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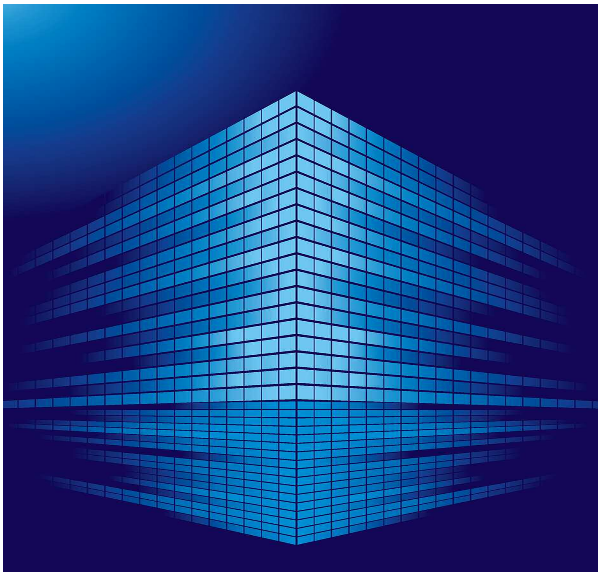
Mitsubishi Electric Guide to Building Information Modelling



Information Guide 45

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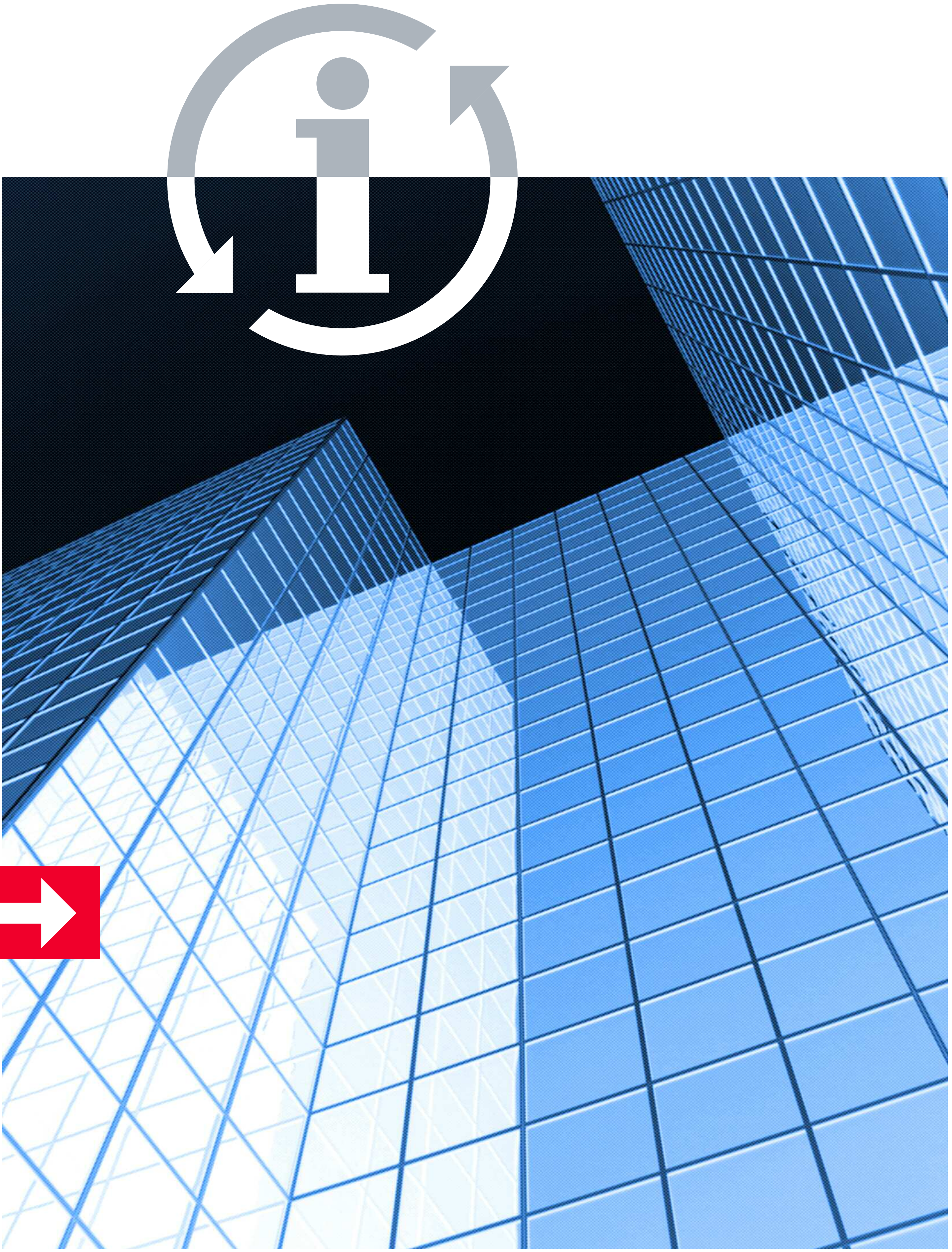

