

Introduction

The birth of BIM

Building Information Modelling (BIM) sits at the heart of digital transformation across the global economic and social infrastructure sector. For the construction industry, a major part of the UK economy, it provides a critical opportunity to significantly improve performance.

As a core element of the UK Government's Digital Built Britain strategy, BIM should also eventually help citizens to make better use of the transport, water, communications and energy infrastructure already in place and help to boost value from the investment made in sustaining those assets.

Essentially BIM involves the use of digital tools to collaboratively manage information and data across the entire life cycle of built environment assets. It is a process, enabled by technology, that focuses on outcomes and derives value from open, sharable asset information. It is a way of working, not just an application.

At its core BIM uses 3D models with attached data and information to connect and share information efficiently across the supply chain and so boost the efficiency of activities around asset delivery and operation. By helping the entire supply chain to work from a single source of information, BIM reduces the risk of error, maximises the project team's ability to innovate and drives efficiency, transparency and productivity.

And if the project information isn't shared or repurposed then it isn't truly a BIM process.

According to the UK Government's later construction benchmarking report, the BIM programme has been a major contributor to the combined record industry savings of £2.2bn between 2013 and 2015. Having contributed to meeting the 2011 Government Construction Strategy (GCS) target of saving 25% on the cost of public sector capital projects, BIM is recognized as a significant tool to help the industry to continue to drive down cost and increase value for money and will contribute to the forecast efficiency savings of £1.7bn over the course of this Parliament, as set out by the latest 2016–2020 GCS.

At the industry's leading edge, there are companies which have the capability of working in a fully collaborative 3D environment, so that all of those involved in a project are working on a shared platform with reduced transaction costs and less opportunity for error; but construction has generally lagged behind other industries in the adoption of the full potential offered by digital technology. Construction Strategy 2011, Subclause 2.29

The purpose of this Guide

This guide is intended to help construction industry professionals, suppliers, clients and asset owners/operators understand and adopt all aspects of Level 2 BIM; a level of BIM maturity defined as embracing "file based collaboration and library management" in the delivery of assets.

The goal is to help construction professionals and clients to build business strategies and plans that capitalize on the benefits offered by these processes.

Each chapter in this guide is designed to help the UK industry understand how BIM Level 2 – specifically the use of 3D models, data and collaborative working – can drive greater performance from asset delivery and operations teams, and so derive greater value from across the capex (capital expenditure) and opex (operating expenditure) life cycle of assets.

The guide also demonstrates how clients have complied with the UK Government’s mandate for the use of BIM Level 2 on public sector projects, and explains what steps can be taken to deliver greater levels of BIM-enabled information exchange, both on new projects and programmes and in connection with the operation of existing asset portfolios.

It is also expected that the guide will help the UK construction supply chain to accelerate the wider adoption of Level 2 principles and so embed the thinking and technology into the supply chain’s business operations.

Who is this guide aimed at?

The guide is aimed at construction professionals at all management levels and from across the entire construction supply chain infrastructure. This includes representatives of businesses and organizations on both the supply and demand side of the construction industry.

