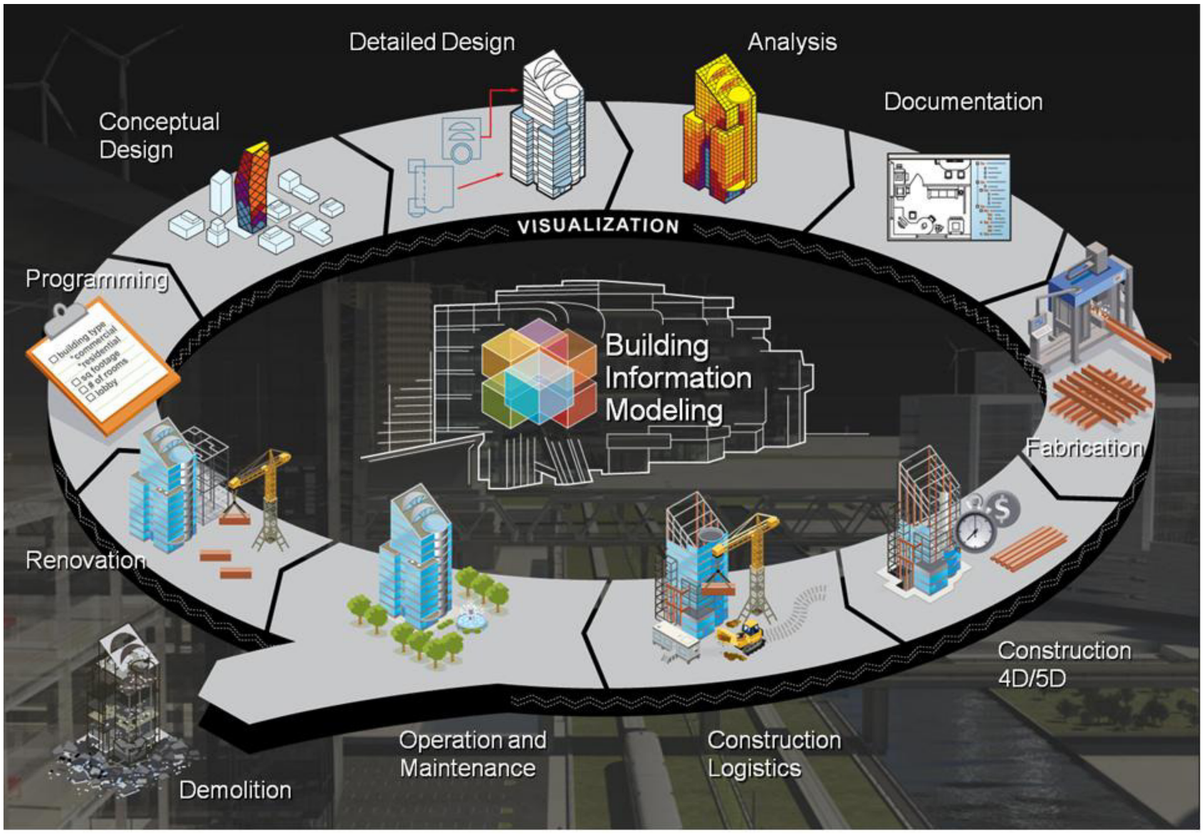
BIM = Building Information Modelling



BIM = Building Information Modelling. BIM is a game changing evolution in the way the 'built environment' is designed, built and maintained through life to the eventual decommissioning and either renovation or demolition of the structure. It provides access to efficiencies and economies, saving time, effort and waste through the use of consistent, structured data. The opportunities for BIM include:

- Reduce asset costs and greater operational efficiency
- Facilitate greater efficiency and effectiveness of construction supply chains
- A reduction in carbon emissions due to:
  - A reduction in wast from the construction process
  - A reduction in errors and rework
  - More efficient operation and maintenance of the building
- Assist in the creation of a forward-thinking sector on which growth ambitions can be based

In the long term, digital data managed through a fully integrated BIM system will enable smart projects, built by super-efficient, lean, integrated teams that will eventually deliver smart cities, connected and digitally enabled on many levels, being energy efficient, optimised and totally sustainable.

