EXECUTIVE SUMMARY

Building information modelling is set to revolutionise the delivery of construction projects. It will help the industry and its clients move from inefficient, often-paper-based information processes within fragmented project teams towards the seamless flow of structured data between collaborators incentivised to deliver whole life value. The technology and, importantly, the associated structures and processes are still being developed, but with the UK government’s 2016 deadline fast approaching, software-as-a-service platforms are likely to form the nucleus for successful BIM collaboration.

BUILDING INFORMATION MODELLING – AN INTRODUCTION

The concept of building information modelling (BIM) is not new, having been around since at least the 1980s, when some architects and engineers began to switch from drawing boards to computer-aided design (CAD). While this change dramatically increased drawing office productivity, the outputs were still largely paper-based 2D drawings – plans, elevations, sections, isometric views, exploded diagrams, etc – and still tended to be shared with fellow team members as paper-based documentation.

In other markets, such as the automotive and aerospace industries, designers had also been switching from manual drafting to CAD. They began to explore 3D visualisation and to relate the outputs of their design processes to manufacturing, designing components that could be accurately produced on computer-controlled machines. ‘Lean thinking’ was also influential and soon the major manufacturers were working closely with their key supply chains, using sophisticated model-based designs to speed up design and delivery of new products to their markets.

In the construction industry, however, things were moving at a different pace, mainly due to the highly fragmented nature of the sector. In the worldwide aerospace industry, for example, there are only a handful of aircraft manufacturers, and they have developed close, long-term commercial relationships with their suppliers. With a history of innovation and a culture of continued investment in research and development, there are high barriers to entry for any company wanting to compete in the aerospace industry.

The global construction industry, in contrast, currently comprises millions of contractors, and many more subcontractors, consultants, materials suppliers and product manufacturers. It is a highly competitive industry in which many businesses work on wafer-thin margins, with little or no investment in research and development. As a result, there is little differentiation between firms; many compete almost purely on price, and only in recent years have we begun to see a small number of major clients looking to develop longer-term partnering or alliance-type framework agreements with key suppliers.

The differences between construction and aerospace or automotive are also exacerbated when one considers the products. Aircraft and cars are produced in a handful of factory environments in large volumes to standard core designs with a relatively limited number of configurations.

1 Alternative abbreviations include ‘Building Information Modelling and Management’ (BiMM), or just ‘Building Information Management’. 
The construction industry’s outputs, on the other hand, are often unique, one-off solutions to a client’s needs, produced specifically for particular locations, and their design and construction can involve an infinite number of variations, often due to the availability of appropriate skills, knowledge, materials, labour, space, etc.

**BIM IN CONSTRUCTION**

It is hardly surprising, therefore, that BIM has developed more slowly than the adoption of modelling technology in other sectors. But, since the 1980s, some construction businesses have expanded well beyond CAD. Reasons include the lower cost and increased processing power of computer hardware, higher bandwidth telecoms links (again at lower cost), wider availability and use of BIM software outside niche disciplines, and the emergence of industry data exchange standards. However, the main catalyst for change in the UK came after the late 2000s global financial crisis when the UK Government began to demand better value for money and better carbon performance from its public sector projects.

Paul Morrell, the Government’s chief construction advisor (2009-2012), had already announced his interest in BIM, but it took the publication of the UK Government Construction Strategy in May 2011— to make the industry realise BIM was no longer optional if they wanted to work for public sector organisations. The UK Government explicitly stated that it aimed to achieve “significant improvements in cost, value and carbon performance through the use of open sharable asset information”, and industry quickly realised that it would need to overhaul more than just its technology if it was to successfully incorporate BIM into its industry practices.

Nonetheless, the initial focus on technology and software was understandable. The introduction of 3D design techniques improved visualisation for project team members, clients, planners and other stakeholders (video walk- or fly-throughs were being laboriously generated by designers in the 1990s, for example). Design disciplines managing particularly complex tasks – structural engineering and building services, for instance – also began to work in 3D, and could merge their outputs to identify potential problems before construction started on site by using them for ‘clash detection’ and other coordination tasks. The introduction of ‘parametric’ 3D design enabled the output of more than drawings and 3D models: an object’s geometrical representation, its physical shape and dimensions, could be augmented by information about its material, cost, colour, manufacturer, etc., and its functional relationship with other components. As designs were amended, so the relationships between items automatically changed.