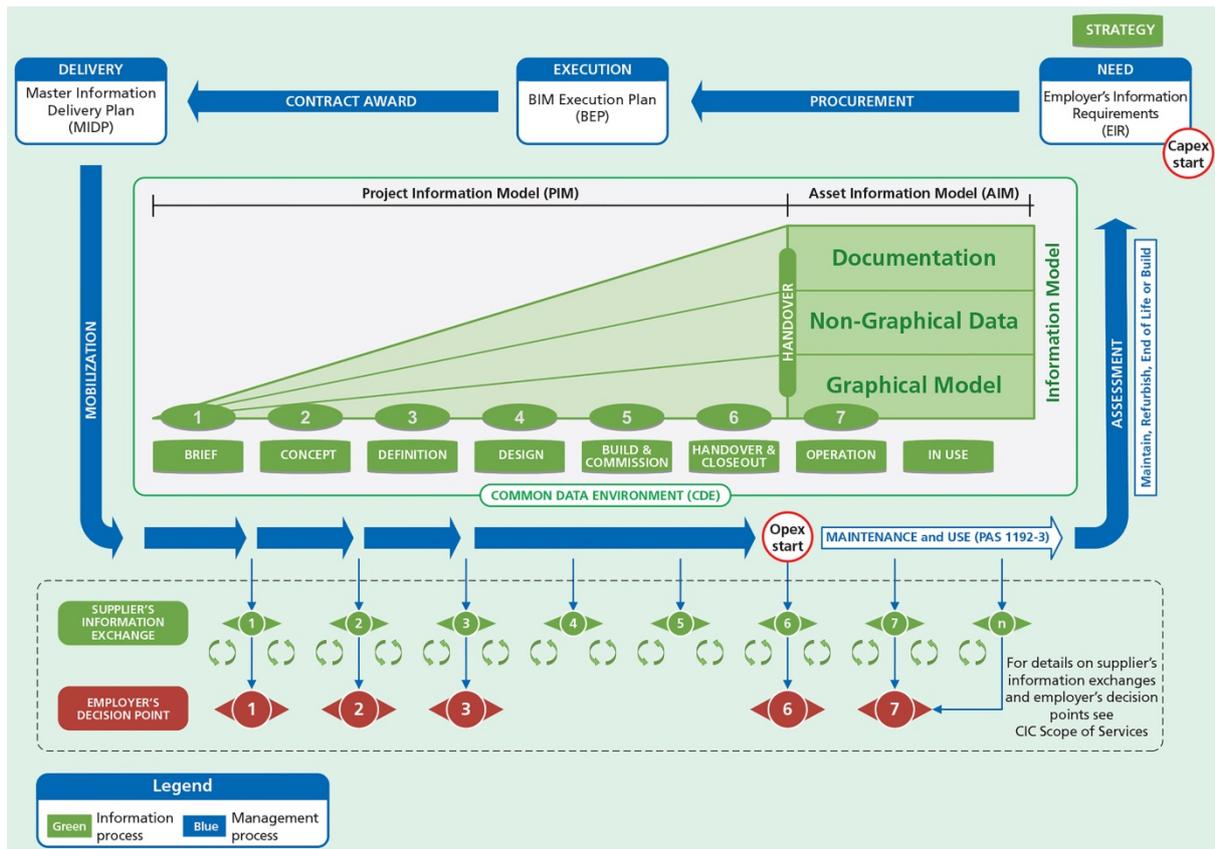
Broadly these professionals fall into four groups:

- **the designer/constructor** user, usually a supplier, tasked with answering to a brief provided by the client;
- **the client/adviser** user, primarily concerned with procurement of services and the final asset;
- **the manufacturer/supplier** user, involved in the delivery of component parts of a project; and
- **the operator** user, responsible for on-going management and operation of the completed asset.

For these users, the guide will provide authoritative explanations of the documents that underlie Level 2 BIM, and allow them to quickly access other core documents and worked examples of how to use them.

Sustained leadership from central government is crucial to maintain industry commitment to invest in BIM capability.

Government Construction Strategy 2016–2020, Clause 23



The information delivery cycle, PAS 1192-2:2013

How do I use this guide?

This guide is intended as a definitive statement of the application of Level 2 BIM to projects and programmes for buildings and infrastructure. It sets out the practical steps that need to be taken to deliver BIM Level 2 so that the objectives of the UK BIM initiative, as set out in the latest Government Construction Strategy, can be met.

It sits alongside, and is consistent with, the requirements of published standards and helps to describe how the component parts of BIM Level 2 relate to client needs and how they are implemented consistently and effectively.

As a digitally-led guide, it enables users to easily browse the content but also to use it as the means to uncover a range of additional background material and case studies.

This content will include topics such as the use of Level 2 processes and tools and their impact on operational management and capital delivery of assets. It will also explain how best to embed BIM Level 2 into project and programme briefings and will demystify the classification and management of data during procurement

This centre of knowledge will serve as a springboard for further discussion and development of ideas across the BIM value chain.

By using the guide, professionals across the breadth of the supply chain should clearly understand:

- the purpose and scope of BIM Level 2;
- the purpose of and relationships between key BIM Level 2 documents and tools;
- the processes used to implement BIM Level 2, described in sufficient detail to enable clients and suppliers to tailor a Level 2 compliant solution to their project needs and to describe their requirements to their suppliers; and
- BIM Level 2 processes in sufficient depth to promote them as a value-adding project solution to clients and their suppliers.