Mitsubishi Electric Guide to Building Information Modelling

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This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today.

This guide accompanies a series of seminars, all of which are CPD accredited.

Contents

Building information modelling - the background and basics

Building information modelling (BIM) is a method of collaborative working in construction which allows the project team and occupants to share a virtual, computerised model of the building throughout its lifecycle. The technology aspects of BIM have often been emphasised, but its key difference is in the working practices that it encourages. This makes BIM a powerful ally in the battle for greater productivity, risk management and sustainability. It also helps reduce waste and cut costs.

Ask Google what building information modelling (BIM) is and you are confronted by almost eight million results containing a variety of definitions. There is clearly considerable variety of opinion about the meaning of BIM and this begs a fundamental question: Which of the many explanations is reliable?

The Royal Institute of British Architects, the Construction Project Information Committee (which provides best practice guidance on construction production information), and buildingSMART (a not-for-profit organisation supporting Open BIM) have jointly proposed a description of BIM as a starting point for discussion and refinement. They define it as:
"A digital representation of physical and functional characteristics of a facility creating a shared knowledge resource for information about it forming a reliable basis for decisions during its life cycle, from earliest conception to demolition."

This is a definition which places a lot of emphasis on the technology behind BIM. However, the most crucial factor to understand about BIM is that it is not a tool, but a way of working and sharing information. It is not a computer model but a process which requires teamworking and collaboration from design to commissioning and operation.

With this in mind, perhaps a more appropriate definition comes from the BIM Task Group, whose mission is to bring together experts from industry, government, public sector, institutes and academia to help deliver the Government's Construction Strategy.

It says BIM is: **"'Essentially value-creating collaboration through the entire life-cycle of an asset, underpinned by the creation, collation and exchange of shared 3D models and intelligent, structured data attached to them."**

Although it seems quite a recent development, BIM is not new. The concept has been around since the 1970s with the term 'building information model' first appearing in a 1992 paper by Dutch university professors, Sander van Nederveen and Frits Tolman. However, BIM did not gain true recognition until the early twenty first century. Current interest in it stems from the UK Government's Construction Strategy, published at the end of May 2011, which calls for a profound change in the relationship between public authorities and the construction industry. The aim is to ensure the Government consistently achieves value for money on construction projects, and country develops the long-term social and economic infrastructure it needs.

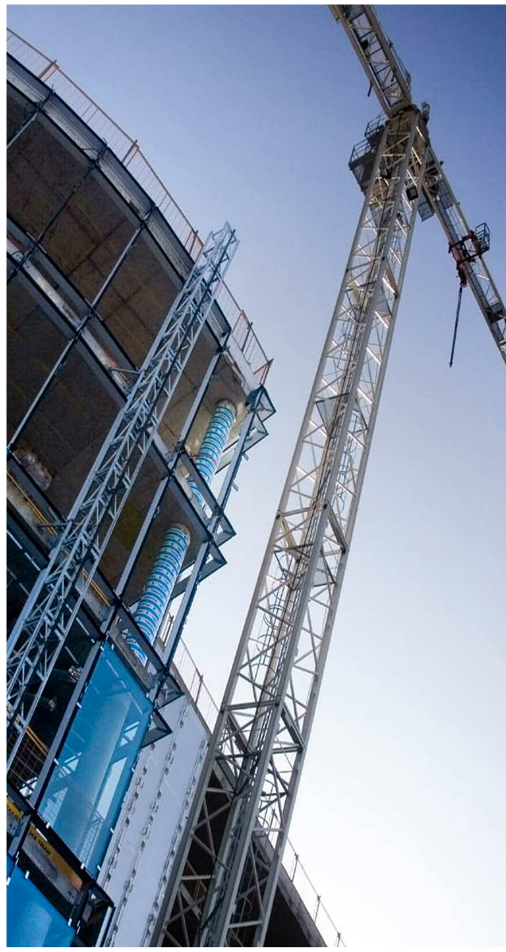
To contribute to these objectives, the Construction Strategy included Government's intention to require collaborative 3D BIM - with all project and asset information, documentation and data being electronic - on Government construction projects by 31 March, 2016. The word 'collaborative' is probably the most important element of this requirement.