The full value of BIM will be unleashed one the supply chain gets fully involved. Rather than 'specifying' a window or other fixture or fitting, the Architect can select the 'object' from a supplier's on-line catalogue and place it into the 3D design. The 'object' contains all of the information about the item including fixing points, weight, price and maintenance information. Other design professionals can use this information to make sure the structure, services and other elements of the design 'fit'. If the successful building contractor

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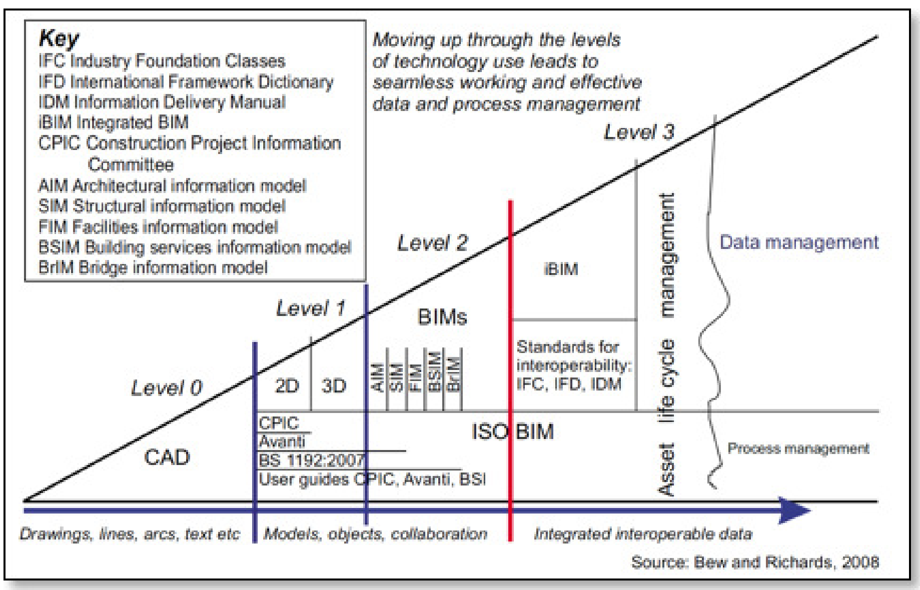
decides to choose a similar item for another supplier making the substitution is easy. Replacing the object updates the design and automated error checking will highlight any necessary changes in the design; maybe the fixing points are in a slightly different position[1].

Pricing information is of course easily available from integrated the BIM model as is information on replacement parts, spares and other maintenance data for the use of the facilities manager once the construction project is handed over to its owner.

The advantage of 'end-to-end' data management in a BIM model is significant. The UK Government is targeting savings of between 15% and 20% in the cost of capital projects due in large part to the efficiencies in design and construction facilitated by BIM. These initial benefits increase further year on year, as around 80% of an asset's cost is incurred during its operational phase.

In many locations including Finland, the UK and the USA the journey has begun. BIM is an evolutionary process with escalating levels of sophistication and information.
A BIM model can contain data relating to any facility in the 'built environment' pertaining to the way it is designed, built and maintained through life to the eventual decommissioning and either renovation or demolition of the structure.

BIM is becoming a world-wide trend; the UK Government has mandated the use of BIM on all major projects by 2016[2], contractors are taking the lead in the USA, BIM is routinely used in China and Hong Kong, and the Australian Sustainable Built Environment Council (ASBEC) is looking at implications in Australia. Used effectively BIM results in a significant reduction in waste, the CMMA-USA estimate up to 30% of construction costs are due to wasted materials, rework and wasted time waiting for information.



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1 The full potential of BIM systems to enhance project controls and the effective management of project work was discussed in our blog ***The future of project controls*** – this post was intended as a 'blue sky' look into the future. In the weeks since publication we have found some organisations have already implementing some of the ideas (see comments under main post): https://mosaicprojects.wordpress.com/2016/11/26/the-future-of-project-controls/

2 Since April 2016, all UK central Government departments require suppliers to demonstrate effective collaborative 3D BIM Level 2 maturity through the delivery of defined and compliant information and data on projects. Level 2 is a 'federated system' involving the exchange of data in a compliant format. Level 3 involves an integrated single model used by all of the project team. USA and Russian governments are mandating similar policies.