Clearly, therefore, BIM is more than graphical presentation of geometrical information. Models can incorporate schedule or sequencing information (3D + time: 4D), cost data (5D), operations information, sustainability data, and more, so BIM is often referred to as ‘nD’ modelling. As a result, project managers, surveyors, environmental engineers and facilities managers concerned with programming, cost management, environmental assessment and future operation and maintenance are today learning about BIM.

**BIM FOR LIFE-CYCLE**

The value of BIM value also extends beyond design and construction and into the asset’s lifecycle management, delivering information that the owner/operator can use for facilities management, operations, maintenance, refurbishment or eventual demolition, for example. And, as an
indivisible part of the built asset, digital data will be something that is also liable for modification and expansion as updates, repairs or redevelopments of the physical asset take place. If we liken this to a car’s service history, the owner will keep the manual up-to-date, and, if the modified car is sold, will be able to provide the new owner with a model that remains as detailed and accurate as it was when the original vehicle was purchased.

Moreover, the data about the physical asset will potentially be augmented by additional information about its in-service performance. Just as Formula One racing cars now generate huge amounts of data from every test-drive or race, so data can be routinely collected from, say, an office building showing its energy use, temperature, humidity, heating, lighting, equipment use, etc., over time. Such real-time data will provide constantly updated information for post-occupancy evaluation; BIM can thus be used by the owner-operator to model and evaluate energy efficiency, monitor the building’s life cycle costs and optimise its cost efficiency. As such BIM could also be invaluable to ‘repeat clients’ in informing future design, construction and operation of similar facilities. Similarly, it will provide designers with actual data about the performance of the built asset, rather than them having to make assumptions and undertake model simulations.

LEVEL 2 BIM FOR COLLABORATION

As more information is incorporated into or integrated with the model, so, too, should the professional inputs to the delivery of the asset. Traditionally, different designers separately produced their own designs and associated information, but BIM offers a means for people to collaborate, to share and develop a single integrated model.3 The whole asset can, in effect, be seamlessly constructed virtually, with everyone ‘working off the same hymn sheet’. The UK Construction Project Information Committee, accordingly, stresses BIM is about “creating a shared knowledge resource”:

“Building Information Modelling is 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.”4

However, this vision of a single, shared, collaboratively-authored model holding all information remains distant for most industry practitioners. Accordingly, the short-term aspiration for the UK is that, by 2016, designers, constructors and other project team members working on public sector projects will achieve ‘Level 2’ BIM. In practical terms (according to a June 2011 report to the Government Construction Clients Board on Building Information Modelling and Management),5 this involves collaboration platforms – such as 4Projects – being used as a “data management server” (later also described as a common data environment, CDE) to share and periodically

3 This immediately challenges conventional industry practices where team members were separately appointed, had separate insurances, and were individually liable if something went wrong.


reconciling differences between multiple ‘federated’ model, with 4D construction sequencing and/or 5D cost information held in separate but linked repositories.

It will also take time for BIM knowledge and expertise to extend across supply chains, and for different disciplines to develop tools and procedures to deliver data into their projects’ BIM processes.

A great diversity of proprietary software tools are already commonly used by industry professionals to create, access, view, manipulate and interrogate BIM data, to exchange data between different applications, to run different analyses, to show information on different hardware devices, etc. Some leading software firms will resort to ‘BIM-wash’ and promote their BIM-related products as though they are the only applications needed – and some practitioners apparently believe that using a particular product means they are somehow ‘doing BIM’ – but the current reality is that most professionals will use multiple programs in BIM-related work. Extrapolated across a typical multi-disciplinary project team, the ‘BIM software eco-system’ may involve dozens of programs, not all of which will be able to seamlessly exchange data with each other.

Proficiency in software use and portability of data are only parts of the requirement. Industry professionals will also need to develop working practices within their companies, and then between their companies and other parties involved on projects to manage their inputs to BIM. As 2016 get nearer, some of these procedures and processes are already being developed. Early adopters have begun to modify their internal structures and methodologies to accommodate BIM, and their experiences have informed the government’s BIM Task Group* and associated pan-industry process recommendations – for example, in February 2013 the Construction Industry Council published its BIM Protocol, and the British Standards Institution published PAS 1192-2.7 The latter, in particular, provides guidance on how the common data environment might work, but other structure and process issues remain, such as model ownership, intellectual property, commercial confidentiality, insurance models, forms of contract, early engagement of supply chain members, etc.

