BIM FOR CONSTRUCTION HEALTH AND SAFETY

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Published by NBS

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Note from the Association for Project Safety

The Association for Project Safety welcomes the publication of this guide outlining the need for the integration of health and safety into the BIM process, and the ways in which both design and construction risk management can be embedded into BIM projects. The synergies between the management of Building Information Modelling and health and safety risk management are clearly set out by the authors, as is the requirement to accept both as fundamental cornerstones of good construction project management and the operation and maintenance of buildings.

Note from Health and Safety Executive

HSE is pleased to acknowledge BIM for Construction Health and Safety. This book is aimed at people working within the construction industry who need to understand how Building Information Modelling and health and safety management fit together. The authors explore how the potential of BIM can be exploited to reduce health and safety risks.

It is recognised that this guidance contains some advice that may go further than the minimum needed to comply with health and safety law. However, it also contains well-explained, practical examples, that will be informative to clients, contractors, designers and health and safety professionals alike. I commend BIM for Construction Health and Safety to you.

Heather Bryant
HSE Chief Inspector of Construction

Foreword

Tiny differences in input can result in overwhelming differences in outcome; this is especially true of health and safety. As we stand at the verge of a new digital era we must aspire to make better and safer decisions through innovative and collaborative working enabled by Building Information Modelling.

Despite being a technology intervention, BIM is still about culture, people and process – essentially bringing teams together to rehearse and optimise activities at all stages of the asset life cycle, from safer logistics to altruistic maintenance solutions.

BIM can help explain complex health and safety information for varied audiences, and provide clarity for all players involved in improving communication and enhancing standards. The model environment becomes a backdrop for a zero-harm culture.

Professor David Philp
MSc, BSc, FRICS, FCIOB, FGBC

Head of BIM Implementation, Cabinet Office

Preface

Too many people are killed and injured in our industry each year, despite the best efforts of all parties concerned. Although it is not new, Building Information Modelling (BIM) has seen a huge upsurge in interest in recent years. This is partly as a result of government support, but mainly due to great leaps in technology. Although perceived as a daunting topic, its basic principle is simple. BIM is about gathering, using, interpreting and transmitting information. Information about design, production and programming. Information that can be passed on to others, and used for operation and maintenance or for costing purposes.

Is it such a departure, therefore, to consider how health and safety information might be included in a Building information model? Is this not a massive opportunity for those of us working in construction to embrace this technology and its development, together with the increased efficiency and discipline that it brings? The commercial advantages are fairly obvious, but the potential benefits in improved health and safety, by reducing accidents and deaths, are so great as to be almost unquantifiable.

This book looks at how these benefits can be brought about. We are not suggesting that it will be easy, but we believe that the incorporation of health and safety into BIM is neither the exclusive preserve of the 'technology' generation, nor something which is beyond us as health and safety professionals. It is, as popular parlance would have it, a 'no-brainer'.

Stefan Mordue and Roland Finch
January 2014

Notes

For ease of use, we propose to use the acronym HSA, meaning Health and Safety Advisor, throughout. This is the term adopted in the RIBA Plan of Work 2013. We have also included a glossary of terms in an attempt to help the reader navigate through other topic-specific phrases and acronyms. All such terms will be highlighted in bold upon first appearance in the text.

Meanwhile, any reference to technologies in order to reinforce or highlight a point will be made, as far as possible, in a vendor-neutral way.

Acknowledgements

The idea for this book first came about when Stefan met with Keith Wilson, Director of Technical Information at the NBS, in a coffee shop in Newcastle upon Tyne one Friday afternoon. Not only did Keith provide encouragement to pursue the project; more importantly, he lent the support and belief needed to actually achieve it. Stefan approached Roland about co-authoring with the idea that 'two heads are better than one', and that looking at the topic from different angles would result in a better appreciation of the subject.

For help with providing case-study material and images, we are grateful to Acua Limited, ARUP, Balfour Beatty Construction, the CIC BIM 2050 Group, Costain, Crossrail, Eurobuild, MGF Ltd, My Zone, the NBS, the New York City Department of Buildings, Nunelah Design Consultants, Scott Brownrigg, Solibri UK Ltd, Turner Construction Company and United Utilities.

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We would also like to thank James Hutchinson, Michèle Woodger and Sarah Busby of RIBA Publishing, who made sure the book came in on time.

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Stefan and Roland

Dedication

To Isabelle and Rosa.

