SEC GROUP

NSCC National Specialist Contractors Council

bimacademy

August 2014

First Steps to BIM Competence

A Guide for Specialist Contractors

INSIDE

Foreword

David Philp

Around the globe Building Information Modelling (BIM) is significantly altering the way that the construction industry creates and cares for its assets. Indeed as we enter a new digital construction renaissance we are increasingly seeing projects being built twice, once in the computer and then once flawlessly on site. Virtually constructing buildings and infrastructure allows organisations to identify and resolve issues before they actually happen, optimise outcomes and reduce process waste, especially rework.

BIM means many different things to different people and they are not all wrong! It very much depends on your perspective and role in the supply chain, however irrespective of what you do and indeed the size of your organisation BIM helps unlock new efficiencies. We believe that the BIM value proposition is not anchored to a particular project size or role and that SMEs are well placed to positively implement BIM within their organisation.

Whilst the information technology side of BIM is part of the equation of more importance is leveraging the rich 3D and infused data sets to help create collaborative joined up working across the supply chain and liberate leaner processes.

In May 2011 the UK Government published the Construction Strategy mandating the use of Level2, 3D Collaborative BIM on all central government construction projects by 2016 irrespective of project value. Our hypothesis is that Government as a client can derive significant improvements in cost, value and carbon performance through the use of open sharable asset information. This strategy will involve all members of the supply chain that are involved in Government Projects not just Tier 1 players.

It is important to start getting ready for this digital switch-over and we believe this guide along with our own **www.bimtaskgroup.org** website are an ideal place to start your journey. BIM is not a fad and as Victor Hugo said “it’s impossible to hold back and idea whose time has come”.

We hope that you find this guide useful. Let us know if you do!

Please email comments or your BIM experiences to contact@secgroup.org.uk

Introduction

David Frise

This Guide is published by the Specialist Engineering Contractors' (SEC) Group in collaboration with the BIM Academy at the University of Northumbria. The Guide also has input from the National Specialist Contractors' Council (NSCC). It is endorsed by the Cabinet Office.

The Guide seeks to help specialist contracting firms become conversant with BIM. We are at a crucial stage in BIM adoption where specialist contractors will have a bigger part to play in system design and integration. Public sector procurers (and also private sector clients) will be demanding more BIM-enabled projects to deliver efficiency savings through the elimination of waste. This guide has been updated to reflect the changes in the application of BIM in the UK since the inception of the original document.

In 2011 the SEC Group and NSCC set up a working group to ensure that the voice of the specialist contracting sector was heard in relation to all issues pertaining to BIM. The aim of the working group was two-fold:

Whilst this Guide – rightly – identifies the potential that BIM can offer, it should not be forgotten that BIM is simply a tool. It will become a somewhat blunted tool unless we also begin to address other issues. The tangible benefits associated with BIM – especially reducing design risk and facilitating faster delivery – can only be fully realised when procurement and contractual mindsets change. For example, early supply chain involvement is an essential but, at present, such involvement is rare.

The construction supply chain will have to work much more collaboratively with design team members to ensure that BIM models have integrity and reliability from the outset. Furthermore the focus is still very much on CAPEX rather than on OPEX. The output of the modelling process is primarily seen as a benefit to asset managers who will be enabled to manage their buildings efficiently and to their optimum use. This was the reason that the Government brought together BIM and Soft Landings; the latter being a protocol to help asset managers obtain the most efficient use out of the asset.

Current feedback from the specialist sector is highlighting some major concerns; for instance, the use of prequalification questions requiring the use of a certain type of software and the problems of interoperability between the different software platforms. Again these are issues that we must confront if we are to achieve a critical mass of BIM use within the sector.

BIM is a manifestation of the digital revolution, just like the smart-phone - as they say better to take part in a revolution than have one"done" to you.

Good luck.

David Frise

Chairman
SEC Group/NSCC BIM Working Group

Feedback on this Guide or, indeed, on any other matters relating to BIM – whether positive or negative – will be very welcome. The working group can pick this up at:

contact@secgroup.org.uk

I would like to use this opportunity to thank Professor David Greenwood of the BIM Academy at the University of Northumbria for drafting the Guide and David Philp at the Cabinet Office for his Foreword.
I would also like to thank all members of the working group, past and present, for their help and support as well as for their input to this Guide. Thanks to Neil Thompson Principal BIM Integrator, Balfour Beatty plc and Paul Marsland MSc CEng MIET LCC Chief Electrical Engineer, NG Bailey for use of photographs in this report.

Executive Summary

1 This Guide is published by the Specialist Engineering Contractors' (SEC) Group in collaboration with the BIM Academy at the University of Northumbria. The Guide also has input from the National Specialist Contractors' Council. It is endorsed by the Cabinet Office

2 Building Information Modelling (BIM) is not a new concept. Digital building modelling has been around for some time but was given added focus by the Government's stated aim, in 2011, of introducing 3D (dimensional) BIM on central government construction works by 2016. This Guide seeks to help specialist contracting firms to become more conversant with BIM so that they do not miss out on work opportunities. Public sector procurers (and also private sector clients) will be demanding more BIM-enabled projects to deliver efficiency and savings through the elimination of waste. Much of this will be achieved through having a "one-stop shop" for all information relating to a project which then becomes available to the user and manager of the asset to help deliver the required performance. Whilst almost all are more aware of the mandate to achieve Level 2 BIM, there are increasing industry concerns about the wholesale ability of the industry to achieve this target. Potential barriers to adoption are: -

- *The perceived unwillingness by clients to invest in BIM or pay appropriately for its use;*
- *The quality of information being input into or associated with the model, and the ability to reuse this information as is intended by working in BIM;*
- *Individual rather than a collaborative approaches;*
- *continuing concerns over the cost of becoming BIM enabled;*
- *lack of capacity within the Industry for re-skilling. Many construction organisations have downsized during the recession, reducing their capacity to adopt new practices.*

3 Awareness of BIM has increased dramatically since the initial publication of this document, according to the latest surveys undertaken by NBS [1, 2] and CIOB's 'Construction Manager' magazine [3]. This Guide explains the potential benefits to individual firms in adopting BIM as well as the benefits of using BIM at project level. BIM is still evolving and the hope is that this Guidance will eventually become an on-line tool with interactive elements.

4 BIM involves both an output and a process. The output is a database that represents all elements of the building and structure and the "properties" of each element. As a process, BIM is about project participants putting together this digital information so that ultimately, it can be handed over to the client or user to manage performance of the assets in a more efficient and effective manner.

5 There is a substantial amount of BIM jargon; much of this is explained as an annex to the Guidance. There are often references to the different 'levels' of BIM. Government is requiring on the use of Level 2 BIM by 2016. At Level 2, project participants individually develop their own models or databases that they share with others through common software platforms. There are standards or protocols governing the formatting of information, data storage and how the data exchange process is to be managed. This Guide focuses on Level 2 BIM.

6 3D BIM can improve the efficiency of the design process through reducing clashes and errors. But there are other dimensions. 4D BIM, for example, can be used to programme and schedule work. 5D BIM enables one to have an instant and accurate assessment of the cost relating to all elements of the work. (The last section in the Guide provides a number of case studies as evidence of the business case for BIM.).

7 Clients – both public and private sector – are no longer simply procuring buildings or structures; they are procuring a certain level of performance in which energy savings and carbon reduction are high on the agenda. BIM is seen as key in facilitating the desired performance. This is the *"top-down"* reason for engaging with BIM but very little consideration has been given to the *"bottom-up"* reasons. Some of the BIM software vendors are making claims that returns on investment in the relevant technologies are,

We hope that you find this guide useful. Let us know if you do!

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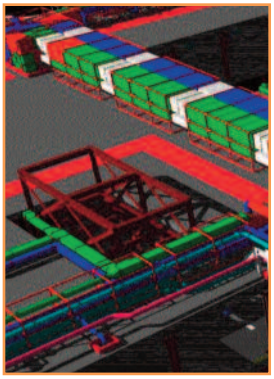

Executive summary

potentially, very high; though these claims should be treated with a little caution as they come from a vested interest.

8 The main challenge for businesses is seeking out reliable sources of information; the Guide addresses this. It is best to make a start by articulating the reasons for wishing to invest in BIM. The answers will determine the appropriate level of investment in the technology, training and in adapting the business to using BIM. A key decision will relate to the software and hardware required. Whatever is purchased must allow for the maximum inter-operability to be achieved with other software platforms.

9 As the use of BIM increases it could impact on the roles and responsibilities of project participants. A new role will involve the management and coordination of the modelling process including matters such as quality control, access rights and security. Data is likely to be acquired at the outset of the design process for the purpose of developing the model. If, for example, such data is to be acquired from the M&E contractor, that contractor may have to be appointed at an early stage.

10 It is not anticipated that Level 2 BIM will create significant legal or contractual issues. Models or databases could, of course, become contractual "documents". Access rights will have to be considered. For example, to what extent can the steelwork contractor access information provided by the cladding contractor? Model BIM protocols or supplements to existing standard contracts have been or will be published. Some risks will need to considered. A key risk is the extent of reliance that can be placed upon data provided by other project participants. These issues can be dealt with through the use and production of a BIM execution plan which clearly sets out required deliverables and responsibilities at the outset of the project.

11 Poor information, lack of information and incomplete information are sources of inefficiencies leading to greater costs, defects and disputes. BIM technologies can reduce these problems by tracking and storing information and enabling its re-use. Early clash detection helps to reduce or avoid variations. BIM-generated information can help with measurement and valuation. Costs can potentially be ascertained with greater accuracy and more reliable information provided to tenderers can reduce contingencies. The sequencing of site operations, optimum site layouts and logistics can all be facilitated by BIM. Over the longer term, BIM is likely to reach into every aspect of construction procurement.

11 The Government is keen that project participants work together to provide data in a more structured way. The means for achieving this is through the development of a COBie datafile. COBie means *Construction Operations Building Information Exchange*. COBie UK 2012 is a data schema typically presented in the form of a spreadsheet that provides a *"one-stop shop"* for all the data relating to the asset. It is intended that this COBie datafile will evolve over the course of the project with a number of *"data-drops"* at certain stages. The Government will require five such *"data-drops"* dealing with the following matters in turn:

1. **Requirements and Constraints**
2. **Outline Solution**
3. **Construction Information**
4. **Operations and Maintenance**
5. **Post-occupancy Validation Information and on-going Operations and Maintenance**

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1.0 Why this guide?

Some questions

Do you feel uneasy when you read the statement in the box next to this paragraph?

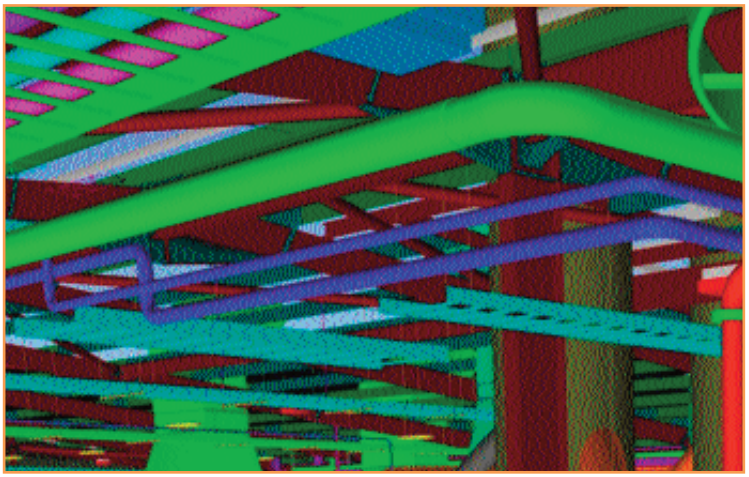
'Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) as a minimum by 2016.'

Government Construction Strategy, p.14 Cabinet Office [4]

Did you know about the requirement?

Did you know about the requirement?

- Do you understand what it means? In 2011 you may have been one of the 21% of the Industry that **wasn't aware of BIM** at all. Now the NBS 2014 survey suggests that this figure is only 5% - so awareness is growing! [2].
- Perhaps you are **already a BIM user**. In the earlier NBS Survey 13% of respondents said they were already BIM users and this has grown significantly to 54% in the 2014 survey.
- 81% belive **they will be using BIM** in 12 months time.
- If you are one of these **new users** you may want to check out your progress against what is happening at the cutting edge.



The purpose of this guidance document is to acquaint firms with the steps they need to take to become comfortable using Level 2 BIM – that is, developing and sharing project-related data in a 3D format with other parties. (We will talk about 'Levels' later.) The guidance addresses matters such as the business case for BIM, the training that needs to be put in place, competencies that need to be developed and issues arising in connection with software.