Background to BIM

The UK Government's Construction Strategy 2011 challenged the industry's existing business models and practices and demanded that adversarial cultures were replaced by collaborative ones; delivering cost reduction and innovation within the supply chain, rather than simply driving down cost through the bidding process.

Construction, it said, under-performs in its ability to deliver value and fails to invest in measures to boost efficiency and growth. The strategy (GCS 2011, 1.9) states:

For the construction industry, the most compelling benefits arising from this strategy lie in the immediate prospects for improved growth and in increased competitiveness: in eliminating waste and inefficiency and stimulating higher levels of innovation that will make construction more affordable for customers at home and create new opportunities abroad.

Procurement reforms were crucial, it added, to reverse the lack of integration, standardization and product repetition in the market, and embracing BIM and the collaborative 3D information environment was central to driving forward the necessary reforms.

The use of BIM processes allows access to more accurate data on the design, construction and operation of assets earlier in the project when changes in the design will cost less and have the greatest impact on the overall project outcome.

The majority of departments have already met the requirements for BIM Level 2 and the remaining departments are on target to meet the 2016 mandate. The task now is to consolidate and embed BIM Level 2 throughout departmental processes. Government Construction Strategy 2016–2020

As such, the UK Government set out a ground-breaking new mandate; “to require fully collaborative 3D BIM, with all project and asset information, documentation and data being electronic, as a minimum by 2016” (GCS 2011, 2.32).

A staged plan to achieve this BIM Level 2 adoption was published with mandated milestones showing measurable progress at the end of each year.

The Construction 2025 challenge to embrace BIM

The use of BIM is central to delivering the UK government's latest vision for Construction 2025, which highlights that while industry and Government has "made a good start through their joint commitment" to the BIM programme, the "challenge is significant and opportunity vast".

Only through the implementation of BIM, it adds, will the UK meet its target to create more sustainable buildings, more quickly and more efficiently, and move successfully towards its wider offsite manufacturing strategy.

The Construction 2025 vision places BIM at the core of its Smart action to create an industry that is efficient and technologically advanced and commits the UK to:

- "Build the UK's competitive advantage in smart construction and digital design through the Digital Built Britain agenda.
- Work with academic and research communities to bring forward more research, development and demonstration to the wider industry and work to remove barriers to innovation." (Construction 2025)

The UK Government target to mandate the use of BIM level 2 by April 2016 has now been supplemented by a new "stretch target", requiring public sector clients to electronically validate BIM data from suppliers by October 2016.

This new target will focus industry attention on the need for validation as an important part of good information management and a key part of Level 2.

Lower costs

33%

reduction in the initial cost of construction and the whole life cost of built assets

Faster delivery

50%

reduction in the overall time, from inception to completion, for newbuild and refurbished assets

Lower emissions

50%

reduction in greenhouse gas emissions in the built environment

Improvement in exports

50%

reduction in the trade gap between total exports and total imports for construction products and materials

Setting global standards

The UK Government has set out a strategy to embed the use of BIM in its domestic programme of construction activity and, by taking the lead in the public sector, expects to see major productivity and efficiency gains across the entire public—private infrastructure sector.

As a result, the UK is now recognized as the leading nation in the use of BIM technology and processes. The on-going government led programme is internationally respected and BIM is recognized as key to driving economic growth in both domestic and international markets.

However, other countries are now rapidly adopting BIM – as evidenced by recent action by the governments of France and Germany to establish new strategies to standardize and promote the use of BIM across their built environment.

Thus to maintain its leading position, the UK has to continue with the process of BIM adoption across the supply chain towards fully integrated BIM, but also take on a global leadership role in BIM exploitation, BIM service provision and BIM standards development.

Central to this global leadership is the BS 1192 standard for the use of BIM, which is intended to help the UK industry accelerate its adoption of BIM, as well as to underpin the UK's ambition to be a global leader in the exploitation of this technology and supplier of BIM services and software.

The [Construction] Strategy [2011] also challenges industry business models and practices. It will replace adversarial cultures with collaborative ones; and will demand cost reduction and innovation within the supply chain to maintain market position Government Construction Strategy 2011

The levels of BIM adoption across the industry and sectors

A BIM maturity model has been devised to clearly explain the varying levels of competence expected, processes required and to highlight the supporting standards and guidance notes that accompany the strategy, their relationship to each other and how they can be applied to projects and contracts in industry.

The different levels can be summarised as:

Level 0 – use of 2D CAD drafting with paper-based or electronic print information and data exchange.

