BIM Outreach

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BIM IN PRACTICE

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0 *BIM Outreach*

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PREFACE

In the past several years Building Information Modelling (BIM) has gained a significant foothold within the construction industry worldwide. Many companies have experienced its benefits (and some of the pitfalls) whilst implementing this technology and the processes that it enables.

However there is still a large portion of the industry that is yet to wade into the murky BIM waters.

The aim of the Outreach group was to explain in clear language, from a practitioner's point of view, some of the benefits, issues, costs and hurdles when implementing a BIM methodology into your business and projects.

The Outreach group consisted of industry leaders that have been using BIM processes to deliver projects for the past 10 years. The projects they have worked on span the spectrum of our industry, from small refurbishments to billion dollar builds. The group has had extensive input from Australian architects, engineers, quantity surveyors, facilities managers and contractors.

The input of these stakeholders was important to collate the common issues a client should be aware of when requesting BIM. One of the main drivers for the group was not to sell BIM to the reader, but to provide practical advice and as little jargon as possible.

These documents are not only aimed at assisting someone just starting down the BIM road, but also at professionals who are keen to understand how other parties within our industry see this new paradigm. These documents hopefully raise the collective awareness within our industry and create an open dialog that encourages best-for-project outcomes where all contributing parties succeed.

The following topics were tackled by this group

- 01 Educating clients – What to ask for when requesting BIM?
- 02 Architects & building designers – What does BIM mean to my business?
- 03 Engineers – What does BIM mean to my business?
- 04 Contractors/builders – Possible uses of BIM for construction
- 05 Quantity surveyors & cost planners – How can BIM improve my business?
- 06 Facilities managers – What benefits are there for me engaging with a BIM process?
- 07 Manufacturers & suppliers – What can BIM do for my products?

Toby Maple (HASSELL)
Chair: BIM Outreach Working Group

The goal of each paper was:

- to be a short document that was clear and easy to understand
- to provide common terminology that industry can use as a foundation to build upon
- be a starting point for someone who was new to BIM, but also a window into other project partners' issues
- assist the reader in locating further information within the other three AIA/Consult Australia working groups

We hope these documents encourage further (and ongoing) discussion to enable closer collaboration between project team members, ultimately reducing waste, and thus improving the industry we work in.

BIM Outreach

01 *Educating clients – What to ask for when requesting BIM?*

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01 *Educating clients – What to ask for when requesting BIM?*

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01 Educating clients – What to ask for when requesting BIM? [Version 1 – August 2012]

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INTRODUCTION

Globally, it is well understood that in comparison to most industry sectors – agriculture, finance, mining etc – that productivity in the construction industry is relatively low. Construction industries contribute significantly to the health of most economies and poor productivity is generally accepted as economically unsustainable.

In response, construction industries have been searching for ways and means to improve their productivity and reduce waste. The adoption of a more integrated approach to the management and delivery of construction projects is widely regarded as a key contributor to potential future productivity improvements. Accordingly many US, European, UK and even now Australian government agencies are promoting, in various forms and capacities, new approaches to project procurement which embrace more integrated approaches to the management and delivery of projects.

There is great potential for projects and clients to benefit from improvements in productivity through the adoption of a more integrated approach to the project's procurement.

THE BIM APPROACH

In this context the term 'integrated' implies the bringing together of participants in a collaborative, cooperative and proactive manner around a common source of information – a Building Information Model (BIM). In the construction industry the participants typically include clients, architects, engineers, quantity surveyors, other consultants, contractors and subcontractors and these parties typically have differing needs from the BIM. Aligning all parties' (and foremost the client's) requirements with a common goal is paramount in a BIM process. This can potentially have implications on intellectual property rights and the AIA/Consult Australia Legal and Procurement Working Group working group has addressed some of these issues.

BIM provides the foundation on which an integrated approach to project delivery can be realised. The BIM allows the project participants to efficiently collaborate through design development in a relatively low risk environment, virtually prototyping (or rehearsing) the project prior to committing to actual construction.

There are many issues to consider for the client contemplating the adoption of BIM for a particular project. It is not simply the adoption of a different software package or new technology. The most effective adoption of a BIM approach will entail reconsideration of workflow methodologies for all parties involved in the project including clients, consultants and contractors.

The planning and programming for schematic design, design development, documentation and construction should consider the BIM workflow methodology that best suits the particulars of the project (see work undertaken by the AIA/Consult Australia BIM Project Plan Working Group). At the outset the approach to the project should consider and establish an approach to, for example:

- A BIM project plan and BIM leadership
- BIM deliverables (i.e., what will the model be used for – documentation, energy analysis, code compliance, cost planning and control, coordination and clash detection, visualisation, shop drawing, manufacturing, etc?)
- Project team communication and decision making procedures
- Software selection and interoperability
- Hardware and network resources
- The roles of participants (e.g., client, consultants and contractors)
- Performance assessment
- Modelling protocols and project standards
- Level of Development (LoD) for different stages of design development and documentation
- Training and support
- Project procurement
- Legal and contractual issues
- Insurance and liability issues
- Copyright and protection of intellectual property
- Data exchange methods and standards

Any BIM project should consider how these aspects of the project will be managed in the best interests of the project. Clients contemplating a potential BIM project should consider adopting an integrated approach to the design development, documentation and/or construction of the project. Coupling the integration of the project team with a BIM process can facilitate efficient project delivery.

THE ROLE OF THE CLIENT IN MULTI-DISCIPLINARY BIM TEAMS

The decision to proceed with an integrated BIM team will require commitment from the client and all participants. Perhaps the most important decision the client can make will be the appointment of the most appropriate design and construction team. Ideally the design and construction team will have some experience in the use of BIM. However, irrespective of its experience, it is critical that the design and construction team is committed to the use of a BIM workflow methodology throughout the project delivery. As a minimum it is advisable that the party entrusted with the primary responsibility for management of the BIM have sufficient expertise and experience.

Some projects will benefit from BIM more than others. Early adoption of a BIM project plan (see work undertaken by the AIA/Consult Australia BIM Project Plan Working Group) will usually deliver the greatest productivity through the lifecycle of a project. The client's vision for the project must be clearly established. What are the project goals? How will BIM be used to most effectively address these goals?

CONCLUSION

There is great potential for clients to benefit from improvements in procurement productivity. For example potential exists for projects:

- to be realised to better meet the performance objectives of their briefs
- to be delivered more cost effectively within tighter timeframes, with less wastage
- to be tuned to perform to higher standards of environmental sustainability
- to be geared to maximise financial performance through the whole lifecycle of the asset

Additionally there are significant benefits for clients in improved efficiencies in facility management, beyond construction, and throughout the operational lifecycles of their projects.

However the best approach will depend upon the circumstances of the project. This requires careful consideration as to the manner in which workflow methodologies need to adapt to service the demands of the project. In order to maximise the potential benefit, this adaptation is logically best lead from the top down. That is, by a committed client with a clear understanding to the project objectives and how they might be best met through BIM procurement methodologies.

Summary Box

- There is great potential for clients to benefit from improvements in productivity through the adoption of a more integrated approach to project procurement.
- An integrated approach to project procurement is supported by the adoption of a BIM workflow methodology that mitigates risk and provides cost savings.
- The adoption of a BIM methodology presents a variety of important considerations in regard to the procurement strategy. This is best lead by the client in order to maximise the impact of potential advantages and savings.

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02 *Architects & Building Designers – What does BIM mean to my business?*

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02 Architects & building designers – What does BIM mean to my business? [Version 1 – August 2012]

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INTRODUCTION

Building Information Modelling (BIM) is a digital representation of a project which contains additional information about building elements, their properties and the construction process. This information (or data) can be used throughout the entire building lifecycle from concept, through documentation, into cost management, construction logistics, project management and facility operation.

BIM is not an application or specific piece of software (although there are many) – it is a process, a methodology.

TECHNOLOGY

You can compare traditional 2D CAD to a digital drawing board, where lines are drawn to represent parts of buildings. BIM is profoundly different. It is the digital equivalent of a physical building where all disciplines and stakeholders in the project collaborate in 3D to digitally construct a virtual building. Traditional documentation can be achieved by simply slicing through the model creating views (plans, sections, elevations). However by adding additional information to the objects within the model (fire ratings, space usage, material selections etc.) this information can be accessed by other parties, reducing misinterpretation and increasing knowledge transfer.

You also need to consider that when changes are made to the BIM, or information is manipulated, you are actually modifying an underlying database, not just lines. This database has relationships between elements (e.g. a door hosted within a wall) and those associations will automatically update any manifestation of that change, be it a drawing sheet, a schedule, a perspective view, plan view or any other element.

PROCESS & WORKFLOW

Incorporating BIM into project workflows may require modification of the traditional process of how consultants currently interact with each other.

As the BIM environment includes discipline-specific input from each consultant and designer, this enables the ability to check for clashing geometry or other contradicting information. The true value of this exercise is achieved when all consultants are involved early and contribute to the shared dataset. Managing and maintaining it with up-to-date and accurate information is critical. As the timing of deliverables often varies, similarly reviewing a design that is in flux is challenging, all parties need to agree at the commencement of the project certain milestones, standards and project BIM requirements that need to be achieved. See document **P1 – What is a BIM Management Plan, and why should we use one?** for more information. This will facilitate information flow, enable reviews of the BIM files and facilitate easy amendment. Alternatively, it will identify and document any significant errors that are found within the BIM.

Clash detection is 3D coordination on the BIM to resolve issues. This scope of work typically falls outside of what may be considered as consultant coordination. The process of procurement often requires an extra layer of services that is delivered by subconsultants or subcontractors that are not part of the initial design process. Clash detection enables this new information to be incorporated into the virtual model to increase the efficacy of the design proposal to ensure a risk-reduced construction process.

Image: Architects and Consultants using a combination of traditional (paper) and improved (BIM) means to resolve coordination and constructability issues (Source: HASSELL)

DELIVERABLES & DATA QUALITY

The use of BIM software doesn't necessarily change the end paper deliverable of a project as the actual documentation still materialises into a drawing set. What can change is the extra information that may be passed to the builder and ultimately the client. To ensure smooth workflows between all parties involved it has to be contractually agreed at the commencement of the project what the actual deliverables will be, and to what Level of Development (LoD) all parties will model to. See document **P2 – What should be addressed within a BIM Management Plan?** for details. It has to be clarified early who owns what in each BIM file and how that ownership might change throughout the project lifecycle. This will ensure the resulting BIM is fit for purpose and will enable auditing of the project to ensure each of the models complies with the project BIM plan.

If it is agreed that the 3D model will be provided to any other party outside of the interdisciplinary coordination process during design, a commensurate increase in fees should also be negotiated. See work undertaken by the AIA/Consult Australia on Legal and Procurement issues in the document **L3 – Stakeholders' Responsibilities** as part of this series of documents.

STAFF & NEW RESPONSIBILITIES

New workflows of a BIM project lead to the creation of new roles and responsibilities to maintain and oversee these virtual building models. Two of the most prevalent are the model manager and the project BIM manager. These roles require time to perform their responsibilities; the amount of time required depends on project complexity.

It is common to have a model manager for each discipline (architecture, structure, hydraulic etc) who is responsible for the integrity of their respective discipline-specific BIM file and information within it. The model manager ensures that the discipline-specific model is created according to their office and project standards.

The project BIM manager can be appointed from one of the disciplines or as an independent consultant. This role defines and enforces project standards and agreements, coordinates the collation of discipline-specific BIM files into a federated model, generates and distributes clash detection and audit reports and facilitates subsequent resolution meetings. They typically work on the client's behalf to ensure the best possible outcome for the client's dollar.

COLLABORATIONS & BIM CAPABILITY

BIM without collaboration is not much more than glorified 3D drafting. The real benefit is realised within the collaborative dialogue that occurs between the designers, engineers, the contractor and owner/occupiers.

The change in workflows caused by the implementation of BIM is significant; any discrepancies or lack of model quality can have big impacts on the delivery of a project. It might be beneficial for a practice to review existing and even long-standing collaboration procedures with other practices and consultancies to see if they are able to successfully deliver a BIM project (are BIM-ready) or if they need additional support from your own team.

The same assessment should be carried out internally within the practice to ensure that your own BIM competencies and capabilities are stated correctly.

INVESTMENT & COSTS

Implementation of BIM requires several financial investments as new software licenses can be required. It might be that the software package currently used offers a BIM solution beside your current 2D/3D CAD software and an upgrade can be purchased rather than investing in new licenses.

Hardware also needs to be audited by the IT department to ascertain if the workstations, network and server infrastructure require upgrading. BIM requires substantial increase in hardware over CAD and should not be underestimated. Up-to-date workstation hardware also shows a significant improvement of production speed (best value for money) and therefore productivity as a whole when accessing memory intensive 3D models.

