BIM for Civil and Structural Engineers

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Introduction

Civil and Structural Engineers have a role across the entire life cycle of assets, from project inception and delivery, to operations and eventual decommissioning. At each stage, engineers rely on robust information to support multi-disciplinary decision making and inform activities, whether design, construction or maintenance. Building Information Modelling (BIM) has been high on the agenda of all organizations involved in the planning, design, construction, ownership and maintenance of the built environment in recent years, influenced significantly by government policy. Advocated as the catalyst for solving many of the industry's shortcomings including quality, collaboration and productivity, BIM is swiftly moving from a niche technology-based concept to the basis for the delivery of projects and asset management across all sectors of the construction industry.

With all this enthusiasm and hype, the message for what 'BIM' actually means has the potential to become confused and lost.

The core principle of BIM complements the life cycle role of civil and structural engineers; that information is created and structured as to make reuse by others, whether through collaborating with other disciplines to deliver a particular task, or to support activities as to make it available for reuse by others in subsequent phases of the asset's lifecycle.

This BSI whitepaper provides a high level overview of BIM for Civil and Structural Engineers. As will be explored throughout, BIM has many different meanings to different roles across the lifecycle of assets. We seek to give practical, concise guidance on what we mean when we talk about BIM and how it impacts the role of civil and structural engineers.

Unfortunately, given the diverse perspectives and uses of BIM and the diverse roles of engineers, this whitepaper will not provide any silver bullet for how to 'do BIM', it is instead intended to provide an introduction to some of the common terms and a commentary to navigate this fast-moving field. Throughout this guide we will simply use the acronym 'BIM', later sections will explore differences in definition between *Building Information Modelling* and *Better Information Management*, with a commentary on how this fits into the wider Digital Built Britain strategy[1], part of the industrial strategy for the construction sector.

Overview and brief background of BIM

That people complain of problems in collaboration and poor quality information is nothing new to the construction industry. It has been a regular argument of industry discourse since a 1965 Tavistock Institute report which stated:

> *'The basic conditions of construction control are often incomplete or unduly rushed because necessary information is not available sufficiently ahead of time, or is not complete enough.'*
>
> (Higgin & Jessop, 1965, p. 77)

These concerns surfaced again through the influential Latham (1994) and Egan (1998) reports. The 2002 *Accelerating Change* report highlighted the opportunity offered by Information Technologies to drive better value through an integrated team.

This culminated with the 2011 Government Construction Strategy which announced that BIM would be a requirement for all Government projects from 2016.

The origins of BIM can be dated back to the 1960s with the definition of a Building Description System. The vision was to create a complete virtual representation of a building within a computer system. Unlike traditional Computer-Aided Draughting (CAD), which uses lines to represent the building's features, the BIM approach uses virtual objects which have attributed properties to describe its geometry, materials, performance requirements, etc.

Through the emergence of the World Wide Web in the 1990s, the use of web-based document management systems became common, with distributed teams able to collaborate electronically without having to rely on the postal service to share documents and drawings. Document management systems became sophisticated, embedding processes to support contract management, quality assurance and technical queries, and as result became known as *Common Data Environments*.

1. See www.digital-built-britain.com

The combination of the Building Information Model with a Common Data Environment became known as *Building Information Modelling*, or 'BIM' for short. To achieve the maximum benefits, projects needed to adopt processes for specifying the information uses, standards, software, hardware and management systems, prescribed through a BIM Execution Plan.

Following this, asset owners and operators recognized that projects represent only a fraction of the life cycle of their assets. Asset Information and Facility Management Systems, the databases and processes which support the operation of facilities, should be able to talk to projects, consume information and transition smoothly between asset lifecycle stages through a digital information exchange, rather than a delivery of box files or DVDs full of unstructured data.

This leads to three views of BIM, based on the scope of those implementing it:

- BIM as a technology supporting a task within the project, such as the use of simulation to verify construction schedules;
- BIM as a project delivery methodology facilitating the delivery of a project by providing a means of collaboration between all project team members, providing project information in the right format for those who need it;
- BIM as a lifecycle asset and facility management approach to the creation and exploitation of information supporting operations, maintenance and decision making as well as optimising the project phase.

