e. virtual 3D models, drawings, documents and data.

Before modelling begins, the project team should agree model development strategies, assignment of modelling responsibilities, standards, methods and processes and document them in the BEP.

6.4 Quality control

Apply quality control measures to all aspects of modelling and documentation to eliminate errors and achieve desired project outcomes. The principle underpinning these measures can be summarised as:

model to a standard, check to a standard

In addition to agreeing standards as part of the development of the BEP, the project team should agree protocols and procedures for checking compliance with them and other quality control measures to be applied to specific processes throughout the project.

Innovations for improving quality control that each party can offer should also be explored.

6.5 General modelling guidelines

6.5.1 Modelling standards

If the appointing party has specific modelling and documentation standards which must be adhered to, they should be included in the project's information standards and information production methods and procedures. In the absence of specific requirements, the prospective lead appointed party should include proposals for them in the prospective BEP.

Once standards and protocols have been agreed and documented in the BEP, information managers/BIM Managers are responsible for implementing them and regularly auditing models to ensure they are being consistently applied.

6.5.2 Data structuring

If the methods for structuring shared data, e.g. naming conventions, classification, metadata have not been specified in the EIR, they should be agreed by the project team and documented in the BEP.

6.5.3 Model management

BIM Managers are responsible for managing building information models to maintain information integrity, manage file size, and ensure compliance with the detailed responsibility matrix (or Model Element Authoring (MEA) schedule, Level of Development (LOD) Table, etc).

They are also responsible for auditing, purging, and compressing models at key deliverable milestones and as required to maintain the quality and integrity of models.

6.5.4 Model sharing

The model sharing methodology should be agreed between information managers/BIM Managers and documented in the BEP. This includes:

- Organisation of the Common Data Environment (CDE) and protocols for its use.
- Frequency of model exchanges
- Acceptable file formats for exchange
- Protocols for issuing models, e.g. checks required prior to sharing.

6.6 Model set-up and authoring

6.6.1 Good modelling practice

Each task team should apply industry-proven, best-practice modelling methodologies. Information managers/BIM Managers are responsible for implementing them across their teams and regularly auditing models to ensure they are being consistently applied.

6.6.2 Model location and orientation

It is essential that a shared model setup point is established before collaborative modelling on a project commences. All BIM projects should use a real-world coordinates system and specify the datum in the BEP.

6.6.3 Level of Development (LOD)

LOD is a numerical scale applied to individual model elements or to indicate their development status at different times during the modelling process, e.g. LOD 100, LOD 200, LOD 300, etc. Its main purpose, when incorporated in responsibility matrices, LOD tables, etc, is to make it clear what each member of a delivery team is required to author in their models, at each stage, and to what extent others can rely on them.

The LOD framework sits within the broader framework of level of information need. See 5.3 Level of information need. It should only be applied as a metric for describing the geometrical resolution of individual model objects. This is one of the commonly misunderstood aspect of LOD – it is often incorrectly applied to models as a whole instead of their constituent objects. There can also be issues with its application in practice, e.g. the difficulty of maintaining and communicating the very granular information that is often included in LOD Tables, etc.

For an overview of Level of Development see NATSPEC Paper: BIM and LOD
https://bim.natspec.org/images/NATSPEC_Documents/NATSPEC_BIM_LOD_Paper_131115.pdf

For definitions of LOD for many construction elements see the BIMForum Level of Development Specification available at https://bimforum.org/LOD/

6.7 Model coordination

3D coordination is one of the inherent benefits offered by BIM processes. Successful model coordination relies on each appointed party understanding their roles and only modelling what they are responsible for within agreed spatial boundaries at any given time - usually by reference to a federation strategy and a detailed responsibility matrix (or MEA schedule, LOD table, etc).

Coordination is much more than just clash detection. A strategic approach to coordination begins in the early design phases by allowing adequate space for services and formulating an overall approach to the reticulation of all services. Buildability and access for servicing also need to be considered as part of this process.

Regular communication between all parties is the key to successful coordination. Before a formal clash detection process is started, visual inspection of models can be used for general coordination. This includes single discipline coordination and coordination of other discipline models. Discipline BIM coordinators are responsible for general coordination.