What does this mean to me? Traditional ways of working enhanced only by technology to speed up the production and exchange of drawings. All changes, checks and interfaces across disciplines are manual.

Level 1 – use of a mixture of 2D or 3D CAD backed by a common data environment for electronic sharing of drawings and data with a standardized data structure and format managed to BS 1192:2007+A2:2016.

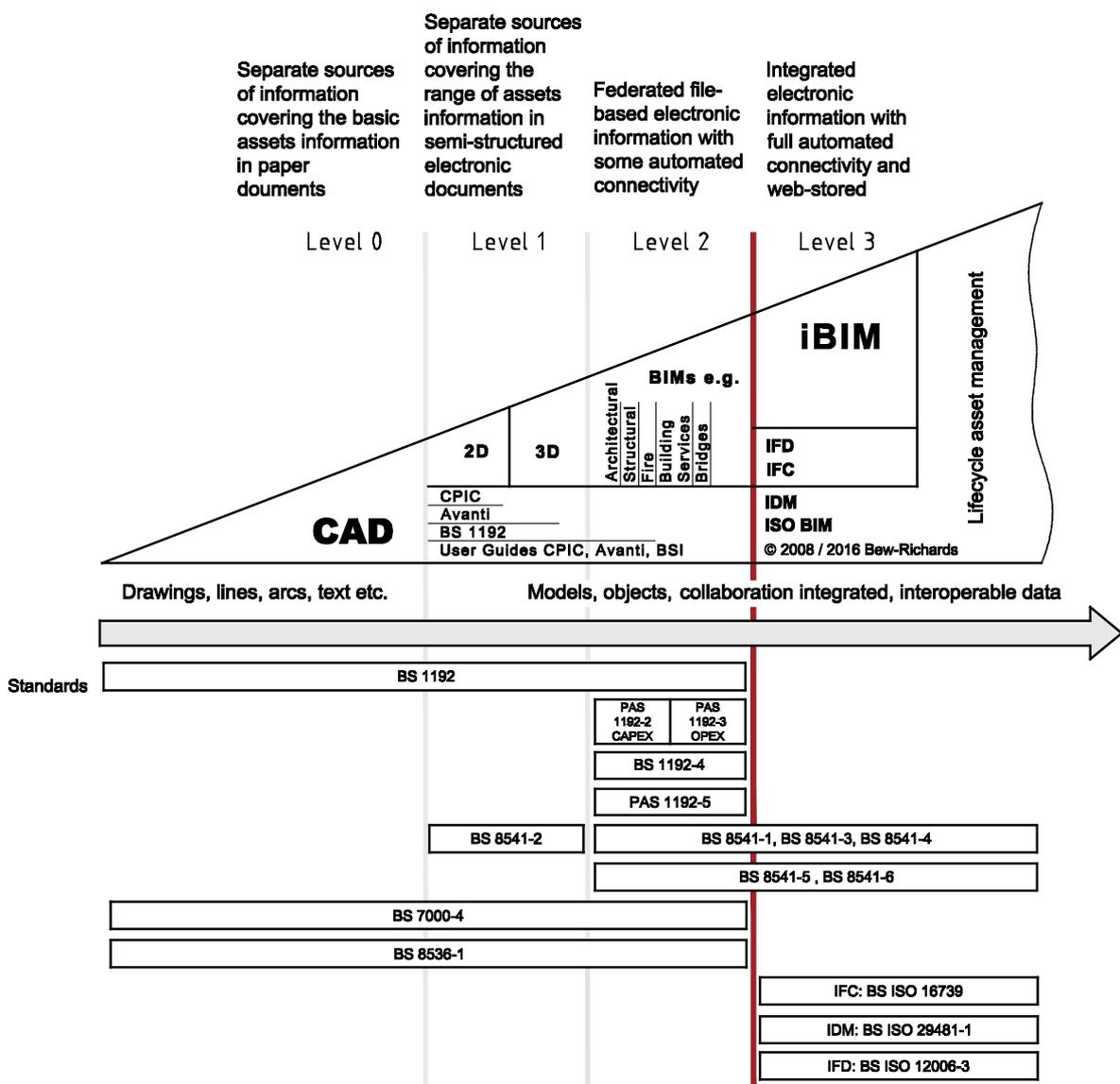
What does this mean to me? Collaboration is limited between disciplines with each controlling and issuing its own information either as 3D models or 2D drawings derived from those models.