Staff training is another major investment that needs to be considered and it is crucial to the successful implementation of the new workflow. See the document **E2 – BIM Learning Providers** for details about what is happening within education.

LEGAL

Documents **L1-L4** created by the BIM Legal and Procurement Working Group offer a detailed view on topics like intellectual property, liability and responsibilities. Please refer to those documents for further information.

CONCLUSION

The delivery of a project using BIM can enable information and knowledge sharing unseen in a CAD or 2D environment. This information is attached to the 3D objects in a relational database. This explosion of information needs to be managed by someone – hence new roles and responsibilities have emerged such as the model manager. BIM projects can increase the efficient delivery of traditional architectural services as well as the potential to offer additional services, such as project BIM manager, should the client or builder require them. Technology and training costs need to be factored as a significant cost when implementing BIM.

Summary

- BIM is not an application or specific software – it is a process, a methodology.
- BIM is the digital equivalent of a physical building rather than lines drawn to represent a building.
- Clash detection is a scope of work that falls outside of what may be considered as consultant coordination.
- The true value of BIM is achieved when all consultants are involved early and contribute to the shared data set and the subsequent collaborative dialogue.
- The use of BIM software doesn't necessarily change the deliverables of a project.
- If the deliverables are beyond traditional drawing sets contractual agreements need to be defined at the commencement of the project.
- BIM projects lead to the creation of new roles or responsibilities.
- BIM competence assessment of project teams should be undertaken.
- The change in the workflow between disciplines caused by the implementation of BIM can be significant.
- The implementation of BIM requires several financial investments in training and technology.

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03 Engineers – What does BIM mean to my business?

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O3 Engineers – What does BIM mean to my business?

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O3 Engineers – What does BIM mean to my business? [Version 1 – August 2012]

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INTRODUCTION

We hear touted that the future of BIM lies in the development and application of virtual building processes, in which the design, construction, performance and operational simulation may be visualised and tested. Many pioneers of BIM are forecasting a steep change in the way that we will work in the future. You can learn from this experience by starting your BIM learning and implementation with three interrelated topics in mind – technology, process and people.

TECHNOLOGY

A very important consideration is a simple balance between scope, fee and program. BIM software gives the author ample opportunity to use, capture or host almost limitless amounts of information (or data) attributable to design, construction or operation of the building. Just because you can, doesn't mean that you are best placed to author and apply the information. Question two things – is anyone likely to gain value from you doing so? And if so, will the information or data you author ever be maintained?

At a project level, there are reported advantages to be gained by interacting with a broad-brush model at early stages of design. Trading of these models frequently with others is encouraged. The coordination of these activities is often undertaken by the lead consultant, at times and in manners described in a BIM Management Plan. See the document **P2 – What should be addressed within a BIM Management Plan?** for details.

PROCESS

If a database-driven program (such as Autodesk Revit) is being used to produce 2D documentation, then good quality sketch output such as plans, sections, isometrics and schedules can be output as work-in-progress snapshots at any time. Developing the design in this way, and demonstrating how it can be applied in an interactive free-to-view software package, will present the opportunity to hold off from producing formal documentation until such a time as the design is nearing a coordinated product.

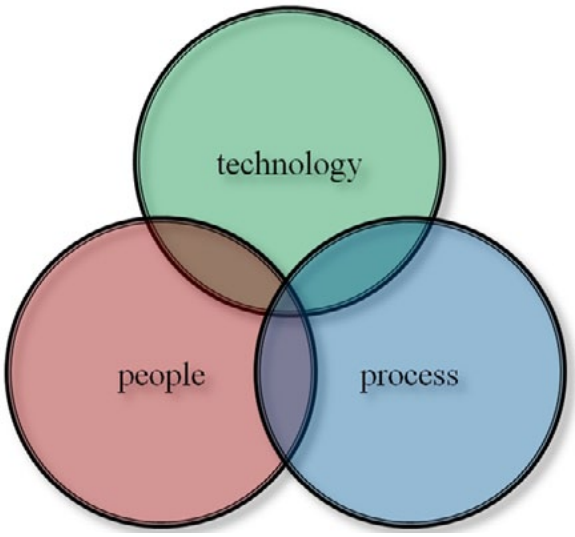
Passing a model for an automated quantity take off attracts no risk; the cost consultant remains responsible for the project to be costed correctly, whether they are modelled, measured or neither. See the document **L2 – Professional Indemnity Insurance** for greater detail.

BIM-enabled software is seeing cost consultants rethink their approach to routine measurement, allowing them to focus on the build-up of the estimate, and for the engineer to be proactive in between the times of traditional estimates.

Some well-established analysis and design software will link to other BIM files or documentation packages. Bi-directional functionality is offered in most software, but in practice it is difficult to maintain when the analysis and documentation models are developed in parallel; simply plan when to break the link.

You will be faced with a challenge to choose the most appropriate BIM enabled technology on offer now, with the likely promise of a more streamlined, right-first-time approach to your documentation activities, and the subsequent construction that you will oversee.

As with most revolutionary change, in practice the people who you employ, work with or report to, will respond better if they are coached and trained in what exactly it is that you are trying to achieve.



Offset against the advantage of the new technology will come disruption to the current processes.

New tools applied in the same way, to produce the same deliverables, will only ever yield similar results, or short-term gain.

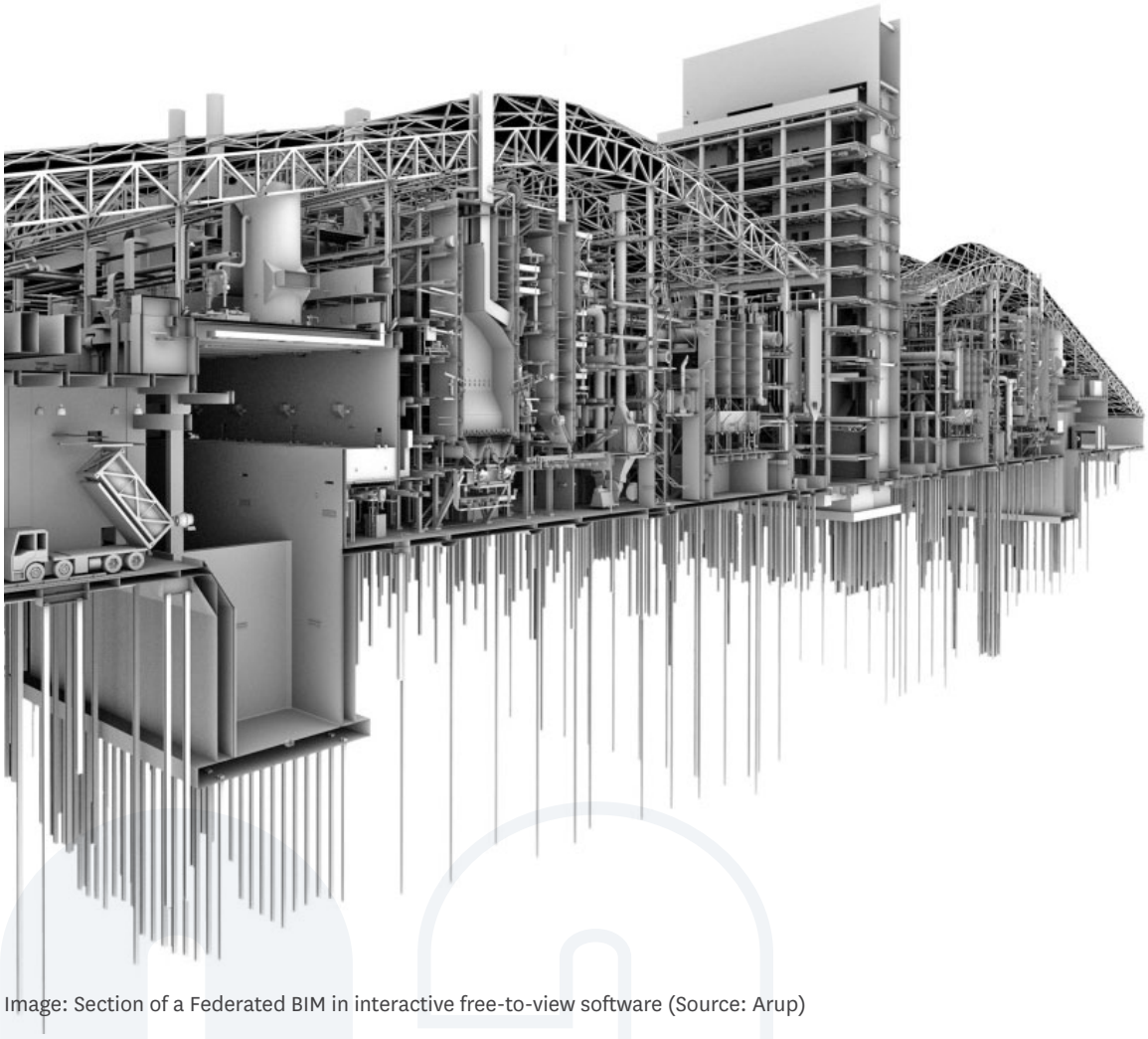


Image: Section of a Federated BIM in interactive free-to-view software (Source: Arup)

PEOPLE

The use of BIM processes can be very fulfilling. There is great satisfaction in creating a virtual prototype of a project, but there is also no substitute for engineering experience.

The output from BIM software driven by inexperienced engineers or technicians is not nearly as good as that coming from retraining experienced practitioners in a BIM process. The use of BIM does not automatically result in the production of better drawings in less time, but rather it contributes to a right-first-time approach to a higher quality, coordinated design and deliverables.

CONCLUSION

The use of BIM software to produce synchronised documentation sets is fast becoming the norm. Training experienced staff to apply processes earlier in a project, to sketch ideas or portions of design, to interact with other designers, to report material estimates, or to rehearse the work ahead in a 'right first time' fashion are potential quick wins that will have a huge impact later.

Summary

- Information is stored in a database and may be viewed in many ways
- A BIM project plan will describe how your work integrates with others
- Focus on the design – build the model first, interact with model next, then produce formal documentation
- Invest in training and coaching experienced staff in BIM concepts and processes

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04 Contractors/Builders – Possible uses of BIM for Construction

04

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04 *Contractors/Builders – Possible uses of BIM for Construction*

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0.1 BIM for Architects [Version 1 – August 2012]

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INTRODUCTION

Contractors stand to gain a great deal from the use of BIM. Much of the development in the BIM authoring tools has been aimed at designers and the design stages of a project. As such, BIM's ground swell suffers from a lack of clarity or objective beyond the designers' intent. Whilst BIM is often refered to as 'the new CAD' it is actually much more – it is a virtual building, a collaborative process and database of computable information (or data) that can be interacted with by many.

In the most simple terms, where contractors will gain is through the process of virtual prototyping – focusing on the cost-saving potential and prevention of design and constructability issues – in three ways: quality, time and cost.

QUALITY

A very important consideration is whether the design team is working in 3D or not. If it is, the design intent models can be used as background to planning work, or as background for fabrication models. Interoperability between software will only ever become more advanced, but both design intent models and trade models will continue to co-exist whilst contractual boundaries remain in place. See the document **L2 – Professional Indemnity Insurance** for greater detail. The designer uses their preferred software to develop their models, and the trades use theirs, resulting in many aggregate models. The way that these co-existing aggregate models are brought together, is through the use of a federated model environment, viewed in 3D interactive review software. The process can be aided using clash detection software, but is most effectively implemented at virtual construction workshops. By producing a virtual model it is possible to effectively visualise and manage design coordination, thereby improving confidence in the design and reducing the chance of late changes and clashes between building systems on site. Combining models over one another in the virtual environment promotes a right-first-time approach to the design, procurement and construction processes.

Interestingly, contractors need not wait for the designers to use BIM. Whether the design team is working in 3D or not, contractors can still rehearse their own upcoming activities by modelling their areas of risk or uncertainty. In doing so and interacting with the resulting models across a non-technical but experienced construction team, opportunities for planning repetitive work, prefabrication, sequencing and costing will be highlighted. BIM challenges the notion of getting some things wrong which may later tie people in litigation. It is a significant opportunity for builders to remove themselves from some risks of litigation through getting it right.

TIME

Communication

The capability of subcontractors will differ at times from the multi-hundreds of skilled tradespeople within a single national company, through to the SME working essentially out of the back of a ute. In order to communicate the construction requirements, free-to-view models are exceptionally easy to visualise and tailored to a specific trade if required, enabling interaction without specialist printing and issuing.

Shop drawing

The speed of shop drawing development and the associated coordination between all trades can be developed simultaneously as the design unfolds, requests for information (RFIs) will be significantly reduced during construction due to the enhanced coordination and conflict reduction through the use of 3D.