Management of the 3D coordination process is the responsibility of the project BIM Manager or other agreed party. The BIM Manager should oversee 3D coordination according to the agreed model coordination matrix and model tolerances at an agreed frequency throughout the relevant design stages.

Discipline BIM leads are responsible for resolving coordination issues identified by the information manager/BIM Manager. The BIM Manager should track the progress of each clash until it has reached an agreed resolution.

6.7.1 Facilitating BIM Coordination

Meetings in which models are used for design review and clash detection/coordination are the preferred means of facilitating technical discipline coordination. Project circumstances will determine whether face to face or online meetings will be the most appropriate.

Consider the following means of facilitating BIM coordination:

a. BIM coordination meetings in a suitably equipped room at a location agreed by the project Team.
b. BIM coordination meetings in a BIM coordination room. Depending on the project procurement strategy, there may be one room or there may be two rooms in succession. During construction, the BIM coordination room should be located at or near the construction site to coordinate fabrication models with respective trades. For each BIM coordination room, provide the appropriate equipment and tools to support coordination.
c. BIM coordination meetings using web conferencing platforms.
d. Specialised applications known as Integrated Collaboration Platforms (ICP).

Record the options selected and those responsible for providing them in the EIR and BEP.

6.8 Model handovers

The protocols for model handovers should be described in the EIR and BEP. When a model is issued, the responsible information manager/BIM Manager should include crucial information about the model – separate from the model – for other users, describing its contents and explaining its purpose and limitations so they have an insight into it without relying entirely on discovery when they open it. It should include information about the relative development and accuracy of parts of the model to provide a clear picture of the extent to which they can be relied on.

This information can be stored in an agreed location in the CDE in an information container/file with a title such as model submission form or model description document. When the form and location of this information has been agreed, it should be documented in the BEP.

7 BIM USES

BIM use cases, or BIM uses, are a way of describing how BIM can used for a specific purpose or to achieve a specific outcome. Each BIM use entails a specific set of interactions between stakeholders, software applications and datasets. They are a useful device for linking these things together in a coherent, readily grasped narrative.

AS ISO 19650 does not explicitly mention BIM use cases but requires the appointing party to consider the purpose for which information will be used when establishing their information requirements (Part 2, clause 5.1.2). The concept of BIM uses complements the information management approach described in AS ISO 19650 because there are many resources available built around it that can be used to flesh out the details of information delivery not covered in the broader framework of AS ISO 19650.

7.1 Short descriptions of BIM uses

The following BIM uses correspond to those in the *Penn State BIM Project Execution Planning Guide* so that they map directly to the selection methodology it describes. *Appendix C – BIM use & enabler descriptions* provides fuller descriptions of them plus guidance on:

- Potential value
- Resources required to implement
- Team competencies required
- Potential output information
- Procurement considerations
- Scope considerations
- Useful references
- BIM enablers: processes and technologies that enhance BIM uses or are enabled by BIM.

1. Existing conditions modelling

Existing site conditions including topography, buildings, structures and utilities are modelled, usually to provide a basis for the design of new work on site. Existing conditions can be captured by methods such as laser scanning and conventional surveying techniques.

2. Cost management (5D modelling)

Geometrical and other data embodied in models enables the accurate measurement of material quantities in proposed designs. The parametric nature of models means these are automatically updated as changes are made, negating the need for manual remeasurement.

3. Phase planning (4D modelling)

Models are used to virtually show construction sequences by linking model elements to a construction program. The resulting animations are powerful visualisation and communication tools for project teams.

4. Spatial programming

Models of individual spaces included in a project's spatial program are assembled to show design relationships. The parametric nature of models enables the relationship of design options to the spatial program to be automatically reported.

5. Site analysis

A model of existing conditions is used to model aspects of the site including solar access and overshadowing by adjoining structures, planning envelopes, circulation paths, exit routes and view corridors to optimise the location and layout of design proposals.

6. Design authoring

Design authoring, auditing and analysis software is used to develop a building information model based on the brief and performance criteria. It supports the iterative development of a design.

7. Design review

3D models are used to communicate aspects of a design within a design team and to stakeholders. Visualisations enabled by models including walk-throughs and virtual reality are powerful tools for engaging and communicating with stakeholders.