A key aim of the Government's programme for sector modernisation is to reduce the capital cost and carbon burden from the construction and operation of the built environment by 20 per cent. By using BIM methodology, Government also aims to reduce timescales, accidents and waste.

Central to this ambition is the adoption of BIM processes, collaborative behaviours and technologies in a bid to unlock new, more efficient ways of working at all stages of the project life-cycle.

But BIM's potentially powerful impact does not end with an efficiency boost. The global export market for UK construction services is conservatively estimated at £7.6 billion a year so BIM also has the potential to be a potent engine for economic growth.

A Government paper published in 2012 titled *Industrial Strategy: Government and Industry in Partnership*, stated: **"It is clear that, through its domestic programme, the UK has come a considerable distance [in the application of BIM] and has now become the centre of international focus. We have a limited window of opportunity to capitalise on this domestic success."**



Building information modelling - the background and basics

As well as enjoying Government backing, BIM is also supported by many large consultants, software developers, end users, architects, engineers, contractors and suppliers. Its adoption is growing because it enables every discipline on a project to share a common model and set of data representing the project. Manufacturers and installers benefit from access to information on product performance and size. This same information is used for the client throughout the building's operational life and for eventual demolition.

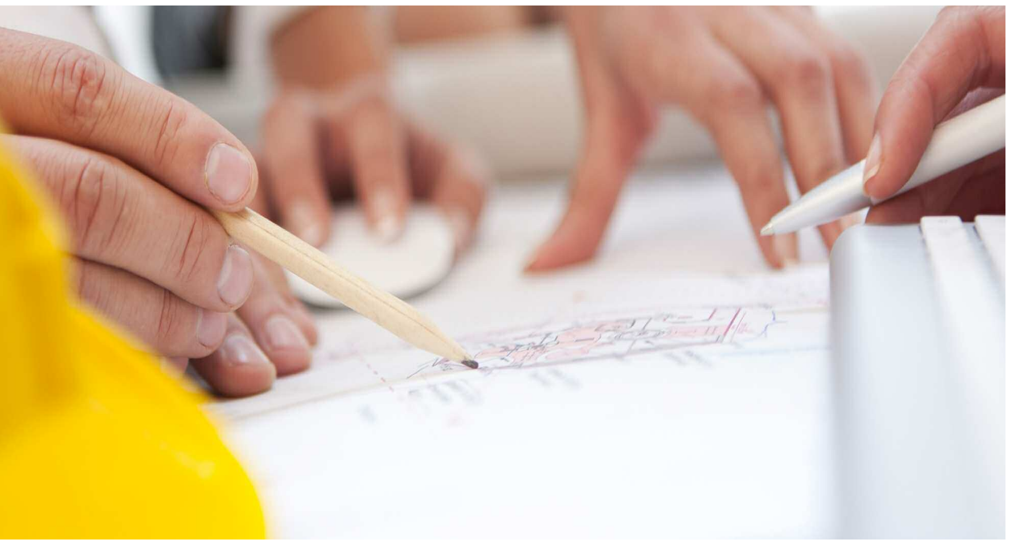
The greatest potential impact of BIM methodology is that it involves a shift away from traditional working practices where each discipline works separately in 'silos', using different, and sometimes incompatible, software packages. Rather, BIM encourages inter-disciplinary collaboration because each party has access to the same data.