**ONLINE COLLABORATION: THE NATURAL HOME FOR BIM**

Of course, BIM technology, structures and processes have not emerged in isolation. Since the 1990s, in parallel, the UK construction industry has been evolving more collaborative approaches to construction product delivery (following exhortations in the Latham and Egan reports, among others, to move towards less adversarial forms of contracting), and it has been at the forefront in the development and adoption of cloud-based platforms to support such collaboration.8 Post-Latham/Egan experience underlined that technology was a cross-cutting issue capable of acting as an enabler or a barrier to collaborative working, but it was a minor issue compared to the people and process issues. For example, it was more important to adapt procurement processes, contracts and associated approaches, and we now have evidence that promotion of collaborative working (eg: in the UK by Constructing Excellence)9 helps team members work towards maximising value for the ultimate owner of the built asset.

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7 Both documents available from the BIM Task Group website: [http://www.bimtaskgroup.org/commercial/](http://www.bimtaskgroup.org/commercial/)

8 Another 4Project white paper covers this topic in more detail.

When Software-as-a-Service (SaaS) tools such as 4Projects first emerged around 2000, there was considerable industry inertia to overcome. Individuals and organisations were often reluctant to move away from tried and tested, largely paper-based forms of communication. Familiar with in-house hosted applications, they were hesitant about outsourcing and entrusting documents, drawings and data to new software providers. They questioned the security and reliability of browser-based technologies, and wondered about the ownership and legal admissibility of electronically stored information, and so on.

However, since 2000, SaaS has become increasingly accepted; the vendors have proved robust and financially viable; their technologies could, as promised, manage data authored by numerous software tools; and their project platforms have also expanded beyond their original document collaboration roles to support complex project work processes, to integrate with back-office tools, and to deliver information via mobile devices (among many other advances). It is small wonder, therefore, that these collaboration systems were identified as suitable platforms to manage the BIM common data environment (CDE).

LEVEL 2 COMPLIANCE – WHAT DOES IT MEAN?

The experience of SaaS vendors in overcoming structural, cultural, organisational and technological barriers to collaboration will also prove invaluable in helping industry make the necessary changes to share BIM data via a Level 2-compliant CDE by 2016.

However, as previously mentioned, adoption of a technology platform is only part of the challenge. Compared to traditional project delivery, clients and other project team members will need to adapt their processes and their peoples inputs throughout the planning, design, construction, commissioning, hand-over and future operation and maintenance of the built asset.

For example, for clients (or owner-operators) commissioning a project, a successful project using BIM will likely involve:

1. definition of the employer’s information requirements (EIR), ie: the information that will ultimately be required from a project information model
2. commissioning a CDE to manage both CAPEX and, importantly, OPEX information
3. early involvement of facilities managers and end-users in project design
4. defining how information models will be used, viewed and kept up-to-date by facilities managers
5. re-using BIM data to add value – for example, creating interactive visitor guides
6. augmenting the building information model by capturing building performance data
For contractors involved in delivering a BIM-enabled project, achieving Level 2 compliance will likely mean:

1. implementation of a BIM execution plan, including file naming and numbering conventions, project processes, agreed standard file formats, etc.

2. enforcing use of the project-wide CDE through documented processes and standards, including use of the CDE to populate, validate and export COBie data

3. PAS1192-2-style workflows for sharing documents

4. provision of model viewing, clash-detection and project planning software to all relevant team members

5. supporting the downstream supply chain in incorporating BIM objects of their products into models.

These lists are not exhaustive, but give examples of how different parties involved in a project will need to collaborate more closely and think in a more integrated, joined-up way about their information requirements. Compared to traditional 2D approaches, it may appear more complex, but the result will be the efficient production of structured data that can then be reused and exploited, and so add greater value than could ever be achieved using conventional information.

4Projects is among the leaders in developing its platform to incorporate BIM capabilities, investing in research and development to support application-agnostic, open-source approaches to BIM collaboration. It is also engaging with industry bodies championing open standards – such as BuildingSMART¹⁰ – and with the BIM Technologies Alliance, looking to maintain high levels of interoperability so that access to data via the browser-based 4Projects CDE remains efficient and reliable, and does not require additional software or plugins.