Level 2 – collaborative working across disciplines with all parties using 3D BIM models, integrated but not necessarily shared. Design information is shared through a common file format such as IFC (Industry Foundation Class) or COBie (Construction Operations Building Information Exchange).

What does this mean to me? Clients will have to be able define and use data and the industry will need to adopt common ways of working based on standard data file formats. All parties will embrace collaborative working and use 3D, data-loaded models to integrate and exchange information.

Level 3 – fully collaborative working across all disciplines using a single, shared project model held centrally and accessible to all to modify and share data.

What does this mean to me? All disciplines and contributors to a project will be able to access, modify and transact using a single, shared project model, held centrally, which would remove the remaining risks of conflicting information and support the development of whole-life approaches.



Maturity wedge model

BIM level 2 mandate – an enabler for UK industry transformation

The UK Government's Construction Strategy 2011–2015 embraced the use of BIM, and set out its mandated requirement for fully collaborative 3D BIM on centrally procured government building and infrastructure construction projects by 4 April 2016. BIM Level 2 was developed specifically to meet this mandate.

The latest GCS 2016–2020 builds on this mandate. It states that to realise the full benefits of BIM Level 2, departments need to “develop the skills, experience and capability around BIM” (GCS 2016, 23).

To support this ambition, new measures are being developed that will require centrally funded government departments to provide “clear and complete” Employer's Information Requirements (EIR) with all contracts, to enable departments to derive further benefits from BIM by 4 April 2016.

Underlining its on-going commitment to leading implantation of BIM, the Government has adopted a progressive handover, concluding with departments fully utilizing level 2 and having the ability to electronically validate BIM information delivered from the supply chain.

“Sustained leadership from central government is crucial to maintain industry commitment to invest in BIM capability,” says GCS 2016–2020, highlighting that the Government will continue to capitalize on advances in digital technology to deliver construction projects more efficiently using BIM and through improved insight into construction related data.

The goal is to challenge existing industry business models and practices and drive greater collaboration, efficiency, innovation and value across all elements of the industry.

Utilizing digital technology has been shown to facilitate collaborative approaches to drive innovation and reduce waste in the construction industry. BIM is key to driving the required cultural shift towards achieving this greater collaboration and efficiency.

- At the planning stage it enables designers, owners and users to work together to produce the best possible designs and to test them in the computer before they are built.
- As an enabler for the Government Soft Landings policy to improve user and stakeholder understanding enabling improved outcomes over the asset life cycle.
- In construction it enables engineers, contractors and suppliers to integrate complex components cutting out waste and reducing the risk of errors.
- At handover it provides a single source of as-built information and data to enable the owner/operator to efficiently implement an operational and maintenance strategy.
- In operation it provides customers with real-time information about available services and maintainers with accurate assessments of the condition of assets.

Essentially BIM is seen as key to helping the industry:

- increase stakeholder understanding of the assets that are being commissioned;
- create better understanding and end-user engagement throughout the project life cycle to underpin the Government Soft Landings policy;
- boost delivery and operational efficiency;
- reduce cost, project duration and risk, and improve value;

- lower the carbon footprint;
- improve collaboration across the supply chain;
- improve quality of customer decision-making and quality of project outcomes; and
- boost data security through better information management.

The advances in digital technology have created opportunities for increased productivity and efficiencies in construction and the operation of assets. Utilising digital technology has been shown to facilitate collaborative approaches to drive innovation and reduce waste. Government will continue to capitalise on these advances to deliver construction projects more efficiently, including through Building Information Modelling (BIM) and improved insight into construction related data. *Government Construction Strategy 2016–2020, Clause 20*

Level 2 hypothesis and tests

The UK BIM Task Group set out its so-called Level 2 hypothesis for BIM adoption across the industry: “Government as a client can derive significant improvements in cost, value and carbon performance through the use of open sharable asset information.”

For the supply chain that means being able to unlock more efficient and collaborative ways of working throughout the entire project and asset life cycle end-to-end.