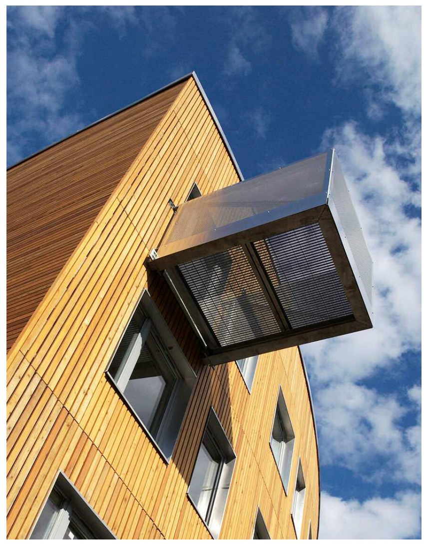
A key competitive advantage of BIM therefore is its ability to promote greater transparency, communication and collaboration between suppliers and thereby reduce waste in terms of procurement, process and material through all levels of the supply chain. This coherent, integrated approach means the information losses associated with handing a project over from design team to construction team and then to building owner/operator are minimised. BIM can improve the quality of the built object as well as its reliability, consistency, cost-saving capacity and timeliness.

And each member of a project team can take advantage of distinct benefits of BIM. For example, designers can use it to examine alternative concepts without the expense of actually building the project. They can also conduct value engineering and optimise their designs. Contractors can 'preview' the construction process as well as preparing and co-ordinating drawings. Owners can optimise building maintenance, boost energy efficiency and monitor life cycle costs.

At its best, BIM also offers other benefits too. For example, it:

- Reduces rework
- Results in fewer errors
- Minimises conflicts and changes during the construction process
- All this leads, in turn, to greater productivity, less waste and lower costs.

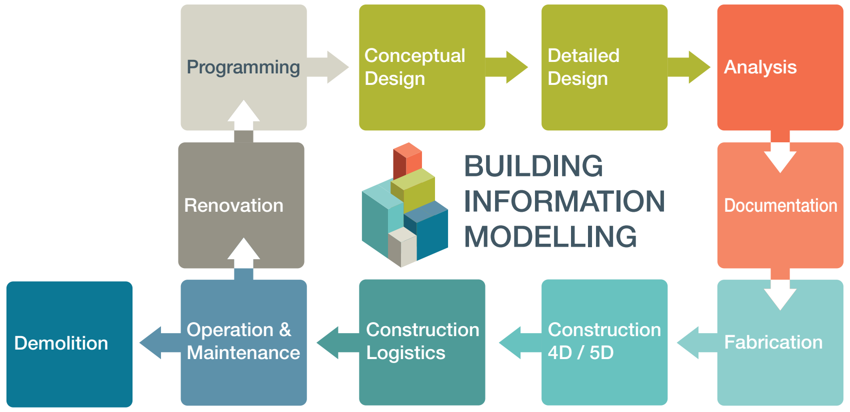




The mechanics of BIM

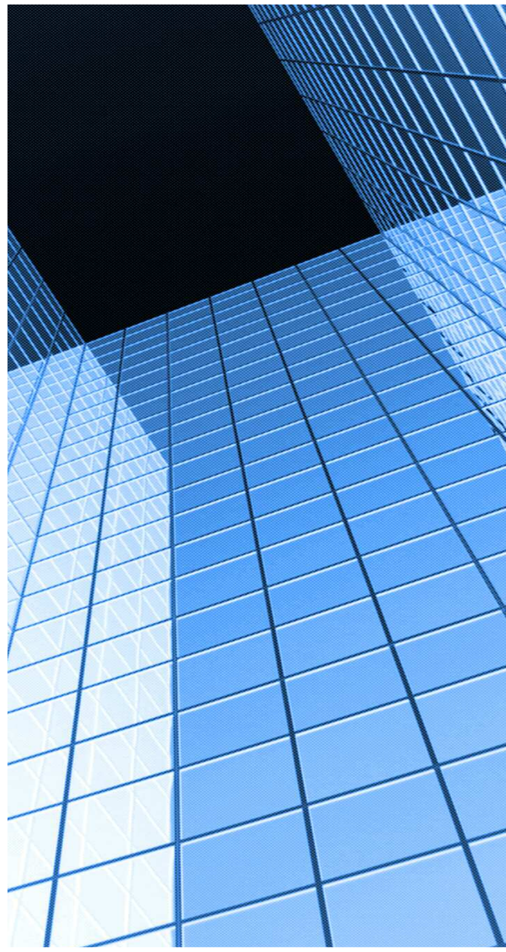
BIM uses software to support those involved in the delivery and management of any built object (including buildings, bridges, roads, etc.) by enabling them to build a digital prototype of a model and simulate it in a digital world. BIM software is not concerned solely with 3D CAD (computer-aided design); it also holds other critical information such as contract and specification properties, personnel, programming, quantities, cost, spaces and geometry.