Although led, technologically, by the buildings sectors, there are examples of BIM applied to all construction project types. As will be detailed in later sections BIM is being leveraged across the built environment leading to smart facilities and asset management and unlocking the opportunity of other digital trends such as Smart Cities[2].

The impact of BIM on Civil and Structural Engineers

Unlike many other disciplines in the built environment, civil and structural engineering comprises a set of skills and competencies that apply to all project types from minor slope strengthening and flood alleviation schemes to vast structures such as tall buildings and multi-span bridges. The variety of roles that engineers take across projects means that there are no hard and fast rules about how BIM is impacting the profession.

However, one that trend can be seen is that the application of BIM for civil and structural engineers varies along two axes. The first is whether the client is a Government department and the second is whether the project is a commercial building or transport and utility infrastructure.

There are examples of BIM applied to all construction project types

2. See www.bsigroup.com/en-GB/smart-cities/

BIM involves all disciplines and professions involved in a project or asset management activity interacting and collaborating via a single source of project information, structuring and presenting data so that others can reuse it.

True BIM implementation requires supply chain wide adoption of the processes, technologies and skills which underpin the approach, the maturity of which varies on a sector by sector basis. Engineers should, therefore, look to their clients, colleagues and competitors to see how BIM is being applied in their market sector (suggestions for where to start are given later in this paper).

This is not to say, however, that civil and structural engineers should wait for supply chain peers to lead the way. There are many benefits to be gained from the adoption of BIM tools and techniques within one's own work:

- integrating analysis and drawing production to improve efficiency;
- 3D modelling to improve quality in terms of coordination and communication;
- a common data environment to improve collaboration within and across teams;
- using visualization to engage non-technical stakeholders during design reviews;
- improve confidence in the design and use the model for prefabrication;
- planning and optimizing the project schedule through simulation;
- monitoring project budgets and spend through linking activity with components;
- using the 3D model to improve site inductions, making safety and risk management tangible;
- maintaining inspection records to monitor asset performance.

BIM as a client-led approach

Suppliers can realize their own benefits from adopting BIM to optimize their processes, but for true life cycle benefits the requirements for project and asset information must be coordinated by the project owner who has the most to gain.

HM Government's view of BIM

In its 2011 Construction Strategy, the UK Government announced it would require 'fully collaborative 3D BIM with all project information being electronic as a minimum by 2016.'

The Government spends approximately £50bn per year as a client and the BIM mandate was just part of a suite of initiatives to improve productivity in its construction supply chain.

Crucially, the BIM mandate was not an industrial strategy. It was a supply chain strategy for the Government as a client to realize the benefits from adopting BIM tools and techniques across the government estate. It applies to central projects, those being procured by ministries and government departments, including the Ministry of Justice, Department for Education, Department for Transport and the Environment Agency.

To facilitate the mandate, the Department for Business Innovation and Skills (BIS) and the Cabinet Office sponsored a programme to develop a definition of BIM which can be written into contracts and is underpinned by standards, known as BIM Level 2.

This was supported by a change management team working with the government departments to develop skills as an 'intelligent client' in the procurement of the information associated with construction services. It also required capability building throughout the supply chain, communicating the new requirements to tier 1 consultants and contractors right through to lower tiers including parts and material manufacturers. Without each of these roles developing the capability to produce information in a structured and consistent way, the vision for BIM could not be realized. The work of the Cabinet Office's BIM team has provided the catalyst and the infrastructure for much wider BIM adoption across the industry.

Government's view of BIM is a lifecycle approach to the creation, management and reuse of information to support the planning, design, construction, operation and maintenance of its portfolio of buildings and infrastructure assets.