Accurate as-built drawings can be made available at handover with the use of BIM and a 3D model. See Document **L3 – Stakeholders' Responsibilities**. The 3D model represents in electronic form the physical design and construction of the project throughout all trades. If this is a requirement of the project the BIM project plan should reflect this. See the document **P2 – What should be addressed within a BIM Management Plan?** for further information.

Project planning – construction scheduling (4D)

Planning a construction site is notoriously difficult. BIM can provide the interactive ability to visualise, inform and rehearse construction sequences, driving more efficiency into the construction process.

In the early stages of a time-critical project it can be useful to witness simple visualisation/video presentations of the construction and site management sequencing. Sequential stills and movies of the scheme can be produced to help disseminate the information in a non-technical fashion.

The term '4D' is a term that has developed to represent the addition of the time dimension to a 3D model. In simple terms, the 3D model contains 'objects' which are controlled and driven by a Gantt chart timeline. The application of the fourth dimension allows us to manipulate the sequence of construction as time is attached to the objects with almost limitless permutations. If we wish to amend the staging process we amend the Gantt chart, not the 3D images which are simply a by-product of the process. Later in the project as more detailed programs are produced, the model can be used to describe the complex sequence of building without the need to read and understand pages of charts. The key aim is to highlight bottlenecks and site constraints within the staging of works in order to optimise the overall time of construction. Site management is assisted by illustrating the true scope of works and the staging necessary to solve key constructability issues. It is a highly effective planning communication tool for disseminating construction impacts to stakeholders, or overlapping and multiple subcontractors.

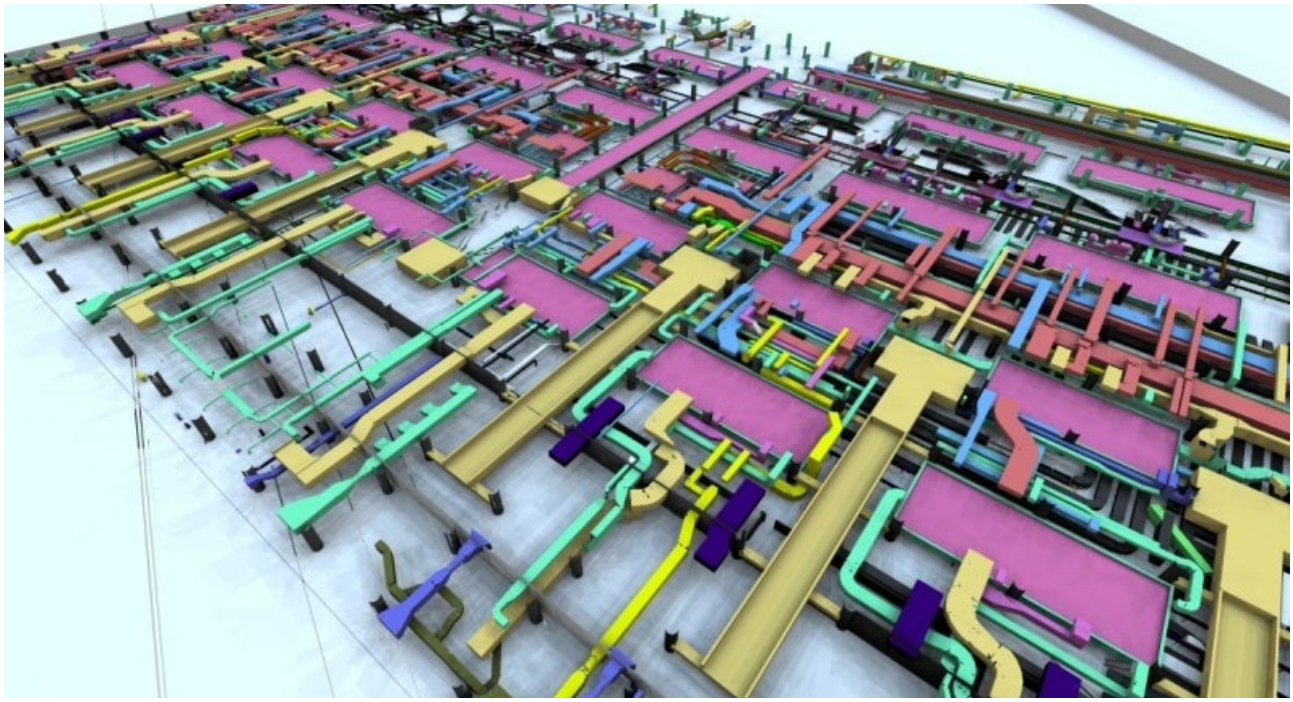

Image: Gain understanding of the project's challenges through interactive visualisation of overlain design and trade models (Source: Arup)

COST

Project planning – quantities

It is now becoming common practice to extract the precise measurement of materials or components from 3D models. Geometric information already has been used to create the model which can be extracted in summary form once complete. The benefit of this is that the manual take-off of quantities, which is often prone to human and scaling error can be verified and linked to instantaneous quantity reports. This is typically called '5D' (cost attributed to the model objects).

Project planning – estimation 5D

One of the great benefits of a 5D process is that rapid assessment and reassessment of costs is now possible once the 3D model is set up. Any changes to the model and its impact on cost can be quickly assessed through the use of software that links the capability of the instantaneous quantity reports, to labour, machinery location and sequence of works to drive a true 5D project plan.

Clearly, human judgment process will never be replaced by software, however teams will be able to tweak designs of the future in real time to match project budgets, and thus eliminate the need for complex value engineering (and redesign) after a design develops to more complete stages.

CONCLUSION

Whilst BIM encompasses many new processes for designers, at its core it features investigative ways of engaging across the whole project team and enables them to interacting with a virtual building of the project. For contractors, this better understanding results in a potential to reduce cost and time risks, and to enhance overall quality.

Summary

- Interactive, visualisation of the project.
- Overlay design and trade models.
- Model areas of risk, sensitivity or alternative approaches.
- Create sequences for rehearsal of the construction activities.
- Extract quantities for budget estimates.

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05 *Quantity surveyors & cost planners – How can BIM improve my business?*

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INTRODUCTION – BIM FOR THE QUANTITY SURVEYING INDUSTRY

The evolution of the construction industry and its implementation of Building Information Modelling (BIM) are designed to streamline the lifecycle systems and efficiency for the industry from facilities through to infrastructure. Quantity surveyors will benefit from this new process, due to the automation involved within the BIM tools available. This automation (quantities, areas and volumes) brings BIM to the forefront as a support mechanism for different stages of the quantity surveyors' project involvement.

BIM for a quantity surveyor is designed to streamline the automatic quantity extraction from a model or federated models. A BIM authoring tool uses intelligent (variable) mapping that is linked into a database system with automatic or manual associations. For example, at early stages of a design and estimate the elements are less detailed than for tender design, reflecting the limited information available.

BIM authoring tools have the capability to embed recognised information (or data) and categories into the elemental breakdown (database) of a model. This data is organised differently depending on which BIM authoring tool is utilised for the design. All authoring tools have an embedded system that as an object is selected, modelled or placed it is added to a particular category. An example of this would be when a door is placed into a model it will be placed under the door category in the database. This information is not only used as the identifier of the element but can also be used as the first category to break down the object, this would be consistent with the work break down structure. BIM authoring tools also offer a manual subdivision which is the result of adding a tag, attribute or parameter into the element (often called QSID) thus providing another way to summarise the data set.

The difference BIM brings to the industry is that, when fully realised, you have a complete database of information relevant to the design and delivered in a 3D format. This allows you to not only produce a visual takeoff, but to automatically generate complete object quantities from the model. This means that those elements can be interrogated to provide details such as finished dimensions, quantities, locations and material composition.

As all quantity surveyors know, a simple bill of quantities is not going to provide a substantial report or cost indication on the construction of a facility and at preliminary stage if the design information is not exhaustive. A BIM will break down the model to materials and fabrics where this information exists. It does not acknowledge the project deliverable and how the construction can be achieved for a particular price ie., including temporary works and sacrificial works that may be required. Elemental breakdowns generally will not include the fixing of the elements nor the time and efforts required to complete them or any factor for wastage. A quantity surveyor utilising BIM in their processes can have more billable time to understand how the facility is to be constructed, to consider where value engineering could be beneficial and to estimate costs related to doing rather than simply scheduling materials for ordering.

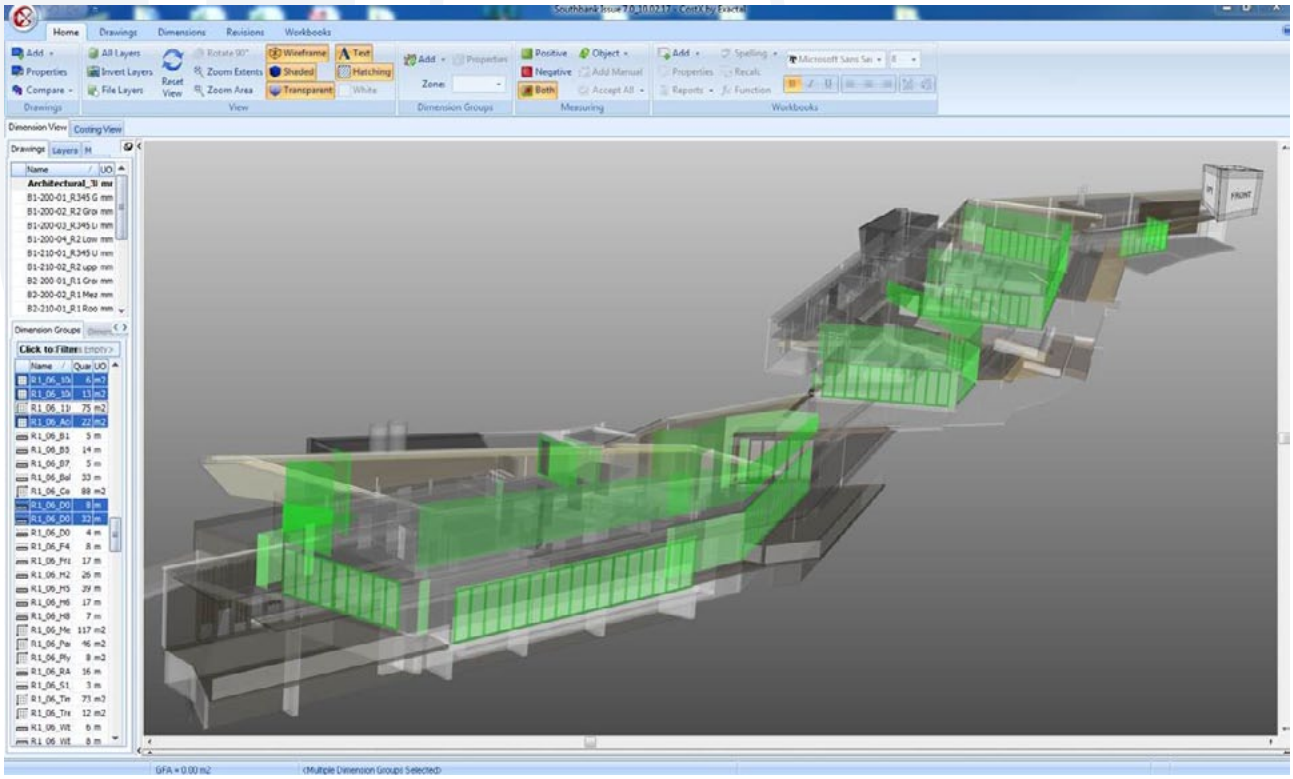

Image: A Building Information Model in a costing application (Source: David Mitchell, MitchellBrandtman)

Stage A - Brief Stage Cost (Indicative Cost)	BIM contributes to the provision of a rough master plan. Mass volumes and areas of different spaces would be produced to indicate the expected use and some estimates can then be compared in line with the client requirements.
Stage B - Outline Proposal Cost (Preliminary Estimate)	To ensure an efficient delivery of the bill of quantities it is imperative that the BIM is configured to construction methodology. This is to ensure the managing contractor can group the activities together and price the project more effectively. Framework to set this up is commonly described as a work breakdown structure (WBS) or standard method of measurement (SMM). In Australia the ACCM (Australian Cost Control Manual) describes the breakdown structure. Preparation of the ACCM elemental breakdown requirements is added to the BIM.
Stage C - Sketch Design Cost (Limit of Cost Estimate)	The model is a rough bill of quantities. This is normally at LoD (Level of Development) starting from 100 at Stage A – LoD 300 by Stage C.
Stage D - Tender Document Cost Plan (Tender Estimate)	Suggested methods of construction will be presented in a visual format for clearer understanding to all stakeholders. The cost planner can utilise the BIM to understand pricings that might have been missed (eg, extra support required below machinery).