All this information is brought together to produce a dynamic **'building information model'** that becomes an updatable, shared knowledge resource to support decision-making about a facility from earliest conceptual stages, through design and construction then through its operational life before its eventual demolition.



So BIM is not so much a technology as a process that encompasses several key areas, each of which involves storing data. The key areas are:

- **Programming**
- **Design** - conceptual and detailed design of architecture, structure and mechanical electrical and plumbing
- **Visualisation and analysis**
- **Simulation** - including structural analysis, energy, solar, ventilation and light analysis and schedules
- **Documentation** - CAD, 3D model, work schedules, costings and product information.
- **Building** - construction logistics and planning.
- **Operation** - maintenance and asset management.
- **End of life** - demolition.



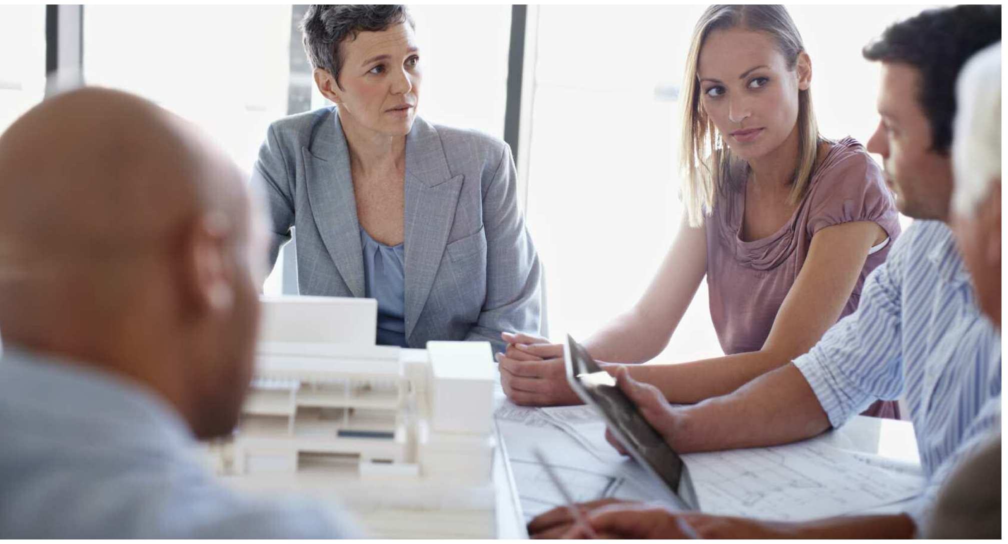
How BIM works - the mechanism explained

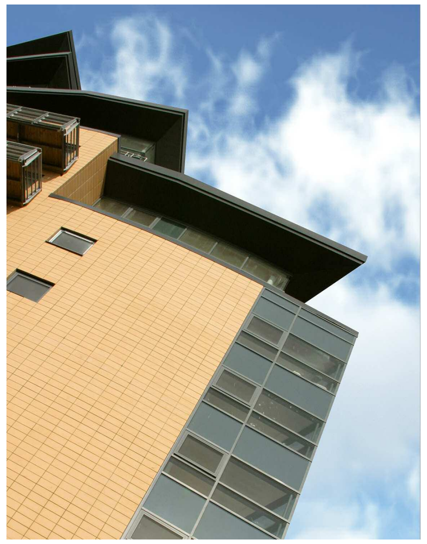
So as we can see, building information modelling (BIM) provides an integrated approach to construction projects so that assets are delivered and maintained as efficiently and sustainably as possible. Largely because of these carbon and cost-saving benefits, the UK Government requires that from 2016 BIM LEVEL 2 is used on all of its construction projects. But how does BIM work in practice?

Construction is a complex process. It requires the coordination of thousands of products and resources; the time of hundreds of individuals and significant financial investment. It is widely accepted that this process does not always work smoothly. Many construction projects suffer from some if not all of a variety of problems such as confused workflows, poor communication, wasted materials, unnecessary expense and squandered time.