Ten key tests have been devised to help the supply chain to understand how it would meet the challenge of the BIM hypothesis and so achieve these more efficient ways of working as follows:

1. Valuable: The overall aim is to maximize client value by increasing benefits at little or no extra cost.
2. Understandable: The approach is to be presented in an understandable learning package suitable for different types of government asset procurers.
3. General: The approach is equally applicable to buildings and infrastructure, whether large or small new build and, where possible, existing structures.
4. Non-proprietary: All requirements are non-proprietary as to applications and required formats of the deliverables.
5. Competitive: Wherever possible there are at least two solutions or methods available in order to minimize market influence in terms of anti-competitive clauses.
6. Open: Wherever possible, low-cost methods are to be made available to allow all stakeholders to participate, irrespective of size and experience, in order to minimize barriers to involvement.
7. Verifiable: All contractual expectations are documented with transparent and testable measurement of pass / fail.
8. Compliant: Measurement of WLC/Carbon/Sustainability/etc. is published to GB, EU and ISO standards.
9. Implementation: The approach is self-funded by the client and the industry.
10. Timescale: The approach is phased in over 5 years.

Push and pull – aligning the client and delivery chain

The 2016 UK Government mandate for the use of Level 2 BIM on all centrally procured public sector projects is a bold step designed to prompt close working between Government and the construction industry to develop the industry's skills and reduce the cost of infrastructure.

This mandate is designed specifically to encourage the public sector to lead construction clients as one side of a so-called “push–pull” strategy, in which the client side and the delivery side are completely aligned both in terms of expectation and capability. The demand side uses the mandate to pull and the supply chain pushes with development of its capability.

Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016. A staged plan will be published with mandated milestones showing measurable progress at the end of each year. Government Construction Strategy 2011.

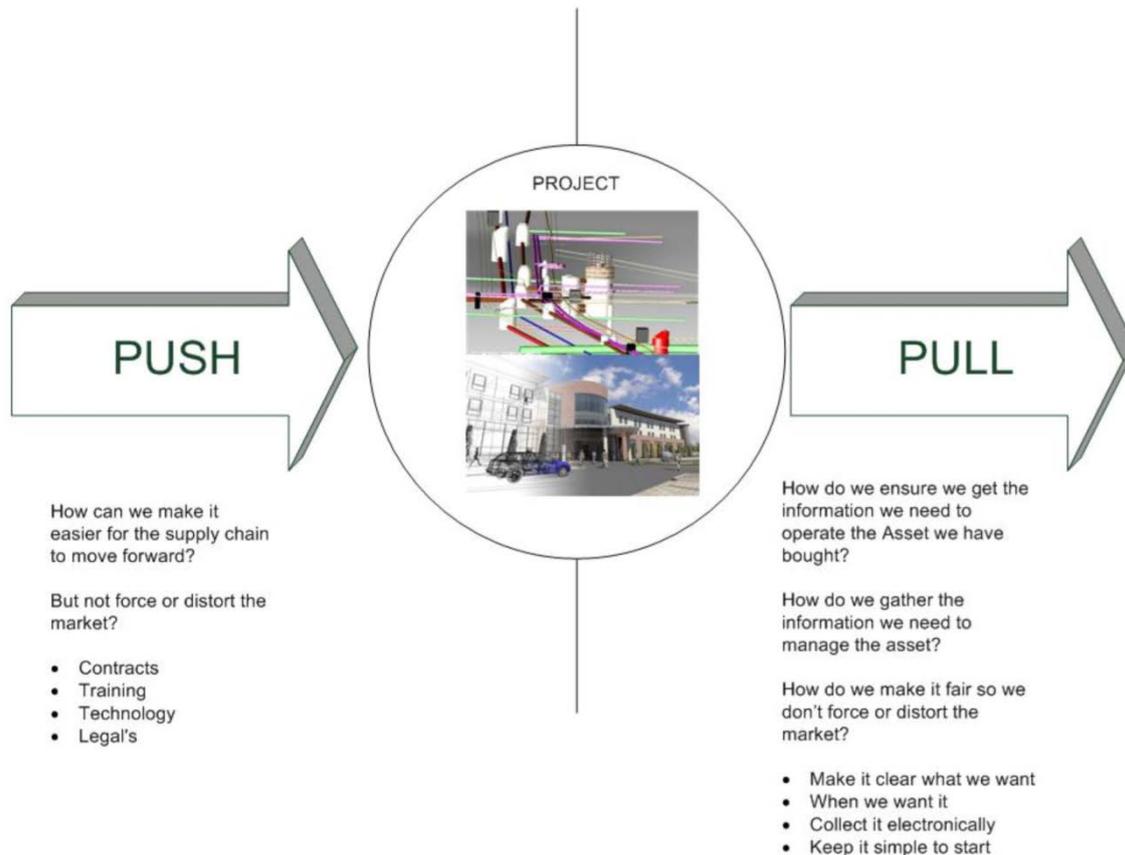
Centrally funded government departments will provide clear and complete “Employer’s Information Requirements” [EIR] with all contracts [to enable departments to derive further benefits from BIM by 4 April 2016].
BIM Task Group October 2015