Table 1.

HOW DOES BIM SUPPORT THE WORKFLOW OF A QUANTITY SURVEYOR?

BIM offers support to areas of the quantity surveyor roles mostly around the later design and preconstruction stages. A BIM, depending on the decided deliverables, can assist at a low level pre-tender stage through to the high-end bill of quantities methods that are mentioned above.

A brief example of the suggested methods is shown in the table above (these methods can change depending on the procurement model).

A contractor's quantity surveyor can utilise BIM from pre-construction, construction and post practical completion. During pre construction the BIM is broken down into trades. The contractor's quantity surveyor can utilise the bill of quantities extracted for tendering purposes. The numbers can be submitted to each trade along with the model so they can look at the materials needed to tender on the project, once wastage factors have been considered and added.

The contractor's quantity surveyor can keep an eye on the timeline of costs for purchasing and logistics as the model is placed into an aggregation tool to sequence the construction. This supports the quantity surveyor as they define what costs are needed at each stage of the construction process. This is sometimes referred to as 5D.

Finally, the as-built model can indicate the variations in quantum that occurred during the construction process. The QS can use the model to support the understanding of what those variations were and check against the estimated costs. The basis of entitlement will still need to be established but quantifying the effect becomes more transparent. Ultimately the BIM can be completed for 'as-built' post practical completion to ensure any defects are also modelled properly. The 'as built' model could be completed by the contractor or a consultant during the construction process. Field BIM tools can be used so that as modifications are made they are photographed or laser scanned and linked to the relevant areas of the model.

HOW DOES BIM CHANGE THE LEGALITIES OF WHAT A QUANTITY SURVEYOR DOES?

Depending on the type of contract you are committed to the liabilities may still be the same, as in traditional design-bid-build contracts. The only areas you can become unstuck is where you're trusting the software to do everything. A BIM is only one-third of the information you need. Like with CAD, a portion of your role relies on the information given to you by the designer. The rest is where your liabilities sit. When utilising BIM, alliance contracts and integrated project delivery (IPD) are the ideal solutions to address the challenges of liabilities. There are ways to adapt other procurement routes like managing contractor, design and construct, and lump sum to adopt some of the BIM benefits. An incomplete model is no different to an incomplete drawing so cannot be the sole source of information to rely on. More information can be found in the document **L4 - Viable Options - Encouraging Collaboration and 'No Blame'**.

CONCLUSION

A BIM is designed to support the roles of many, acting as a knowledge base to be used for the entire lifecycle of a facility or infrastructure. When broken down, BIM for a quantity surveyor is a support mechanism for the design economics and cost planning/cost management of projects.

Summary

- Utilising the early massing model for Stage A – brief stage cost (indicative cost) is beneficial
- Ask the design teams to assign an elemental cost parameter to all the elements in the BIM for costing as the model progresses through various project stages/ phases
- Get the quantity surveyor involved with the design team early to advise on how to model correctly (no overlapping geometry) so accurate quantities can be derived

BIM Outreach

06 *Facilities managers – What benefits are there for me engaging with a BIM process?*

06

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06 *Facilities managers – What benefits are there for me engaging with a BIM process?*

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06 Facilities managers – What benefits are there for me engaging with a BIM process? [Version 1 – August 2012]

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INTRODUCTION – FACILITY MANAGERS & BIM

Facility managers have a great opportunity to participate in the development of project and facility standards to suit their management procedures. By collaborating early with the design team in Building Information Modelling not only makes the handover of information a lot more efficient but it also allows a facility manager to engage and discuss their key issues and concerns with managing the costs and maintenance of a building. An operation cost of a facility over its lifecycle is approximately 80% of the total initial cost to build. The design analysis stage of the facility will tackle the building's efficiencies in running; however an experienced facility manager will be able to drive the information (or data) management and production to enable efficient information collection for the lifetime of that asset.

Record modelling

Record modelling can be achieved by combining the BIM and all of the information (or data) generated relating to the design, construction and operation of the facility. The BIM needs to contain links to information such as serial or barcodes, RFIDs, warranties and expected maintenance needs of the equipment and spaces within the building. To ensure the BIM is utilised effectively, facility managers must be involved in the beginning of the project to guarantee the success of creating the record model in accordance with the way the facility is intended to be used. See the document **P2 – What should be addressed within a BIM Management Plan?** for information on defining BIM requirements.

COBie (Construction Operations Building Information Exchange) is fast becoming a neutral way of capturing the relevant information required by a facility manager.

http://www.wbdg.org/resources/cobie.php

A BIM authoring tool will export raw data which is then filtered or processed into COBie format to be linked to a facilities management database or software solution. This image is the system commissioning stage information (part 1) that is the suggested handover of data for a facility manager.

Below is a list of key items the facility manager needs to understand when working with a project team utilising a BIM process.

- How is information currently managed, maintained and inputted into the facilities manager's current FM tool?
- What information is important to the facility manager to the running and maintenance of the facility?
- Who in the design/construction team is providing the federated or individual discipline specific BIM files and what level of information will these files contain?
- Is a compliant BIM authoring tool being used to accommodate the deliverable?
- What format is the deliverable going to be provided (COBie, database, IFC, Revit, ArchiCAD, dwf)
- Will the database of the BIM contain assets and equipment with information attached?
- What Level of Development (LoD) is expected for each stage of the design, construction and operation?
- Who will be updating the BIM during a renovation? The facility management team, current contractors or a new model delivered with each renovation?

Many of these questions have legal ramifications (see work undertaken by the AIA/Consult Australia Legal and Procurement Working Group) and will require the facilities manager to engage in the BIM project plan early to assist the design and construction teams with their requirements. See the document **P2 – What should be addressed within a BIM Management Plan?**.

INFORMATION NEEDED TO REALISE POTENTIAL VALUE

Building maintenance scheduling

Building maintenance scheduling enables proactive maintenance thus reducing costly repairs on the facility (if poorly maintained) and assures the facility is running at optimal performance as per the designed solution. This covers;

- Building structure: understanding the material's and fabric's life expectancy and expected environmental needs, eg, expected traffic on particular carpet
- Building systems: for the upkeep and running of machinery and interrelated building systems to assist with work orders, eg, air-conditioning filter servicing
- Contract management: to understand what machines are maintained by external parties versus internally and when they are expected to be serviced or cleaning contracts and tendering for these

Building systems analysis

Building system analysis is currently a hot topic and is about analysing how the facility is running compared to the designed expectations. This is not limited to mechanical systems, and lighting and solar analysis. The BIM is infused with information captured by sensors and other facility data to graphically understand the facility's effectiveness. Often a good systems analyst will use the BIM to perform 'what if' scenarios and test if better functional use of the facility is obtainable.

Asset management

Asset management of a facility is very much about the management and location of items. The BIM can be used to communicate with the finance, security and policy related functions of the facility.

- Asset management and tracking: management of the data. This can be linked to RFID, barcodes or QR codes
- Secure areas: for access, keying, security, etc
- Code compliance: for certification, yearly energy audits and retrofitting
- As-built information: for further expansion, re-use, decommissioning and environmental impact
- Change order: to understand the history behind the facility lifecycle

Space management & tracking

Space management and tracking relates to aspects from transition planning for retrofitting through to resource planning.

- Space functions: from department to occupancy and building services required
- Area and volume calculations: for space rentals, department or faculty requirements
- Area utilisation: to limit servicing unoccupied spaces

Disaster planning

- An up to date federated model can assist with emergency responses and disaster management. The key areas this relates to is egress and ingress. Access to models by special and uniformed services will provide reduced risk to those forces in cases of building failure, emergencies or times of conflict.

CONCLUSION

The integration of BIM into the construction industry is opening up the channels for all stakeholders to better understand how the facilities manager works. Understanding the facilities operational needs can only be determined by those than run it. Engaging at the early stages of the design process will enable embedding the fundamental requirements of the facilities manager to streamline information and data flow to the people that will use that information long term – the facilities manager.

Summary Box

Record modelling: What data is needed to form an informational link to where and at what stage?

Realising the potential value:

- Building maintenance scheduling
- Building systems analysis
- Asset management
- Space management and tracking
- Disaster planning

BIM Outreach

07 *Manufacturers & Suppliers – What can BIM do for my products?*

07

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07 *Manufacturers & Suppliers – What can BIM do for my products?*

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07 Manufacturers & suppliers – What can BIM do for my products? [Version 1 – August 2012]

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INTRODUCTION

The paradigm shift from 2D CAD to Building Information Modelling (BIM) is affecting the entire building industry and it doesn't stop with designers, engineers or the contractors. For BIM to work throughout the industry, manufacturers, suppliers and subcontractors play a pivotal role in providing virtual representations of their physical products that can be utilised across disciplines. Furthermore, there are industry initiatives for the integration of design intent models and construction models[1], assisting to rationalise the construction process and reduce duplication of effort. What is required by industry is BIM objects that represent a product geometrically and embed product data in a format that can integrate with the systems used for design, analysis, coordination and operation – hence the entire building lifecycle.

CHALLENGES FOR MANUFACTURERS WHO WANT TO DO BIM

Apart from a very small number of large firms, most product manufacturers are usually not knowledgeable about how to set up a BIM equivalent of their product catalogue. The use of BIM authoring tools is likely not part of their core business. Further, BIM requirements for architects, engineers, contractors and facility managers are different. It is not easy for a manufacturer to find one common denominator (ie, standard) that would inform them what information about a product to include in a BIM object and what not to.

A solution for those firms who don't usually produce BIM objects themselves is to employ a third party that specialises in working with manufacturers in order to create their BIM objects. Firms and initiatives such as Autodesk Seek, ArchiCAD Warehouse, Arcat, bimstore, SmartBIM, Sweets, RevitCompontents, ArcXL, TurboSquid, Design Content, Product Spec, Andekan, All-In-One, Broutek, BIMstop and BIMobject complement the efforts by some large scale manufacturers who make BIM objects of their products available via BIM content libraries. Even the UK construction industry (via the NBS) has developed the UK's National BIM Library for industry approved free content.

OPENING THE BIM DOORS TO MANUFACTURERS

A key objective for manufacturers and suppliers is to make high quality BIM objects of their products available to a large number of consultants and subcontractors. These industry groups rely on high quality content libraries that they usually source via third parties (either for free or not). The quality aspect of a BIM object does not depend on the level of geometrical (or even data) detail. Instead it depends on understanding what information is useful for the various parties who will specify the product in their design at any given stage of the project. BIM needs to follow strict naming conventions to be useful. Hence the initiative of a group of Australian and New Zealand professionals using Revit created ANZRS to form a set of industry standards http://www.anzrs.org/.

WHAT ASPECTS OF BIM MODELLING ARE NEEDED?

BIM requires the information necessary to define, track and analyse elements. From a lifecycle perspective, the correct tagging of information is crucial to identifying the sum of components constituting a building project. From a documentation perspective, BIM components often encompass a range of parameters that allow them to be used under varying conditions (either in terms of geometry or notation). In some cases these parameters need to be supplemented by additional parameters that are utilised by the design consultants, builder, subcontractor, fabricator and facilities managers. These parameters need to be the same between the various groups that utilise them and they need to be interoperable between various BIM software packages. No small task!

It is important to note that not all information that can be included in a digital model should be included. The volume of data requires both the technology to drive it and the systems to manage it. Some products do not need to be modelled in 3D, such as paint or coating finishes nor flashings and individual bricks.

Some products should have:

- Sustainability parameters added so that they can be utilised by ESD consultants.
- Mechanical, electrical, hydraulic and structural parameters so that they can operate effectively in those environments.
- Cost information to be utilised by quantity surveyors.

Every category has its own particularities and needs its own specific list of parameters. By modelling the elements correctly in 3D/2D and adding the correct BIM parameters, one will have a product available to be used by all BIM consultants and project participants.

1 Successes in this realm can be seen with the Air Conditioning and Mechanical Contractors' Association of Australia (AMCA). The BIM-MEP^{AUS} initiative has been launched with the aim of facilitating the implementation of Building Information Modelling and integrated project delivery within the Australian construction building services sector. The AMCA is seen as a global leader with this initiative http://www.bimmepaus.com.au/home_page.html.