It is unlikely that such a compact guide will answer all current questions about BIM. However, the guide also acts as a pointer to other sources of information, many of them electronic, which will help supplement your awareness and knowledge of this rapidly evolving area. It should be acknowledged that the use and understanding of BIM is still very much evolving and therefore, guidance will have to be constantly updated. Thus, it is expected that this guidance will ultimately become an on-line tool with interactive elements. It is intended that publication of the guidance will generate seminars and help standardise the BIM competencies required for pre-qualification.

SEC/NSCC Group will work closely with the Cabinet Office to ensure that the guidance is aligned to the Government's expectations as far as the development of BIM is concerned. This document has been prepared for the SEC/NSCC Group by BIM Academy (a joint venture between Northumbria University and Ryder Architecture). BIM Academy is unique in that it combines industry experience and academic expertise to support the sector in the adoption of Building Information Modelling (BIM) through research, consultancy and education.

We hope that you find this guide useful. Let us know if you do!

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2.0 Introduction to BIM

2.1 What is BIM?

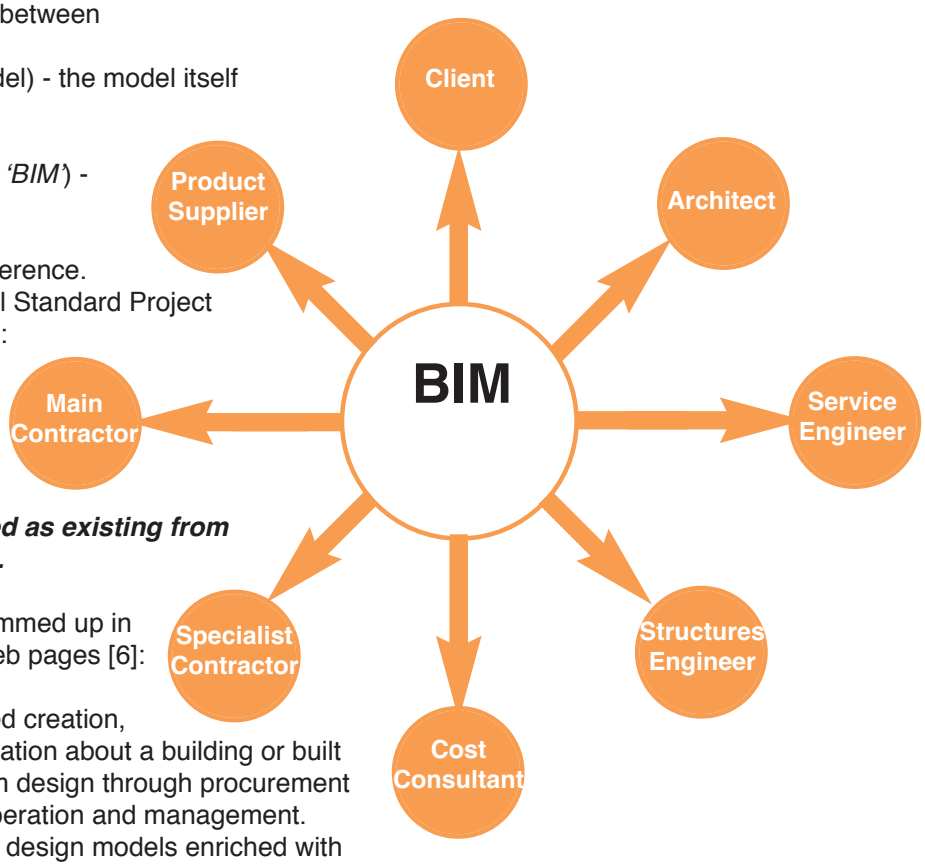
There are many definitions of Building Information Modelling (BIM) in circulation. But first, note the difference between

- ‘*A BIM*’ (a Building Information Model) - the model itself - essentially a database, and
- Building Information Modelling (just *‘BIM’*) - as a process.

The following definitions sum up the difference.
The National Building Information Model Standard Project Committee in the USA defines a BIM as:
‘a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition’ [5].

It is important to note that BIM is, as summed up in this definition from the BIM Academy web pages [6]:

‘BIM is a process involving the structured creation, sharing, use and re-use of digital information about a building or built asset throughout its entire lifecycle, from design through procurement and construction and beyond, into its operation and management. This involves the use of coordinated 3D design models enriched with data which are created and managed using a range of interoperable technologies.’



BIM: A way of working

Finally, there is a wider view of BIM as ‘a way of working’. So when, in November 2012, the Government’s Chief Construction Advisor, Paul Morrell argued that ‘BIM is unstoppable’ [7] he was referring to the broader idea of BIM as a way of working. Some people even say that this BIM should be ‘Building Information *Management* (not Modelling); others have it both ways, and prefer BIMM (Building Information Management and Modelling). This last view of BIM (or BIMM) is described by ‘buildingSMART alliance’ as
‘an interoperable process for project delivery, defining how individual teams work and how many teams work together to conceive, design, build & operate a facility.’

Indeed many people link this BIM process to another, *Integrated Project Delivery* (IPD) a term coined by The American Institute of Architects and described by them [8] as
‘a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction.’

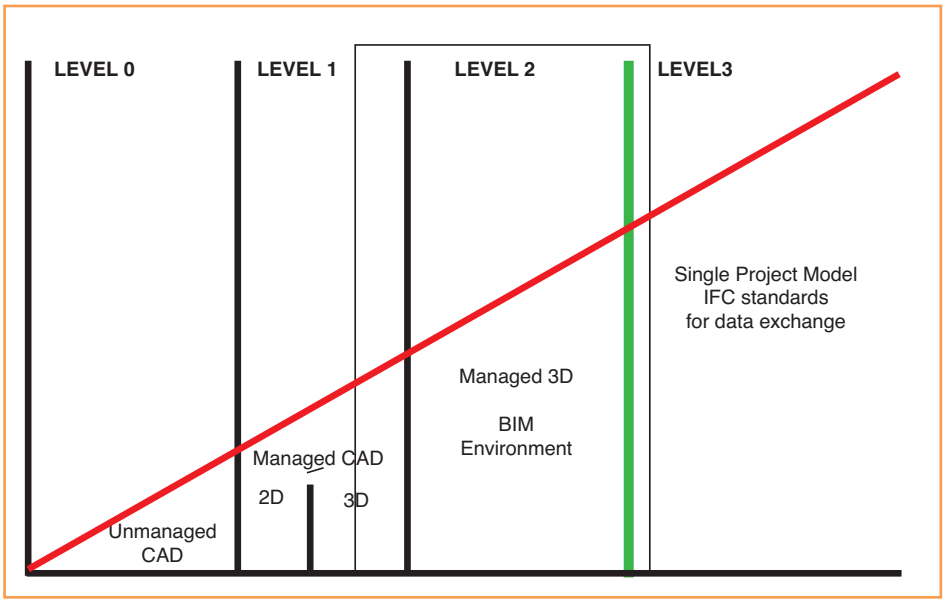
It is the wider view of BIM – an approach to project delivery - that this document addresses.

2.0 Introduction to BIM

2.2 Levels and stages in BIM adoption?

Throughout this document, and in general, you will see a lot of terminology that you are perhaps unfamiliar with. We hope that the 'Jargon Buster' (Appendix C, at the end of the Guide) will help you find your way through this. However, it is an advantageous, right at the start, to have an appreciation of what is meant by the different 'levels of BIM'.

Most references to levels of BIM development refer to the BIM Maturity Diagram devised in 2008 by Bew and Richards, and adapted in the illustration below. These can be explained, as follows:



BIM Maturity Diagram

Level 0 BIM (not really BIM, but often a starting point) involves the use of 2-D CAD files for design and production information. Information is often sent as pdf. files and printed off on paper.

Level 1 BIM marks the move to 3-D information as increasingly used to visualise designs. Typically the user (who may be a designer) is 'alone' in exploiting the benefits of the 3-D model, or there are several users who may have their own models. This level has been called 'lonely BIM'.

With **Level 2 BIM** we see 'Managed' 3D models in 'a BIM Environment'. This is what the Government is asking for (see above). But what does this mean exactly?

A closer look at degrees of BIM maturity reveals that it involves the degree of integration and interoperability of four distinct elements: *platform software(s), database(s); specialist design analysis tools;* and *mechanisms for asset data drops.*

Platform software(s)	Database(s)	Design Analysis tools	Asset Data Drop

No single model; discipline-based software, with individual proprietary databases, that have limited interoperability between them or with associated design analysis software. **Asset data drop into COBie UK 2012.**

No single model; discipline-based software, **with individual proprietary databases, that are fully interoperable**, but with limited interoperability with associated design analysis software. **Asset data drop into COBie UK 2012**.

No single model; discipline-based software, **with individual proprietary databases, and associated design analysis software that are fully interoperable. Asset data drop into COBie UK 2012**.

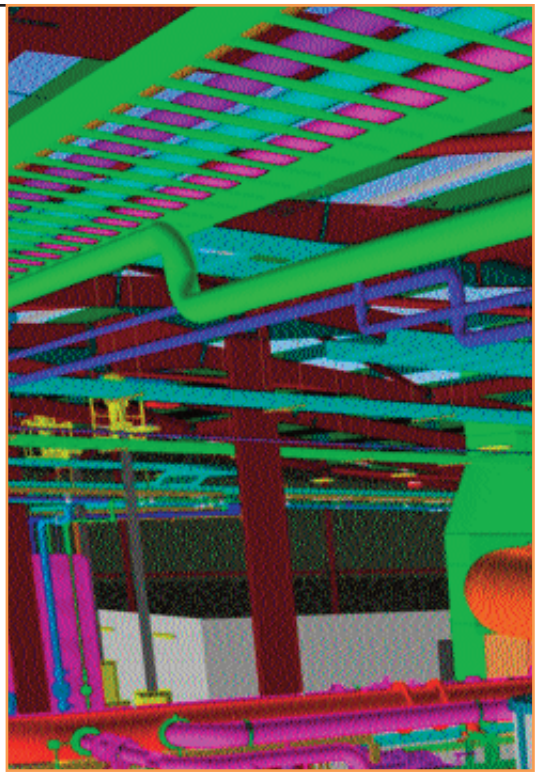
Fully integrated BIM: A single model with single software platform and relational database, associated design analysis software tools that are fully interoperable. **Asset data drop into COBie UK 2012** (Potentially automatic).

Increasing maturity levels within BIM

2.0 Introduction to BIM

2.2 Levels and stages in BIM adoption?

(reference to these elements is taken from Publicly Available Specification, PAS 1192-2:2012. This document will be discussed in Section 9.



- BIM is about digital prototypes of buildings made up of data and 'parametric objects'. Each model requires 'platform software' and a database of information that 'sits behind' the model and gives the objects their intelligence (i.e. 'knowing' their shape, size, weight, cost, etc.)
- With the ideal Fully Integrated BIM, there is a single project model, platform, and database, allowing parties to fully integrate their designs. Current opinion is that this remains aspirational.
- The 'ideal model' would also be compatible with the range of design analysis tools (for example, for environmental design) as well as commercial data.
- This 'Fully Integrated' stage would require an effort of integration, that would include contractual and liability issues, as well as the practicalities of running the model itself. These are addressed in later Sections.
- One of the key Level 2 requirements is a series of as-built 'Data Exchanges' (also known as 'Data Drops') for the Client. The vehicle for doing this is a system called COBie (actually, COBie UK 2012) and this is discussed in more detail in Section 9.

This extra sophistication in data exchange required by Fully Integrated Level 2 BIM brings the need for project 'information protocols' (principles for how to share information and work together on a model). Further development of these data exchange capabilities and established standards, definitions, taxonomies and protocols will be required for the next envisaged level of maturity: Level 3 BIM.

Level 3 BIM (and beyond) aspires to a single real-time Project Model in which collaborative use of the information is a 'given', but where software interoperability, IT infrastructure problems, and contractual and legal obstacles have been overcome to allow exploitation of related simulation software products that aid design decision-making. This would be enhanced by the use of 'standard libraries' of common objects that contain manufacturers' data as well as just their size and shape. An example of this initiative is the work being undertaken by NBS (National Building Specification) in their efforts to produce a National BIM Library of 'generic' standard components, as well as a growing range of proprietary products containing information provided by manufacturers [9].

Ultimately then, beyond Level 2, each project may have a **fully interoperable real-time model** whose creation an use is shared between all the major players in the project supply chain.