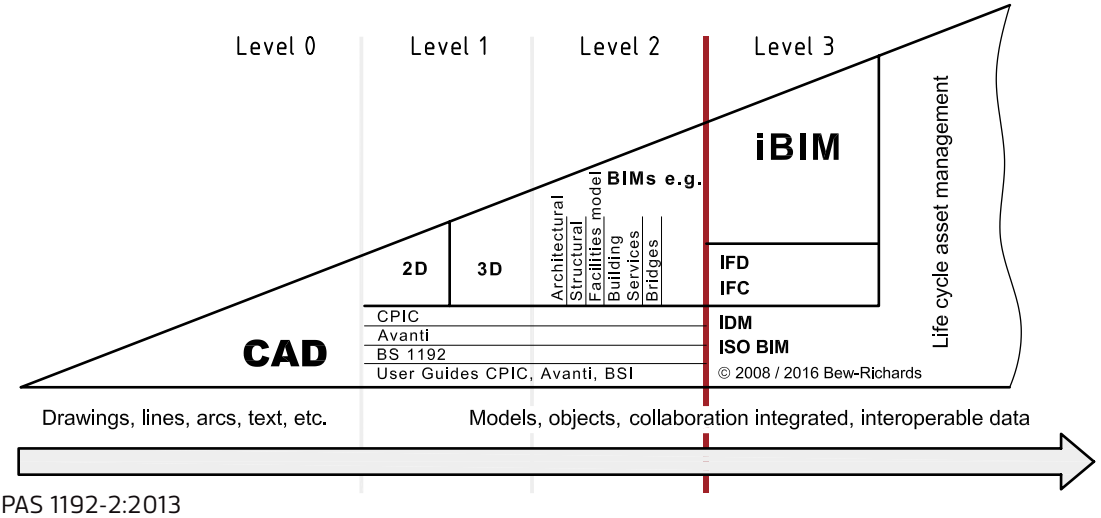
BIM Levels

Coming to a set definition of BIM is difficult and, perhaps, unhelpful. As we continue to innovate, new technologies become available and lessons are learned, the application of BIM will continue to develop and evolve.

However, in order to achieve any change it is helpful to have a vision and clarity over what we're aiming for. The BIM Maturity Model defines BIM in terms of three levels of maturity. Each level is underpinned by standards which cover the management and modelling aspects of BIM. The Government's 2016 target was to achieve BIM Level 2.

Level 0 'Just get on with it'	In a pre-BIM world we use CAD simply as a means of drawing production. Drawings, whether in PDF or printed, are used as the basis for communication and collaboration across teams. Companies may use internal standards for the authoring, management and sharing of information internally, but these are often ad-hoc and may vary by discipline and supplier.
Level 1 'Collaborate'	BIM Level 1 introduces standards for consistent approaches to CAD and 3D model authoring, and sets management practices for collaboration. BS 1192 provides the basis for BIM Level 1, documenting processes for quality control, information sharing, document naming and CAD naming – the basis of the Common Data Environment.
Level 2 'Coordinate'	Coordinating the creation of an information model which combines the geometric elements of an asset in three dimensions with the attribute information usually stored in schedules, bills of materials and specifications, BIM Level 2 provides a methodology for asset owners and suppliers to collaborate through information rather than documents. BIM Level 2 applies equally during capital projects and throughout operations with processes defined for the Project and Asset Information Models and an emphasis on the handover, the 'information exchange', between the two.
Level 3 'Integrate'	The vision for BIM Level 3, is a completely integrated approach to the management of asset and project related data. Information will be seamlessly available to those who need it in a format that allows different stakeholders to reuse information for different purposes. BIM Level 3 starts to make links with other digital innovations like Building Management Systems, Smart Cities and the Internet of Things[3].

Figure 1 – BIM Maturity Model



Source: PAS 1192-2:2013

3. See www.bsigroup.com/en-GB/about-bsi/media-centre/press-releases/2016/july/Internet-of-Things-interoperability-specification-is-published/

The 8 pillars of Level 2 BIM

To support the implementation of BIM Level 2 and, crucially, define it as something that can be written as a requirement in to contracts, the Government sponsored the development of a suite of documents and standards. These represent eight pillars which give a definitive boundary to those seeking to adopt BIM Level 2, underpinned by BSI's BS/PAS 1192 series of standards.