One way to mitigate these problems is for the project team to collaborate more closely and communicate more clearly. This is a long-standing viewpoint, and was recommended by Sir Michael Latham in his 1994 report Constructing the Team. Building information modelling (BIM) encourages better teamwork and collaboration by employing a digital system to virtually model the construction project from inception to end of life.

However, although it is based on a digital system able to produce drawings, BIM is far more than computer-aided design. It can also store architectural, engineering and construction information about a project which can be shared among every member of the project team. And the dynamic digital models that BIM produces can be used to refine the design, produce 'what-if' scenarios, detect potential clashes, or validate performance.





But, other than as a sort of digital toolset, BIM is not used at all, a fact acknowledged by the BIM Task Group that is supporting and helping deliver the objectives of the Government Construction Strategy. It points out that BIM is not a technology, but a way of working:

> **It is what you do - information modelling and information management in a team environment".**

BIM models associate information about asset components with geometry which allows the project team to build documentation in a more structured way. The information can be shared by different project participants and at different stages of the design, construction and operation processes.

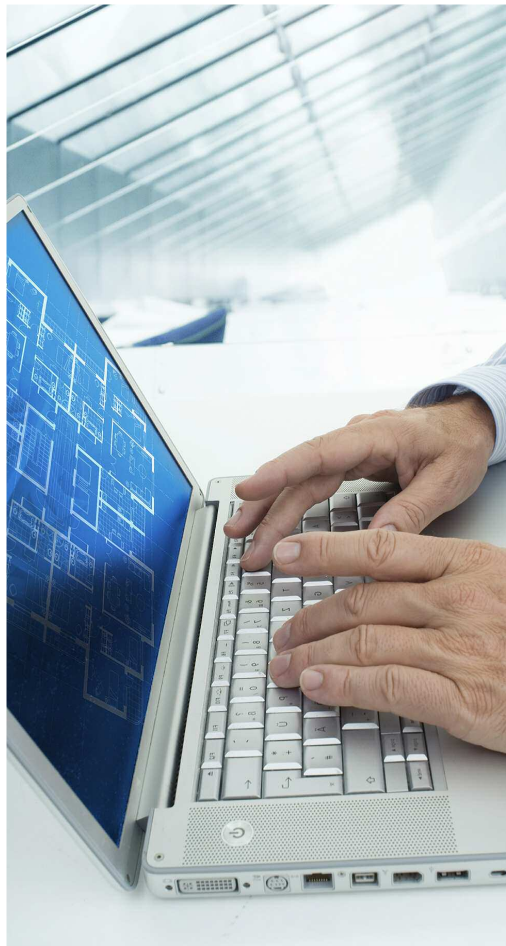
The BIM Task Group offers this example: "An engineer is able to use information sourced from the architect to prepare energy calculations or a contractor can check the co-ordination of contributions from different members of the project team. Programme and cost information can also be captured using BIM."

Most importantly, BIM allows information about the use of the building to be collated and held in formats that can be used by the operators of facilities, enabling buildings and other assets to be used and maintained efficiently.

Different organisations in the UK are at different stages in the implementation of BIM. Some communicate project information in a relatively unsophisticated way, simply employing 2D CAD supported by spread sheets.

At the other end of the scale are those organisations that use a fully integrated collaborative project model covering all key design disciplines and based on IFC (Industry Foundation Class)-compliant data exchange standards and protocols.

The IFC data model is an open, object-based file format designed to facilitate interoperability in the architecture, engineering and construction sectors. It is not controlled by a single vendor or group of vendors. This means IFC can be used to exchange and share BIM data between applications developed by different software vendors without the software having to support numerous proprietary formats.



How BIM works - the mechanism explained

The spectrum of BIM compliance is represented in a series of levels from 0 to 3. A maturity model has been devised to represent this and ensure clear articulation of the levels of competence expected and the supporting standards and guidance notes, their relationship to each other and how they can be applied to projects and contracts in industry.

Defining the levels helps to categorise types of technical and collaborative working to enable a concise description and understanding of processes, tools and techniques to be used.