The reasons for the client pull for BIM are rooted in demonstrable cost savings. The UK Government has identified BIM as a significant contributor to the £2.2bn of construction costs savings reported by the Cabinet Office between 2013 and 2015.

Specifically, the Ministry of Justice identified BIM as having enabled £800,000 of savings in the development of its Cookham Wood Young Offenders Institution and BIM is now central to the delivery of new rail projects like Crossrail and HS2, confirming the UK's leading role in the development of digital technologies for infrastructure and construction.

This client pull is balanced by an increasing push from the supply chain, which recognizes how investment in BIM Level 2 strategy and technology to manage data and collaborate during the design and delivery of projects can boost efficiency, reduce errors and rework and lift overall margins.

The target of adopting BIM to Level 2 maturity is aimed at the so-called ‘trailing edge’ of the industry supply chain and in particular the second and third tier sub-consultants and contractors. Leading organizations are clearly encouraged by this push–pull strategy to set their sights forward towards Level 3 and beyond.



HM Government

Key Level 2 documents and tools– leading to the global standard for adoption of BIM

Since 2006, the BSI technical committee B/555 "Construction design, modelling and data exchange" has worked to develop standards to underpin the use of BIM, a strategy crystallized in the B/555 Roadmap.

The most well-known and used standard is BS 1192:2007+A2:2016, *Collaborative production of architectural, engineering and construction information*, which sets out the methodology for effective information exchange on construction projects. Although this document describes standards and processes aligned to Level 1 working, the concepts of the Common Data Environment (CDE) and Standard Methods and Procedures (SMP) are fundamental building blocks for Level 2 working.

A family of codes and standards now exists to assist construction professionals and can be summarized as follows:

- **BS 1192, Code of practice — Collaborative production of architectural, engineering and construction information.** Provides the outline methodologies for setting up a project for effective information exchange.

- **PAS 1192-2, *Specification for information management for the capital/delivery phase of construction projects using building information modelling***. Provides information on the management of data produced within a BIM project environment, and supplements the processes and procedures contained in BS 1192.
- **PAS 1192-3, *Specification for information management for the operational phase of assets using BIM***. Takes the processes and develops them for use in the operational life of assets. An important document for the FM industry as it sets out the need for comprehensive and accurate asset information, which can be used as the basis for all asset-related decision-making.
- **BS 1192-4, *Code of practice — Collaborative production of information — Fulfilling employer's information exchange requirements using COBie***. Defines expectations for the exchange of information throughout the life cycle of an asset, and includes requirements for reviewing and checking for compliance, continuity and completeness.
- **PAS 1192-5, *Specification for security-minded building information modelling, digital built environments and smart asset management***. Outlines security threats to the use of information during asset conception, procurement, design, construction, operation, and disposal. It addresses the steps required to create and cultivate an appropriate security mindset and the security culture necessary to enable business to unlock new and more efficient processes and collaborative ways of working.
- **CIC BIM Protocol**. A supplementary legal agreement incorporated into professional services appointments and construction contracts by means of a simple amendment. The protocol creates additional obligations and rights for the employer and the contracted party and is based on the direct contractual relationship between the employer and the supplier.
- **Government Soft Landings (GSL)**. A strategy to champion better outcomes for public built assets during the design and construction stages using BIM to ensure that value is achieved in the operational life cycle of an asset, from design, through to construction, handover and operation.

Beyond Level 2

The Level 2 mandate is based around the understanding that digital technology, BIM and the use of data is set to transform the construction industry over the next decade.