2.0 Introduction to BIM

2.3 Technology, Process and People

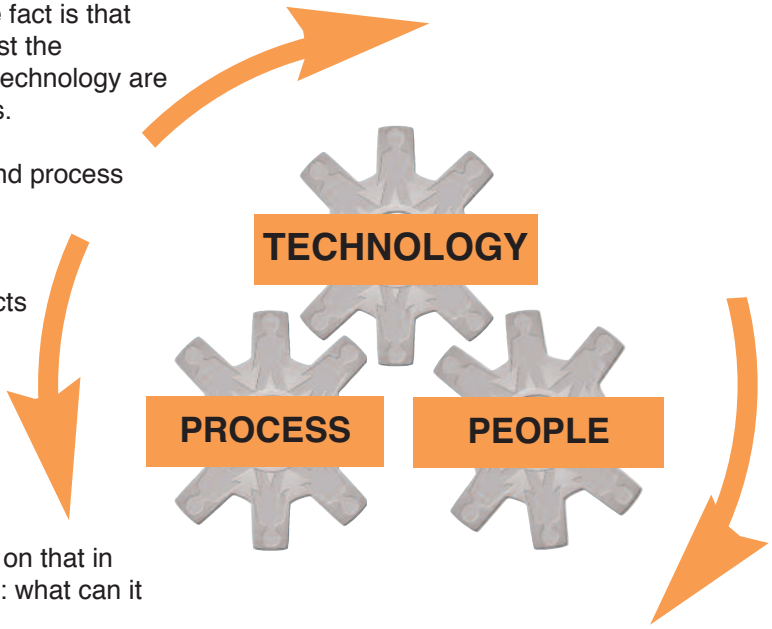
So much for the future. At every level of BIM, the fact is that effectiveness is about people and process, not just the information technology. Both the people and the technology are essential for the proper functioning of the process.

All levels of BIM will require changes to people and process alongside the adoption of new technology.

This is particularly true as we move up the levels towards Level 3 BIM and beyond. In many respects this will be a big step up from Level 2.

For fully integrated BIM there will need to be significant changes to the processes in order to exploit the technology to its maximum; and the people need to be on board.

That is for the future, though we speculate a little on that in Section 11, which is entitled 'The potential of BIM: what can it do?'

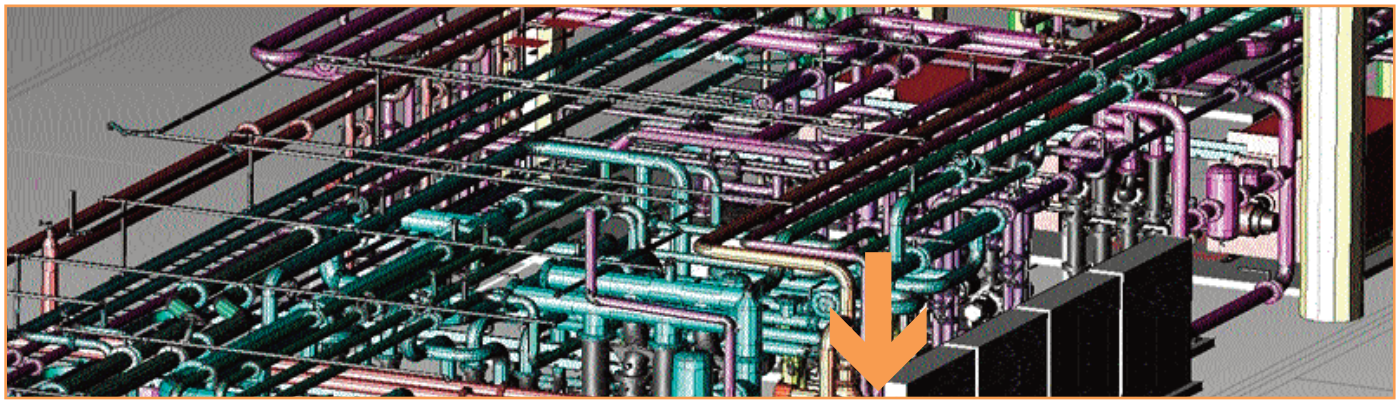


The main purpose of this guide is to acquaint firms with the steps they need to take to become comfortable using Level 2 BIM – that is, developing and sharing project-related data in a 3D format with other parties.

BIM is about people and process as much as it is about technology.

3.0 The Business Case for BIM

3.1 How does BIM relate to my business?



Together, BIM and IPD represent a new way of delivering built assets (buildings, infrastructure, etc.) by transforming the process of designing and constructing them. This has all been made possible by the advances in the digital technologies that underpin the development of BIM. It is done by embracing the inputs of key participants in a single, accurate digital model that removes or reduces many of the risks that currently exist in the construction process. If you are one of those key participants, or you deal with them, then BIM will affect you.

Alongside the advantages of designing (and concurrently visualising that design) in 3-D, this goes well beyond the use of 3D-CAD. BIM models can also be populated with additional associated information such as *time* and *cost*, often referred to as '4-D' and '5-D' BIM. But BIM actually goes further than that. As mentioned earlier, BIM is about 'the use and re-use of digital information' (note the emphasis) which relates not only to the *delivery* of a new asset, but means that the asset can be managed more intelligently through its whole operational life.

So BIM is not just for new buildings: the retro-modelling of **existing buildings and other structures** will be an important aspect of BIM's adoption.

Many changes are evolutionary; some are revolutionary. In the UK construction sector we are at the early stages of BIM deployment. However BIM-like technologies have been around for a number of years in manufacturing, and the construction sectors of other countries (particularly the US and Scandinavia) are familiar with BIM.

What is different here, and what has 'kick-started' UK construction into what is almost a BIM Revolution is the Government's Construction Strategy (published by the Cabinet Office on 31 May 2011) which stated that it will mandate 'collaborative 3D building information modelling (with all project and asset information, documentation and data being electronic)' on all its projects by 2016. [4]

'BIM allows the virtual design, construction and operation of a building by developing and testing a digital prototype in advance of its physical realisation, thus delivering greater cost certainty, eliminating error, improving programme duration and reducing risk.'

Paul Morrell, Government Chief Construction Advisor (2009-2012)

FROM THEN, ANY FIRM THAT IS, OR WANTS TO BE INVOLVED WITH A GOVERNMENT-LED PROJECT WILL BE CAUGHT UP IN THE *BIM REVOLUTION*, WILLINGLY OR OTHERWISE.

3.0 The Business Case for BIM

3.2 Why should my business engage with it?

The top-down reasons

If the answer to this is not already obvious from what has been said above, then read on. Put simply, the reasons for engagement with BIM are both 'top-down' and 'bottom-up', or as Government call them 'push and pull'.

First, the top-down reasons: it's clear from what is coming from Government that BIM fits their two prime agendas: efficiency savings and carbon reduction. This is clear from what is being said, about why this unique step has been taken. As the Government's first Chief Construction Advisor Paul Morrell has commented:

'There will be spectacular change – we are only just beginning to understand the scale of what can be achieved and the amount of waste that can be eliminated from the system.'

As noted earlier, the Government '2016 BIM edict' made in 2011 has triggered massive interest in BIM. Furthermore, there have been back-up actions, reproduced here from the SEC Group's own publication: 'BIM: What the Government has been doing'. The Construction Industry Council has established Building Information Modelling (BIM) Regional hubs in partnership with the Government's BIM Task Group. In Autumn 2012, 11 Regional BIM hubs were launched in order to raise awareness and the benefits of BIM to the industry as a whole and facilitate the early adoption of BIM processes and working methods throughout the UK's construction industry.

Regional BIM champions were identified in each nation and region as the conduit for a unified and coordinated package of information which will allow dissemination of the programme at a local level. Through engaging with the industry at grass roots they provide valuable feedback to the BIM core team.

Regional BIM champions act as chairs of the national and regional hubs with local links within the nations and regions; and will act as a conduit of information exchange, signpost interested employers to BIM buddies (practitioners already active in the field of BIM); and provide a valuable source of information to feedback to the central BIM teams on progress.

The objectives of the Regional BIM Hubs are to:

- Interface with the core team and the emerging legacy support organisation to raise awareness of the BIM programme and its requirements;
- Act as a conduit for relevant information on the programme to ensure a consistent and contextualised message is disseminated;
- Enable regional engagement in national discussions;
- Encourage the sharing of BIM knowledge and best practice within the networks;
- Facilitate regional activity to support the development of the supply chain's BIM capabilities;
- Provide linkage with the GCS BIM Task Group and the CIC BIM Forum;
- Provide valuable feedback to the core team.

It is also predictable that the revolution will not stop with public projects, and that BIM will become the industry norm for all projects of a certain scale (whatever that may be). The ability to exploit these opportunities offers firms a competitive advantage that smart ones cannot afford to miss.

We are living in a world of "too little cash and too much carbon", according to [the Chief Construction Advisor]. We have to "think our way out of these new metrics of design and try new ways of working".

AEC Magazine. 'BIM: what your government wants' .

BIM: What the Government has been doing

- **BIM Implementation Task Group to help Government clients operate in a BIM- environment;**
- **Government clients are now developing implementation plans;**
- **A digital data exchange format known as COBie 2012 has been prepared;**
- **A publicly available specification (PAS 1192-2:2012) has been produced;**
- **Work on contractual terms is underway;**
- **Agreement reached with buildingSMART to develop a national standard for interoperability.**
- **A network of regional BIM hubs has been rolled out.**

Adapted from SEC Group
http://www.secgroup.org.uk/pdfs/bim/SEC%20Group%20FocusBIM0512.pdf

In NBS's National BIM Survey [2] completed in 2014 by nearly 1,000 design professionals

80% **thought that BIM was the future of project information**

54% **are now using BIM – up from 13% in 2010**

80% **said they would be using BIM in one years time**

77% **of users agreed BIM improves coordination of construction documents**

65% **of users said it given us a competitive advantage.**

3.0 The Business Case for BIM

3.3 Why should my business engage with it?

The bottom-up reasons

Now for the 'bottom-up' reasoning: this is perhaps not so evident. There has been a fair amount of discussion over the benefits to be gained by adoption of a BIM approach **by the entire construction supply chain**. However, there are four main problems about the evidence:

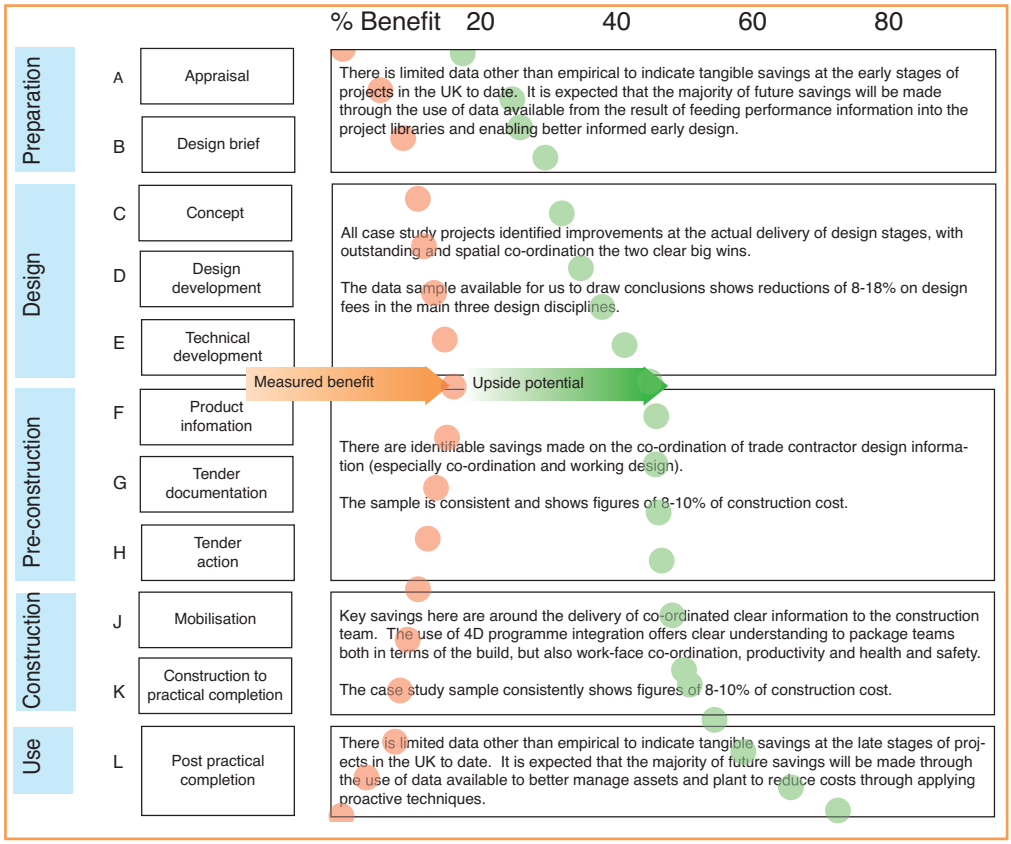
1. The lack of hard data, particularly from the UK, as opposed to predictions of what might be;
2. Concentration on the collective (industry or project) benefits of a BIM approach rather than those enjoyed by individual users (other than clients);
3. The image of BIM as something for designers, who have been its early adopters, to-date;
4. Any analysis of incoming technology suffers from the 'tipping point' effect, namely, when a technology \ becomes dominant, it becomes irresistible.