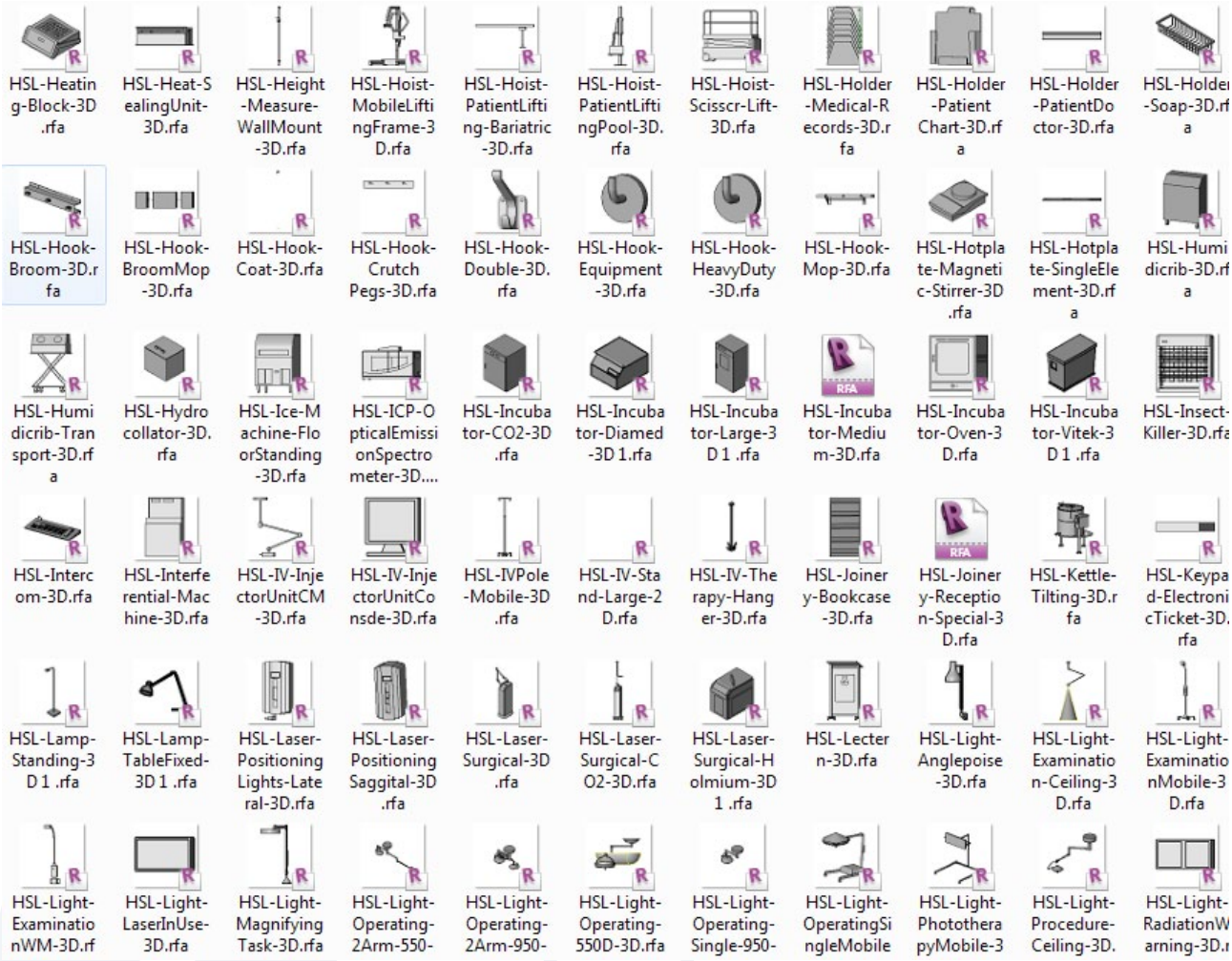

Image: Example of a BIM product library (Source: HASSELL)

FILE SIZES

In large projects, the file size of individual elements can be important. From the manufacturer's point of view, they would like to see their product represented as accurately as possible. Many fine details will not be visible or needed at the scale, or the level of detail that the designers work in. To show every screw, fold, junction, connection etc may result in a file size that is 3MB compared to a simplified version that is 400K. At times it is not just an excessive level of detail that conflicts with the usability of the component. Some objects will require a high number of polygons in order to represent a curved element and the polygon count will also lead to a drastic increase in file size if multiple instances of that element get included in a BIM project.

VIEWS

Most BIM software performs best when the plan, section and elevation views are set as 2D representations of the 3D element. This does not affect the file size, but will affect the software performance. Again, most consultants do not need to see the full 3D representation all the time.

BIM PRODUCT LIBRARIES

The industry is becoming increasingly concerned about the lack of high quality BIM content that is available to all at no (or low) cost. Consultants and subcontractors are unhappy about the need to model a large number of BIM components themselves. Software vendors shy away from the responsibility of providing BIM libraries, arguing it is the manufacturer's duty to do so.

We are starting to see some efforts emerging in this realm, driven by industry bodies and manufacturers.

CONCLUSION

Most manufacturers have already spent time and money creating CAD content, now they need to embrace BIM. For most this is not part of their core business so the creation of their product library usually gets contracted out. This can produce highly detailed objects that are large in file size and when loaded into a large project dataset slows the team down. Compounding this is the need for all content to be interoperable across the design teams and greater supply chain (using their individual BIM software of choice).

SELECTED BIM LIBRARIES

http://seek.autodesk.com/

http://construction.com/bim/

http://www.nationalbimlibrary.com/

http://www.arcat.com/bim/bim_objects.shtml

http://archicadwarehouse.blogspot.com.au/

http://www.productspec.net/cad-files.aspx?index=0&ext=.rvt

http://www.archvision.com/

http://www.formfonts.com/

http://revitbay.com/

http://yellowbryk.com/

http://www.pinnaclecad.com/revit-families.html

http://andekan.com/?brtk=1

http://revitcomponents.com/

http://smartbim.wpengine.com/

http://bimstore.co.uk/

http://www.parametrx.com/912/templates/index.asp?

http://www.hilti.co.uk/holuk/page/module/home/browse_main.jsf?lang=en&nodeId=-411802

http://www.bradleycorp.com/bim/products/bim/

http://www.flexymodels.com/revitwarehouse.html

http://www.revitcity.com/index.php

Summary

- Efforts have been made to rationalise the requirements of industry (BIM MEP AUS and ANZRS) so manufacturers should seek to align themselves with these industry initiatives.
- Currently many consultants are creating the same content across many firms. This is hugely wasteful and manufacturers have the opportunity to create one consistent object to represent their product rather than hundreds of potentially substandard clones.
- This content needs to be provided free to industry to eliminate duplication of effort and reduce waste.
- This would also increase productivity as the industry can concentrate on designing efficient, sustainable buildings (its core business) rather than building content.

BIM Outreach

08 BIM for Interior Designers

08

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08 *BIM for Interior Designers*

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08 BIM for Interior Designers [Version 1 – October 2013]

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INTRODUCTION

As with many other professions in the building industry, Building Information Modelling and its application within the built environment has enhanced workflows and deliveries for Interior Designers. Along with this development comes a redefinition of roles, processes and responsibilities among Interior Designers who apply BIM on their projects. The division of model and element ownership gives an Interior Design firm the opportunity to reconsider and streamline their process within the wider built environment workflow.

BIM for Interior Design is one of the most prominent areas that requires clarity as interiors links to many facets of the information model. Despite strong alignment between BIM for Architecture (as described in document O2 of on this series) and BIM for Interior Design, there also exists distinguishing factors between the two approaches when it comes to their application in everyday practice.

This paper, which builds on the series of BIM Outreach papers (O1-O7) published by the Australian Institute of Architects and Consult Australia, will highlight the specific considerations that should be taken into account when working in BIM as an interior designer.

WORKFLOW AND COLLABORATION

Starting the interiors part of a project

The starting point for the use of BIM in interiors is usually substantially different from the architects and building designers. Interior designers usually start with an existing situation, or working alongside the project team that develops the base building. In order to commence their work, interior designers and architects depend on the quality, accuracy, and software interoperability used to produce the base building model. It is important for the interiors team to have boundaries set early so that integration of the interiors model is seamless to the base building, thus reducing rework. Understanding "who is responsible, for what elements" is critical. An example of this is to understand how a wall is constructed and divided. This insight allows the interiors team to define the materials and the finishes of those materials. If thought isn't given to these areas, an Interiors model will overlap and a more cumbersome workflow of managing the coordination will be needed. This is also prominent when looking at joinery, and when considering those elements and an architect needs to have a placeholder for the Interiors team to swap out at a later stage in the project.

There are many issues surrounding the area of coordination. The BIM workflow can lead to changing the traditional approach, so ensuring a structured set of processes is paramount. It is best to discuss the specific workflow during the procurement as part of generating and advancing a BIM Management Plan (as described in document P1-3 of this series). If the team has not defined the elemental ownership at project stages of the design in the BIM Management Plan, stakeholders will retain ownership of their elements beyond the stages required by them. This inhibits the interior designer from leveraging that information and further developing it.

BIM - Model and task subdivision

The definition of element ownership for the interiors team is dependent on the procurement and engagement methods of working within the greater project team. Interior teams use BIM authoring tools to share ownership of BIMs by breaking down a functional space into pieces or elements and by embedding information into those elements so that it can be used for construction, fabrication, purchase, occupancy and maintenance. Having all of this information in one platform and as one point of truth enhances the interiors **deliverable.** For example: by simply placing a joinery element in a room, one will have enough information in the model for the client to visually understand the design. Information for constructability or fabrication is maintained once the virtual element gets enriched with data so a true reference for downstream parties can be obtained. Based on this method, information such as the materials, joins, finishes and additional hardware is kept within a database for future maintenance or reference.

Interacting with consultants

Based on the approach agreed upon and documented in the BIM Management Plan (see document P2 - *What should be addressed within a BIM Management Plan?*) the team breaks down a building, facility or asset into smaller working parts and systems and defines them by categories, workflow and ownership. Certain elements link to the different disciplines and those elements can be accessed by stakeholders at different stages of the design.

In an integrated fitout the architectural and interior design teams work together, either within the same practice or as two separate consultants. It is common in these cases for the architectural model to be linked into the interiors model and vice versa. For example the architect may place a generic WC, the Interiors team will then swap the generic WC for a more defined model that allows the hydraulics team to locate and connect their pipes. This enables the structural team to locate the penetrations in the slabs or wall structure. In addition to the architecture workflow, interior designers must also consider the workflow with other disciplines such as services engineers. This workflow will also need to consider specific requirements and elements related to these disciplines. The benefit of collaboration with services engineers enables interior designers to see every electrical box and plumbing or light fixture which enables better correlation than traditional 2D. Being able to locate services items requirements with joinery elements in 3D allows interior designers to plan circulation around equipment and adequate equipment space and clearances.

INVESTMENT REQUIREMENTS

Augmenting staff skills and training

BIM for Interiors requires a richer level of detail and information compared to most other disciplines. This in return requires a higher level of competency among staff who add components to an Interiors BIM library. The emphasis on training methods are more around data, content creation; including joinery, furniture, fixtures, fittings, materials and schedules rather than base building elements such as roofs, external walls and site elements. Interiors are less reliant on 'off the shelf' architectural components (such as windows, doors, etc.), and more dependent on custom-developed objects such as furniture, joinery and partitions. This is because their workflow has a larger focus on purpose built elements such as custom solutions; therefore the investment in Interiors-focused training for staff will return greatly to the business.

The following pitfalls frequently occur when poorly trained staff develop custom BIM objects:

- unnecessary effort is put into the modelling process with time wasted on details that are irrelevant to either visualisation or documentation/data output
- inadequate file sizes due to a mismatch between an object's polygon count and its actual representation requirements (Fit for purpose setup of geometry is often misjudged)
- LOD (as described in P2 - *What should be addressed within a BIM Management Plan?*) need to be well defined as it can be time-consuming to modify content at a later date
- workflow/process for content creation insufficiently considering the ultimate documentation and specification/ scheduling requirements of downstream parties.