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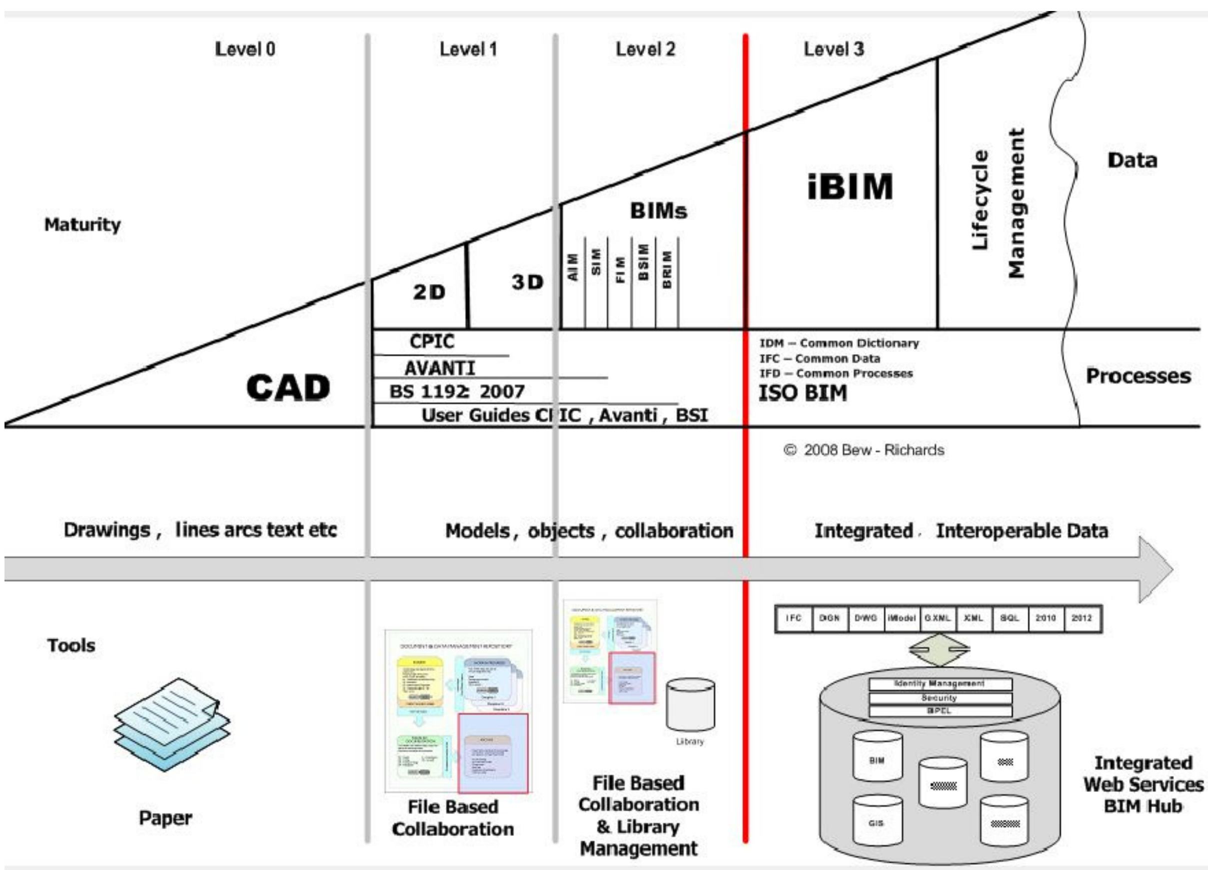
BIM is going to change the way the construction industry does things, new technologies, new working patterns and new partnerships. Organisations must embrace these changes over the next few years or risk missing out on the BIM opportunity. However, using BIM is not just a technology issue. Some of the factors needed to implement BIM effectively include:

- Managing the culture change and stakeholder issues to allow collaborative working.
- Adapting contracts and insurance policies to allow the collaborative development and use of shared data. The CIOB have developed a new form of contract to assist in this[3].
- Managing data exchange formats and other technical issues. To maximise the benefits, this will require standardization, the new BS 8541 "Construction Library Objects" and the example templates published for the UK Government BIM implementation strategy are a good example.
- Designing the BIM model and Execution Plan; including deployment, quality assurance, ownership (stewardship) of data, defining the audience for the information extracted from the model and selecting the appropriate level of detail to put into the model and to extract from the model for different audiences.