Currently the most convincing attempt at an independent approach to benefits analysis is to be found in the BSi "Investors Report" [10] but even here, the evidence is so far limited.

Less 'independent' but worth considering, are the claims of software vendors, whose claims range from a modest 'conservative estimate' of 25% average estimated Return on Investment (ROI) for designers [11] via an 'easy to show' 60% ROI [12] to a spectacular 300-500% in cost avoidance and savings for contractors [13]. A US architectural firm reported on two projects of similar size during the early stages of their adoption of BIM software. Their results indicated a 37% average saving over CAD when they used BIM. The evidence suggests an initial productivity loss, followed by considerable efficiency gains.

Work is still in progress to produce hard data for the BIM business case.

BIM: The business case



Criteria will vary with the size and sophistication of firms; what they have; what they need; what they want. Currently most evidence comes from a limited number of case studies (see Section 10, below) but Government and others are currently working on the cost-benefit case for BIM. But returning to the 'top down' reasons for BIM, the question remains;

'Can we afford not to?'

4.0 The challenges of using BIM

Having heard the Government telling you why you should adopt BIM, why are some people still holding back? Some answers came from a recent CIOB survey (see Figure). The findings showed that there were a few common themes amongst those who were reluctant to start. Here we have tackled some of the main questions that flow from these challenges. The same survey undertaken in 2013

CIOB Survey

4.1 Enough understanding of BIM

***Question:** Where do I get enough information to let me make proper decisions?*

1. Check the Web. The Government's BIM Task Group has a website with Frequently Asked Questions (FAQ) at http://www.bimtaskgroup.org/.
There are others, such as NBS at http://www.thenbs.com/topics/BIM/index.asp
Other reports giving good guidance and insight to BIM are : -The NBS International BIM Report 2013; NBS IFC/COBie report 2012 and NBS's 'BIM for the terrified'.
2. The sites of other organisations such as BIM Academy, at www.bimacademy.ac.uk . BIM Academy is a joint venture between a university and a design organisation, and aims to provide independent advice, consultancy, training and research in BIM.
3. Go to BIM Awareness Meetings in your area. Attend as many as you can. The Government has launched a number of Regional BIM Hubs that will be the point of contact for anyone wanting to know more.
4. http://bimtalk.co.uk has great advice and links.

4.2 Financial return

***Question:** If we invest in BIM, will it pay off? And if so, how long will that take?*

Answer: Experts agree that BIM can have benefits throughout the supply chain. The problem is that most talk about the 'benefits to the Industry', or to 'the Project' and not 'the Firm'. Your level of spend will differ depending on what you want out of it. Probably the first piece of advice is:

- Decide what you want BIM for, and why;
- Be clear on what it will take to use BIM – money, training, change management, etc.;
- Look around for advice.

Advice can come from Government (the BIM Task Group), from independent organisations (such as BIM Academy), or from the experiences of early adopters in the same business sector. Case Studies are increasingly available on the Web. We present some examples in Section 10 below, entitled The Evidence for BIM: Project and Business Case Studies.
In terms of 'how long' it would be before any investments start to pay off, there will clearly be a time investment to match that of money. Time spent in training staff; in staff familiarising themselves (the 'Learning Curve'); and even time spent reordering business processes, have all been cited as necessary.

Again, try to look at case studies (there are some in Section 10) or talk to firms like yours to discover their experiences. There are a number of sites that exchange information. Examples are given in *Appendix A: Websites, Blogsites and BIM Groups (see below).*

4.0 The challenges of using BIM

4.3 Buying Software

Question: **Should we buy software? What should it be? Will it be expensive? Will it last?**

Answer: As above, don't just dive in and buy technology until you have a good idea what you need. There are many brands: some are clearly 'leaders' in different disciplines or in different parts of the world. For example, Eastman's BIM Handbook [14] lists 70+ different software companies with hundreds of different software packages.

Most BIM tools are sold on a 'per user licence' basis. Your level of spend will differ depending on what you want out of it: some BIM software is free, while some requires expensive licences. More than anything, you will want to 'future proof' your investment as far as possible. Some organisations wouldn't actually require BIM software to perform design activities, rather they need to view, check, or manipulate information they are provided with by others, up and down their supply chain. Find out about and consider the benefits that can be derived from such products, or even from *BIM from free viewers*, and of course, be aware of their limitations.

Of course, with so many brands available, people are worried about investing in a 'Betamax 'or a 'MiniDisk' and getting technologically 'stranded'. The process is not without risk and expense, but there are some mitigating factors:

- It is Government policy to allow all stakeholders to participate in the use of BIM and to minimise barriers such as cost (e.g. by making requirements 'non-proprietary').
- The new 'open source' information culture on the Web means that some ICT is low-cost or even free.
- One of the key requirements of the Government's 2016 policy will involve the use of COBie, which allows open exchange of project data (the so-called 'data drops') in a spreadsheet format. It may be that contributing to such 'data drops' may be only BIM requirement that you will face in the near future (see Section 9, below, for more information about COBie).
- There are ways that allow data exchange between different BIM software applications This is referred to as 'interoperability'. An example is the IFCs (Industry Foundation Classes) developed by buildingSMART.
- Various systems allow users to easily interact with IFC files, view IFC files without the need for expensive software, and create bespoke data views for sharing. An example is the xBIM toolkit (http://www.openbim.org/) and it's free!

'A realistic budget for a workstation is around £10,000 once you include hardware, software and training. … However viewed in relation to technical staff costs and fee income, it starts to look a little less scary. We believe that if you have high quality professional staff it makes commercial sense for them to be using the best available tools.'

David Miller Architects [15]

4.4 Buying Hardware

Question: ***What about the hardware? Can we make do with what we've got?***

Answer: This really follows the answer to the last question.
1. First decide what you want to do with the software tool.
2. Select the software that does it (see above). Take advice. Get demos. Read blogs. Talk to people whose advice you trust.
3. Check out what you already have in your business: it may be adaptable. And you'll need to think about compatibility of any new stuff.
4. Select the hardware that runs it. Will your existing set-up cope? Don't spoil things by skimping. Upgrade if you're serious – time is money. Again, take advice, read reports, get demos, check what you've already got.

4.0 The challenges of using BIM

4.5 Training

***Question:** Will we need training? Who can provide it? Is there an accreditation scheme?*

Answer: It depends what training you want. Most software vendors offer training, as do software retailers ('re-sellers'). Universities, colleges and even schools are starting to offer courses; as are the Professional Institutions. There is already a variety of BIM related courses across strategic, management and technical roles required for Industry up-skilling. The Regional BIM Hubs will help. Some firms report that their most significant training costs have not been in software usage but in enhancing the engineering capabilities of their current CAD draftsmen to the levels required.

There is currently no nationally-recognised BIM accreditation scheme, and naturally enough the Government's BIM Task Group won't be recommending any specific one. But accreditation schemes are under development, and it is worth keeping an eye out for these, particularly the more impartial ones that aren't aligned to providing any particular brand of software application. Some of the links in Appendix A will be good sources of up-to-date information on this.

'BIM will change everything. There's no point attempting to implement BIM software throughout the industry with the expectation that things won't change. They will.'

10 Truths about BIM. WSP Report on BIM. (www.wspgroup.com)

4.6 New processes and change

***Question:** Will we need to change the way we work?*

Answer: ultimately, yes. BIM works best in a collaborative environment. For example, a project in Level 3 BIM with collaborative use of shared information would certainly require **different procurement models, different 'deals'** between the parties, and **different processes** to the ones we are used to. However, that isn't the way in which you will necessarily first encounter BIM.

You may be asked to provide design data for someone else's BIM model, or do your own in a certain way. Or you may want to view, check, or manipulate information they are provided with by others, up and down their supply chain. At its most basic, you may just be asked to work to defined 'COBie drops' in a spread sheet (see below for more on COBie).

You may feel you want to 'wait and see' what the others you work with do. OK, but don't be caught unprepared. Over time, embracing a new system like BIM will allow you to reconsider the way you do things. Focus on the high-value returns and how BIM could help maximise those. In most cases this could be a positive opportunity to grasp.

4.7 Legal Liability, Insurance and Contracts

***Question:** How will legal and contractual matters change with BIM? Will we be on the receiving end?*

Answer: It has already been noted that 'Fully Integrated' BIM would require changes in the way projects were procured, and the way contractual and liability issues were dealt with. What must be avoided is a future 'free-for-all' with exploitation by those with greater know-how or commercial power. Feedback from early trials (including the Government's 'proof of concept' projects for the Ministry of Justice [16] should produce interesting reflections on some of these questions. There is further discussion of potential legal and contractual issues in Section 7.

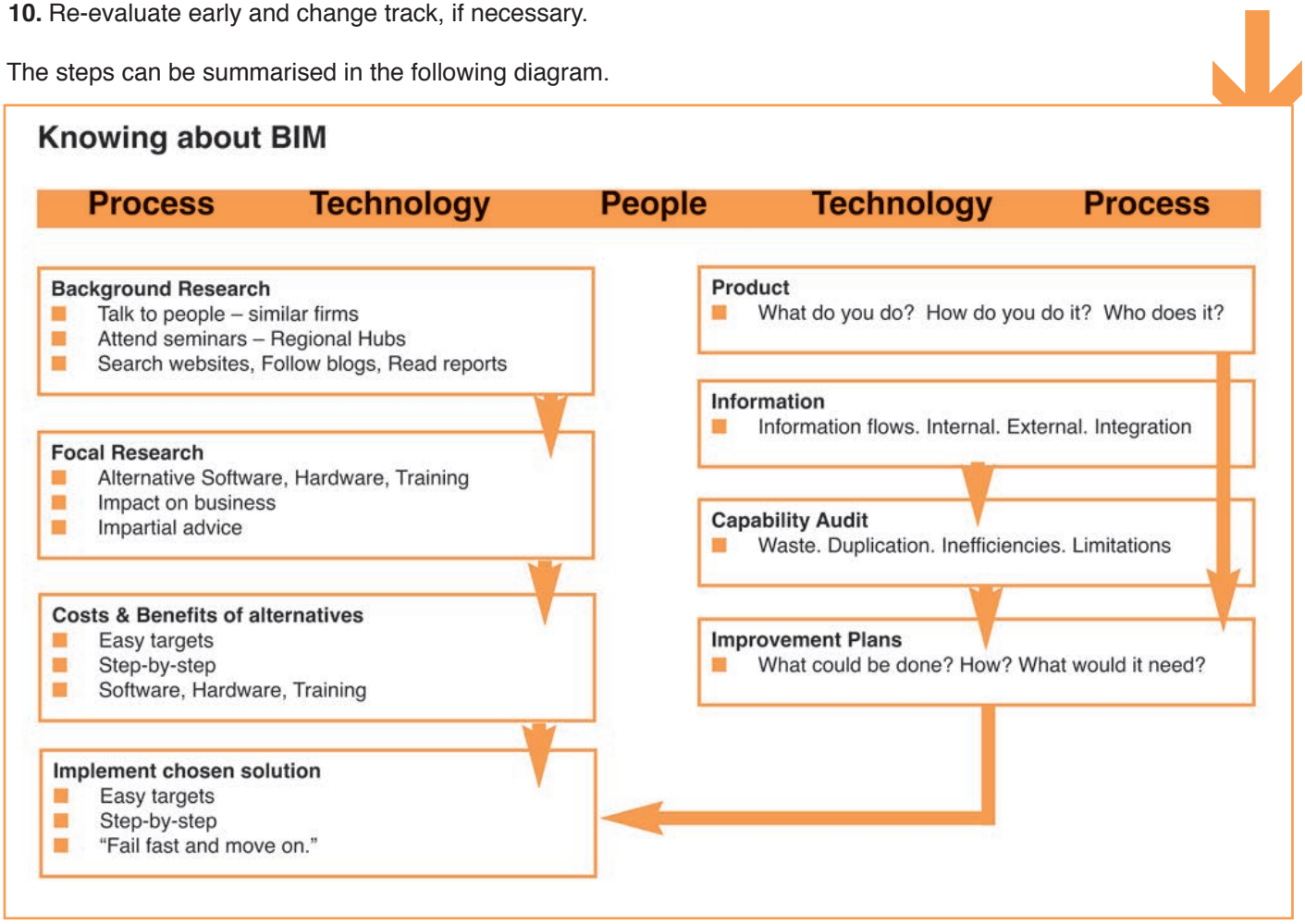
5.0 A Roadmap to BIM Competence

5.1 The basis of the decision

Starting BIM may seem a daunting prospect but the move doesn't have to occur overnight. It is an issue of change management, involving the three factors of People, Process and Technology This ideally comprises a series of small, measured steps along two lines of direction: knowing about your business, and knowing about BIM. These include

1. Knowing what you do: what you produce and how (processes and information flows)?
2. Who is best to lead this? Ideally someone with experience of both BIM and your processes.
3. What is your current performance and capacity: is there waste, could there be improvement?
4. Finding about BIM: build from little knowledge to a point when you can start to make choices.
5. Based on 1 to 4 (above) decide what you want BIM for, and why.
6. Seek out options (in the form of BIM outcomes) for what you want.
7. Be clear on what each option – software, hardware, training, cost of change ,etc.
8. Evaluate the options on the basis of their costs and benefits.
9. Implement the chosen option, starting with quick, easy wins.
10. Re-evaluate early and change track, if necessary.