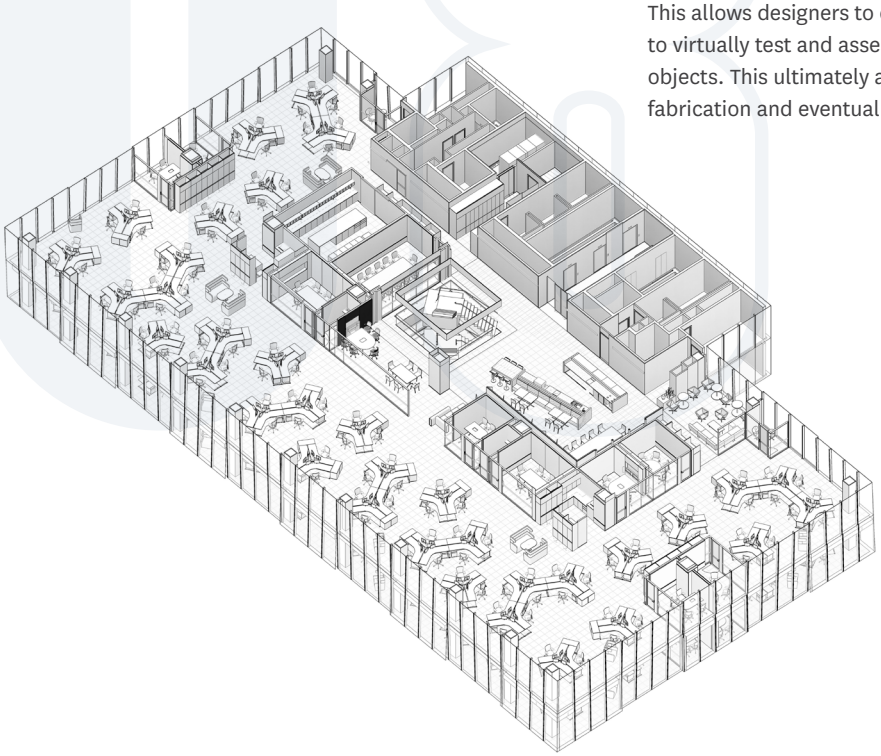

Image: (Source: GEYER)

Protocols for information exchange and data output

Next to facilitating traditional 2D plans and sections, BIM for interiors provides new opportunities for appropriating visual output such as the automation of interior elevations, interactive walk-throughs and 3D prints. On the data side, BIM enables the interiors teams to introduce various levels of automation for the generation of Room Data Sheets, **furniture, fixtures and equipment** schedules, links to specifications and the costing of interior elements.

Developing well-established company protocols to regulate how the above information gets appropriated will help to improve the quality and consistency of information and will assist in leveraging data efficiently downstream. The guidelines need to focus on the end-deliverables for interiors to output information in a format that can easily be shared with others and that can be managed by the entire team.

Adherence to well established guidelines and protocols will make BIMs and projects in general run more efficiently. The information that gets embedded in the library components needs to allow for variation, while the data needs to be consistent across all fields. It is crucial to maintain data integrity, as a break in the system will have staff trying to manually manipulate aspects of their project with associated high costs and risk. If content outsourcing is engaged, a firm is well advised to carefully define its processes and requirements with any third party developers in order to keep information links intact, no matter what individual elements are used for. Manufacturers' BIM data and BIM data in (freely) available third party object libraries is often inadequate as its authors often lack an understanding of the particular modelling requirements of the end users.

BIM enhances the interior designer's workflow when the BIM maturity of interiors staff has reached a saturation point and the creation of content fit for purpose is built and utilised. This allows designers to concentrate on space planning, and to virtually test and assess the information pertaining to the objects. This ultimately adds value to project delivery via fabrication and eventual maintenance and facility management.

CONCLUSIONS

BIM will continue to enhance interior designers' projects if efforts are made to structure and define the stages of delivery from within a team to within an office. BIM delivery enhances the interior designer's ability to innovate as they can test their solutions virtually.

Summary

- It is important for the Interiors team to have boundaries set early so that the integration of the interiors model is seamless.
- The information embedded in the elements needs to allow for variation, while the data needs to be consistent across all fields for maximum reuse
- It is best to discuss the specific workflow for interior design (element ownership during stages) during the procurement so all stakeholders understand how changing their workflow slightly will enhance the model deliverables
- BIM enables interior designers to convey complexity and illustrate spatial planning in a dynamic 3D representation, whilst maintaining the integrity of embedded information within a model enables more accurate scheduling of quantities, costing and FF&E schedules

BIM Outreach

09 Surveying for BIM

09

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INTRODUCTION

Over the last decade both the Land Survey (Survey) discipline, and the Design Consultants (DC) disciplines have changed significantly through the introduction of new technologies and processes such as Building Information Modelling (BIM). These changes now require all stakeholders to both reassess the opportunities technology provides, and consider changes to traditional processes, if the maximum value is to be realised.

In order to achieve additional value through BIM, stakeholders should increase their level of understanding about the capabilities and requirements of other stakeholders, in particular those who depend on the direct input of others. Key considerations relate to an understanding of the benefits and limitations of tools, data types and the levels of detail possible or required, when data is required, and the optimum outputs and deliverables required to support the project.

This paper explores the interface between the Surveyor and DC disciplines, the processes and outputs required to facilitate BIM. The paper further suggests key elements to be included in a brief to hone the potential efficiencies offered by BIM.

BACKGROUND, DATA SOURCES AND ACCURACY

The role of the Surveyor has evolved over the last decade. The use of tape measures, theodolites, dumpy levels and staffs is increasingly giving way to total stations, GPS, GIS and laser scanning technology. New technology has broadened the potential scope of the Surveyor into areas that were previously handled by other disciplines. Surveyors still mainly focus on the geospatial information of positioning the site and recording the levels. At the same time some firms are developing their BIM capabilities and the technology they specialise in. This approach can help them to gather existing conditions data (such as detailed internal and external building data, and in ground services) in more detail and faster than the traditional processes used by DC.

On the other hand, for DC, the use of publicly accessible Geospatial Information Systems (GIS) data is becoming more common, and with the relative decrease in the cost of survey equipment, some are now developing their in-house skills to avoid the need to engage Surveyors for anything more than the bare minimum of service. There are risks associated with this approach as some aspects of the survey work related to site establishment are covered by legislation, and prosecutions for breaches are not uncommon. The fidelity of diverse data sets and the nuances of geospatial systems also add legal and insurance risks.

Due to this ongoing transition, the demarcation lines between services offered by Surveyors and DC become increasingly blurred, which in return may result in missed opportunities. Both scenarios fail to acknowledge the highly skilled and increasingly technical aspects of both fields.

BIM has brought some of these issues to the fore. What worked for manual drafting or CAD is no longer adequate. Instead, BIM is based on a rich and robust data set to resolve design problems “in the office” through detailed coordination. Simply knowing that there is a tree, wall, or light pole is no longer enough. Each element will either impact or be impacted upon by the design.

Without quality existing conditions data the BIM will be compromised as the DC will need to make assumptions where detail is not available. The second-guessing of conditions data reduces its reliability and value by limiting design brief and statutory compliance, and constructability analysis functionality.

FIELD TO SIM

There are a number of BIM authoring software applications in general use in Australia. Some provide more options than others when importing survey data, but where the option is provided they work similarly across applications. Regardless, the creation of an accurate and reliable "existing conditions" Survey Information Model (SIM) is vital to support the design process in BIM.

SURVEY DATA AND FORMATS

The data collected in the field by the surveyor is manipulated in specific surveying software to generate items such as Digital Terrain Models (DTMs), Triangulated Irregular Networks (TINs) strings and point cloud files. Software typically is the variable as the checking and maintenance of the accuracy and integrity of the data sets is constant no matter the data collection method and file format being used.

TOPOGRAPHY

BIM applications, by definition, focus on the building or site elements, and it is important to note that the topography and planting in the BIM is only indicative and not as detailed as the DTM.

The most common methods for data transfer into a BIM are via 3D CAD files (.DWG, .DXF, .DGN, .SAT or .SKP) or Point Files (.csv, .pts or .pcg). Once the CAD file is imported into the BIM, the relevant "layers" / "levels" are selected, and the RL data from them is transferred to create the topography. As a CAD file is typically used as a drawing rather than a medium to transfer RL data, problems like randomly incorrect Z values for points, "flattened" files, and inconsistent use of layers and layering systems have hindered the process.

An alternative is the use of a Point File (PF) which contains comma-delimited X, Y and Z values for each point and is much smaller and produces topographic surface more quickly when loaded directly into the BIM. Useful for simple surfaces, this method lacks the fidelity of a TIN or DTM as during the creation of these the point data set undergoes a process involving a mixture of point filtering and cleaning; break line data inclusion and quality checks through the use of applications such as LISCAD, Terramodel, Civil 3D and 12D Model to name a few.

FEATURES

Having created the topography in the BIM, the features need to be located and CAD files remain the most effective method. The DC needs to be aware that Surveyors use different methods for locating features depending on required accuracy. Failure to specify accuracy requirements at the outset can greatly diminish the quality of the data delivered.

The creation of point clouds through laser scanning present further options to enhance data exchange while improving accuracy levels. Managing the data effectively and using a combination of techniques has the potential to add considerable value to the collaborative effort between DC and the Surveyor.

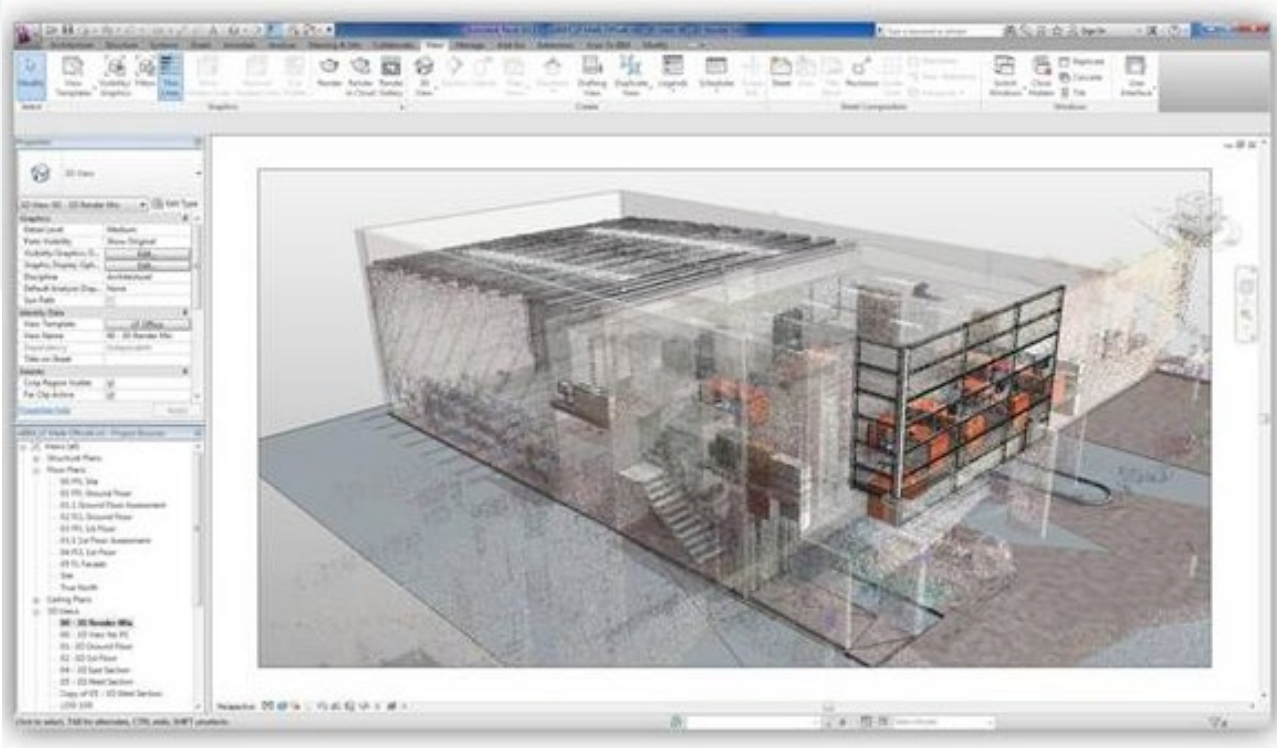

Image: (Source: LESTER FRANK)

WORKFLOW

Currently Architects transfer survey data into a BIM to generate the topography. If however the Surveyor data creators / gatherers format their data to meet the DC requirements, then the Surveyor could create the geo-spatially located SIM file so it can be loaded directly into the design BIM (to then be manipulated by the DC). In return, the risk of the DC "interpreting" the Surveyors data incorrectly would be reduced.

Challenges remain with the above approach: For Surveyors to create a SIM file, they not only need to be across their traditional core areas of expertise, they also need to develop more detailed working knowledge of BIM, the various authoring tools, building construction and services planning.

BIM knowledge by the Surveyors as a prerequisite presents a quandary as no one group in the value chain has all the required expertise to gather and structure the existing conditions data in a highly efficient way. Therefore collaboration is required and the management of these interactions in the BIM world is now widely handled by means of a BIM Management Plan (BMP) (refer to the 'P' series of documents that form part of this publication). By planning the collaboration methods and resolving the data exchange protocols in the early stages of the design / documentation process, the broader team can more easily provide reliable data at a suitable level of detail in a timely fashion.

The dilemma with the work of the Surveyor is twofold. Firstly, unlike the majority of the rest of the consultant team, the property and topographic survey work may be complete prior to most, if not all, other consultants having been appointed. The second is that traditionally, once the initial survey has been done, there is no allowance for additional or follow up work.