Dream big, work hard and the rest will fall into place.

Contents

01. **Introduction**

Models are not new. Over the centuries, many landmark buildings would not have existed were it not for the use of models. If you care to visit, you can see Sir Christopher Wren's 'Great Model' of St Paul's Cathedral, now in the cathedral's Trophy Room. It contains geometric information about the proposed construction, and is therefore an early **Building Information Model (BIM)**.

Wren's model took about ten months to design, between 1672 and 1673, and another two years to build. Crucially, however, it does not correspond with the finished building, so while it provides us with a fascinating insight into the ideas of the designer, it could only partially be used as an aid to construction, and since it is not an as-built record, it is practically useless in the post-construction phase. This is where the modern building information model comes into its own.

There are no accounts of injuries or fatalities during the construction of St Paul's, but historically, the record is not good. The design team for the Empire State Building reputedly included an allowance – one death per floor – in their calculations for the project. In the event, only seven people lost their lives, which at the time was seen as a positive outcome. Specification is not new either. Nor is a requirement for health and safety. The ancient Babylonian law, the Code of Hammurabi, dating from around 1750 BC, contains the following general rule: *'If a builder has built a house for a man, and has not made his work sound, and the house he built has fallen, and caused the death of its owner, that builder shall be put to death'*.[1] Similarly, the Old Testament of the Bible states: *'When you build a new house, make a parapet around your roof so that you may not bring the guilt of bloodshed on your house if someone falls from the roof'*.[2]

But is it possible to use models to improve health and safety? And if so, how?

Chapter overview

The aim of this guide is to introduce the concept of BIM from the construction health and safety advisor's viewpoint. In a construction context, this role is often associated with the implementation of the Construction (Design and Management) Regulations (CDM Regulations) or, more generally, with the application of risk management techniques to the building process. However, there is potential and opportunity for the use of BIM technology well beyond these fields, as BIM applications may be used in all areas of workplace health and safety.

This guide is not exclusive to the health and safety advisor's role (HSA), and is applicable to all core project roles working in a collaborative environment, such as designers, clients and contractors. It is relevant to practitioners and students alike.

We explore the idea that BIM is about a combination of processes, people and information – a means to effect collaboration and sharing of data among the project team – supported by information technology. BIM is of the utmost relevance to the HSA role, which is increasingly utilising shared and structured information in a variety of electronic formats.

This chapter covers the following:

- The scope of this guide
- BIM concepts
- BIM in the design process
- BIM in the Government Construction Strategy
- BIM for health and safety
- Government policy on health and safety regulation
- Who benefits from the introduction of health and safety information in BIM?
- Is BIM applicable to simple projects?

The scope of this guide

This guide looks at the various stakeholders, and their roles in construction health and safety, and BIM, with the focus on activities rather than specific job titles or membership of professional bodies.

Chapter 2 investigates the many opportunities for the HSA in the BIM world. Chapter 3 discusses the uses of health and safety information in the **BIM environment**, while chapters 4 and 5 consider the movement of data to and from

the model, identifying the processes, and how, what and when information is transferred. These chapters discuss how the HSA can add to, view and access information from the model, in addition to the reporting and feedback of information.

The guide introduces the idea, highly relevant to HSAs, that just as their role is not confined to CDM but relates to the much wider health and safety aspects of a project, so BIM is not just about data collection but also change management and quality assurance.

This guide is also of interest to other members of the project team – designers, contractors, consultants, subcontractors and suppliers – who have much to gain from utilising the benefits BIM brings in producing safer projects.

Understanding the context

A number of recent trends demonstrate the changing landscape we are working in and place BIM in context for the HSA:

We have already seen a digital switchover happening in many other industries. We only have to think of vinyl records, tapes and CDs being replaced by MP3 digital downloads; videos and DVDs being replaced by streaming from the internet; and books being replaced by the E-reader. In many cases, digital sales are outstripping those of traditional media. Although there will always be some who remain steadfastly nostalgic for the past, we are clearly moving from a mind-set of 'owning' a physical copy of the data to an era where simply owning 'access' to data, information and services will become the norm.