The steps can be summarised in the following diagram.



Roadmap to BIM competence

5.0 A Roadmap to BIM Competence

5.2 Sources of advice

Advice can come from Government (e.g. from the *BIM Task Group* and from *Regional BIM Hubs*), independent organisations (such as BIM Academy), or early adopters. Case Studies are on the Web, and there are examples in Section 10: The Evidence for BIM. Talk to firms like yours to discover their experiences. There are a number of useful sites (see *Appendix A: Websites, Blog sites and BIM Groups*). Clearly, at some point, you will need information from someone who is trying to sell you something.

5.3 Some do's and don'ts

Do	Don't
Start now. The first step on a journey is often the hardest. But make the steps small and manageable	**Wait** till 2016 and find you've missed out on proj ects that work in BIM.
Seek out as many events as possible. Go to the ones that seem the best. Surf the Web. Discover your Regional BIM hub. Twitter#UKBIMCREW	**Assume** everything you hear is true. Lots of people profess to be ahead of the game, whereas the reality is somewhat different.
Find out what kind of BIM technology you will need. It won't always be You will most likely have all the information that is needed; all you need to understand is how to get it into the chain.	Assume that you will need expensive BIM design tools for what you do. You may just need a 'viewer', or have your products authored as BIM components; or simply provide information for a COBie spreadsheet.
Check what technology you need and what can offer it. Some BIM software is free (some is very expensive). Test this on one job before you decide to change your entire operation	**Presume** that you can buy BIM out of a box. It's not just about software.
Think about the *i* in BIM, and know the way that information travels in your firm; who drives it? where? And why?	**Ignore** the challenge. You must respond to your buyers, and to theirs. And an increasing number will want BIM.

5.4 But what if we're an SME?

OK, so you feel you've got to be more careful when you take on something new. You don't have the resources of the larger firms.

But you have one big advantage: flexibility. You can adapt quicker, and once you have your strategy you can see it through (see the quote by David Miller, opposite).

And Government is adamant that adoption of BIM by SMEs is fundamental to its Strategy and BIM objectives. The Regional BIM Hubs, the Government's BIM Task Group, and the SEC Group itself are all devoting special attention to SMEs to ensure that you don't get left out, or exploited, and that you get the opportunity to drive the industry forward through innovation.

We have come to realise that small organisations like us have got it easy when it comes to change management… So whether you approach BIM through ROI calculations or you act on instinct and experience, a small practice can simply make the decision to buy the tools and get on with it!

David Miller Architects [15]

There are possibilities for Government financial support (such as Innovation Vouchers[1]) which allow you to access expertise from expert suppliers such as universities, colleges, and technical consultancies.

For further information speak to your trade association.

BIM is scale-able! It isn't just for big projects or big firms.

[1] See http://www.innovateuk.org/content/competition/innovation-vouchers.ashx

6.0 Roles and Responsibilities in a BIM environment

As we have seen, working in a BIM environment will potentially impact all members of a project team. Traditional roles and responsibilities may remain, though inevitably there will be new ones.

6.1 Signs of change

There are already signs that BIM is causing changes in the way the construction process is thought of and carried out. RIBA, the architects' body, published a new **RIBA/CIC Plan of Work** in early 2013. One of the main reasons for changing the time-served version (with its A to L Work Stages) to a new framework that comprises seven numbered stages, was for mapping BIM processes. An earlier concession to BIM came in the form of a 'BIM overlay' to the 2007 Plan of Work, but in 2013 this was replaced by the entirely new framework [17].

There are also emerging discussions over BIM **Protocols** and standards.

The essence of Level 2 BIM (see above, p.6) is that there is some degree of collaborative design. This can be in the form of a group of 'federated models' forged into a single one by one of the project team or a fully integrated single-platform model. This is what distinguishes it from Level 1 ('lonely') BIM, where BIM users operate in isolation.

Thus, for any degree of Level 2 BIM to work it is necessary to set rules, conventions and ways of working to cope with the work of different design contributors.

These include numbering, naming, file hierarchies and formats, object libraries, layers, reading and authoring rights and change management conventions. Many of these are defined in BS 1192:2007 (Collaborative production of architectural, engineering and construction information) which has now been updated to reflect the use of BIM, and is available as PAS 1192-2:2013 [18] (see below, Section 9 for a fuller description).

Standard protocols exist[2] (initially adapted from examples for the United States [19, 20], but there are now home-grown examples) but it is normal to adapt them to the specific needs of the project.

6.2 New roles and old

In re-evaluating project roles for their revised Plan of Work (2013) (see above [17]) the RIBA list the following:

- Client Adviser
- Project Lead
- Design Lead
- Construction Lead
- Architectural Designer
- Landscape Designer
- Structural Designer
- Building Services Designer
- Cost Consultant
- Contract Administrator
- Information Manager
- Health & Safety Consultant

These are familiar and well understood, but in addition we should consider others, including the providers of software and project communications infrastructure. However, one role merits special attention; that of the Project Model Manager.

The Project Model Manager

A number of variants have been used for this role, including BIM Manager, Model Manager and Project Information Manager. Here, the title Project Model Manager has been used, to differentiate it from a firm's overall BIM Manager (who may not be project-based). The duties will normally include:

- negotiating, developing and enforcing the Project Protocol (see above);
- liaising with each contributing designer's BIM modelling team;
- coordinating BIM use on the project , including quality control, access rights and security;
- helping resolve design issues and change control procedure;
- managing and distributing digital outputs, data transmission, and archiving.

If this role is separate from that of Lead Designer or Client's Project Manager (as it well may be) it is important that their relationships are properly defined. A logical response is to give the Information Manager responsibility and authority for all BIM-related issues. It remains to be seen if the role will create a new profession, or be picked up by an existing one.

[2] Examples of standard project protocols are given in Appendix C

6.0 Roles and Responsibilities in a BIM environment

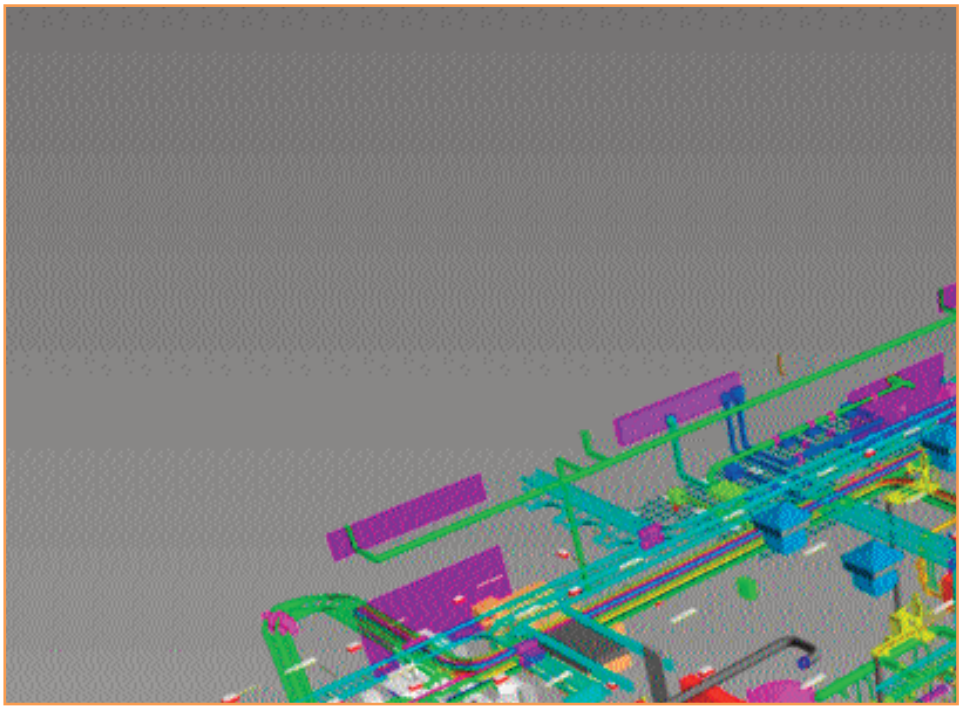
6.3 New responsibilities: whose are they?

In a fully integrated 3D BIM environment a variety of new issues arise that require responsibility allocating to a specific role or roles. These include:

- submittal processes for prior confirmation that materials and their installation matches the design intent (for design elements that require interpretation);
- process for agreeing and recording changes and design development;
- control of the nature and status of all information that is being shared;
- treatment of, and responsibility for errors. BIM will expose errors earlier;
- the coordination of all relevant information required for 'data drops' at defined stages.

The (ultimate) responsibility for allocating and paying for the assumption of these responsibilities would most likely fall to the Employer in a Client-led procurement system and the Main Contractor in the case of Design and Build.

Conversely, some of the matters above will ultimately have an impact on the way projects are procured. For example, if the point of working in an integrated BIM Environment is to maximise design certainty and minimise change, then it makes no sense to delay (in the traditional way) the appointment of those who significantly contribute to the design, such as specialist contractors.

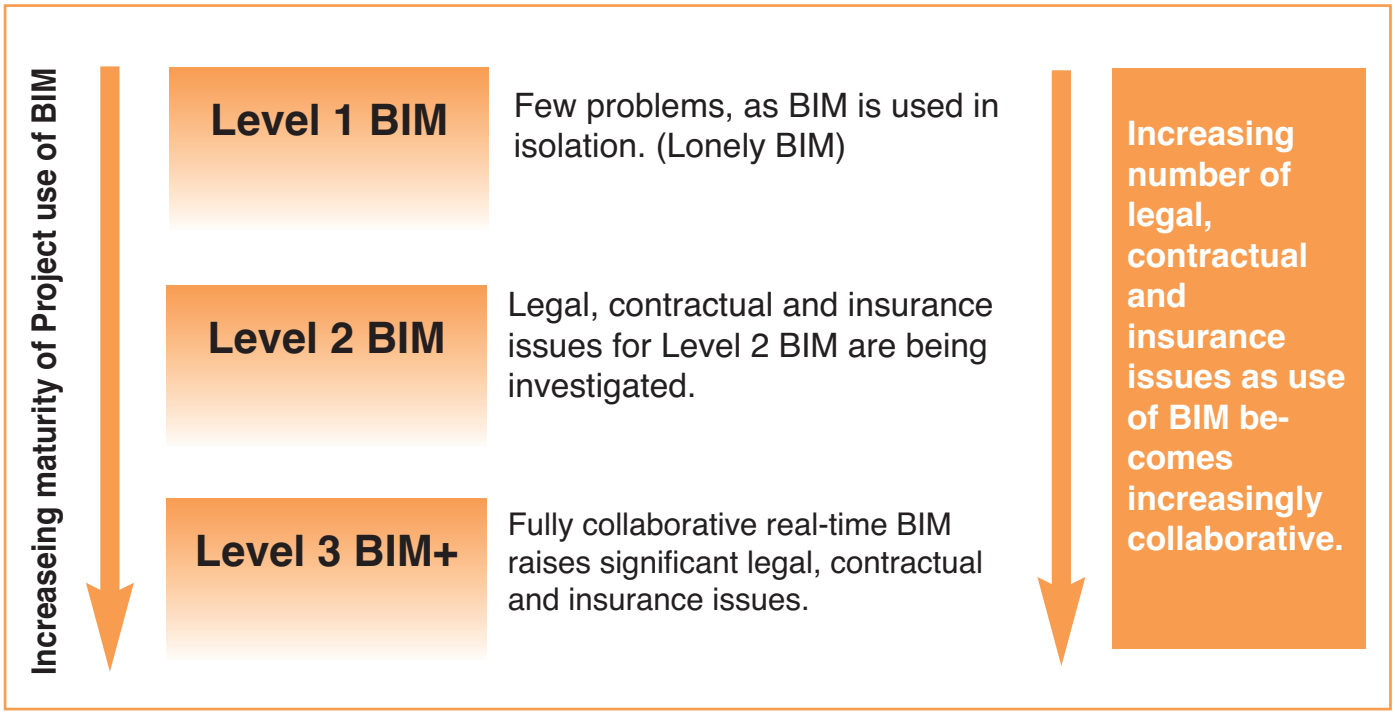


[3] Ultimately, the BIM model should minimise the need for this process, as information could be transmitted directly from design to fabrication, and then installation.