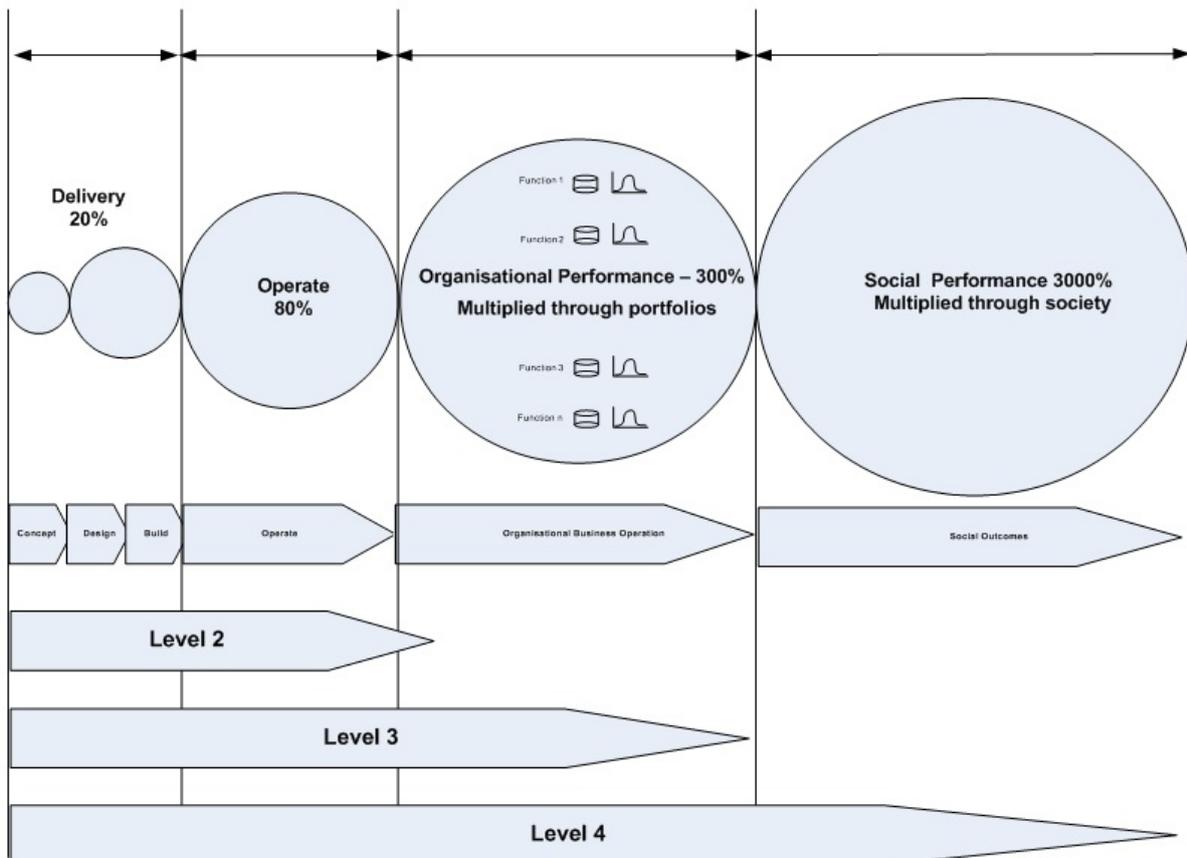
As the UK Government's latest Construction Strategy points out, advances in digital technology have created opportunities for increased productivity and efficiencies. These advances in data driven technologies, the internet of things, embedding sensors and the creation of smart technology-enabled infrastructure will radically change the development and operation of built assets.

Increasing BIM Level 2 maturity across government will enable departments to gradually move to BIM Level 3, which would support a fully integrated and collaborative process. The Government's 2016–2020 target is to increase maturity of BIM Level 2 implementation across government to a point that supports development of BIM Level 3 with a view to government adoption at a later date.

At this maturity level, all disciplines and contributors to a project would be able to access, modify and transact using a single, shared project model, held centrally, which would remove the remaining risks of conflicting information, and support the development of whole-life approaches.

“This has the potential to realise further improvements in construction, operation and maintenance, paving the way for smarter, better connected cities,” explains GCS 2016.

Armed with these tools we will increasingly see advanced data analytics help to plan, deliver, maintain and operate new and existing infrastructure more effectively, built at lower cost and operated and maintained more efficiently. The use of design and construction automation, robotics, additive technologies and virtual/augmented reality simulation modelling increasingly become second nature.



The circles of influence – planning-design-construction-operation-service

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