- Communication and interaction via social networks and websites is on the increase. This will facilitate collaboration, online communities, and the use of multimedia applications for disseminating information and training.
- Design and construction is delivered in a variety of models, with information increasingly stored online and accessed remotely by the principal contributors and participants.
- The focus of learning and design has a greater emphasis than before on outcomes, competencies and measurable objectives, with object modelling and simulation a key part of this strategy.
- Information is becoming more personalised. As the particular needs and requirements of each party in the production supply chain are identified based on data and activity logging, that party will be able to filter the outputs so that information which is not relevant to them is discarded.

- As technologies and software develop and mature, there will be less of a reliance upon proprietary file formats, and an adoption of open-source formats. Well-managed construction data, shared across disciplines and running through the building life cycle, offers clear efficiencies and huge potential value to the client in both construction and maintenance. It important that the information is not held only in one piece of software or is held in a format that could face eventual depreciation.[3]
- The term **'big data'** is a buzzword, which refers to data that is so large and complex that it needs to be handled by machines rather than humans. The production of data is increasing year on year. According to research by business solutions provider CSC, data production will be 44 times greater in 2020 than it was in 2009, and it is predicted that one third of all data will 'live in' or utilise Cloud technology. It is now cheaper than ever to processes and store data. However, the real advantage is in increased capacities to analyse it.

So, we are now moving from analogue to digital technologies and data is increasingly generated in structured spreadsheets. We need to adopt strategies and develop classification, filing and storage systems to harness this new world of big data, in order to access, retrieve and reuse it. This will allow us to realise the potential of BIM, in particular for health and safety purposes. The coordination process is still largely the same as it was, but new techniques, process and procedures will make it far more accessible.

What questions should we be asking?

In order to get the best from BIM for health and safety coordination, some important general questions need to be answered, including:

- What information can be gathered?
- How can it be translated into something useful, which adds value to the health and safety arena?
- What new techniques and processes will need to be adopted?
- What new skills are required?
- Can health and safety information be embedded into BIM - related information, such as in a **COBie (Construction Operations Building information exchange)** file?
- Does the same apply to pre-construction information – the Construction Stage Health and Safety Plan, or the Health and Safety File?
- What practical applications can be developed at each stage of the construction process to improve it, and how do the users of this information become part of the process and interact with the rest of the design team?

One fundamental question that follows all the others is: What new opportunities does this present for HSAs – and others who are involved in the design team from a health and safety perspective?

BIM concepts

BIM is not a software package. It is an approach, which requires people to work within a process and share information – often using software. Its successful implementation relies on three main activities:

- Generating information
- Maintaining the information
- Using the information

Throughout a project, information is generated, checked and used at several key stages.

- Initially, a client brief is generated.
- At concept design stage, the design is checked against the brief and then developed.
- At tender stage, drawings, specifications and bills of quantities are issued.
- During construction stage, checks are made of the installation against the agreed contract requirements.
- At completion, details of the installation are handed to the project owner and user in the form of operation and maintenance manuals (O&M manuals).

In the world of BIM, these critical information-generation points are referred to as '**data drops**'. The level of detail produced at each drop must be relevant to the stage of project development.

In early forms of computer modelling, the data included in the model mainly comprised graphical representations of the kind previously found on drawings, with possibly the addition of materials-and-workmanship specifications. Some models were also adapted to include factors like labour and material resources, which allowed quantity surveyors to extract schedules of quantities, and calculate estimates of cost.

Contemporary models developed for BIM contain much more than geometric information. BIM has been described by the UK **National Building Specification (NBS)** as *'A rich information model, consisting of potentially multiple data sources, elements of which can be shared across all stakeholders and be maintained across*

the life of a building from inception to recycling'.[4] Health and safety information falls squarely into this category, and the technology now available presents many opportunities for the development of practical applications for this information.

In traditional documentation we would *say it once, and in the right place*; however, that still means it has to be located in a particular document and located by cross-reference. With BIM, the mantra is *describe it once, and in the right place, to be able to use and update it many times*. This move away from documents to data allows us to reassess past processes and begin to apply more rigorous checks to what we do (see Chapter 4).

BIM in the design process

Let us now turn to the design process, where we have seen the demise of the drawing board, giving way to the computer and the graphics tablet. Today, buildings are being modelled rather than drawn; the implications of this development are profound, and will result in considerable changes in our approach. Traditionally, 2D drawings were produced and viewed together to imply a 3D representation. Now, 2D drawings are an 'output' of a **3D model**, relatively easily generated using computer graphics. However, unlike 3D CAD (computer-aided design), which results in a model confined to a single discipline without the integration of other disciplines' models, BIM requires a much more collaborative approach.