	Pillar	Description	R
1	Defined information management process with information requirements	Two key documents govern the BIM Process. A BIM Execution Plan (BEP) list how will be applied to the project, identifying how information will be modelled and managed, who is responsible for what, the appropriate level of model detail and the amount of asset and attribute information. Clients can pass on their requirements for BIM to suppliers through an Employers Information Requirements (EIR) which ensures separate suppliers follow compatible processes.	PAS 1192-2
2	Life cycle approach to information management with a plan for Operations and Maintenance	Beyond the delivery of the physical asset BIM puts an emphasis on the delivery of the information which supports operation and maintenance and also the business processes and outcomes that the project seeks to improve. The creation of Asset Information Requirements (AIR) and an Organizational Information Requirements (OIR) provide the means of communicating these information needs respectively. Created by the owner operator as part of the organization's business management systems these documents help ensure projects, as well as maintenance activities, deliver the maximum benefits.	PAS 1192-3
3	Standard formats for exchanging information with clients and other suppliers	The power of a PDF document is that anyone, anywhere in the world, can open it. It is a standardized document format which means that you do not need specialist software to see what it contains. As we seek to move from transferring electronic documents to electronic information, we need an open format which supports the transmission of asset data in the same way. Construction to Operations Building Information Exchange (COBie) is the format selected by Government to act as the standard carrier of information between suppliers and clients. COBie is an electronic filebox which, once fully adopted, will support the exchange of building and asset information between any discipline, function and organization type.	BS 1192-4
4	Appreciation and management of information security risks	The more we structure and manage information relating to sensitive assets, the more vulnerable it becomes to those who could use it for malicious purposes. PAS 1192-5 gives the process for a security-minded approach to information management associated with construction and asset management. By following a simple triage process, those responsible for implementing BIM can ensure that they are following best practice information security management.	PAS 1192-5
5	3D Models with associated data. Level of model and information development defined for each work stage	The information model is at the heart of the BIM process. Different roles within projects and the asset lifecycle have different needs and uses for information. The creation of information can be an expensive activity, however creating too little information can be even more expensive as poor decisions are made and information must be recreated downstream. By defining a level of definition for both the 3D model and the non-graphical information that accompanies it, engineers can ensure the right amount of information is created at the right time to deliver the maximum lifecycle benefits.	Digital Plan of Works

Continued

	Pillar	Description	R
6	Consistent way of naming and classifying assets, elements and activities	What we call a tap in the UK, they call a faucet in the USA. As humans we are good at understanding the background of different people, appreciate that we use different words for the same thing and can make the logical connection. Computers aren't so clever. A classification system provides a common language across disciplines and organizations so that different data sets can be linked to create additional value. The creation of a 4D construction simulation can be a laborious activity with someone creating the links between a construction schedule and a 3D model. Using a common classification system can make this process much simpler as the computer automatically makes the connection.	Uniclass 2015
7	Engagement of client, users and maintainers throughout design to ensure facility meets needs	How can clients be sure the project will deliver what they expect it to do? Or how can suppliers be sure that they've fully understood what the client wants? The visualization capabilities of BIM models mean that non-technical stakeholders can be much more engaged with decision making and design review. Simulation can test whether the project will do what it needs to do from and operations and maintenance perspective and that the right information is available for it. This part of the process has been badged as 'Government Soft Landings' and is about making the transition from the project to operations as smooth as possible.	BS 8536-2
8	Contractual basis for the BIM approach	Through client-led BIM, the client is no longer just buying a building, bridge or power station, they are buying the data supporting better decision making during the project and throughout its life. The increased importance of information puts increased value on the process and the parties involved need to make sure they are secure from a contractual perspective. The CIC BIM Protocol can be appended to all contract forms, confirming the liabilities, responsibilities and intellectual property rights of the contracting parties.	CIC BIM Protocol

BIM in the Private Sector

Since the Government's announcement of its BIM strategy, many in the non-government public sector (such as local authorities) and private sector have seen the vision and also mandated BIM. Some view the full definition of BIM Level 2 as too onerous, adding an unnecessary layer of bureaucracy which is incompatible with the project objectives. For those with such views the PAS 1192 standards provide the basis for BIM implementation, but the scope or application of BIM is lighter with people selecting the requirements that best suit their needs.

This is completely valid as different organizations have different objectives and operating models. However, as a client requirement, there is no accepted definition of BIM Level 2 beyond the eight pillars described previously. Clients wanting suppliers to apply BIM principles to their projects must therefore be specific as to how they expect BIM to be used and managed, and what they are willing to pay for.

BIM in different project types

BIM is applicable to all forms of construction. Good information governance, leveraging the latest technologies and optimizing processes is sound business practice. However, the focus in different project types is notable and can be drawn, crudely, down the line of the difference between building projects and transport and utility infrastructure projects.