8. Structural analysis

Specialised software for analysing and modelling structural behaviour is used to select and optimise the design of structural systems. Model elements need to incorporate appropriate properties and connections to other elements for this purpose.

9. Lighting analysis

Software for analysing and modelling natural and artificial light is used to select and optimise the location and design of windows, skylights, shading devices, reflectors and light fittings. Model authoring software or specialised applications can be used for this purpose.

10. Engineering analysis (mechanical, other)

Specialised software for analysing and modelling performance of building services including heating, ventilation and air conditioning systems (HVAC) is used to select and optimise their design. Model elements need to incorporate appropriate properties and connections to others for this purpose.

11. Energy analysis

Energy simulation software is used to model the thermal performance of building envelopes and HVAC systems, usually to verify their conformance with building energy standards and optimise them to reduce life cycle costs. Spaces, building elements and building services need to be appropriately modelled for this purpose.

12. Sustainability analysis

Specialised software is used to analyse the sustainability performance of designs. Data about the recycled content, biodegradability, embodied energy and other metrics of materials included in models enables life cycle analysis (LCA) to be conducted and designs to be assessed against sustainability schemes such as GBCA Green Star and NABERS.

13. Code validation

Specialised code validation software is used to check model parameters against project-specific codes through the application of programmed sets of rules

14. 3D coordination

Clash detection software is used to identify geometrical and spatial conflicts between elements of federated discipline models. This provides the opportunity to resolve them before construction commences.

15. Construction documentation

Documentation including plans, elevations, sections, schedules, specifications, 3D diagrams and renderings can be generated from models. This offers the advantage of being able to readily update each type of documentation in a coordinated manner as changes are made.

16. Site utilisation planning

BIM software is used to graphically represent permanent and temporary facilities, delivery areas, material stockpiles, etc on site during multiple phases of the construction process. Visualisations of these items are powerful tools for communicating with site users.

17. Construction system design (virtual mock-up)

BIM software is used to design and analyse the construction of a complex building systems, e.g. form work, scaffolding, glazing, tie-backs, in order to improve constructability/buildability, maintainability and health and safety.

18. Digital fabrication

The process of using data from BIM to direct machines such as cutters, drills, lathes, 3D printers and milling, punching and folding machines to fabricate ductwork, steelwork, etc. It can also be used to create fabricated parts that form a final assembly and facilitate Design for Manufacture and Assembly (DfMA).

19. 3D control and planning (digital layout)

A process using data from a model to lay out construction works. Geometrical locations in the model are translated to physical location points on site by means of GPS-enabled digital theodolites ('total stations') and a target retroflector positioned on those points. It significantly increases speed and accuracy.

20. Record modelling

The process of creating an accurate record of a built asset in model form. Generally, two types of record model should be available at the end of a project: 1. As-Designed (provided by the design team) and 2. As-Built (provided by the contractor). The first needs to be updated as design changes are made and the second as any changes are made on site.

21. Digital twins

A digital twin is a digital representation of a physical asset, process or system. What distinguishes a digital twin from other digital models is its connection to the physical twin. In particular, the bi-directional exchange of data between the two.

22. Asset management

A process in which an organisation's asset management system is bi-directionally linked to a record model, or data within the record model is imported into the asset management system to aid the maintenance and operation of a facility and its assets.

23. Building maintenance management

BIM is used as part of the process of maintaining the functionality of the building structure (walls, floors, roof, etc.) and building services (mechanical, electrical, plumbing, etc.) over their operational life. This can be done by linking data in the model with the Computerised Maintenance Management System (CMMS).

24. Building system performance analysis

The process of measuring how a building's performance compares to the specified design. This includes how well the mechanical system is operating and how much energy a building is using. Performance can be measured by comparing real-time data from building systems with design and commissioning data included in a model.

25. Space management and tracking

A process in which BIM is used to manage and track the use of spaces and related resources within a facility. A model enables facility managers to analyse the existing use of spaces and to use it as a planning tool when allocating spaces to optimise the functionality and amenity of a facility.

26. Emergency response planning

A process in which emergency responders access critical building information in the form of a model and information system. The model provides critical building information to the responders that helps improve their response and minimise safety risks.