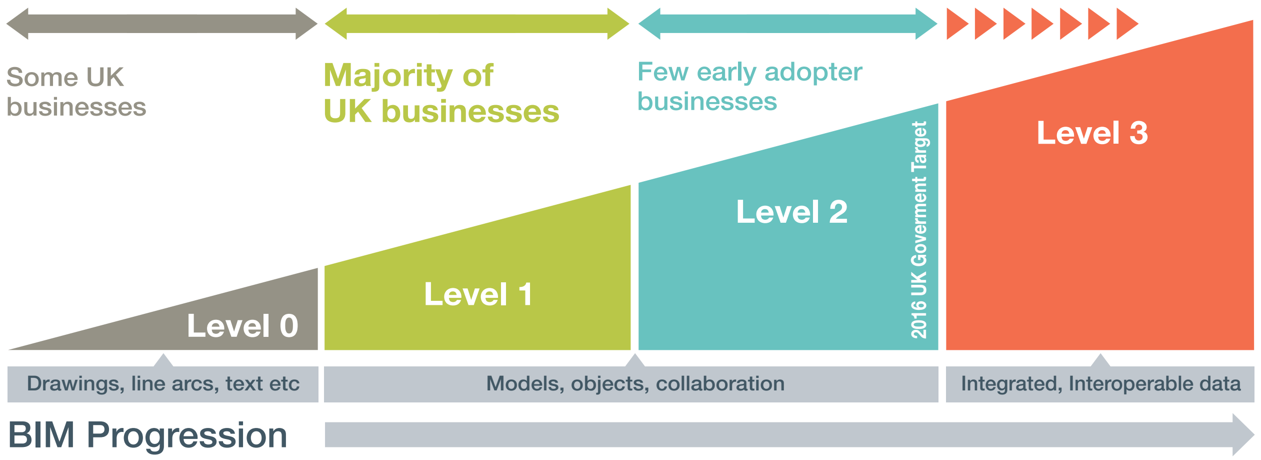
The **levels** are as follows:

Level 0 - Unmanaged CAD, probably 2D, with paper (or electronic paper) as the most likely data exchange mechanism.

Level 1 - Managed CAD in 2 or 3D using BS1192: 2007 ('Collaborative Production of Architectural, Engineering and Construction Information') with a collaboration tool providing a common data environment, possibly some standard data structures and formats. It also includes commercial data management by standalone finance and cost management packages with no integration.

Level 2 - Managed 3D environment held in separate discipline BIM tools with attached data. Commercial data is managed by enterprise resource planning software. Integration is on the basis of proprietary interfaces or bespoke 'middleware', which could be regarded as 'pBIM' (proprietary). The approach may use '4D' program data (modelling to include schedule/programme data and simulations) and '5D' cost elements (modelling to include cost data and simulations), as well as operational systems.

Level 3 - Fully open process and data integration enabled by 'web services' compliant with emerging IFC (Industry Foundation Classes) / IFD (International Framework for Dictionaries) standards, managed by a collaborative model server. Level 3 can be regarded as iBIM (or integrated BIM), potentially employing concurrent engineering processes.

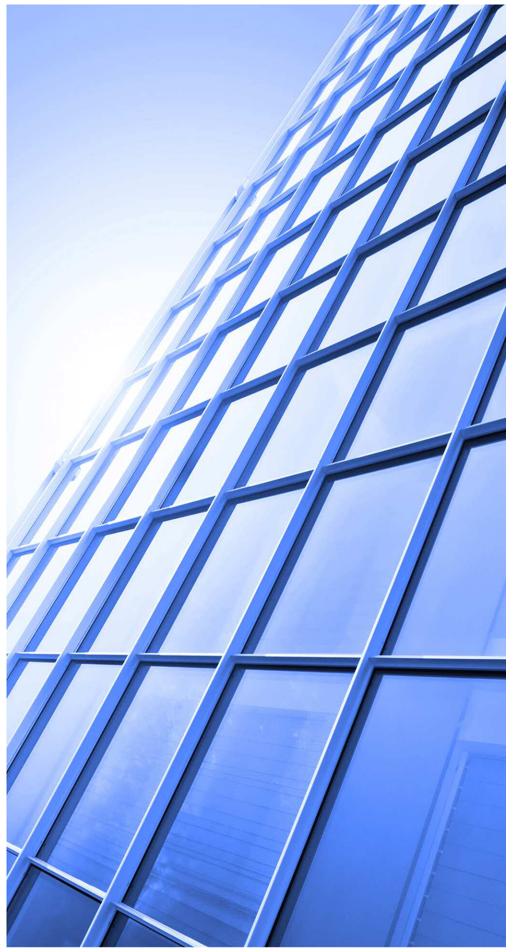


Of course, not all organisations are adopting the new systems and technologies at same time or the same rate; some UK businesses are at Level 0 with most at Level 1 and a smaller number at Level 2.