PROCESS CHANGE DUE TO NEW TECHNOLOGY

New technologies are being used by both Surveyors and DC, and this can extend the role of the Surveyor into a more ongoing one through the entire design and construction phase of the building lifecycle. They can identify and locate the site at the outset, and make major contributions to increased efficiency of modelling / documenting the existing structures and services. This, in tandem with the ongoing utilisation of BIM can increase accuracy and decrease building tolerances. Further, with the rapid uptake of BIM during construction, Head Contractors (HC) are utilising BIM data for digital set out, resulting in reduced costs and improved site safety. Surveyor engagement, however, is often done along traditional obligation lines meaning Sub Contractors (SC) and HC engage their own Surveyors for one project in an effort to manage their risk / liability. The result is duplication of effort which in turn prevents the full potential value that BIM and Surveyors can provide being realised.

The workflow changes described here require a paradigm shift in thinking and a new way of communicating. In this context it needs to be considered that not all Surveyors or DC are at the same level of their adoption in BIM and the industry is still undergoing a learning process. If Surveyors are approached by clients directly they need to understand the client's data objectives and encourage a closer interaction with the DC. At the same time clients and DC need to consider in detail how the surveyors' new processes and technologies can benefit their workflows. Such changes to traditional ways of collaboration are more likely to succeed in an environment that encourages innovation and that respects the notion that the cheapest fee does not always represent the best value.

DC and surveyors should foster strategic relationships that encourage the sharing of knowledge to reduce the learning effort by both consultants on every new project.

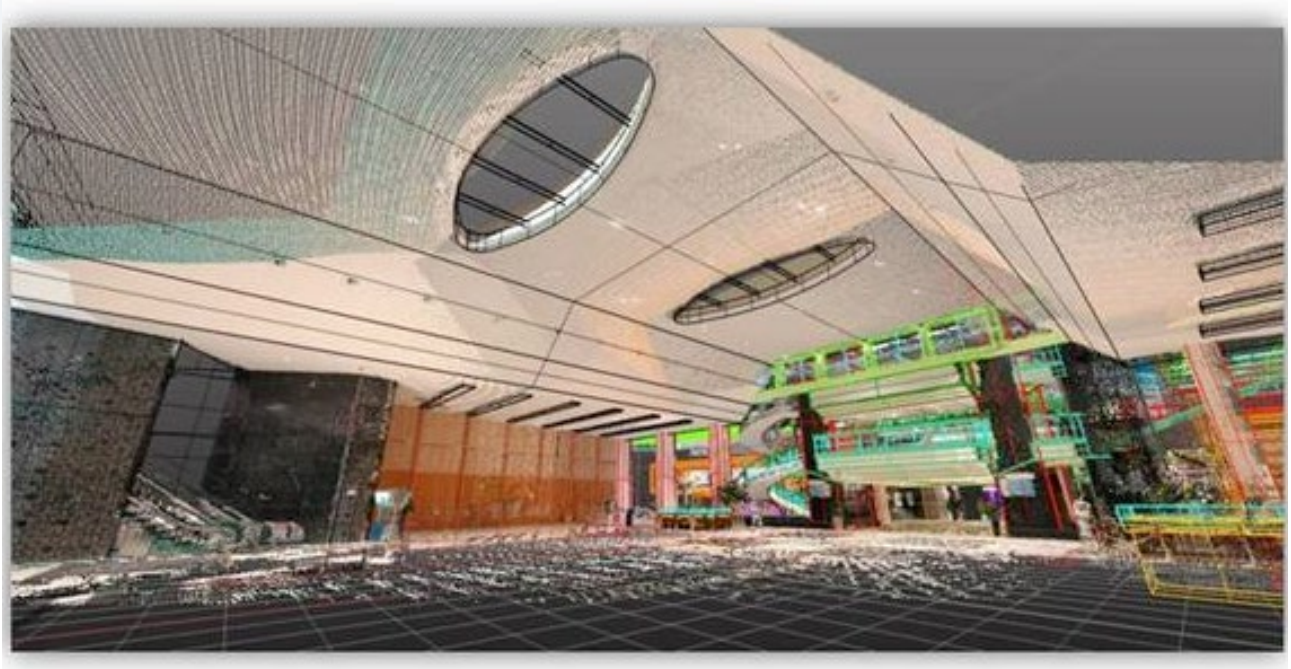

Image: (Source: LESTER FRANK)

BRIEFING REQUIREMENTS

The survey brief generated by the DC for the surveyor should contain a detailed description of all the BIM-related data requirements to be met. The brief will be based on the DC data requirements and it typically includes: format, benchmark locations, units, coordinated systems, etc., as well as a clear definition of the survey extent - what is to be surveyed and to what level of detail. The data set may even include intangible site conditions like site height restrictions and zoning. It should also include opportunities for the surveyor to propose alternative processes to achieve better outcomes.

As part of the BMP process, the project team will carry out a downstream value chain analysis to determine all possible uses for the BIM data. Currently, this process occurs too late for most, but not all, of the surveyors' work. DC's therefore should engage with surveyors to understand the nuisances of file format and data interoperability considerations prior to the surveyor briefing phase to ensure "best for project" outcomes are achieved.

Readily available data in the public domain, which may seem cost effective, can vary greatly in accuracy making its use inappropriate, unreliable or problematic. The accuracy of field work can also vary depending on required levels of detail. Without a clear direction surveyors will assume minimum standards and budget accordingly, which makes it even more important for DCs to communicate the specific project requirements.

CONCLUSION

The development of the BMP must include input from all DCs including, where possible, the surveyor. By utilising the collective skills within the broader project team and by identifying needs and responsibilities of all stakeholders involved, the most appropriate technologies can be applied. This ensures the gathering and formatting of data to solve design issues is to a high level of accuracy, and may also extend to the construction phase to incorporate the requirements of the builder.

In order to facilitate the workflow changes described previously, surveyors need to develop and maintain capability statements that manage expectations, communicate their technical and process requirements and outline their value proposition. These statements should accompany fee proposal letters to assist clients / DC to understand the varied options to increase value for the project.

Technology alone will not solve all the challenges that project teams face when gathering existing conditions data. New tools such as 3D laser scanning rely on "line of sight" technology. Where required data involves non-visible building elements embedded in walls, ceiling spaces or underground the laser technology's shortcomings are evident.

Historically surveyors were not necessarily seen as part of the consultant or construction teams. New technology and processes allow them to provide critical, valid and ongoing services throughout the design and construction phases of the building life-cycle.

From a qualitative perspective, surveyors can add significant, ongoing, value to the project, which suggests that their input should fall under the supervision of the lead consultant, similar to other consultants. Surveyors should be directly engaged in the BMP development. This is where the majority of the decisions on data requirements, flow and format control are determined, and where the greatest positive impact can be implemented.

BIM Outreach

010 BIM for specialist sub-contractors and trades

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BIM IN PRACTICE

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O10 BIM for specialist sub-contractors and trades

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O10 BIM for specialist sub-contractors and trades [Version 1 – October 2013]

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INTRODUCTION

The purpose of this paper is to describe practical applications for the specialist sub-contracting and trade supply chain with adopting BIM tools/workflows and to introduce them to the associated process change. Subcontractors form an essential 'link' in the supply chain of lifecycle BIM, and an increasing number of subcontractors adopt BIM as part of their delivery process. Further, the use of BIM suggests new pathways in the workflow between consultants, the head contractor and subcontractors and the client / owner with new opportunities for physical pre-assembly and off site fabrication to reduce safety risks, plus just-in-time site deliveries.

LINKING DESIGN TO CONSTRUCTION (AND BEYOND)

Similar to the physical world where subcontractors are responsible for the assembly of custom built products and installation of precisely specified building equipment. they now also do so virtually by pre-assembling and coordinating the installation of 'Construction BIM'. Subcontractors thereby aim at obtaining not just 2D documents, but 'Design Intent' BIM from consultants as a basis to specify the precise equipment to be installed. In doing so, subcontractors interpret the Design Intent BIM to then select components and /or materials for virtual coordination and construction.

Design Intent BIMs contain the design/procurement/CAB (commissioned as built) technical schedules and provide a basic range of standard, generic design models covering the majority of the designer's requirements. Design data embedded in the BIM objects that are compiled during the design development stage includes the extraction of specification relevant data for the equipment schedules, as well as system integration information. It is expected that the design model schedules should significantly improve the quality of design technical data scheduling assuring the majority of technical parameters are clearly specified to aid the tendering and letting of contracts workflow processes.

Construction BIMs on the other hand are manufacturer specific models which have both the design schedule and procurement schedule data completed. Models are dimensionally accurate sufficient for workshop detail drawings for manufacturing and installation purposes. The technical data schedules will include a range of parameters, some of which are not accessible and others which are defined as shared parameters – i.e. can be scheduled. Construction BIMs consider the non-geometrical data (properties/attributes) that needs to be attached to the BIM for Operation and Maintenance (O&M) further down the track; they also need to consider the installation constraints and safe handling sequencing, as well as the spatial requirements for access and servicing during operation. In some cases (e.g. within the realm of mechanical subcontracting), well configured Construction BIMs allow specialist trades to communicate their workshop detail drawings straight to the fabrication equipment and robotic site positioning layout equipment, thereby strongly reducing the need for 2D documentation. The Construction BIMs can now be accessed via the cloud and viewed on hand held tablet devices that can extract the data on demand.

The closer we can link from design to fabrication and construction, the greater the overall benefits to the industry lifecycle as a whole. One open question related to these new opportunities deals with the effort consultants put into configuring their 'Design Intent' BIM. Most sub-contractors and trades who receive such models lament the inadequate information content within 'Design Intent' BIMs that were not set up with their estimating, fabricateable, installation and maintenance needs in mind. A trend is noticeable among mechanical subcontractors: they increasingly take over modelling tasks that were traditionally performed by engineering drafters who would provide more than just the performance outline, scope of works and design intent of uncoordinated services routes and equipment to be installed.

SKILLS AND TRAINING

Australian subcontractors in general are undergoing a major transition in their education of object based 3D modelling. Current and novice professionals undergo dedicated BIM training as the entire industry gears up to become BIM enabled. A pivotal part of this education process is BIM advocacy and stronger awareness of the change in work practices by major industry bodies representing subcontractors in Australia. As stated in the BIM Education papers that form part of this series of documents, BIM Education should cut across all major disciplines that are involved in the management of building information during its lifecycle. Implementing BIM is more than picking up software skills, it is about acquiring communication and collaboration skills that enable and encourage us to deliver projects in an integrated way.

The entire workflow for designing, estimating, procuring, manufacturing, delivering, installing, commissioning and maintaining buildings needs to be reconsidered (revamped). For subcontractors this process-change means: preparing for early involvement in the design process and interpreting "Design Intent" BIM for the purpose of creating "Construction BIM" models that contain bespoke equipment/materials/construction systems. Key to this learning process is an understanding of the relation between expected output from BIM and the manufacturing/installation/maintenance process. Some sectors of the construction industry introduce knowledge-based engineering to support informed transitions from "Design Intent" to "Construction" BIM. Such support requires prior definition of standards for information exchange and the generation of BIM content in order to comply with technical schedules. In this context it becomes crucial to associate Construction BIM components with numeric product data (quantities, cost, servicing), to consider interfaces to CAM (computer aided manufacture) for rapid (and less waste) manufacture, and to facilitate the generation of O&M manuals that can be accessed by a facility's operator. The subcontractor can therefore advise the Facility/Asset Manager on how the Commission As-Built (CAB) will influence the operation of the building.

CHALLENGES

A lack of standardisation within the industry has created numerous barriers to the effective uptake and use of BIM in Australia. Concerns about the viability of BIM remain among a large number of subcontractors irrespective of a particular discipline; specific concerns reported include:

- Significant time and cost burdens involved in customising BIM modelling software to suit Australian design and construction requirements.
- Lack of industry standards supporting BIM.
- Inconsistent interoperability between different BIM software packages.
- Poor consideration of the requirements for integrated project delivery.
- Limited BIM project management and file management expertise within the industry.
- Reluctance to share the models
- Not enough time allowed with subcontractors to engage earlier
- Contracts exchanged (let) too late
- The tender documents fall short
- The construction overtakes the design
- Client expectations not understood
- Consultants not educated to understand the fabricateable, installation and maintenance site constraints

With some notable exceptions, there currently exist only limited advantages for subcontractors to take the 'Design Intent' BIM generated by consultants to then generate 'Construction' BIM for detailed specification, spatial coordination, assembly and beyond. Models generated by consultants serve a different purpose than models used by the subcontractors. Architects and engineering consultants typically apply far less detail when authoring their 'Design Intent' BIM than what is required by contractors for fabrication. In some cases, consultants still only pass on 2D CAD information (at times in PDF format) to the contractor despite working in BIM themselves. The disruption of the BIM workflow is usually based on a lack of contractual obligations by the consultants to share their BIMs and the risk they perceive (IP, liability) in handing over their original models.