7.2 Modelling for cost management

BIM is well suited as a cost management tool. Its capacity to accurately model quantities which are automatically updated as changes are made to the project offers many advantages over more manual processes; but its effectiveness relies on models being appropriately structured for this purpose. This includes breakdown structures, element classification and object properties including units of measurement aligned to quantity surveyors' (QS) needs.

When cost estimation is selected as a BIM use for the project, the appointed QS or pre-construction estimator should provide an input to the EIR and BEP. Their inputs to an object information strategy will enable models to be developed with their requirements in mind.

Refer to Cost management in *Appendix C – BIM use & enabler descriptions* for a more detailed coverage of this topic.

7.3 Modelling for asset management

As noted elsewhere in the Guide, one of the main value propositions for BIM is the potential to capture asset information during the design and construction phases that is useful for the operation and maintenance of the asset without the labour-intensive and error-prone process of manually re-entering this information after handover.

When asset or facility management is selected as a BIM use for the project, those expected to be responsible for the facility's management should provide an input to the asset information requirements (AIR), exchange information requirements (EIR) and BIM Execution Plan (BEP). Their inputs to an object information strategy will enable models to be developed with the AIR in mind. After handover, the facility management (FM) model can be used to quickly find the location of assets and information about them.

Many of the challenges of capturing asset information for the operation of an asset are cultural rather than technological, e.g. the design team being adequately briefed on AIR early enough in the design process to effectively deliver the information, and task teams having the ability to reliably deliver accurate product and as-built information.

For guidance on formulating AIR see the *ABAB AIR Guide* https://www.abab.net.au/wp-content/uploads/2018/12/ABAB_AIR_Guide_FINAL_07-12-2018.pdf

7.3.1 Construction-Operations Building information exchange (COBie)

Information for the operational phase of a built asset needs to be collected from many parties throughout the design and construction phases. Traditional methods of collecting and handing over this information in the form of printed documents and/or PDFs on CDs or USB drives are very inefficient and unreliable, requiring the information they contain to be manually entered into Computer Aided Facilities Management (CAFM) or Computerised Maintenance Management System (CMMS).

COBie is an open data exchange specification designed to standardise and streamline the handover of asset information to built asset owners and operators.

COBie is commonly associated with preformatted Excel spreadsheets for recording asset information but it is also available encoded in other formats including IFC-SPF (STEP-File) and ifcXML. These open file formats enable COBie data to be exchanged between proprietary design authoring applications and CAFM systems.

The advantages of adopting COBie for the asset data collection and handover process include:

- The availability of tools and plug-ins for software applications for the integration of COBie.
- Freely available resources such as spreadsheet templates.
- Extensive supporting information and guidance material; much of it free.
- Training courses and accreditation programs.

COBie provides a well-documented method for information handover and a flexible framework that can be adjusted to the needs of each project. However, if it is to be used on a project, items that need to be specified to deliver the required outcomes include:

- Which assets are to be included (generally those requiring regular management and maintenance).
- Properties to be included for each asset type.
- The classification system to be used. The CAFM or CMMS classification system can be used if known. OmniClass and Uniclass 2015 are incorporated in the spreadsheet templates.

- If and how COBie data will be linked to models, e.g. ifcGUIDs.
- An information delivery schedule, e.g. set intervals, project phase changes, project handover.
- The organisation of the data collection and coordination process including the allocation of individual roles and responsibilities.

For more information on COBie, see https://bim.natspec.org/resources/bim-topics/32-facility-and-asset-management/161-construction-operations-building-information-exchange-cobie

7.3.2 Soft landings

The rigid separation between construction and operation means that many buildings are handed over in a state of poor operational readiness and suffer a 'hard landing', particularly if the commissioning period has been reduced due to delays in construction. The soft landings approach is designed to smooth the transition from construction into use, enabling owners and occupiers to get the best out of their building. It represents a strategic approach entailing greater involvement of designers and constructors with building users and operators before, during and after handover, with an emphasis on improving operational readiness and performance in use.

The soft landings approach complements the whole-of-lifecycle approach of defining AIR early, and progressively collecting asset information throughout the procurement process.