7.0 Legal and Contractual Issues

7.1 Legal and contractual issues relevant to the different maturity levels

There has been much debate over the precise legal, contractual and insurance effect of adopting BIM. The relative importance of these issues depends on the level of maturity of BIM use within a project. Relating this to the maturity diagrams in Section 2.2 (pages 6-7, above) we see that:



At Level 1 maturity there are few issues. BIM tools are used 'internally' by members of the same firm. This would not require changes to current contracts or invoke legal questions. There may be a need for dialogue with the firm's P.I. insurers.

Level 2 maturity, as has been argued, represents a range of different maturity levels within itself. It is likely that there would be an increasing number of legal, contractual and insurance issues as use of BIM becomes increasingly collaborative.

Fully collaborative real-time BIM (Level 3) raises significant legal, contractual and insurance issues.
At Level 2 and beyond there is the potential for independent firms (consultants, manufacturers, specialist contractors, and facility mangers) all working collaboratively. Current contracts in use would require amendment, or possibly replacement.

In summary the contractual / legal / insurance issues that are likely to arise[4] are:

- Ownership of IP, data and models, including confidentiality;
- Design liability for the BIM single model and resulting P.I. Insurance issues. Reliance;
- Priority of contract documents, including the relative status of the BIM Project Protocol;
- Relationship between multiple models and between the model(s) and derived information;
- Changes to participants' roles and responsibilities. Model management and access;

To help standardise contractual provisions relating to BIM the BIM Task Group in conjunction with CIC has published the BIM Protocol [21]. The Protocol should be incorporated in contracts where the parties are involved in the use, production or delivery of models.

The Employer is advised to use the Protocol in contracts with Project Team Members (these are project participants who have a direct contract with the Employer). Each Project Team Member should then

[4] For a fuller discourse on these issues, see the article by Koko Udom on the NBS website at: http://www.thenbs.com/topics/bim/articles/bimMap-pingOutTheLegalIssues.asp)

7.0 Legal and Contractual Issues

7.1 Legal and contractual issues relevant to the different maturity levels

include the Protocol in sub-contracts to enable it to discharge its obligations to the Employer. The Protocol includes the Information Requirements and a Model Production Delivery Table. The former defines matters such as the software to be used, formatting of the information, file naming and numbering and data drops that will be required. The latter defines the level of detail required of each party in respect of its input to the modelling process.

In the event of any conflict between the Protocol and contractual provisions the Protocol will apply. Sub-contractors should scrutinise carefully protocols issued alongside sub-contracts to ensure that there aren't conflicting requirements. Moreover they should compare sub-contract protocols with the standard BIM Protocol (downloadable from https://www.bimtaskgroup.org.uk) and, if possible, with the main contract protocols.

BIM working will continue to give rise to legal, contractual and insurance issues. The current section of the Guide is a very brief overview of some of the issues, and current thinking on them. They are not exhaustive. Matters such as computer failure and data security will have increased importance. This brief summary is not a substitute for legal advice on specific matters. In case of doubt, consult your advisor or contact your trade association.

"When it comes to contracts there are five key issues to address:

- What data will be created/managed in a BIM format?
- What is the scope and level of detail required in respect of your input to the modelling process?
- What rights of access do you have to data produced by others?
- What degree of reliance can you place on the data produced by others?
- What steps have you taken to preserve your intellectual property rights in the data you have provided?"

Professor Rudi Klein, Barrister
CEO, SEC Group

7.0 Legal and Contractual Issues

7.2 The Risks

However, it is within this context that you are likely to be confronted by some major challenges. Procurement and contracts continue to be structured around risk transfer. This is not going to disappear while working within a BIM-enabled project.

A key concern will be the reliance that can be placed upon the data. To be effective information-sharing requires that the party or parties should be able to place a certain level of reliance on the data received.

PAS 1192-2: 2013 states:
'The fundamental requirement for producing information through a collaborative activity is to share information early and to trust the information that is being shared as well as the originator of that information'.

Unfortunately the BIM Protocol seems to contradict this.

'Without prejudice to the Project Team's Member Obligation under this Protocol and the Agreement, the Project Team Member does not warrant, expressly or impliedly, the integrity of any electronic data delivered in accordance with this Protocol'. (clause 5.1)

Inevitably contractual restrictions will be placed on what information can be relied upon and/or for what purpose the data can be relied upon. This may also be encouraged by some PI insurers.

There may be some concern about inputting data in case it inadvertently changes the design generated by another party; in such case you run the risk of assuming design responsibility. It will be necessary to ensure that you clearly define the purpose of the data that you are inputting.

There has been a substantial amount of comment on inter-operability risks. These arise where different software platforms are used. For example one has to be careful when converting data from one software package to another. This could result in the loss of data or in the loss of the level of detail that you might have expected to receive. The data could also become corrupted so that it would be unsafe to rely upon.

It will become necessary to carefully check the compatibility of your software with that of other project participants with whom you are likely to be exchanging data.

"The Contractor uses reasonable endeavours to keep current the information in the Master Projects Database***, but the Contractor has no liability to the Subcontractor in respect of any inaccuracy, error, mis-statement contained in or any omission from the*** Master Projects Database***."***

*Extracted from a **Z clause** in an NEC Sub-Contract*

"The issue of the interoperability of various modelling software programmes meaningfully to share data is one of the greatest current challenges in the use of BIM technology".

'Contract issues in the use of Construction BIM': paper presented by Hurtado K.A and O'Connor P.J. at a Society of Construction Law Conference (October 2008)

7.0 Legal and Contractual Issues

7.2 The Risks

Equally, risks may emerge from interoperability itself, particularly in the case of a single integrated model . For example, if an architect changes areas of the model, these changes could impact upon all dependent areas, whereas currently, work is compartmentalised and changes in one area can be evaluated and costed prior to being implemented in others.

It is also true that work is still required to improve the functionality of some areas of the mainstream BIM software platforms. For example, many specialist contractors utilise bespoke and specialist software whose facilities and functionality could potentially be lost when integrated into a mainstream BIM software platform.

In some cases, the calculative capability detailed design work of available mainstream BIM systems may not yet be as sophisticated as the stand-alone software used by specialists. This is an issue that must be addressed by the providers of mainstream BIM applications.

It is vitally important that you provide the feedback to your trade association on any concerns that you have in relation to issues of risk arising from the use of BIM. If these issues have arisen on public sector projects they can be taken up with government.

8.0 Estimating and bidding with BIM

8.1 Various forms of estimating

F	**Production Information**	**F1**	Preparation of production information in sufficient detail to enable a tender or tenders to be obtained.
		F2	Preparation of further information for construction required under the building contract.
G	**Tender Documentation**	Preparation and/or collation of tender documentation in sufficient detail to enable a tender or tenders to be obtained for the project.	
H	**Tender Action**	Identification and evaluation of potential contractors and/or specialists for the project. Obtaining and appraising tenders; submission of recommendations to the client.	

BIM in use in estimating and tendering

In the Introduction to BIM (in Section 2 of this Guide) we stated that BIM involves '…the structured creation, sharing, **use and re-use of digital information**.'

In the normal project process, once the design authoring is complete, we enter the stage described in the RIBA Plan of Work [17] as 'Preconstruction', comprising Work stages F-H.

In the new 2013 RIBA Plan of work, these are now within Stages 4 (Technical design) and 5 (Specialist design).

Throughout this document, both pre- and post-2013 RIBA classifications are used: the numbered post-2013 terminology is the more current and now correct, but people will continue to be more familiar with the pre-2013 'Stages' A to L for some time.

The various forms of estimating (carried out between Work stages F-H /4-5) present a great opportunity to re-use the digital data that by then exist within the model.

Traditionally, cost estimating has taken various forms, ranging from the high level elemental approach that informs the design process (at RIBA Stages D&E); via the generation of Bills or Quantity or other bidding documents (traditionally produced by digitizing designers' drawings, or importing their CAD files) (Stage G); through to the resource-based unit rate estimating that contractors use to build the bids that are evaluated at Stage H. BIM data can be used for all of this, and for more.

8.2 Getting to bidding stage

Prequalification: Clients may now use BIM capability as a criterion for pre-qualification, and this position may also be adopted by some Main Contractors. PAS 91:2013, the publicly-available pre-qualification standard has been updated to include such questions [22] . Within this document, Table 8 (Optional Question Module O4: Building information modelling, policy and capability) 'will be used for UK Government procured projects for Departments that have commenced their implementation of the BIM Strategy and may be used by other clients adopting a similar path.' There are four questions in O4. These explore:

8.0 Estimating and bidding with BIM

8.2 Getting to bidding stage

1. The 'capability of working with a project using a "Common Data Environment" as described in PAS 1192:2:2013'. (see below, Section 9).
2. The ability to demonstrate 'documented policy, systems and procedures to achieve "Level 2 BIM" maturity as defined in the government's BIM Strategy.'
3. The capability of developing and delivering or working to a BIM Execution Plan (BEP) as described in PAS 1192:2:2013 (see below, Section 9).
4. Ability to demonstrate the existence of 'arrangements for training employees in BIM related skills' and that their capabilities are assessed.

Tender documents can be generated from BIM data in a number of ways, though experience to-date suggests a lack of quality in models received from design consultants, and require considerable skills in interpretation by the estimator. At the most basic level, tenderers can be done by just outputting a take-off from the data to a spreadsheet-based bill of quantities, which then becomes part of the tender documentation for submission by the bidder.

A more sophisticated approach might involve using an ODBC or API system (see Appendix, B) that can be used by the tenderer to export digital design data to other (costing) software.

BIM allows packages of the model data to be chosen and used selectively for bidding purposes, thus only the appropriate information can be accessed by tenderers.

Tender submission: the reverse process can be used to 'read back' tenders into versions of the model for comparison and evaluation (Stage H).

Based on the BIM model, contractors can include extras in their bids, such as visualisations and process simulations.

Tender acceptance and incorporation: there can be facilities for incorporating tender data into the BIM model; particularly important when it is necessary to integrate performance specified or Contractor Designed Portion work into the Model.

Note that this is about developing and sharing 3D data 'with others involved in a project'. There is special mention of providing 'an as-built "Data Drop" for use by the Client' based upon 'a database of object information.' However, the expected level or extent of BIM capabilities, policies, systems, etc, depends upon 'the role(s) that [the] PQQ covers'. In other words, prospective tenderers only will be expected to have capabilities appropriate to their input.. A Tier 2 specialist, for example, would not be expected to have the same BIM capabilities as an organisation operating as a Main Contractor.

'At the owner's request, the model was also passed to contractors to help with the bidding process. One contractor used the model for a walk through presentation to the client and used the data to show 4D [schedule] construction.'

'Leveraging BIM to Demonstrate Value while Saving Time and Money: Aylesbury Crown Court'. McGraw-Hill Construction SmartMarket Report (2010). Available at: www.construction.com

"You simply get better bids with BIM, as you can accurately demonstrate the complexity of projects. The scope is better defined and it gives you an accurate tonnage right from the time of bids – all at the touch of a button".

Kyle Krall of Thornton Tomasetti, at the Build Smart 2009 conference, Yas Hotel, Abu Dhabi

9.0 Contract administration and the flow of information

Traditional practices that relate to project information flow – including submittals, approvals, production of 'shop' and 'field' drawings, certification, valuation and interim payment - are prone to deficiencies that arise from incomplete, inexact, ambiguous or contradictory information.

9.1 Information flow throughout the project

A major advantage of BIM technology is the ability to re-use information, throughout the construction process, and (potentially) automatically. This could lead to greater process efficiency.

BIM enables a more efficient processing of information at all stages in the project life-cycle (as illustrated in the table opposite). The advantages of concurrent design and 3-D design outputs have already been highlighted. BIM-enabled detection of design clashes in the early stages of the project can greatly reduce the need for change orders/variations. Some of the gains from this are illustrated in the examples in Section 10, below.