BIM Levels

BIM is an evolutionary process with escalating levels of sophistication, integration and information:



3 For more on the new CIOB ***Contract for Complex Projects*** see: https://mosaicprojects.com.au/PMKI-XTR-005.php

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There are three different elements to the BIM data model that can be integrated in different ways depending on the sophistication of the parties involved in the design and construction processes.

#1: The number of data 'dimensions' included in the model.

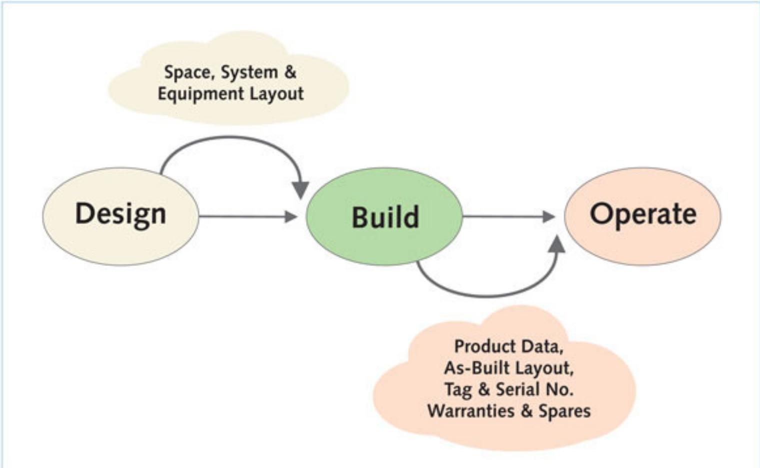
- 2D Drawings (not really BIM).
- 3D Models showing height, width and depth.
- 4D Models that integrate time sequencing in the model[4].
- 5D Models that also incorporate cost.
- #D[5] Models that also incorporate facilities management and life cycle information.
- #D Models that also incorporate elements of sustainability such as carbon, energy usage, water usage, etc.

#2: The degree of data integration (refer diagram above)

- Level 1 involves independent systems with file based collaboration.
- Level 2 is a federated system with data exchange and common libraries of data objects; 'lonely BIM' data transfers between systems are not seamless.
- Level 3 is a collaborative model using a single integrated data system with different aspects of the model accesses by different users. Beyond Level 3 the integrated data is designed for use 'through the life' of the building as part of a facilities management system.

The amount of detail in the model or 'Level of Development'

COBie UK 2012[6] is a formal schema that helps organise information about new and existing facilities. Level of Development (LOD) describes the purpose of the information in a model.



Both models consider data for the 'whole of life' of the facility. The systems are generally defined as follows:

- LOD 100 - The equivalent of conceptual design, the LOD 100 model usually consists of overall building mass designed to perform whole building type analysis including volume, building orientation, square foot costs, etc.

4 For a discussion on the opportunities offered by **4D modelling** see: https://mosaicprojects.wordpress.com/2012/07/01/the-4th-dimension-of-bim/

5 After 5D, the order varies depending on source.

6 For more on COBie see: https://www.cdbb.cam.ac.uk/

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- COBie Data Drop 1: Model represents REQUIREMENTS and CONSTRAINTS