The CIBSE *Soft Landings Framework Australia and New Zealand* outlines a process for ensuring a smooth handover of a building from the design and construction team to its owners, operators and users. Download the framework from https://www.cibse.org/networks/regions/australia-new-zealand/anz-regional-news/the-soft-landing-framework-australia-new-zealand-m

7.3.3 Digital twins

A central idea of BIM is that a virtual model of a physical asset is created to facilitate its design before it is built. Recognition of the value of updating the design model to reflect what is actually constructed so that it can be used as a source of information for the operation and maintenance of an asset has been increasing steadily.

Digital twins build on the concept of as-built models of an asset. The key difference that distinguishes digital twins from as-built models is that they are digitally linked in a dynamic way. Information collected from the physical asset/twin by sensors can be used to update the model/virtual twin. They can act as ongoing data repositories for operational outcomes using technology to understand and add value to an asset over its lifecycle. This information can then be used to monitor performance and run simulations of how the asset might perform in different scenarios. The link can also be bi-directional – information generated from the virtual twin can be used to change settings in control systems or operate devices such as actuators, relays, displays, lights, pumps and fans in the physical twin.

Digital twins have enormous potential but, like BIM, the business case, scope and intended purposes need to be well-defined before implementation to ensure the expected benefits and returns on investment are realised. A sound as-built model is an essential foundation for a digital twin. This outcome can be achieved by applying the principles outlined in this Guide.

See Digital twins in *Appendix C – BIM use & enabler descriptions*.

For an overview of digital twins, see the *ABAB Digital Twin Report* https://www.abab.net.au/wp-content/uploads/2021/01/ABAB-Digital-Twins-Position-Paper-Web-210118.pdf

7.4 Selecting appropriate BIM uses

As noted in 4.1 Appropriate implementation of BIM, a structured process should be used for selecting BIM uses that will deliver the greatest value to the project. This is a necessary part of developing exchange information requirements (EIR) and BIM Execution Plan (BEP).

7.4.1 Selection criteria

The selection of BIM uses should be based on project goals, information requirements and team capabilities. Many of the difficulties associated with implementing BIM stem from not adequately defining its use based on these factors at the outset. It is also an essential prerequisite for planning how BIM uses will be deployed during each phase of the project.

With BIM, the effective management of data is essential for anything beyond basic geometrical modelling. Each BIM use has significant datasets associated with it which need to be managed – additional uses multiply the effort. Any non-essential data simply becomes chaff that makes finding important information more difficult. This is why defining information requirements and level of information need is such a fundamental part of the information management approach described in AS ISO 19650. Once BIM uses have been well defined, many aspects of planning the implementation of BIM can be resolved with greater certainty.

The *Penn State BIM Project Execution Planning Guide* includes a methodology for selecting BIM uses (see http://bim.psu.edu) and *Appendix C – BIM use & enabler descriptions* include details of tools that can assist selection.

8 BIM DELIVERABLES

The EIR defines the appointing party's deliverables including their level of information need and format. The BEP describes the method for delivering them.

8.1 Final BIM deliverables

Final deliverables include:

- Asset information model (AIM): Models, documents and data that provide information for the operation and maintenance of the built asset. It usually includes asset information additional to the project information model (PIM), e.g. asset register. However, the PIM will include a lot of information unnecessary for day-to-day facility management purposes, so extraneous information should be removed and separate models combined to form a single model. More detailed information that may be required for major works should always be available in the PIM.

  For more details see the *ABAB AIR Guide* https://www.abab.net.au/wp-content/uploads/2018/12/ABAB_AIR_Guide_FINAL_07-12-2018.pdf

- PIM: Models, documents and data that provide information for the delivery of the project. At handover to the operators of the built asset, all information in the PIM should be fully coordinated so it represents a reliable record of the built asset as it has been constructed.

The value of these deliverables does not reside in each item alone – the way they are linked and integrated is also crucial. The methods of structuring data described in 6 Modelling practice are critical to fully realising their value.

8.1.1 Generation of 2D deliverables

Any traditional 2D documentation should be prepared with the approved BIM authoring software

recorded in the BEP. Plans, elevations, sections, schedules, and details should be derived from, and fully coordinated with the model. Do not modify 2D deliverables so they contradict the model.
All other documents should be submitted in compliance with contract requirements.