Every member of the project team makes a contribution. The architect considers the appearance of the building, while the services and structural engineers consider their own specialist areas, but invariably they do it in isolation because that fulfils their own particular needs. Strictly speaking, each therefore represents only a partial model, and there is a need for all of these parts to be combined into a single '**federated model**' that contains all the information needed to fully describe the building at each stage during its life cycle. Unfortunately, this has historically been restricted, due to limitations in technology, disagreements as to who provides and coordinates the data, and a number of potential contractual issues. However, *Building Information Management: a standard framework and guide to BS 1192*[5] sets out a framework for achieving the collaboration required. This publication is the result of a government-sponsored project to test the method in the **CPIC** publication *Project Information*.[6]

With fully federated BIM, design and construction documents can be produced more quickly, and more effective design decisions can be made at an earlier point in the design process, because of the automation and utilisation of data

from the original source. This means that we have greater opportunities for coordination, collaboration and production efficiencies, which, for example, can limit the necessity for redesign.

Increasingly, the construction industry is realising the benefits of BIM, with figures from the NBS National BIM Survey[7] suggesting that in 2012, 94 per cent of respondents were using some form of BIM compared with 57 per cent in 2010.

As we will see in the next section, the UK government believes that by developing these standards and associated technologies, and applying them to the construction industry, significant savings in time and money may be achieved.

BIM in the Government Construction Strategy

The Government Construction Strategy[8] contained almost 50 strategy objectives aimed at reducing the costs of government construction projects by 15–20 per cent.

Among these objectives were governance and client skills, value for money and cost benchmarking, efficiency and waste elimination, reduction of duplication, new procurement models and Building Information Modelling.

The extent of the projected saving is based on research recorded and published over many years in the UK. Research was first carried out by the UK Building Research Establishment (BRE) in the 1970s and 1980s, and was reinforced following the publication of reports on the state of the UK construction industry by Sir John Egan and Sir Michael Latham, among others, during the 1990s. It also led at that time, to the establishment of the **Construction Project Information Committee (CPIC)**.

The **BIM maturity model** devised by Mark Bew and Mervyn Richards provides a way in which the construction supply chain can clearly identify and help the client to understand what BIM means on a project. It offers levels of definition from 0 to 3, which categorise types of technical and collaborative working. The 2011 strategy document announced the government's intention to require 'fully collaborative 3D BIM' (with all project and asset information, documentation and data being electronic) on all central government department projects as a minimum standard by 2016. This corresponds with Level 2 of the maturity model.

As part of this strategy, the **BIM Task Group** – comprising experts from industry, the government, the public sector, institutes and academia – was set up to support and help deliver these objectives.

A number of trial projects were established to test the new approaches. Although the strategy does not focus in any detail on health and safety or integrated supply chains, it is clear that there are many potential benefits to both areas by adopting its 'joined-up' approach.

The BIM Task Group has published its initial BIM Learning Outcomes Framework to provide early information for employers developing their BIM training programmes, and to guide institutions, training providers and educators that are developing and delivering training courses to employees in the sector. Central to these programmes and courses is a requirement to establish and maintain systems for managing site health, safety and welfare.

The Construction Industry Council (CIC), in partnership with the BIM Task Group, has also established a network of **regional BIM hubs**. These centres are intended to spread knowledge and best practice, as well as becoming a focus for activity from the regions and allowing for a local feedback mechanism to the government BIM Task Group at grassroots level.

Beyond this, Level 3 BIM requires 'fully integrated' models, wherein data should be fully interpreted and interoperable, enabled by web services and compliant with **Industry Foundation Class (IFC)** standards. At this level, BIM will incorporate integrated construction sequencing, cost and project-management tools. Add to this health and safety management tools, and it is easy to see how there are huge opportunities and benefits to be realised. Some commentators have predicted a long and bumpy road towards Level 3 (fully integrated) BIM. There are, indeed, a number of challenges along the way, but with the technology we already have the goal is tantalisingly close, and the potential rewards surely make the effort worthwhile. To make it work, however, the business case must be made. The UK government is convinced and is taking the lead, along with a growing number of major clients.

We hope to offer reassurance that although it may initially seem daunting, much of the subject matter revolves around information that participants in the construction industry already deal with . The critical factor is that, under BIM, it will be handled, transmitted and presented in a different way.