Traditional	Task	BIM-enabled
Linear, sequential	Design Input	Concurrent
2-D 'dumb'	Design Outputs	3-D 'intelligent'
Slow, sequential	Design Compatibility	Instant clash detection
Slow, sequential	Regs. Compliance	Potentially automated
Separate activity	Health & Safety	Integration to H&S files
Slow, independent	Value Engineering	Instant evaluation
2-D, independent	Site and Shop Drawings	3-D, link to fabricators
Slow, sequential	Data Sheets	Automatic generation
Separate activity	Cost Estimating	Link to cost software
Separate activity	Sequence and Planning	Link to planning software
Inexact and contested	Interim payment regime	Possibility of automation
Separate activity	Cost and Resource control	Link to software
As-built & Ops. manual	Commissioning & Handover	Auto (COBie) data drops

BIM improving process efficiency

Software for the planning and sequencing of work, and project logistics such as site layout, can also benefit from integration with the BIM model, as can the projects resource and cost control procedures.

Alongside other technologies, BIM-generated information can assist in verification of on-site measurement and valuation, adding increased certainty to applications for interim payment and reducing the potential for costly related disputes.

9.2 PAS 1192-2: 2013. Specification for information management for the capital/delivery phase of construction projects using building information modelling

The production of PAS 1192-2:2013 [18] was sponsored by the Construction Industry Council (CIC). It sets out how to share information on BIM projects and has been made available to public and private sector clients for use on jobs. The standard is designed to eliminate clashes between firms using different BIM practices and software, leading to costly delays and conversion costs. Compliance with the standard will be mandatory on all public sector jobs from 2016, as part of the government's overall BIM requirement. Peter Hansford, the Government's chief construction adviser, said the standard was the 'first of its kind anywhere in the world' and would 'ensure level two BIM can be adopted successfully'.

PAS 1192-2:2013 specifies requirements for achieving building information modelling (BIM) Level 2. The requirements within this PAS build on the existing code of practice for the collaborative production of architectural, engineering and construction information, defined within BS 1192:2007.

PAS 1192-2:2013 focuses specifically on project delivery, where the majority of graphical data, non-graphical data

9.0 Contract administration and the flow of information

and documents, known collectively as the project information model (PIM), are accumulated from design and construction activities.

The intended audience for this PAS includes organizations and individuals responsible for the procurement, design, construction, delivery, operation and maintenance of buildings and infrastructure assets. Where possible, generic language has been used, but where necessary, specific definitions are included.

A partner document to PAS 1192-2, named PAS 1192-3 was published in March 2014. While P1192-2 focuses on the delivery phase of projects, this new document focuses on the operational phase of assets; being about the availability, integrity and transfer of data and information during this phase.

This section of the Guide is not intended to replace the need to carefully read and understand the content of PAS 1192-2:2013, concentrating on the parts that apply to your particular role in the project. This is particularly recommended for those just embarking on involvement in any project using BIM. This will result in knowing what the expectations will be, and a strategic approach to how they can be met, when embarking on a BIM-enabled project.

9.3 Commissioning, Handover, and Beyond update

With assets of around £337 billion (according to the Treasury's National Asset Register) the Government has a particular interest (as a Client) in what happens to projects after their handover.

Closely linked with its interest in BIM is the Government's 'Soft Landings' (GSL) project. GSL is related to work by BSRIA (http://www.bsria.co.uk) and the Usable Buildings Trust (http://www.usablebuildings.co.uk) and aims to improve the performance of built assets through more effective commissioning and handover of projects, with a 'clear, cost efficient vision and strategy for managing the facilities', with specific plans to 'meet the needs of the End Users, Building Managers, Facilities Managers and Occupiers' [25].

The whole supply chain can play its part by embedding appropriate data via BIM, into their products, which in turn can be incorporated into BMS and FM systems. The link to BIM is through the important concept called 'COBie'. The next Section explains what COBie is, and why it is becoming so important.

9.4 COBie and 'Data Drops'

COBie stands for Construction Operations Building Information Exchange. The concept was developed by the US Corps of Engineers, but a more appropriate version (COBie UK 2012) has now been designed for use in the UK and published by the BIM Task Group (see http://www.bimtaskgroup.org/cobie-uk-2012/).

COBie is basically a data schema typically presented in the form of a spreadsheet. As such, users and producers of COBie data will be able to create and/or access COBie files with little or no software investment cost, and the format permits open access to and exchange of the relevant data.

COBie provides a "one-stop shop" for all the data relating to the asset. The main recipient of this data exchange via COBie is the client (e.g. the government). There are a predefined number of exchanges (data drops) that are required during the construction phase (and beyond, in the case of Number 5). These are set out in a new digital Plan of Work (dPoW).
There are five main exchange points are defined as:

1. Requirements and Constraints
2. Outline Solution
3. Construction Information
4. Operations and Maintenance
5. Post-occupancy Validation Information and on-going Operations and Maintenance

9.0 Contract administration and the flow of information

Basically, it serves as a standardised index and 'viewer' of all data held about the spatial and physical aspects of the facility. Project data are classified spatially (into Facility - Floor – Space – Zone) and then physically (into Type – Component – System – Assembly – Connection). The information entered into a COBie file should come from either the traditional handover information required for projects (such as as-built drawings, CDM files, Operating and maintenance manuals) or equivalent data from the project BIM model or models. The advantage of the latter is that the transfer is potentially automatic, accurate, and virtually costless, though challenges remain in extracting COBie data from BIM models. It is the intention that the COBie data file 'grows' as the project progresses, with the series of increasingly comprehensive and accurate data drops at the predefined stages of the project, as listed above.

After its completion, the COBie data file can be retained in its original (spreadsheet) form, or imported into a database, or FM software. It is intended that each project should have its own COBie UK 2012 file; where there are multiple buildings in a given project, each should have its own worksheet within the file.

An example specification for the delivery of COBie files may be found on the BIM Task Group Website. COBie is important because it represents the basic minimum compliance with the Government's 2016 mandate (see above, Section 2.2, p.6.)

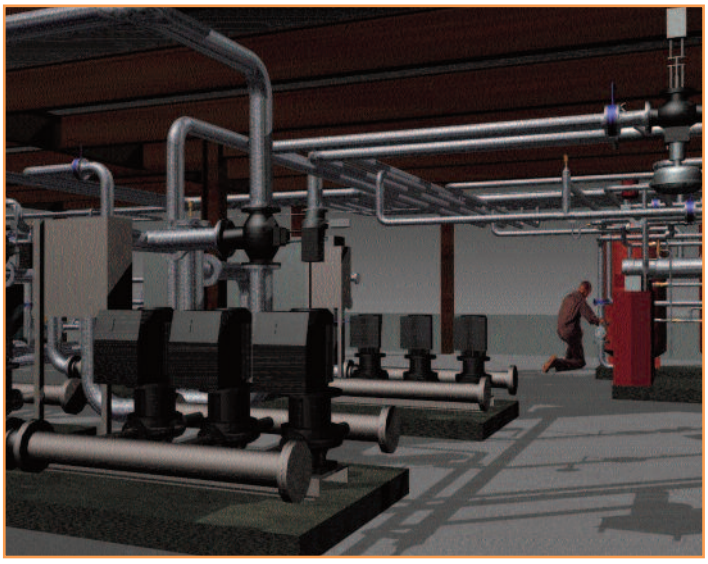
PAS 1192-4 fufilling employment information exchange requirements using COBie will be published shortly following public consultation.

The Technology Strategy Board (TSB) is currently running a competition to develop a free-to-use digital BIM tool that can capture, validate and store information based on the PAS 1192 standards.

This will incorporate a digital plan of works (DPOW) and a classification system.

"In order to improve the measurement and management of public assets, it is recommended that … specific information be delivered by the supply chain. The specified information set, called COBie, delivers consistent and structured asset information … to the owner-operator for post-occupancy decision-making."

Appendix 10 on page 59 of the **Strategy Paper for the Government Construction Client Group**. (March 2011)



10.0 The Evidence for BIM:

10.1 Project Cases

There are an increasing number of examples of businesses that have adopted and integrated BIM methods of working, and projects that have reaped its benefits. Here is a selection. The list is growing and the evidence is becoming more quantified.

'Avanti' Projects

Set up in 2002 by the Department of Trade and Industry in 2002 to promote ICT-enabled collaborative working. Avanti is an approach, rather than a particular project. There are a number of case studies available, in which were found significant savings achieved by using BIM techniques.
http://www.constructingexcellence.org.uk/ceavanti/

PalaceXchange (Avanti)

The PalaceXchange £30M retail development reported savings of up to 50% + in exchange of information and documentation and improved spatial co-ordination and cost certainty.
http://www.constructingexcellence.org.uk/ceavanti/

St Helens and Knowsley Hospitals (Avanti)
The St Helens and Knowsley (£350 million) PFI project reported:

- the issuing of information was up to 85% quicker
- a saving of 25% + in administering the document control process
- a saving of 75% + in design coordination

http://www.constructingexcellence.org.uk/ceavanti/

Endeavour House, Stansted

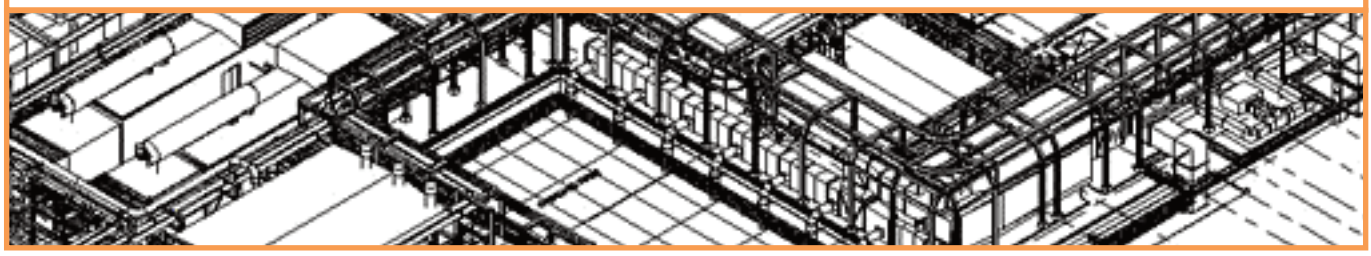
UK headquarters for KLM, commissioned by BAA Lynton. Individual 3D models (architecture, structural and building services) and then combined into a fully co-ordinated 3D project model, used for spatial co-ordination and clash detection. Audited project cost savings of 9.8% overall, with 18% cost savings in drawing production
http://www.buildingsmart.org.uk/

Festival Place, Basingstoke

£110 million redevelopment of retail centre. A 3D model of the development was used for spatial co-ordination and clash detection as well in the construction programme. Marketing benefits (e.g. enabling virtual walkthroughs) and estimated 9%construction cost savings.
http://www.buildingsmart.org.uk/

Barts and Royal London Hospitals redevelopment

A £1 billion, 10-year programme, with planned completion in 2016). BIM used for design co-ordination and managing fit-out. Field use of tablet PCs allows access to BIM models by construction staff.
Savings in the process of quantification but indicated ROI of 2:1.
http://www.buildingsmart.org.uk/



10.0 The Evidence for BIM:

10.2 Business Cases

Irrespective of whether BIM is used on a particular project, the use of BIM as an internal resource in the business is likely to bring about greater cost savings.