8.2 Submission of digital deliverables

Throughout the project, all digital deliverables should be uploaded to the CDE to the appropriate location/state and with the appropriate revision coding and status metadata described in the EIR and BEP. Otherwise, without the single source of truth about models, documents and data that the CDE provides, this information becomes fragmented very quickly.
Any specific submission requirements, e.g. record storage medium and information organisation, should be described in the EIR and BEP.

9 TECHNOLOGY AND PROJECT INFRASTRUCTURE

9.1 BIM software

9.1.1 Interoperability

The ready access to building information over the life of the capital asset is critical. Proprietary software is usually subject to regular updates, meaning anyone wanting to open files created in an earlier version may also need to update their software. In some instances, unless the version in which the file was originally created is available, it may not be possible to open it at all. The long-term interoperability of data is also important.

For these reasons – unless expressly approved otherwise by the appointing party - only software that is Industry Foundation Class (IFC) compliant and meets their interoperability standards should be used for model authoring.

9.1.2 Software selection

If the appointing party has any requirements for specific software, they should be specified in the EIR. The prospective lead appointed party should specify any other BIM software proposed for use on the project in the BEP.

The criteria used to evaluate the suitability of software for use on the project should be specified in the EIR. Any non-compliance with the criteria should be brought to the attention of the appointing party for a ruling on whether it is acceptable to them.

Examples of software requirements include:

- Model authoring software certified as being suitable for use with the most current version of IFC file format available at commencement of the project.
- Model authoring software certified as being able to export native files to IFC file format without loss of geometric integrity.
- Model checking software being interoperable with the model authoring software agreed for the project.
- BIM-based energy analysis software supporting IFC import or using a native BIM model format that is IFC compliant. Energy analysis software selection should be based upon US Department of Energy (DOE) Recommendations and ANSI/ASHRAE 140-2020 and conform to the Australian Building Code Board (ABCB) Protocol for Building Energy Analysis Software.
- All BIM software support tools used for managing information directly linked to the model, e.g. database applications for managing room data sheets, configured and operated so that the integrity of the model is not compromised.

9.1.3 Software Compatibility and Data Flow Testing

Proposed software should be tested for compatibility by the information manager/BIM Manager, and approved versions used for the duration of the project. Any proposal to upgrade to a later version of software should be submitted to the information manager/BIM Manager for assessment in consultation with the project team. No upgrade should be implemented on the project until the proposal is approved by the information manager/BIM Manager. On approval, its implementation should be coordinated by the information manager/BIM Manager.

9.2 Common data environment implementation

See 5.5 Common data environment for coverage of the concepts associated with CDEs including their structure and management.

AS ISO 19650.2 clause 5.1.7 requires the appointing party to establish a CDE for a project and strongly recommends that it be in place prior to issuing the invitation to tender to enable the benefits of it to be realised from the outset. Enabling tenderers to access a single source of secure information offers obvious advantages over distributing it to them individually.

If they prefer, the appointing party can appoint a third party to host, manage or support the project CDE on their behalf. This is best done prior to making any other appointments.

For the best results, the appointing party should define a functional and non-functional brief for the CDE.

For guidance on implementing CDEs see:

- *Asset Information Management - Common Data Environment - Functional Requirements* UK Government BIM Working Group CDE Sub Group 2018 https://www.cdbb.cam.ac.uk/news/2018AugCDE

Implementation of a Common Data Environment - The Benefits, Challenges & Considerations Scottish Futures Trust 2018 https://www.scottishfuturestrust.org.uk/storage/uploads/cdeimplementaionresearchaug18.pdf

9.3 Data security

The project team should establish data security protocols to prevent any possible data corruption, virus "infections", and data misuse or deliberate damage by their own employees or outside agents. All project teams should establish adequate user access rights to prevent data loss or damage during file exchange, maintenance, and archiving.

For guidance on data security see:

- AS ISO 19650 *Information management using building information modelling, Part 5: Security-minded approach to information management*
- Australian Government Cyber Security Guidelines: https://www.cyber.gov.au/acsc/view-all-content/ism/cyber-security-guidelines

State governments and their agencies also have cyber security policies and/or guidelines. It is good risk management practice to confirm which jurisdiction's requirements apply and then conform to them.

Note: AS ISO 19650.5 provides a framework for developing data security management plans but does not include technical details of measures that can be implemented. Guidance on the technical implementation of data security measures should be sought from appropriately qualified experts.

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