- LOD 200 - Similar to schematic design or design development, the model would consist of generalized systems including approximate quantities, size, shape, location and orientation. LOD 200 models are typically used for analysis of defined systems and general performance objectives.
    - COBie Data Drop 2: Model represents OUTLINE SOLUTION
- LOD 300 - Model elements equivalent to traditional construction documents and shop drawings. LOD 300 models are well suited for estimating as well as construction coordination for clash detection, scheduling, and visualization. LOD models should include the attributes and parameters defined by the owner in the BIM deliverable standard.
    - COBie Data Drop 3: Model represents CONSTRUCTION INFORMATION
- LOD 400 - This level of development is considered to be suitable for fabrication and assembly. This LOD is most likely to be used by specialty trade contractors and fabricators to build and fabricate project components including Mechanical Electrical and Plumbing systems. LOD400 models integrate substantially more stakeholders into the process from the early design stage to provide input and review, test the constructability, and determine the best materials and methods for design and construction, in accordance with the project's budget, schedule and quality. The model incorporates such fine details as seismic and gravity hangers, metal framing systems, and detailed models of components like rebar. These models can be used to produce shop drawings for fabrication, determine material quantities, produce accurate model-based estimates, perform cross-trade prefabrication, and produce actual installation drawings.
- LOD 500 - The final level of development represents the project as it has been constructed including as-built conditions. The model is configured to be the central data storage for integration into a facilities management system including building maintenance and operations. LOD 500 models will include completed parameters and attributes specified in the owners BIM deliverable specification. Typically items of equipment can be bar coded and have a unique history starting with installation information and continuing through the life of the item until disposal.
    - COBie Data Drop 4: Model represents OPERATIONS and MAINTENANCE INFORMATION
    - COBie Data Drop 5 (and subsequent drops): Model represents POST OCCUPANCY VALIDATION INFORMATION and ONGOING O&M

BIM Levels Summary:

These three elements of a BIM model are to an extent, both independent and interdependent. The BIM Execution Plan that specifies how and when the model will be developed and who is responsible for the information included needs to take into account all three aspects and a timeline and sequence for developing the different elements of information. Care is needed to ensure the standardisation of components within the model and library, to avoid over engineering the data and to manage change effectively.

The creation of an effective model needs:

- Planning the BIM.
- Managing the development of the Model.
- Validating and maintaining the data through the construction period.
- Transitioning the data to the facilities management system at the end of the project.

The real transformative power of BIM is likely to be the standardisation of ***I***nformation – work is underway to develop a standardised approach to object libraries that would allow manufactures to develop BIM objects that designers would be able to put into a model enabling the builders and maintainers direct access to the manufacturers data (not to mention eliminating manufacturing errors when the builder places its order for the element).

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Incorporating the 4th Dimension – Virtual Construction

One of the more exciting opportunities created by BIM is when the 4th D of ***time*** is integrated into a reasonably sophisticated BIM model. Adding the '4th Dimension' allows the schedule to be linked with data objects at an appropriate level of detail and the project to be built virtually, testing different options before deciding on the best approach. Data from the USA suggests time savings of up to 10% are not uncommon.

Using the 4D model has many advantages. As a starting point, because the work can be seen in 3D, implementing concepts such as lean construction and last planner become much simpler. The workers can see what the current situation is and contribute effectively to decisions as to what work will be done in what sequence during the next few days and then see the results in virtual reality before starting on the actual work. This involvement can operate at the detail level such as services integration in a congested ceiling space or at a higher level looking at plant and materials movements. Some of the other opportunities include:

- Using BIM to model the overall sequence of work on site. This is particularly useful for showing clients how the building will be constructed.
- Using the visualisation to develop stakeholder engagement with the schedule at all levels from client to on-site workers.
- Optimising phasing and temporary works, particularly on complex expansion and refurbishment projects.
- Modelling the optimum vehicle, plant and material movements for maximum efficiency, particularly if there is restricted access.

Considerable skill is needed to integrate the schedule with the BIM model and make effective use of the information; a BIM expert will typically work with a scheduling expert to pull the data together.

Future extensions of BIM could see the need to manage supply items removed from the schedule. The construction schedule defines when the element is needed, the BIM system knows what data items are included in the element and it should not be too difficult in an integrated model to then work back from the 'install date' to the required manufacture date and before that, the required design date for each item. The integrated nature of the data would make tracking and managing the supply chain a real-time process with everyone fully informed of the current situation and any issues or problems.

BIM also has the potential to shift planning from activity based scheduling to location based scheduling allowing the optimisation of workflows through a project. In fact with the increasing power of computers, it is possible to foresee a time when the process of scheduling changes from using traditional tools to a virtual construction space where the planner physically moves elements of the building into place in the optimum sequence (or tests alternatives), in the same way a Lego model is built, and the BIM system creates the schedule from the optimum sequencing information created in 'virtual space'.