The owners of buildings acquire an estate to operate a business model or service using the building as a platform to facilitate their operations. The operation of the building is secondary to business operations.

BIM is applicable to all forms of construction

For infrastructure owners the operation of the asset is the business model. The availability of a transport network or a utility system is the value that the system creates, it allows others to operate their business models and for society to function.

Although quite an academic observation, this difference between the focus of different owner types has led to fundamental differences in the priorities for BIM implementation.

BIM for building design and construction

Building projects involve the intricate coordination of a myriad of structures and services, wrapped within an architectural design, which facilitate the use and operation of the building. Since its inception, BIM in the buildings sector has been about coordinating and communicating the design and leveraging the model to optimize construction through simulation and better management of site activities.

With each discipline creating a 3D model of their part of the project, coordinating this with others and using this same model as the basis of drawing production quality and coordination during construction is dramatically improved and the requirements for rework and risk are reduced.

The constrained nature of building sites means that the logistics that support the project are vital to a smooth delivery. Any delay can have major repercussions on other activities and trades. The simulation of construction, including temporary works better coordinates the dynamic nature of the construction programme.

The focus of BIM in buildings is in optimizing the delivery of projects and making the handover into operations smooth.

BIM for infrastructure – An asset management approach

Infrastructure owners have very mature estates, typically spending only 1–3 per cent of the asset value on capital works each year, of which the majority is expenditure on major maintenance or upgrades rather than building from fresh.

Within infrastructure owning organizations sophisticated asset information management systems are employed to manage estates. However, the operations and projects parts of such organizations have historically been segregated with the interface being facilitated by a not-so-smooth handover process.

BIM for infrastructure owners has become 'Better Information Management' across the asset lifecycle, with a big focus on orienting projects to deliver the information to support asset management and being smarter about the exploitation of information through operations and maintenance.

'Building' has proved to be a language barrier for those involved in infrastructure projects. Rarely does a project involve a building and if it does, it is secondary to the function of the infrastructure it serves (e.g. a railway station). Secondly, infrastructure projects, particularly minor upgrades, are rarely complex enough to justify the effort required by 3D modelling.

Projects will be more efficient, project delivery can be improved through virtualization of the planning process and impact on service can be better managed, but the big prize for BIM is asset management.

In summer 2016, the UK Roads Liaison Group and the Department for Transport published a guide for infrastructure owners on the implementation of BIM. This guide emphasises the focus on BIM as promoting creating and exploiting information and translates the BIM Level 2 standards into a language suitable for infrastructure bodies. BIM Level 2 is fundamentally applicable to all asset types, but switching the terminology from modelling to information management has subtle but significant impacts on the focus of the BIM implementation.

Integrating BIM into the civil and structural engineer's role

As we have tried to make clear throughout this whitepaper, BIM is not a silver bullet. There is no easy answer to 'what do I have to do?'. Each person has their own part to play in the delivery of a project and therefore has a different role in the BIM process.

In this section we briefly discuss some of the different technologies and processes associated with BIM to give you some indication of how your role may be improved by adopting BIM and the types of tools which are supporting the project lifecycle.

Technology/tool/process	Description	Project Role
Three Dimensional Design	An engineering design consists of a geometric representation and schedule of material properties. These are determined and validated through analytical models. Modelling in 3D (as opposed to two dimensional draughting) with the schedule information embedded against objects in the model and linked to the analytical model closes a loop to maintain a consistent and accurate record of the design.	Designer
Automated drawing production	With the design existing in a 3D model, BIM tools can accelerate the drawing production process. Taking snapshots from the 3D model automatically updates plans, elevations and sections. Similarly, schedules can be automatically produced. Following this approach any changes to the BIM model are automatically reflected in drawings and schedules.	CAD Technician
Clash detection	In BIM Level 2 each discipline creates and manages its own 3D model. The process of clash detection ensures that the different models are coordinated to avoid potential problems during construction. It is also possible to detect 'soft clashes' where there isn't a physical clash, but where the proximity of interfacing assets could cause a problem during maintenance, etc.	Design Manager
Visualization	Presenting an interactive 3D model contextually situated using photo-realistic models of the real-world provides a much more engaging means of carrying out consultation with clients and the public than engineering drawings.	Design Manager