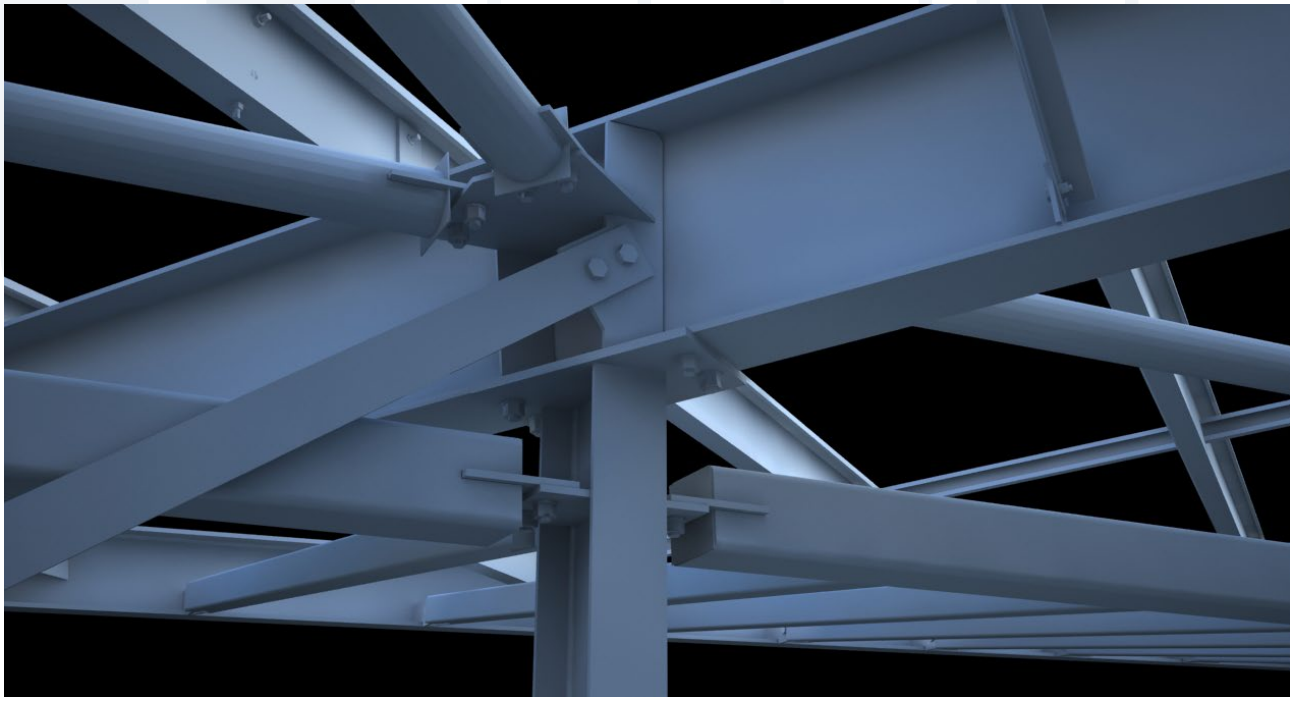

Image: Fraser Coast Detail Model (Source: Jackson Roxborough)

BRIDGING BETWEEN 'DESIGN INTENT BIM' AND 'CONSTRUCTION BIM'

Several industry bodies representing subcontractors and the trades have started to address the challenges mentioned previously. Standardising data formats and exchange to increase interoperability has been on the agenda of the Australian Institute of Steel Detailers (AISD) for a number of years; the 'Air Conditioning and Mechanical Contractors' Association' (AMCA) supports the development of bespoke standards and BIM content for their members through their initiative 'BIM-MEP^{AUS}[1]'.

Other organisations are on their path to consolidate the diverse BIM approaches of their members in order to develop streamlined national policies that are in line with broader industry requirements.

Industry feedback illustrates that one first needs to consider the interoperability of digital formats applied in the exchange of modelling data for linking between 'Design Intent' and 'Construction' BIM. This interface is currently dealt with on two levels among Australian subcontractors.

The first level addresses the consistency of BIMs when exchanging data across BIM software from different providers. There is a need in the industry to develop a mentality of linear integration with a focus on process. A process where consultants and contractors collaborate and communicate digitally, using a standard data model that is growing in intelligence as information moves from discipline to discipline. Over the past years, the globally accepted 'Industry Foundation Classes' data model (iFC) has proven to be a stepping stone to allow trade contractors (and others) to communicate digital design information and intent with consultants for the purpose of re-interpreting their intent for shop detailing. As a neutral and open specification, the iFC allows for file exchange between sub-contractors for (spatial) coordination purposes and more.

It should be noted that the iFC is still under development, but it has continuously been improved since its conception in 1994. There remain a number of iFC sceptics in the industry, but inconsistencies, and the level of hand-holding required during data transfer, are diminishing with every new release (currently: IFC4).

The second level considers alternative project delivery strategies that specifically target the use of BIM. The BIM-MEP^{AUS} initiative has so far been the most pro-active approach by proposing a 'BIM-all-the-way' design/construction/ (CAB) workflow. The

BIM-all-the-way workflow enables a building to be designed and coordinated in a virtual environment before being built on site whilst also allowing best of breed fabrication software to be used for the manufacture and estimating. The workflow is fundamentally dependent on the use of managed content to deliver standard models which are certified, to assure compliance with the technical schedules and functionality with the BIM-MEP^{AUS} add-in for BIM authoring and fabrication software needed for manufacturing purposes and procuring bought in equipment. There is also a range of opportunities for suppliers, particularly interaction among various businesses that link project components from various subcontractors together during off site assembly processes called modulisation for 'just in time' site deliveries. There is also a range of opportunities for suppliers, particularly interaction among various businesses that link project components together during assembly processes.

The BIM-MEP^{AUS} approach could be adjusted to suit other trade contractors and their specific workflow. The combination of strong standards in parallel with the development of referring BIM content facilitates a fluid transition from Design Intent BIM to Construction BIM.

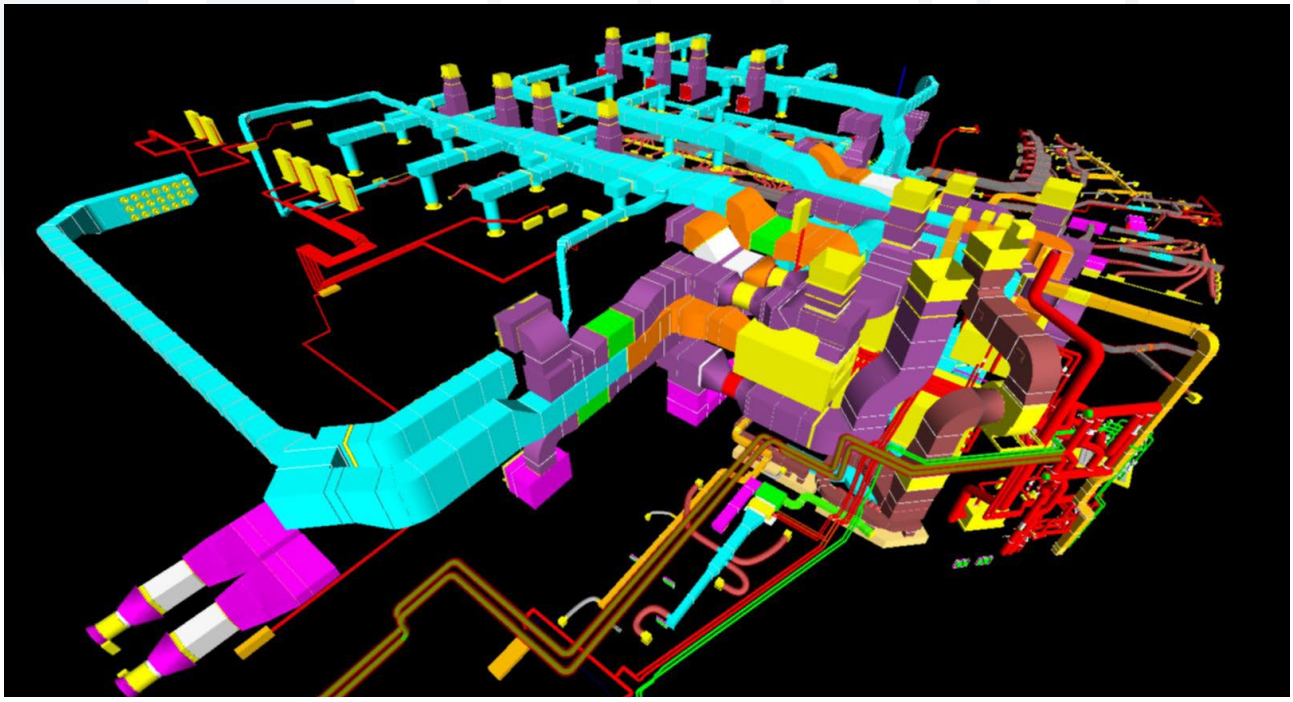

Image: MUEF Star Casino (Source: BSA Limited)

1 http://www.bimmepaus.com.au/home_page.html

MODEL DEVELOPMENT

Where BIM models for a specific item were not provided by the item's manufacturer, they can either be developed in-house or generated by third party BIM content creators. Where manufacturers have existing content, those third party providers can assess the models and determine whether they are suitable to either modify or augment to generate models that comply to the subcontractors' specification with the shared parameters data fields added for exchange of data between the schedules, during the workflow phases.

There currently exist initiatives to setup a National Object library of BIM components. This development is still in early stages, but should be observed closely as it may one day become the common interface for product manufacturers and specifiers/BIM users.

Design phase

Manufacturers should be able to promote vendor neutral 'Design Intent' BIMs related to their respective trade (ideally hosted on an online library). Examples of where this is likely to occur are where a new product is introduced into the market.

Where a manufacturer works with a designer/detailer, they would ideally have access to a framework for certification by their respective industry body. This should allow manufacturer models to be inserted in the design model. The design schedules generated will identify the manufacturer as either a nominated supplier, or approved or equal supplier as deemed appropriate by the designer.

Construction phase

Once the key structural elements are determined and the 'Design Intent' BIM is clearly defined at the end of Design Development, it is envisaged that the trade installers will take custodianship of certified BIM components and will develop them to 'Construction BIM' model status, which will:

- incorporate the manufacturer models for the equipment selected for the project; and
- sufficiently resolve spatial coordination for general construction purposes.
- consider procurement data schedules
- target commissioning data prior to commissioning commences

Fabrication phase

Once the construction models are approved, it is envisaged that installers will convert them into Fabrication Models in cases where their workflow allows for this mode of delivery (e.g. for ducts and pipeswork). The level of automation that can possibly be applied to this process depends on pre-defined, knowledge-based semantic interpretation capabilities of the fabrication software in use.

- Fabrication models can be used for a variety of purposes including construction detailing, fabrication and CAM routines for manufacture.
- Construction BIMs can get converted to Fabrication models whilst retaining their geometry
- Conversion back to a BIM Construction model will be possible using the fabrication to provide accurate as-built documentation as required.
- It results in greater opportunities to explore value-adding services.
- Data extracted to exchange onto the robotic site positioning layout equipment,
- The fabrication BIMs can be uploaded to the cloud and viewed on hand-held tablet devices that can extract the data on demand for the installation teams.

SIGNIFICANT WORKFLOW CHANGES AFFECTING THE SUPPLY CHAIN

In consideration of the changes in the nature of information flow between 'Design Intent' BIM and 'Construction BIM', but in particular when linking BIMs further into fabrication, one can currently observe a new industry trend in Australia (as well as internationally). BIM allows for transparent and well-coordinated supply-chain integration of single or multiple trade models into 'smart assemblies' that can be modulated or unitised. Leading edge subcontractors and trades increasingly opt for offsite fabrication of such assemblies in controlled environments such as a factory or warehouse close to the projects. The resulting modules or units adhere to size and weight constraints required for transport and installation. Offsite prefabrication has significant impact on time, material waste, cost and safety related matters. It reduces risk and offers more certainty about the quality of the assembly and the time required for installation and 'just in time' deliveries. Cost savings are proving to be significant and principals and head contractors are likely to expect from their subcontractors to be able to deliver such assemblies based on well-coordinated BIM.

In addition to the above, the industry is likely to experience a development towards further automation of assembly and construction with the use of robotic equipment that can directly interpret coordinated datasets provided by BIM.

CONCLUSIONS

The success of the BIM workflow for subcontractors depends on their skill in operating in this virtual context, the availability of (trade) certified BIM libraries of the components they are installing, and the implementation of clear industry standards relating to their trade, but also the trades of other subcontractors they collaborate with. Overall, BIM and IPD signify a major cultural change for subcontractors if it allows them to be more linked into the design process while simultaneously having tighter control over fabrication and installation.