IPD = Integrated Project Delivery

Advances in Building Information Modelling software will enable owners, contractors, designers and other project stakeholders to deliver planning, design, construction, commissioning and maintenance services more efficiently. But only if integrated teams capable of leveraging the advanced software tools operate collaboratively. Private and public entities seeking to increase efficiency must deploy effective integrated agreements[7] and / or develop new and improved procurement laws, protocols and regulations.

[7] Such as the new **Time and Cost Management Contract Suite**, see: https://mosaicprojects.com.au/PMKI-XTR-005.php

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The scope, quality and depth of the conversation regarding integration of the planning, design, construction, commissioning, operation and maintenance of facilities and infrastructure is expanding at an exponential rate[8]. Support for these organisations is critical to realising the increased efficiency promised by BIM[9].

Conclusions

BIM is a threat and an opportunity! Early adopters, including designers, leading contractors and suppliers, will turn BIM into real competitive advantage. They will win more work, providing services and project certainty that non-BIM companies will not be able to match resulting in business failures for the slow adopters. It will be essential to embrace change to survive.
The BIM evolution is unlikely to stop; the key benefits of adopting BIM already identified include:

- Early cost certainty
- Reduced delivery costs
- Reduced operational costs
- Green performance
- Reduced risk
- Predictable planning

Other potential advantages (or threats to established organisations that are slow to adapt) include *Leftfield* players entering the industry. Companies from other industries will use BIM to enter construction. Offsite manufacture, Design for Manufacture, and Computer-Aided FM are prime targets. It is not too farfetched to imagine Ikea supplying buildings that arrive on site on a lorry, exquisitely designed and packaged, ready to be constructed smoothly and speedily. Or Amazon offering a similar service — click, visualise, select, check out, and built a few weeks later.

However, achievement of the promise will only be as good as the supply chain capability and its engagement with BIM environments. The key is a cultural change away from current 3D technology and thinking. BIM is much more than software to be rebooted and reloaded. It requires more collaboration, integrated teams, new workflows and ways of working. This means that implementing BIM is much more than 3D, requiring business and cultural change on a grand scale.

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8 See ***The future of project controls***: https://mosaicprojects.wordpress.com/2016/11/26/the-future-of-project-controls/

9 A 2011 insurance settlement related to a building information model shows that BIM without communication can be costly. A lawsuit over construction of a life-sciences building at a major USA university stands as the first known claim related to the use of building information modelling by an architect. Furthermore, the claim and its settlement serve as a cautionary tale to others using BIM.

For the life-sciences building, the architect and its mechanical-electrical-plumbing engineer used BIM to fit the building's MEP systems into the ceiling plenum. But the design team did not tell the contractor that the extremely tight fit, coordinated in the BIM, depended on a very specific installation sequence. When the contractor was about 70% through assembly, it ran out of space in the plenum. "Everything fit in the model but not in reality,"

The contractor sued the owner, the owner sued the architect, and the owner's insurer brought in the MEP engineer. The negotiated settlement was for millions of dollars, which was shared by the architect, the MEP engineer and the contractor. The problem was poor communication. The design team never discussed the installation sequence with the contractor, and the contractor wasn't sophisticated enough to understand the importance of assembling the components in a certain order. Even though the project was delivered under a traditional design-bid-build contract, it was not enough for the architect to say *"I designed it, it fits, here you go contractor, figure it out"*. In the BIM world, parties have to communicate with each other and make suggestions; that did not happen on this project,

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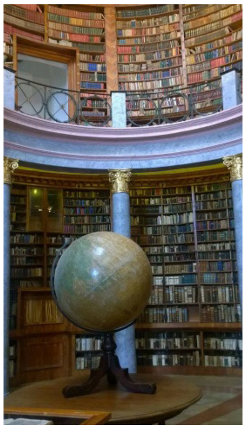

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For more on project controls and scheduling see:
https://mosaicprojects.com.au/PMKI-SCH.php

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- Building Products Innovation Council: https://www.bpic.asn.au/
- **CPC 2016** – the first general from of contract designed specifically for BIM: https://mosaicprojects.com.au/PMKI-ITC-013.php#CIOB-CPC
- British Standard — B/555 Roadmap — to encourage best practice implementation of BIM: http://www.mosaicprojects.com.au/PDF-Gen/B555_Roadmap.pdf
- **UK BIM Level 2** website: https://bim-level2.org/ - latest guidelines.

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