The Government's target is that work on its construction projects will be carried out using BIM Level 2 - fully collaborative 3D BIM with all project and asset information, documentation and data being electronic - by 2016.

Five dimensions of BIM:

2D	Traditional documentation and 2D drawings.
3D	Space (width, length and height) which enables 3D visualisations and model walkthroughs, virtual mock-ups, prefabrication, clash detection and co-ordination and scheduling.
4D	Time (sequencing) which enables construction planning and management, including scheduling, tracking and phasing.
5D	Cost estimation, including the generation of bills of quantities and calculation of productivity rates and labour costs.
6D	Operational applications such as computer-aided facilities management, data capture (using sensors to feedback and record relevant data) and life cycle management.



BIM and Soft Landings - a recipe for effective partnerships

Sharing information along the entire supply chain and throughout a building's lifecycle eliminates the need to re-enter data and prevents data loss and miscommunication. More importantly, it breaks down the barriers between different disciplines in the project team. Building information modelling (BIM) contributes to these benefits, but it is only part of the solution.

There are many compelling business reasons for construction teams to collaborate closely on projects. As early as 1994 the Latham Report pointed out that as well as helping to minimise carbon emissions and maximise productivity, effective teamwork also results in lower costs and higher quality; less waste and more efficiency; decreased running costs and increased sustainability; smaller energy bills and bigger time savings.

Building information modelling (BIM) can help achieve all these benefits by encouraging a collaborative approach. However, BIM does not have to operate in isolation; at its best, it is part of a bigger picture that also encompasses other strategies for collaborative and efficient working.

One example Soft Landings, a five-stage building procurement initiative developed by research organisation BSRIA and the Usable Buildings Trust. Soft Landings encourages designers and contractors stay involved with buildings beyond their completion. This assists the client during the first months of operation and beyond by helping to fine-tune and de-bug the systems and ensure that occupiers understand how to operate their buildings for optimal effectiveness.

A development process led by the Cabinet Office has resulted in the creation of a version of Soft Landings called Government Soft Landings (GSL) which is designed to cater for the procurement needs of central Government departments.

GSL has also grown out of Whitehall's Construction Strategy, which demands that the interests of those who design and construct a building are aligned with those who subsequently use it. **Like BIM, GSL will be compulsory on Government construction projects from 2016**.

GSL has several guiding principles including:

- Early engagement of end user and inclusion of one or several GSL champions on project team during the design/construction process.
- Commitment to aftercare post-construction from the design and construction team.
- Post occupancy evaluation and feedback to the design/construction team and 'lessons learnt' captured for future projects.

Implementing BIM and GSL in tandem can help to achieve a number of efficiencies, not only during construction but also post-construction and into the early stages of occupation. For example, BIM can help with the implementation of GSL by providing a fully populated asset data set to feed into computer-aided facilities management systems, and modelling will enable planning modifications. The Ministry of Justice, an early adopter of GSL, has reported significant savings (including a seven-figure sum saving on one major project) by using it on many of its projects.

The **five** stages of Soft Landings

- **Stage 1: Inception and briefing** - clarify operational outcomes in the client's requirements
- **Stage 2: Design development and construction** - Review past experience, agree performance metrics, agree design targets, regularly reality-check
- **Stage 3: Pre-handover** - Prepare for occupation, train FM staff, demonstrate control systems, review monitoring strategy of occupants and energy use
- **Stage 4: Initial aftercare** - Support staff in first few weeks of occupation, be resident on site to respond to queries and react to emerging issues
- **Stage 5: Long-term aftercare** - Monitor, review, fine-tune, and perform periodic feedback studies for up to three years to reach performance targets.

If you missed the CPD seminar on Building Information Modelling you can call your Mitsubishi Electric Regional sales office to arrange an in-house presentation of this information.

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