Continued

Technology/tool/process	Description	Project Role
Laser Scanning	Laser-scanning, or LIDAR, combined with detailed photography to create a 3D point-cloud provides a much richer representation of the real-world than the traditional topographic survey, reducing the need for exploratory site visits. The Scan-to-BIM process creates accurate 3D BIM models from the point cloud, but often the point cloud itself is sufficient as a contextual tool without the manual conversion.	Surveyor
Common Data Environment	A single source of project information through a common data environment is a useful tool for collaboration. Real value is realised with the inclusion of workflows for document approvals and audit trails for when decisions were taken and by whom.	Quality Manager
4D Modelling	By combining the 3D model with a construction programme the planner can validate the schedule to mitigate schedule clashes and resourcing errors. There are several 4D BIM tools which allow the planner to build a construction programme based on the 3D model, ensuring nothing is forgotten.	Planner
5D Modelling	A 5D model brings together the 3D model with the cost schedule. Three dimensional objects in the model allow the computer to calculate volumes and dimensions for the basis of calculations. Combining the 4D and 5D models allows the estimator to visualize the spend profile of a project	Estimator
Simulation	At a finer level of granularity the 4D model can be enhanced to simulate the construction sequence so that the model represents a digital dress rehearsal of the construction activity. Plant and materials can be modelled and animated to plan for logistics issues and as the basis of an engaging briefing for workers.	Site Supervisor/ Engineer
Mobile devices and forms	Tablets and smart phones negate the need to carry around large paper drawings and fill out quality forms on site. A device connected to the Common Data Environment can access and save information directly into the central database. Quality assurance, risk assessments, material records can all be instantly transmitted and the managers can have a live view to make sure the processes are being followed correctly.	Quality Manager
Information Exchange	At the end of the project, when all the work is done, nobody likes to hang around and fill in all the paper work, ship it to a client and manually update asset management databases. Following a BIM approach, a basic design model being added to throughout detailed design and construction with in-built quality checks makes the handover process for the health and safety file much smoother through a digital information exchange.	Design Manager

Contractual issues

One of the biggest issues faced by engineers trying to 'do BIM' is the contractual side of specifying and paying for deliverables. Whilst a promise of BIM is to reduce risk and cost across projects and the asset life cycle, BIM is not entirely free. It should instead be seen as an investment which pays for itself. BIM requires more effort earlier in the process, for designers this can mean time spent setting up models for speeding up drawing production and for the overall project it can be more time spent on ensuring that information is accurate and in the correct format. A contractor should not expect to get more value from the designer in a design and build a contract without understanding this 'left shift' in costs. Similarly, BIM is a collaborative process where information is provided for reuse by downstream users. If no guidance is given as to the structure or format that information should be provided then it leaves people making wild guesses.

Suppliers being asked to 'do BIM' without any further guidance, should inform the client of the need for an Employers Information Requirements (EIR) and a BIM Protocol appended to contracts, specifying exactly what the anticipated

BIM can unlock the potential of smart cities and the Internet of Things

outcomes are and defining any specific requirements. It protects all parties, making sure fair payment and that deliverables are received as expected.

The process of devising the EIR can feel painful, it poses both strategic and very detailed questions, but the benefits are felt unanimously. Suppliers are able to set up their processes with the confidence that they will please the client and there will be no nasty surprises downstream when technologies, processes or expectations prove incompatible.

The future of BIM

The exploitation of emerging technologies, reapplication of best practice and capability in the creation and management of information will continue to develop.

The unbounded problem of 'what is BIM?' and its remit encroaching on many other parts of the delivery of assets has led to the term *digital* becoming a fashionable alternative to differentiate all the other things we can do with new technology from the core of BIM Level 2.

Through the Digital Built Britain Strategy (supported by £15m in funding announced in the 2016 Budget), Government is continuing to push forward with its supply chain strategy to unlock value from its estate. Digital Built Britain includes activities for developing BIM Level 3 and maintaining the UK's global position as thought leaders in BIM and sets a vision for how BIM can unlock the potential of Smart Cities and the Internet of Things.