Ryder Architecture

The practice has four UK locations and works principally in the education, healthcare, residential and commercial sectors with project values typically £1 -150M. Started trialling BIM in 2003, and in 2007 made the decision to use BIM software for all design work carried out by its 120-staff. Ryder is now totally committed to the use of BIM tools for use in Concept design; Concept massing; Green Guide rating; Environmental, Daylight, Energy, and Sun path and shading analysis, Pedestrian modelling, 4D modelling, Design audit and Visualisation. In 2011, Ryder joined with the University of Northumbria to form BIM Academy.
http://www.thenbs.com/topics/bim/articles/RyderArchitectureAndBIM.asp

David Miller Architects

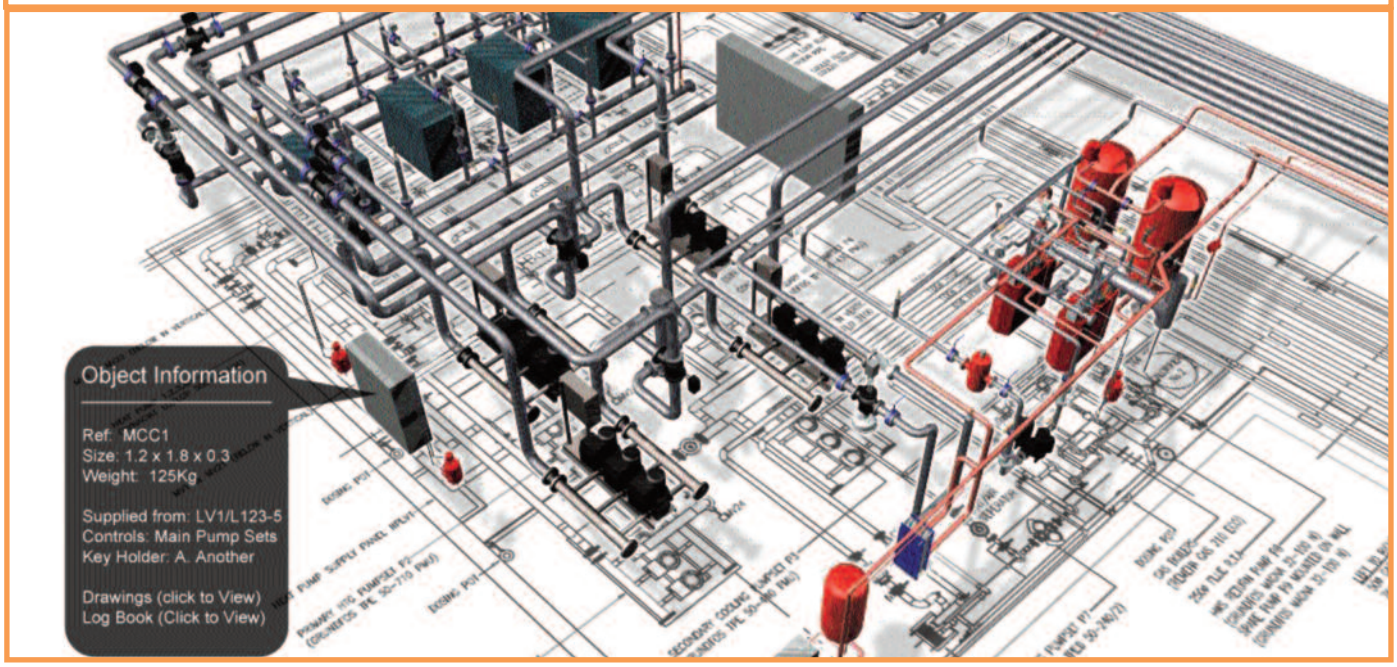
DMA started with BIM in 2007 and fully committed in 2009. Since then. BIM has had a contributed to the 250% growth of the practice over 3 years, the trebling of fee income and the increased capacity to deal with larger projects.
http://www.thenbs.com/topics/bim/articles/bimsmallpractice.asp

Tocci Building Companies (USA)

Tocci is on the cutting edge of VDC [virtual design & construction] and BIM implementation. In using BIM throughout its projects, Tocci has reported:

- The virtual elimination of design coordination errors
- Direct fabrication from BIM : 0 errors, 12-16 week savings
- Increased investor confidence
- Verified Return on Investment (ROI) range = 3:1 to 12:1
- 70% claim reduction
- Reduced insurance premiums

http://www.tocci.com/



11.0 The potential of BIM: what can it do?

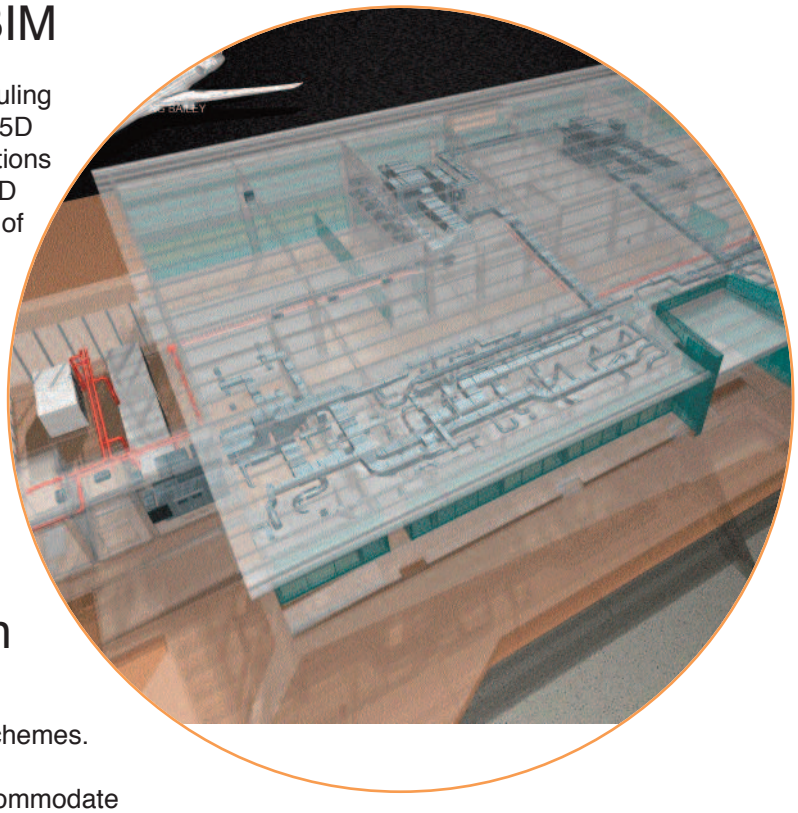
Section 2.2 (p.7) described how Level 3 BIM could work as a single real-time design model in which the different design disciplines interact to input and access information collaboratively. Software interoperability, IT infrastructure, and contractual and legal issues will have been solved and there will be seamless working with the latest software simulation tools that inform the decision-making processes. There will 'standard libraries' of common intelligent objects that contain manufacturers' data and geometry. The resulting model will be shared with the major players in the project supply chain.

All this is in the future. But there are currently other existing opportunities that we have not yet discussed.

11.1 4D, 5D and 6D BIM

BIM users refer to 4D BIM (that is, with Time scheduling added as a dimension to the 3D project model) and 5D (where Cost is considered). Already, many organisations are equipping their models with these capabilities. 4D BIM can be used to produce informative animations of the build process.

6D BIM considers the aspect of Life Cycle Costs, to enable the Facilities Management of the asset. This 6D model could potentially be delivered in the form of an 'As-Built' BIM model at handover, and may be populated with appropriate component and product information, operation manuals, warranty data, and so on, all of which would be supported by the COBie information discussed above (at p.21).



11.2 WLC and Carbon

Both Whole-Life-Cycle (WLC) and carbon costs are increasingly important aspects, particularly of PFI schemes.

The object modelled data in the BIM model can accommodate information such as embodied carbon, including that created by the process of construction, to facilitate optimal modelling and its possible use as a bid selection criterion.

An example is the recently-developed iCIM modelling software, with which data can be uploaded and exchanged using interoperable IFCs, and the impact of design development decisions on embodied carbon can be tracked.

(See http://bim.northumbria.ac.uk/iCimWebApppro/)

We hope that you find this guide useful. Let us know if you do!

Please email comments or your BIM experiences to contact@secgroup.org.uk

Appendix A: Websites, Blog sites and BIM Groups

The following is a selection of useful sites for up-to-date information and discussion.

AISFPDC	http://aispdc.org/bim4fitout
BIM Academy	http://bimacademy.ac.uk
BIM Manager	http://www.bimmanager.com/
BIM4SME	http://www.bim4sme.org
BIM1M (video resource)	http://www.bim1m.com
BIM Technologies	http://www.bimtechnologies.co.uk/news
BSRIA	http://www.bsria.co.uk/
BuildingSMART:	http://www.buildingsmart.org.uk/
CIBSE, BSRIA, Landscape Institute and Institute of Structural Engineers	http://www.bimcrunch.com
CIC Regional BIM Hubs	http://www.cic.org.uk/aBIMfocus/
CITA BIM Group (Linkedin)	http://www.linkedin.com/groups/CITA-BIM-Group-3238552/about
Constructing Excellence	http://www.constructingexcellence.org.uk/
Construction Industry Council	http://www.cic.org.uk/home/index.shtml
Government BIM Task Group	http://www.bimtaskgroup.org
Graphisoft	http://www.graphisoft.com/openbim/bim/
McGraw-Hill Construction	http://www.bim.construction.com/bdc/news_and_topics/
NBS Resources	http://www.thenbs.com/topics/BIM/index.asp
NSCC	http://www.nscc.org.uk/
SEC Group	http://www.secgroup.org.uk
The case for BIM	http://www.caseyrutland.com
UK Government Construction Strategy	https://www.gov.uk/government/publications/government-construction-strategy

Appendix B: List of common abbreviations

3D	Three-dimensional (e.g. Three dimensional modelling)
4D	Four-dimensional modelling (i.e. including time schedule data)
5D	Five-dimensional modelling (i.e. including time and cost data)
nD	Use of further 'dimensions' to represent, for example: carbon, energy…
AIA	American Institute of Architects
API	Application Programming Interface (API) offers a direct link between the BIM model and other industry software (e.g. costing)
BIM	Building Information Modelling
BIMM	Building Information Modelling and Management
BMS	Building Management System
BSRIA	The Building Services Research and Information Association
CAD	Computer Aided Design.
CDE	Common Data Environment
COBie	Construction Operations Building Information Exchange
iBIM	Integrated Building Information Modelling
IDM	Information Delivery Manual
IFC	Industry Foundation Class.
IFD	International Framework Dictionary
IPD	Integrated Project Delivery
ISO	International Standards Organisation
LOD	Level of Detail (or Development)
NBS	National Building Specification
ODBC	Open Database Connectivity. A 'middleware' system for translating from databases to other software
RIBA	Royal Institute of British Architects
XML	Extensible Mark-up Language (XML): a free open standard creating custom mark-up languages, allowing users to share structured data via the Internet.
WLC	Whole-life cost. The cost of a building, assembly, etc. throughout its life.

Appendix C: Jargon Buster

Combined Model	A BIM Level 2 model consisting of linked (federated) individual models and other information.
Component	An individual element that can be reused in a number of situation (e.g. doors, stairs, columns, walls) by insertion into the model.
COBie (Construction Operations Building Information Exchange)	COBie a spreadsheet system that permits open access to and exchange building management data. See p.21, above.
IFC (Industry Foundation Class)	An open data exchange specification that facilitates interoperability between software applications.
Interoperability	The ability to communicate electronic between organisations, their business processes and the software applications they use.
Level of Development (LoD)	Levels of Development. E.g. in the American Institute of Architects E202 Protocol: LoD 100 is concept design LoD 200 is schematic design or design development LoD 300 is construction documents & shop drawings LoD 400 is for fabrication and assembly. LoD 500 is 'as-built'.
Parametric modelling	Design using rule-based relationships between intelligent objects that enable related properties to be updated when one property changes.
Permitted User	User who is permitted access to a Model at a particular Level of Development as specified in the Project BIM Protocol
Project Execution Plan	The Project Execution Plan is designed maps a structured, consistent process for the project's lifecycle with common terminology for job titles, descriptions, responsibilities, and processes.
Regional BIM Hub	Construction Industry Council (CIC) launched 11 Regional BIM Hubs in October 2012. They offer free, impartial advice on Government's BIM mandate and signpost specific expert advice. See: http://www.bimtaskgroup.org/bim-regional-hubs/.
Soft Landings	A building handover protocol that helps client / users 'get the best out of their buildings'. It encourages the greater involvement of designers and constructors with building users and operators before, during and after handover.

Appendix D: References

We hope that you find this guide useful. Let us know if you do!
Please email comments or your BIM experiences to contact@secgroup.org.uk

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Members of the Specialist Engineering Contractors' (SEC) Group


Members of the National Specialist Contractors' Council (NSCC)

Association of Concrete Industrial Flooring Contractors


Association of Ductwork Contractors & Allied Services

Association of Interior Specialists


Association of Sealant Applicators Ltd

Association for Specialist Fire Protection

Association of Specialist Underpinning Contractors plus

Association of Technical Lightning & Access Specialists

British Blind and Shutter Association

British Drilling Association

British Geomembrane Association

British Woodworking Federation

Confederation of Construction Specialists

Catering Equipment Distributors Association

Contract Flooring Association

CONSTRUCT Concrete Structures Group

Concrete Repair Association

Door & Hardware Federation

Drilling and Sawing Association

Resin Flooring Association

Federation of Piling Specialists

Glass and Glazing Federation

Insulated Render & Cladding Association

The National Federation of Roofing Contractors Ltd

Painting and Decorating Association

Rural & Industrial Design & Building Association

Road Safety Markings Association

Specialist Access Engineering and Maintenance Association

Single Ply Roofing Association

The Tile Association

This guide also supported by this Association