The recently formed UK BIM Alliance is a cross-institutional group set up to coordinate all the activities relating to BIM Level 2. The group has an ambitious target that BIM Level 2 will be embedded as business as usual across 75 per cent of the construction supply chain by 2020 and will continue to develop the guidance, standards and templates required to enable the transition to BIM to be as smooth as possible. This includes working across the buildings and infrastructure sectors to create a common language for naming what we do so that knowledge can travel across traditional discipline and sector-based boundaries.

In 2017 a new standard will be published by BSI, PAS 1192-6 will provide guidance on the use of BIM to support health and safety management.

The best way to find out about BIM is to try and do it

Where to get started?

- The BSI website[4] hosts the BIM Level 2 standards as freely available downloads. This should be the first place to start with understanding what is involved with BIM.
- There are many freely accessible online resources which discuss BIM in plain language theB1M.com, BIMplus.co.uk, and even Youtube are great places to start.
- Each part of the UK has a BIM Region, these provide a local point of contact for knowledge exchange around BIM.
- For most sectors, there is a BIM4 Group, these work towards developing the specifics of BIM implementation for their sector and represent these needs to the UK BIM Alliance.
- There are many courses, conferences, seminars and presentations where you can learn best practice and find out about the latest developments.
- Give it a go. The best way to find out what BIM is, how it works and how you can get benefits is to try and do it in anger. Each role and discipline will have a different relationship with BIM and what it means to their jobs, working out what this is can only really be understood through practice.

Conclusions

BIM, whether Building Information Modelling or Better Information Management, is here to stay. The Government's BIM Mandate has achieved far beyond its remit as a client strategy to begin the process of transforming an industry that is typically reluctant to change.

Civil and Structural engineers, whether involved in design, construction or maintenance, have a lot to gain from the better exploitation of technology, collaboration through information sharing and embracing good practice.

Unfortunately, there are no hard and fast rules about what BIM will involve for the individual, by its nature BIM is a group level process and requires everyone to adopt the right tool and process to suit both themselves and the team. Owners, client organizations and suppliers can have conflicting aims, BIM requires negotiation between these parties to determine the most appropriate methods on a project-by-project basis.

The principal factor to consider is that we no longer create information just to help ourselves do our own job; we create information so that other people can find it and reuse it for their job too.

4. See www.BIM-level2.org

BSI is grateful for the help of the following people in the development of the white paper series.

Author

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Tom leads the company's Digital Highways strategy and has experience as a BIM Manager on a range of civil engineering and infrastructure projects and programmes for local and national clients. He sits on the Institution of Civil Engineers BIM Action Group and the PAS 1192-2 Steering Group and regularly speaks on BIM for institutional and university groups and is a co-founder of dotBuiltEnvironment. In 2017, Tom will complete his Engineering Doctorate in BIM for infrastructure project delivery at Bristol University.

Peer Reviewers

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John Lane is a Civil Engineer with more than 40 years' experience. His career spans from 1970, commencing with the design, construction supervision, and maintenance, of highway projects. He subsequently specialised as a bridge engineer and from 1980 to 1999 worked for UK Consulting Engineers on the design, construction and maintenance of bridges. In 1999 John moved to the UK Transport Research Laboratory where he was Department Head with responsibility for the management of bridges and ground engineering research. Since 2003, John has been the Structures Engineer for the Standards Directorate of the Rail Safety and Standards Board (RSSB), where his responsibilities include the drafting and review of technical standards, and the provision of technical direction for research into structural aspects of the railway infrastructure.

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About BSI Group

BSI (British Standards Institution) is the business standards company that equips businesses with the necessary solutions to turn standards of best practice into habits of excellence. Formed in 1901, BSI was the world's first National Standards Body and a founding member of the International Organization for Standardization (ISO). Over a century later it continues to facilitate business improvement across the globe by helping its clients drive performance, manage risk and grow sustainably through the adoption of international management systems standards, many of which BSI originated. Renowned for its marks of excellence including the consumer recognized BSI Kitemark™, BSI's influence spans multiple sectors including aerospace, construction, energy, engineering, finance, healthcare, IT and retail. With over 70,000 clients in 150 countries, BSI is an organization whose standards inspire excellence across the globe.

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